REPUBLIC OF DJIBOUTI
MINISTRY OF AGRICULTURE, WATER,
FISHERIES, LIVESTOCK AND MARINE RESOURCES

THE REPUBLIC OF DJIBOUTI

THE MASTER PLAN STUDY FOR SUSTAINABLE IRRIGATION AND FARMING IN SOUTHERN DJIBOUTI

FINAL REPORT

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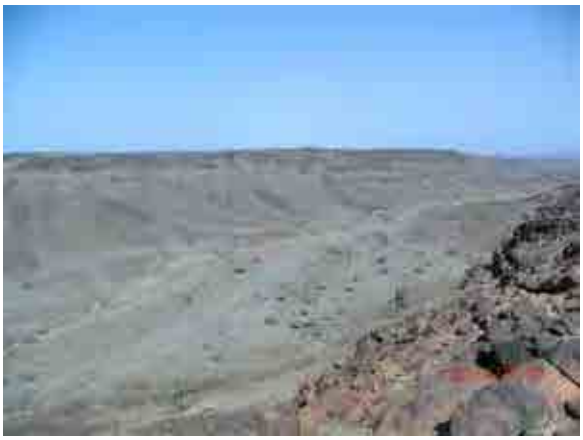
The Master Plan Study for Sustainable Irrigation and Farming in Southern Djibouti

Location Map of the Study Area

Present Situation of the Study Area



Afka Arraba Catchment Area in Dikhil Region

Vicinity of Holhol in Ali Sabieh Region

Surface Water Flowing into the Kourtimalei Pond from the Catchment Area in Flood (2nd May 2014)

Surface Irrigation in an Existing Farm

Baseline Survey

Market in Djibouti City

Pilot Farm

Pilot Farm in Kourtimalei (April 2014)

Pilot Farm in Hambokto (April 2024)

Pilot Farm in Afka Arraba (April 2014)

Water Source Facility

Kourtimalei Pond Catching Heavy Rain Water in 25th May 2013

Shallow Well
(Hambokto)

Protection Works of the Shallow Well
(Hambokto)

Shallow Well No.1
(Afka Arraba)

Shallow Well No.2
(Afka Arraba)

Irrigation Facility

Intake Works
(Kourtimalei)

Intake Works
(Hambokto)

Water Tank
(Hambokto)

Hydrant
(Kourtimalei)

Solar System
(Afka Arraba)

Drip Irrigation
(Afka Arraba)

Cultivation Activity

Tilling in the Pilot Farm

Sowing in a Nursery

Making Manure

Moringa Cultivation

Tomato Cultivation

Harvest and Weighting

Training and Meeting

Site Visit Training on Advance Farms

Leader Training

Women's Training

General Assembly for Establishment of Cooperative in Afka Arraba

Steering Committee Meeting

Workshop

List of Abbreviations

Abbreviation	French	English
AFD	Agence Française de Développement	France Development Agency
CERD	Centre d'Etude et de Recherche de Djibouti	Study and Research Center of Djibouti
C/P	Homologue	Counterpart
DJF	Franc Djibouti	Djibouti Franc
EC	Conductivité électrique	Electric Conductivity
EDD	Electricité de Djibouti	Djibouti Electricity
EIU	Economist Intelligence Unit	Economist Intelligence Unit
EL	Élévation	Elevation
E/N	Échange de notes	Exchange of Notes
EU	Union Européenne	European Union
FAO	Organisation pour l'Alimentation et l'Agriculture	Food and Agriculture Organization
FEWSNET	Réseau de systèmes d'alerte rapide pour la famine	Famine Early Warning Systems Network
GDP	Produit Intérieur Brut	Gross Domestic Product
GIS	Système de l'Information géographique	Geographic Information System
GNI	Gros Revenu National	Gross National Income
IGAD	Autorité Intergovermental sur Développement	Intergovernmental Authority on Development
IMF	Fonds Monétaire international	International Monetary Fund
INDS	Initiative Nationale de Développement Social	National Initiative for Social Development
JICA	Agence Japonaise de Coopération Internationale	Japan International Cooperation Agency
MAEPE-RH	Ministère de l'Agriculture, de l'Eau, des la Pêches, de l'Elevage et des Ressources Halieutiques	Ministry of Agriculture, Water, Fisheries, Livestock and Marine Resources
M/P	Plan ou Schéma-Directeur	Master Plan
NGO	Organisation Non Gouvernementale	Non-Governmental Organization
PACCRAS	Projet de Développement des Fermes Pilotes Agro-Pastorales	Agro-Pastoral Pilot Farms Development Project
PDDSP	Plan Directeur de Développement du Secteur Primaire	Development Plan for the Primary Sector
PNSA	Programme Nationale de Sécurité Alimentaire	National Food Security Program
PRSP	Papier de la stratégie de la réduction de la pauvreté	Poverty Reduction Strategy Paper
PVC	Chlorure Polyvinyl	Polyvinyl Chloride
S/W	Etendue des Travaux	Scope of Work
UNDP	Programme des Nations Unies pour le Développement	United Nations Development Program

Abbreviation	French	English
USAID	MilleUnited Etats Agence pour Développement International	United States Agency for International Development
UNICEF	Fonds des Nations Unies pour l'Enfant	United Nations Children's Fund
WB	Banque Mondiale	World Bank
WFP	Programme Alimentaire Mondiale	World Food Program
WHO	World Health Organization	World Health Organization

Scale and measures are based on the metric system

Exchange Rates

1USD = 109.06JPY = 177.91DJF (Djibouti Francs)

(1DJF = 0.613JPY)

[Based on JICA's official exchange rates for November 2014

SUMMARY

Chapter 1 INTRODUCTION

1.1 Objectives of the Study

The objectives of the Study are as follows,

(a) To formulate a Master Plan of sustainable agriculture development, including water resources development in the arid area, through verification of the pilot projects

(b) To develop the capacity of concerned government organizations on planning and project implementation through the Master Plan study and the implementation of the pilot projects

The study area covers the southern three regions of Djibouti, namely Arta, Ali Sabieh and Dikhil. The pilot project was implemented at Kourtimalei in Arta region, Hambokto in Ali Sabieh region, and Afka Arraba in Dikhil region.

1.2 Contents of the Study

To improve the livelihood and reducing poverty of nomads in the rural areas, farming models were considered from the viewpoints of sustainable water resources management, efficient irrigation methods, and proper cultivation systems. Moreover, the pilot project was conducted to verify their adaptability and sustainability of the farming models. As for the formulation of the Master Plan (M/P), the development potential was studied and development methodologies and subjects in the study area were considered in order to propose the development plan for sustainable irrigated agriculture.

In the Study, the baseline survey and the pilot project were carried out from January 2012 to January 2014 and the pilot project, analysis of the results and formulation of the M/P were conducted from January 2014 to December 2014. The counterpart agency of the Study is the MAEPE-RH, including the central main office and the three Sub-Directorates in the southern regions.

Chapter 2 BACKGROUND OF THE SOCIOECONOMY AND AGRICULTURE DEVELOPMENT

2.1 Socioeconomic Background

The Republic of Djibouti is a Muslim country located on the corner of the 'Horn of Africa', covering a land area of 23,200km^2. It shares borders with Eritrea to the north, Ethiopia to the west and southwest and Somali to the southeast. The Gulf of Aden, the gateway to the Red Sea, is on the east of Djibouti. As Djibouti is located in a geopolitically very important position, France and the United States of America have military bases there. In June of 2011, Japan also opened a Self-defense Force base for anti-pirates mission after approval of the Government of Djibouti.

The Djibouti Bay facing the Gulf of Aden is an important strategic position for transportation and also a hub of economic activities. The activities and services in/around the port such as transportation, communication, construction, hotel lodging, banking and insurance, use of military base, etc. are the main industries, contributing 80% of the GDP of Djibouti. This shows that Djibouti is a typical nation depending on transit trade economy. GNI was 1,270 USD in 2009, while the economic growth rate was 5.0% in the same year. However, the primary sector, mainly agriculture and pastoral activities, is an important industry for rural people although it accounts for only 4% of GDP. The population of Djibouti is reportedly 820,000 inhabitants (national census in 2009). The main tribes are Issa of Somali line and Afar of Ethiopia line, accounting for 50% and 37% of the population, respectively.

2.2 National Development Plan

The basic plan for the national development of Djibouti was the Poverty Reduction Strategy Paper (PRSP) which started in 2009. The National Initiative for Social Development (INDS) is the plan succeeding the PRSP. The INDS program shows four pillars mentioned below.

Pillar 1 Accelerating growth and preserving the major macroeconomic balances
Pillar 2 Developing human resources and ensuring universal access to basic services
Pillar 3 Promoting harmonious, balanced local development and preserving the environment
Pillar 4 Anchoring the principles of good governance and building capacities

The PNSA was formulated in 2007 for the first time by the government of Djibouti supported by FAO and USAID. In December 2011, a new program focusing on the successive 5 years was formulated and is currently managed mainly by the MAEPE-RH and FAO. The program contains the following 4 priority subjects, and each subject contains several projects to overcome problems.

- Ensuring Food Security
- Assistance to Vulnerable groups
- Introduction of Modern Technology and Export Support
- Support for the Implementation of PNSA

2.3 Outline of the Agriculture Sector of Djibouti

2.3.1 Agriculture

(1) Types of Agricultural Production

The source of irrigation water in Djibouti is classified into three types, namely, deep groundwater, sub-surface water (or shallow groundwater) and surface water.

In general, farms with deep groundwater as water source occupy relatively large areas and have the potential to grow crops throughout the year since deep groundwater has a higher potential to supply stable volumes of water. Date palm trees and tomatoes are often cultivated under the monoculture

system in the farms using deep groundwater, which are established by private enterprises and the MAEPE-RH.

Farms with sub-surface water or shallow groundwater as water source are relatively small and cover around 0.5-2 ha per water source point due to the limitation of supply capability and stability of irrigation water.

The Government of Djibouti has currently excavated ponds in order to develop and utilize surface water. However, the water in the ponds dries up if successive droughts occur.

(2) Agricultural Production

The most farmers in Djibouti engage in irrigated vegetable cultivation. The cultivated area is only 1,250ha, and the number of farmers is also low, covering approximately 1,700 people in total. The average cultivated area per person is 0.7 ha. Moreover, there are many farmers stopping their farming activities due to the severe droughts or damages of their farms and irrigation facilities by floods. The situation of agricultural production by region shows that more than 50 % of the total cultivated area is located in Dikhil, followed by Djibouti city and Arta, standing at 16.4% and 12% respectively.

The cultivated crops in Djibouti are varied. The production of tomato shows the highest in Djibouti, while other vegetables such as pepper, melon and onion are also produced much more than other crops. As for fruits, the production of citrus and guava are high, while grain cultivation is not seen in Djibouti due to its difficulty. On the whole, the agricultural production and food self-sufficiency rate are very low in Djibouti. According to FAOSTAT, the self-sufficiency rate of agricultural products is quite low, which is only 1 to 6%.

2.3.2 Animal Husbandry

In Djibouti, the livelihood of local people depends mainly on animal husbandry. The livelihoods are categorized into three (3) types as follows;

- Nomadic type: Total animal husbandry through roaming during the whole year from one field to another where natural forage is obtainable
- Semi-settled-and-semi-nomadic: Making base camp for family while males undertake nomadic life, spending life with livestock
- Settled type: Totally settled with livestock, roaming near the house or farming / purchasing forage for livestock

Recently, the Nomadic type has decreased due to continuous drought which causes the reduction of natural pastures in the grazing land. In contrast, the Semi-settled-and-semi-nomadic type has been increasing. According to the United Nations, Data Retrieval System (2007), 512,000 heads of goats, 466,000 heads of sheep, 297,000 heads of cattle, 69,000 heads of camels and 8,800 heads of donkeys are raised in Djibouti. At present, the number of livestock has probably decreased due to the affects of the severe droughts.

2.3.3 Strategy of Agricultural Development and Administrative Organizations

(1) Policy of Agricultural Development

Based on the basic concept of the national plan and the strategy (INDS and PNSA), the MAEPE-RH has formulated the PDDSP as a basic strategy for the primary sector. The strategic target is to develop the condition to achieve continuous food security, which contributes to poverty reduction and promotes the economic development in the rural areas. In the PDDSP, the primary sector is divided into four (4) sub-sectors, such as water, agricultural production, animal husbandry and fishery sub-sectors. The strategies for each sub-sector are mentioned in the PDDSP.

(2) Administrative Organizations

The Government of Djibouti has 15 ministries. The MAEPE-RH takes responsibility for the primary sector such as agriculture, animal husbandry, fishery, etc. and has the duties of planning, implementing and evaluating development projects. The annual budget of the MAEPE-RH is 1,355 million DJF (as of 2009), which accounts for only 3% of total national budget.

The MAEPE-RH has five directorates under a secretary general. The Directorate of Agriculture and Forest takes charge of matters of agricultural production, irrigation support, technical extension, etc. The Water Directorate is in charge of the wells for water sources. And the Directorate of Grand Works is in charge of the establishment of ponds, recharge dams, etc. The five Sub-Directorates exist in the regions to conduct administrative activities and follow-ups for the MAEPE-RH in cooperation with the governors of the regions.

2.3.4 Support by International Organizations

Many international organizations have their offices in Djibouti. FAO and WFP support the agricultural sector and AFD, UNICEF, EU and UNDP support the water resources sector.

Most international organizations put emphasis on water resources matters. FAO, UNDP and WFP engage in farmland development, agriculture and animal husbandry technologies.

Chapter 3 PRESENT CONDITIONS OF THE STUDY AREA

3.1 Location and Regional Administrative Organizations

3.1.1 Location and Outline of the Study Area

The table below shows the current situation of Arta, Ali Sabieh and Dikhil regions. While the area of Arta region is small, it is very close to the huge consumption area of Djibouti city, and the wadi area of the east coast has a locational advantage for agriculture in suburban areas. For Ali Sabieh region, both farmland area and number of farmers are small. At present, nomadic grazing is more dominant than agriculture. Dikhil region has the largest farmland area and the number of farmers among the three southern regions of Djibouti. Dikhil region is recognized to have a potential in developing agriculture and nomadic grazing due to its large farmland area.

Outline of the Study Region (2009)

Region	Area (km^2)	Population		Agriculture	
		Whole Region (person)	Local Area (person)	Farmland Area (ha)	Number of Farmers (person)
Arta	1,800	42,380	29,120 (69%)	148	230
Ali Sabieh	2,200	86,949	47,010 (56%)	74	128
Dikhil	7,200	88,948	64,062 (72%)	699	525

3.2 Natural Conditions

3.2.1 Meteorology

The meteorology of Djibouti is characterized as typical arid climate with fluctuating and low rainfall and continuous high temperature in summer.

Annual mean precipitation of southern Djibouti is extremely low around 100-200mm with two peaks of monthly rainfalls in March and during the period from August to September. Precipitation is low in any month, making it obvious that it is not enough for crop growth in Djibouti. The maximum temperature rises over 40°C, and the minimum relative humidity is below 40% during the summer season (June to August). The maximum wind speed rises in these months as well. In contrast, the temperature drops, and the relative humidity rises during the winter season (October to April). Under such climate conditions, crop cultivation is mainly made during the winter season that is relatively cool.

3.2.2 Groundwater and Water Quality

Djibouti has scarce rainfalls and high rates of evaporation. Therefore, the rainfalls cannot supply much water to the aquifers in the rock foundation. If salty ingredients are accumulated through repeated evaporations, water salinity in the aquifers increases. Under these natural conditions, the development of abundant volumes of water in the aquifers for drinking purpose is not easy. Most wadis in the study area flow to low elevation inland lakes. Salt is accumulated in the inland lakes through repeated impoundments and evaporations.

One of the FAO standard values of irrigation water is less than 3,000μS/cm. Irrigation water exceeding the standard EC value impedes the growth of agricultural crops. According to the survey of EC values of irrigation water recorded at 9 existing farmlands in Dikhil and Ali Sabieh regions, the irrigation water of only Ali Adde farmland exceeded the EC value of 3,000μS/cm. EC values recorded in the other farmlands are lower than the standard value.

3.2.3 Soil

The climate in the study area is a desert climate characterized by a poor vegetation. Thus, the soil usually does not contain organic matters. The soil textures in the farmlands are usually sandy loam or loamy sand. Fluvisols are distributed around wadis, while Leptosols are found in plateau areas. Fluvisols are the types of soil suitable for the cultivation of vegetables and fruits trees.

According to the results of soil analysis in the pilot farms, the soil pH (H_2O) is more than 7.5, indicating that the soil is alkaline. Besides, nitrate nitrogen and water soluble potassium are very small in quantity, meaning that cropping in Djibouti requires application of these soil nutrients.

3.3 Water Resources

3.3.1 Classification and Characteristics of the Water Resources

(1) Classification of the Water Resources

In Djibouti, fresh water resources are obtained from deep groundwater, surface water and seepage of rainfall. While 83.5% of the rainfall evaporates to the air, the rest flows to the surface (6%) or penetrates into the sub-surface (5.5%) and the ground (5%) (PDDSP). The water volume penetrating into the sub-surface and the ground is roughly estimated to be 345Mm^3/year (= 11.5% of the total rainfall).

(2) Characteristics of the Water Resources

1) Surface Water

This is the water flowing on the surface and in wadis. At the time of floods, water is diverted from the main stream to ponds and dams where it is stored. This water is somewhat muddy but contains less salt. The impounded water volume varies every year because of the changes in the amount of rainfall. There are water losses caused by evaporation and infiltration. Therefore, surface water is not a stable water source for all year round.

2) Sub-surface Water

This is the water retained in or seeping from wadi deposits. In the study area, many traditional simple shallow wells supply this water for domestic use. It can be fetched manually or by pump for domestic use, livestock and agriculture. It is not necessarily fresh, but its content of salty ingredients is low. This water sometimes dries up in a relatively short time, although depending on the scale of the wadis and the depth of the wells.

3) Shallow Groundwater

This is the water retained in the foundation of Diluvium deposit and on the top layer of the rock foundation. Also water naturally seeping from deep rock foundations is included in this category. In the study area, this water is frequently pumped from shallow wells that are excavated in the beds or terraces of wadis at 5-7m depth. Seasonal changes of the water level and water volume are not large except in very severe series of drought. Constant use of the water for irrigation may be possible. If this water is found in rock foundation, it is generally clean and of good quality.

4) Aquifer in the Middle Depth of Sediment Rock

Since the water in the Quaternary sediment rock foundation is affected by marine deposit, it has high salt content. Generally, the water cannot be used for domestic and irrigation purpose.

5) Aquifer in the Deep Rock Foundation

This is the water penetrating into the Basalt and/or Rhyolite rock foundations. Rainfall in distant places and in Djibouti penetrates into these rock foundations and reaches the aquifers. It has sometimes high salt concentrations. In the study area, many deep wells are excavated to utilize this water, which is exploited mainly for rural society. The surplus water is utilized for agriculture. However, the initial construction cost for deep wells is considerably high, which makes them economically difficult to be built only for agriculture. Also, the over establishment of deep wells may cause some environmental damages such as decrease of water level in a large area. Therefore, this water is not a target water resource in the Study.

3.3.2 Issues of Water Resources Development

(1) Water Resources Development

The sub-surface water in/around wadis is the most easily developed water resource among the target water resources in the Study. However, the facilities for the water sources may be often damaged by floods. Repairing or resettling the wells should be done for long term use.

Identifying the water points for the shallow groundwater is not easy since these points are related to geology and fault formation.

(2) Development of Water Resources Facilities

Many shallow wells established along wadis were damaged by floods and abandoned. In order for local people with prior farming experience to restart farming, the rehabilitation of the existing shallow wells is one of the priorities, and its prompt implementation is required. In Small Bara Desert, one small dam which was established in the French era was abandoned because of the damaged embankment. It is required to study the causes and to plan a dam that would not be frequently damaged.

When developing any water source, it should be clear that the initial cost cannot be covered by poor local people. Obtaining a budget or clarifying role of the official support is an important matter to consider.

3.4 Agriculture and Animal Husbandry

3.4.1 Agricultural Land Use

Since the farmlands are established in areas where irrigation water is available, most of the farmlands exist along wadis. The farms established by individual residents are usually small and have shallow wells as irrigation water sources.

In Arta region, farmlands were confirmed in Douda, Damerdjog and Atar. The irrigated farms in these areas are located 200-300m away from the coast of the Gulf of Aden and at low altitude of 20-50m. The size of each farm is around 1-2ha.

In Ali Sabieh region, farmlands were confirmed in Holhol, Hambokto, Assamo, Ali Adde and Dhourreh. However, the size of the total farmland in each area is relatively small (less than 50ha).

In Dikhil region, farmlands were confirmed in Hanle, As Ela, Afka Arraba and Mouloud. As Ela and Hanle are especially prominent vegetable production areas in Djibouti. The sizes of the farmlands there are approximately 343ha and 120ha, respectively. Most of the farms in these areas are located on terraces along big wadis such as Gobaad and Hanle. The general farm size is approximately 0.5-1ha in both areas.

3.4.2 Agricultural Production and Farm Management

Farmers in the study area generally cultivate some annual crops (vegetables and fodders) and tree crops (fruit trees and fodder trees). In addition, they raise livestock, mainly goat and sheep, and use the dung as manure for the cultivation. Therefore, their farm management is multiple farming.

1) Cultivated Crops

The major crops cultivated in the study area are shown below. However, the kinds of crops are not many. The cultivation of tomato, onion and melon is relatively major among the crops below while almost no major grain is cultivated in the study area.

Vegetables	Tomato, Onion, Green pepper, Okra, Eggplant, Table beet, Melon, Watermelon
Fruits	Guava, Mango, Date palm, Citrus, Papaya
Fodders	Sorghum, Guinea grass, Rhodes grass, Moringa, Leucaena

2) Agricultural Inputs and Sale

Suppliers of agricultural inputs are very few and most agricultural inputs are sold only in Djibouti city. Since it is difficult to buy chemical fertilizers and pesticides even in Djibouti city because of their availability, farmers do not use them generally. In addition, once they get the seeds, many farmers collect seeds from their harvest and use them for the next cultivation. Farmers use manure as a fertilizer for their crops. The difficulty to get agricultural inputs is one of the causes of low yields.

Small scale farmers consume their products and also sell them individually to neighbors and in nearby markets. On the other hand, a few farmers, who commercially cultivate in a relatively large scale, transport their products to Djibouti city for sale, which is a large consumption area.

3.4.3 Animal Husbandry

Most residents in rural areas are semi-settled nomads or former nomads, who are target groups of the Study. Therefore, almost all of the households have livestock. In the study area, the number of goat is the highest followed by sheep, camel cattle and donkey. On the other hand, the number of poultry is very low. Among the regions, the number of livestock is the highest in Dikhil region (224,000 heads). It is 99,000 heads in Ali Sabieh region and the lowest in Arta region (26,000 heads).

3.4.4 Farm Household Economy

The biggest income source is “sale of livestock”, which accounts for 28% of the total income. The percentage of “others (including the food support from WFP)” is also a relatively bigger income source (20%). The third biggest income source is “salary from part time job” (20%). The percentage of “sale of agricultural products” is 8% and is not so high. A farm household has several income sources, including the sale of livestock to maintain its lifestyle.

Engel’s coefficient, which shows the proportion of food expense to total expenditure, is 78%. Therefore, expenses for clothes and education are limited. The average annual expenditure per farm household is about 236,132DJF/year. Since the average number of people in a household is 5.5 persons in these areas, the daily expenditure per person is 118DJF (0.66US$). This shows that people live on less than 1US$ a day, which is generally said below the poverty line.

3.5 Irrigation

3.5.1 Current Situation of Irrigation System

Various types and levels of irrigation systems, including traditional and modern, are observed in Djibouti. These can be categorized according to the types of water sources and the levels modernization of irrigation.

(1) Irrigation Systems Using Deep Wells

In the 1980s, irrigation systems using deep wells as water sources have been introduced by the agricultural development projects of the Government of Djibouti. Mouloud and Atar agricultural cooperatives group irrigation are cited as examples of these projects. Traditional surface irrigation is applied at on-farm level, and distribution canal network with earth or concrete lining is developed at these project sites. In recent years, modern irrigation systems combined with drip irrigation and pipeline network are highlighted in Djibouti. A typical example is the Damerdjog farm which was established with the support of the Government of Morocco.

(2) Irrigation Systems Using Shallow Wells

This type of irrigation system is used by most agro-pastoralists and farmers in Djibouti. It is widely observed that water is lifted up by means of a small engine pump from the shallow wells constructed along wadis, and is supplied to their farms in surface irrigation manner. This system requires laborious work, especially for the excavation of the shallow wells. However, it is a low cost water source development approach as farmers themselves can do the work.

The biggest challenges of this irrigation system using shallow wells are 1) high fuel cost for pump operation, and 2) damage by floods. Meanwhile, it is possible to rehabilitate some of the shallow wells damaged by floods. With this background in mind, the irrigation system using shallow wells is recognized to have high potential as a prospective agricultural development model targeting nomads, agro-pastoralists and farmers.

(3) Irrigation Systems Using Surface Water

In Djibouti, intense rainfalls have sometimes caused abrupt runoff on bare land surface and resulted in flood damage along the wadis. Considering the limited water resources, the Government of Djibouti promoted the use of surface water for agriculture. In Kourtimalei, crop cultivation using the water in the pond has been undertaken on a small scale by one farmer.

The biggest constraint of this irrigation system is the instability of the water amount impounded in the pond. To establish this irrigation system as new agricultural development model, the potential of the water resource development, utilizing surface water, was carefully examined in the pilot project, along with the practical adoptability of this irrigation system.

3.5.2 Water Pumping Facilities

Any irrigation system needs water pumping in Djibouti.

In regard to shallow wells, small engine pumps are commonly used in different manners: water is distributed directly to farm plots, or by gravity after storage into the water tank. Gasoline pumps are widely used because cheaper in price. In contrast, diesel pumps are not commonly used higher in price. The fuel cost for pump operation is extremely high and hinders the sustainability of the farm economy.

Solar energy generation becomes popular in Djibouti especially for rural drinking water supply. Meanwhile, it is a rare case that solar energy generation is used as power source for irrigation water supply. Considering the advantage that the operation cost is free, the Government of Djibouti is

promoting the dissemination of solar energy generation for irrigation water supply. In line with such governmental strategy, FAO launched the support for installations of solar pumps for irrigation purposes in 2013.

In the Study, economic comparison between engine pumps (diesel and gasoline) and solar energy generations (solar pump) was made for a period of twenty years for an area of 1.5ha irrigated with one shallow well. As a result, the cost for the solar pump was 5.1 million DJF, compared to 8.4 million DJF and 11.6 million DJF, for respectively diesel and gasoline pumps. Therefore, solar pump is more economical than other pumps.

3.5.3 Irrigation Methods

In regard to distribution method, earth lining canals are dominant, but some farmers have taken remedy in reducing seepage loss from irrigation canals by making concrete lining or using pipelines. In regard to irrigation methods at the farm level, surface irrigation such as basin irrigation and furrow irrigation is dominating.

Meanwhile, modern irrigation methods such as drip irrigation have been introduced in recent years. It is noted that water consumption with drip irrigation would be reduced to one third or half to that with surface irrigation. In fact, drip irrigation systems have been already applied to the modernized large scale farms, and high quality vegetable production has been realized there. The Government of Djibouti has a policy to disseminate drip irrigation. However, there are some challenges in disseminating the drip irrigation that 1) Drip irrigation equipment is not available in Djibouti market, so that all of the equipment must be imported from overseas; 2) Life span of drip tubes is supposed to be about five (5) years, so that the replacement cost must be considered. It seems to be difficult for small scale farmers and nomads to cover such expenses.

3.6 Rural Society

3.6.1 Life Style

Most residents in rural areas are nomads, semi-settled nomads and former nomads. Therefore, taking care of livestock is essential, and all family members take part in this work. In addition, adult men carry out part time jobs and cultivation activities if they have farms. According to the results of the questionnaire survey conducted in the pilot project sites, 37% of the households have already settled life. 53% of the households are semi-settled nomads and 10% are nomads.

3.6.2 Role of Women

Generally, women take the main roles in raising goats, sheep and donkeys. On the other hand, women assist men in raising camels. Regarding the semi-settled nomads, men generally move with the livestock. Regarding farming activities, women generally assist men in tilling, seeding and irrigation although women take prominently care of harvesting and marketing. Regarding household chores, although women and children do the water drawing, cooking and washing, men generally do not take part in them.

3.7 Support Systems for Agriculture

3.7.1 Agricultural Cooperatives

According to the list of agricultural cooperatives collected in the Study, 26 agricultural cooperatives are registered in Djibouti. Among these cooperatives, 8 manage relatively good activities in the study area. Actually performed activities are “distributing agricultural inputs supported by the government or donors”, “buying and distributing agricultural inputs”, “digging shallow wells”, “rehabilitating shallow wells”.

3.7.2 Agricultural Extension

(1) MAEPE-RH

Regional Sub-Directorates of the MAEPE-RH take charge of agricultural extension in each region. However, the number of extension staffs in the regional Sub-Directorates is limited, and each regional Sub-Directorate has only one agricultural extension staff.

(2) Ministry of National Education and Vocational Training

The Ministry of national education and vocational training has vocational training schools. The schools provide technical trainings in agriculture, animal husbandry and fishery for agro-pastoralists and fishermen.

(3) Donors

The donors implementing agricultural extension activities in southern Djibouti are mainly FAO, UNDP and WFP. The donors provide facilities and materials for agricultural activities to farmers in southern Djibouti and do not generally provide the extension services for agricultural techniques.

Chapter 4 PILOT PROJECT

4.1 Outline of the Pilot Project

4.1.1 Objective and Content of the Pilot Project

In the pilot project, farming activities and trainings were implemented for the following objectives. The pilot project sites were at Kourtimalei in Arta region, Hambokto in Ali Sabieh region and Afka Arraba in Dikhil region.

- To verify the applicability of irrigation and cultivation techniques to be applied in the M/P
- To extract lessons learned and items to be considered for the formulation of the M/P

Pilot farms with water sources and irrigation facilities were established. After that, participants were selected in each pilot project site to grow vegetables, fodders, etc. The study team and the counterparts (C/P) provided inputs, technical support and opportunities of training to the participants. Through the monitoring of the cultivation and harvests, the applicability of the farming and irrigation techniques were confirmed and the lessons learned and items to be considered were extracted for the formulation of the M/P. The pilot project was implemented from May 2012 to August 2014.

4.1.2 Irrigation Facility Plan Relating to the Pilot Project

Within the pilot project, the following major irrigation facilities were designed to be set up at each pilot farm.

Outline of Irrigation Facilities within the Pilot Project

Pilot site	Kourtimalei	Hambokto	Afka Arraba
Water source	Surface water	Shallow groundwater	Shallow groundwater
Water source facility	Pond	Shallow well	Shallow well
Irrigation area	0.6ha	0.6ha	0.6ha
Pumping facility	Engine pump	Engine pump	Solar pump
Water tank	Existing water tank	Water tank	Water tank
Distribution pipe	PVC pipe	PVC pipe	PVC pipe
Hydrant	8 set	8 set	8 set
Number of plots	16 plots	16 plots	16 plots
Irrigation method	Surface irrigation	Surface irrigation + Drip irrigation (partially)	Surface irrigation + Drip irrigation (partially)

4.1.3 Cultivation Plan for the Pilot Project

The pilot project aims that the participants learn basic cultivation techniques for several vegetables and fruits etc., and are able to cultivate them by themselves in the pilot farms. The participants practice the cultivation three times: twice in the winter season (from October to March) and once in the summer season (from March to July).

The crops cultivated in the pilot farms are vegetables (tomatoes, onions, hot peppers, etc.), fruit trees (Date, etc.), fodder crops (Sorghum, Guinea grass, etc.) and fodder trees (Moringa, Leucaena, etc.). The objectives of the cultivation are for self-consumption, sales, protection against sunshine and wind (trees), and soil improvement (fodder crops).

In addition to the cultivation and irrigation methods relating to the crops mentioned above, the participants learn ways of making manure, using inputs, and managing the facilities and equipment by a group.

4.2 Plan and Activities of the Pilot Project

4.2.1 Selection of Pilot Project Participants

The pilot project participants should be cooperative and positive to continue the agricultural activities. Thus, the study team selected 15 pilot project participants in each site based on the selection criteria. In addition, the following processes were applied for the regional administration and rural people to understand and cooperate in the pilot project.

- Explanation of the pilot project contents to each governor
- Explanation of the pilot project contents to the residents of pilot project areas
- Selection of the pilot project participants

4.2.2 Establishment of the Water Sources and Irrigation Facilities

(1) Kourtimalei Pilot Project Site

The existing pond is planned as the water source for the pilot farm in Kourtimalei. To utilize the pond more effectively, the pond bed was excavated (2.5m in depth and 5,400m^3 in volume). This was aimed at reducing evaporation from the water surface, collecting the water into the excavated portion when the water volume in the pond becomes small.

A pilot farm of about one (1) ha was established just beside the existing farm. An irrigation network was also set up within the pilot project. Water is pumped up from the pond to an existing water tank with an engine pump. After that, the water is conveyed by gravity through the pipeline from the water tank to the pilot farm. For the monitoring of the water amount consumed at the pilot farm, a flow meter was installed close to the water tank downstream. The pilot farm has 0.64ha in total and 16 plots with an area of 400m^2 (10m × 40m) each, and one hydrant was set up every two plots. In regard to the irrigation method, furrow irrigation was applied. These plot allocations and irrigation methods were also applied to the other 2 pilot farms.

(2) Hambokto Pilot Project Site

The water source of Hambokto pilot farm is a newly constructed shallow well upstream of the wadi flowing beside the pilot farm. The foundation of the well was hard rock, so that the study team introduced an electrically-driven jackhammer in addition to man power excavation. Prior to setting up the irrigation facilities, land preparation work was carried out by heavy construction machines belonging to the Directorate of Grand Works of the MAEPE-RH, because the site of Hambokto pilot farm was stony and irregular.

The irrigation system was designed as follows. Water is pumped up from the well with a 3 inch engine pump, and then conveyed to the water tank constructed in the compound of the pilot farm. The well was constructed at the opposite bank of the wadi, so that the construction of a pipe bridge was required to cross over the wadi.

(3) Afka Arraba Pilot Project Site

The water source of Afka Arraba pilot farm is a shallow well of shallow groundwater similar to that of Hambokto pilot farm. Including a supplementary water source, two shallow wells were excavated. Depths of the wells are about 10m.

Since Afka Arraba pilot farm site has many stones and land irregularity, land preparation work was executed similar to that of Hambokto pilot farm site. The water distribution system of Afka Arraba pilot farm is basically same as that of Hambokto pilot farm. However, a solar pump was applied in the case of Afka Arraba, because the solar system is more economical in the long term compared to the

engine pump.

After the completion of the water source facility, water-level sensors were installed at the well in order to monitor the water level. The monitoring results show clear relevance between rainfall and water level of the shallow well as well as in Hambokto pilot farm.

4.2.3 Farming and Cultivation Activities

The participants experienced 3 cropping seasons (two winter cropping seasons and one summer cropping seasons) in the pilot farms from October 2012. The study team periodically visited the pilot farms and guided them. In the winter cropping season of 2013, which was the third cropping season, the participants could independently cultivate in the most part.

1) Preparation of Field and Manure Making

The study team provided farming tools such as hoes, shovels, picks, wheel barrow, etc. The participants removed stones from the plots, leveled them, developed on-farm channels, tilled land and made ridges. The manure was made from dung of the participants' livestock (mainly goat). The participants carried and put the dung into common manure pits in the pilot farms and mixed them with water.

2) Sowing, Growing Seedlings, Transplanting and Crop Management

The study team provided seeds in each cropping season and the participants sowed them in nurseries or fields directly. The nurseries were owned jointly and the participants took care of the seedlings. After growing the seedlings, the participants transplanted them in the fields and managed them. The crop management included irrigation, insects and diseases control, manure application, etc. Although only manure was used as fertilizer, the quantity of dung collected was not sufficient. Therefore, spot application of the manure was adopted to increase its effectiveness and to reduce application quantity. Regarding the insects and diseases control, agricultural chemicals were used in some parts since the damage caused by insects was serious. Regarding irrigation, furrow irrigation technique was adopted.

3) Harvesting and Chicken Raising

The participants harvested, consumed and sold the products. The harvested products were weighted as much as possible. For contributing toward improving livelihood, hen houses were established in the pilot farms in Hambokto and Afka Arraba and the chicken raising was started. In both pilot farms, hens have laid eggs and chicks are growing. The participants started considering distribution and sale of the chicks.

Since the pilot farms were newly established on virgin soils, soil conditions etc. needed to be improved for the cultivation. In addition, because of a delay in starting the cultivation, the harvest of winter crops in 2012 was not favorable. However, the participants who were former nomads could get relatively good yields, and many participants sold the surplus of the products harvested in the 2013 winter cropping season. Therefore, it is clear that former nomads can understand cultivation techniques and get harvest if the cultivation method is of low input and is relatively extensive.

4.2.4 Training Activities

(1) Training of the Pilot Project Participants

1) On-farm Instruction for Crop Cultivation

Crop growing is a first experience for most participants who are semi-settled nomads or former-nomads, meaning that it is essential to support them when they start agricultural activities.

According to the results of monitoring, the necessity of several farming works such as removal of stones and gravels, establishment of irrigation channels, manure making, establishment of nursery, etc. were well understood and relatively conducted smoothly. However, the leveling of the farmland, adjustment of irrigation interval, insects and diseases control, etc. were conducted arbitrarily by the participants. In addition, the works on seeding, thinning, bud and leaf picking were not well conducted or understood.

2) Study Tour on Advanced Farm Visit and Mutual Farm Visit

To motivate the pilot project participants in farming, study tours to advanced farms located at 3 sites (Abaito, Afka Arraba, Mouloud) were conducted in each pilot project site. Exchange visit trainings were also conducted for the participants of Kourtimalei and Afka Arraba sites, and the participants visited Hambokto pilot farm. Questionnaire surveys conducted for the study tours shows that most of the participants were satisfied with the study tours and showed interest in the advanced farming skills and cultivation of cash crops. This type of training seemed to be effective for the improvement of farming skills and the enhancement of motivation in farming.

3) Training for Cooperative Leaders and Women

A leaders' training was conducted for leaders of the 3 pilot farms. The objectives of the training were to provide 1) information on activities and rules of cooperatives and 2) information regarding agricultural extension activities of the Directorate of Agriculture and Forest of the MAEPE-RH. Besides, the study tour was conducted for Hambokto women participants (10 people) who visited a women cooperative. After the implementation of these trainings, discussions regarding the collection of cooperative fees were conducted in all the pilot sites. In addition, women's cooperative in Hambokto and agricultural cooperative in Afka Arraba were established and registered.

(2) Training for Agricultural Extension Staffs

In this pilot project, the study team undertook administrative and managerial works in the pilot farms with the local extension staffs (C/P) in each region in order to strengthen their capacity and clarify problems relating to agricultural extension activities. The most important qualifications for an agricultural extension staff are: good knowledge of agricultural techniques; ability of planning, and; administrative and managerial ability. The study team attempts to improve these abilities for local extension staffs through the pilot farm activities. The extension staffs involved in the pilot farm activities were not active. On the other hand, they tended to participate in irregular activities such as planning, some parts of management of the pilot farms.

4.3 Analysis of the Problems Relating to the Pilot Project

4.3.1 Considerations on the Adaptability of Surface Water for Irrigation

The precipitation is not constant by year and season in Djibouti, and drought continues for some years as well. High-intensity rainfall in a short period of time is required to induce runoff water flow and impoundment in the ponds. Irrigable area was estimated in the case that an irrigation pond is a single water source under the condition of the catchment area ($40km^2$) and storage capacity of Kourtimalei pond. To estimate the irrigable area with this irrigation system, a water balance simulation was conducted, using 10-year daily rainfall data. As a result, the cultivable area depended on the amount and distribution of yearly rainfall. The maximum cultivable area was 26.6ha from June 2006 to May 2007. On the other hand, it was 0 ha in the two years. The simulation results concluded that the pond is not a stable water source for irrigation.

4.3.2 Considerations on the Proposed Irrigation Farming Model in the M/P

In chapter 5, farmers are classified based on the present farming systems in Djibouti, adding water

source classes to the farmers' groups. Finally, the 7 irrigation farming models shown in the table below are proposed. The validity of each irrigation farming model is examined based on the results of pilot project.

Proposed Irrigation Farming Model in the M/P

Water Source / Facility		Farmers' Group			
		Home-garden Farmers' Group	Beginners Farmers' Group	Self-sustained Farmers' Group	Advanced Farmers' Group
Groundwater	Shallow Well	Shallow well (Home-garden farmers' group) **SW-H**	Shallow well (Beginners farmers' group) **SW-B**	Shallow well (Self-sustained farmers' group) **SW-S**	Shallow well (Advanced farmers' group) **SW-A**
Surface Water	Pond	Pond (Home-garden farmers' group) **P-H**	Pond (Beginners farmers' group) **P-B**	Pond (Self-sustained farmers' group) **P-S**	Pond (Advanced farmers' group) -

(1) Estimation of Forage Production and Consumption in Each Irrigation Farming Model

The major livestock in Djibouti is goat. Based on the baseline survey, the number of goats in Home-garden farmers' group is assumed to be 20 heads, while that in the Advanced farmers' group is assumed to be 40 heads. As a result, it is estimated that Home-garden farmers' group, with the least number of goats, requires 23t of forage annually, including the 3t of forage consumed by young goats.

Using the results of the pilot project, the annual forage production of each farming model is estimated. According to the results, the amount of forage produced in SW-H, where the water source is a shallow well, can meet about 49% of the annual consumption of young goats. In case of SW-B, it is possible to produce 54% of the total annual consumption of all goats. The farmers' group SW-S and SW-A can produce more than the necessary amount of forage in their farms. On the other hand, the forage production in the farmers' groups depending on the pond water is generally low due to the absence of summer cropping. The farmers' group P-S can produce more than half (51%) of the total consumption of all goats.

(2) Estimation of Vegetables Production, Consumption and Sale in Each Irrigation Farming Model

Vegetable production and sale in each farmers' group are estimated based on the average yield and the self-consumed amount. Regarding tomato, production amount (36kg) in SW-H and P-H is similar to the amount self-consumed (36.3kg). In case of hot pepper, the production amount (5kg) is more than the amount self-consumed (2.5kg) in these famers' groups. Therefore, it seems that, it is possible to produce vegetables at least for self-consumption even in the farmers' groups SW-H and P-H, which have a minimum farming area. In contrast, other farmers' groups can get some income through the sale of surplus products of the farms.

(3) Considerations on the Suitable Crop for Each Irrigation Farming Model

Based on the results of the pilot project, suitable crops for each irrigation farming model are considered in terms of 1) cultivation difficulty, 2) seed procurement difficulty and 3) market price. As a result, most of the irrigation farming models are recommended to cultivate tomato, hot pepper, okra, onion and sorghum.

Crops with lower cultivation and seed procurement difficulties (watermelon, niebe, etc.) are recommended to the Home-garden farmers' groups (SW-H, P-H) and Beginner farmers' groups (SW-B, P-B). In contrast, crops with high market value such as eggplant and melon are recommended to the Self-sustained farmers' groups (SW-S, P-S) and Advanced farmers' group (SW-A).

Chapter 5 FORMULATION OF THE MASTER PLAN

5.1 Framework of the Master Plan

There are several constraints to be solved for the development and establishment of a sustainable irrigated agriculture. The main subjects considered in the M/P are as follows; establishment of a sustainable water resource development, establishment of an irrigation farming model applicable to the natural and regional conditions, improvement of the distribution system of agricultural materials, enhancement of agricultural cooperative activities, enhancement of an extension system of agricultural techniques, and capacity development of the government in implementing the project.

First, a sustainable water resource development for irrigation is considered as the starting point of the M/P. Sub-surface water under the wadis, shallow groundwater, and surface water during floods are regarded as suitable water sources for agricultural development in the M/P. These water resources have not been used effectively or have been wasted so far. Furthermore, it is possible for local people to develop these sub-surface water and shallow groundwater by themselves. In addition, the pilot project successfully verified that the said water resources are certainly available and can be utilized further in the study area.

Accordingly, another important point of the M/P is to establish a sustainable irrigation farming model. The cultivation plan to be adopted at the pilot farms was formulated considering the current cropping pattern and marketability. It is an agro-pastoral system creating virtuous cycles of agriculture and pastoralism. This M/P aims at developing and establishing a sustainable agro-pastoral system in southern Djibouti.

Meanwhile, this irrigated agriculture development project will be implemented under the supervision of the MAEPE-RH. Since the capacity of the MAEPE-RH is not sufficient in terms of organizational structure and project implementation ability, capacity development of the MAEPE-RH is considered as an essential point of the M/P.

5.2 Consideration on the Sustainable Use of the Water Resources

5.2.1 Targeted Water Resources and Methods of Water Sources Development

The target water resources of the project are shallow groundwater, sub-surface water and surface water. The facilities for these water resources are shallow wells, ponds and sub-surface dams.

(1) Shallow Wells for Shallow Groundwater

In watersheds including the sites of Hambokto and Afka Arraba, clean shallow groundwater is obtained throughout the year from shallow wells constructed manually in rock foundations of wadis. The common condition of all these sites is that they belong to the same geological era of early Miocene Delha Basalt, which is a somewhat older geological era in southern Djibouti volcanic zone. Basalt holds normally many open cracks during the process of cooling after eruption. However, the cracks of older Basalt may be filled with calcareous components in the long term geological aquifers. Delha Basalt spreads on the southern hill range along the national route No-1.

(2) Shallow Wells for Sub-surface Water

Sub-surface water increases in the mid and downstream stretches of a watershed. If watersheds are large, they can provide water all the year round. Based on observed examples, one can roughly conclude that a watershed with size less than 30 to 40 km^2 cannot provide all year round sustainable water.

Farming in Gobaad big wadi in Dikhil region, where sub-surface water is abundant, is very active. On

the other hand, however, the flood volume in Gobaad wadis is very high due to the presence of a big watershed. This has damaged many shallow wells along the wadis in recent years that has caused many farms to be abandoned. The rehabilitation of the wells will have a direct effect on the return of farmers to agriculture again. There is a high demand of wells rehabilitation here, and the M/P focuses on this rehabilitation matter. The same cases can be identified in other sites, where medium to large wadi are running.

(3) Ponds

The MAEPE-RH is carrying out the development of surface water as one of water resources development methods. Until recently, surface water was mostly untouched and free in vain, but its use as a water resource is very attractive. Ponds are made in the moderate or flat plain by excavation. The excavated soil material is used for embankment. The height of the embankment may be 5-10m. The construction can be made cheaper, using only heavy equipment for the earth work. Three ponds are built for water supply in the study area. The size of the watershed for each pond is over 30km^2.

(4) Sub-surface Dams

Sub-surface dams can store wadi water in void of sediment foundation beneath the surface by constructing impervious walls reaching the rock foundation. Sub-surface dams have an advantage of yielding little evaporation since the stored water is underground. Using sub-surface dams in dry areas is done for that reason. The sites of Boule wadi in Arta region and Arouo wadi in Dikhil region have the potential.

(5) Micro Recharge Dams

A micro recharge dam is a small dam, 4-5m high, with cemented bolder in the wadi foundation. These doms were constructed upstream of Hambokto and downstream of Midgarre of Darrah wadi in Ali Sabieh region to recharge groundwater. The effect has been recognized. A recharge dam is not typical facility commonly used to directly store water for use. It is an intermediate method for wells to obtain sustainable water. A recharge dam is applicable to places, such as wells sites, where wells have been abandoned due to the reduced amount of natural groundwater. The selection of possible applicable sites for the recharge dam is not reported in this report, despite that its necessity is admitted.

5.2.2 Potential Volume of Water and Possible Irrigated Area

The estimation of the water resource potential of the basin and the possible irrigated farmland area could be clarified by studying the existing water resource facilities and the scale of the farmland. Besides, the analysis of the Kourtimalei pond study in terms of water balance analysis could lead to estimate the possible irrigated area based on the pond-based water resource. The table below describes the possible irrigated area based on the type of water source and the catchment area.

Types of Water Sources and Possible Irrigated Area

Water Sources	Catchment Area Ac and Possible Irrigated Area Ai
Shallow well (A) (rock foundation)	Ac=10km^2→Ai=2ha
Shallow well (B) (wadi terrace)	Case of Ac＞150km^2; Ac=10km^2→Ai=8ha Case of Ac＜150km^2;Ac=10km^2→Ai=4ha Case of Gaggade basin ; Ac=10km^2→Ai=2ha
Pond	Ac=40km^2→Ai=2.5ha
Sub-surface dam	By direct effect of a sub-surface dam; Ai=10ha and Ac=10km^2→Ai=6~10ha

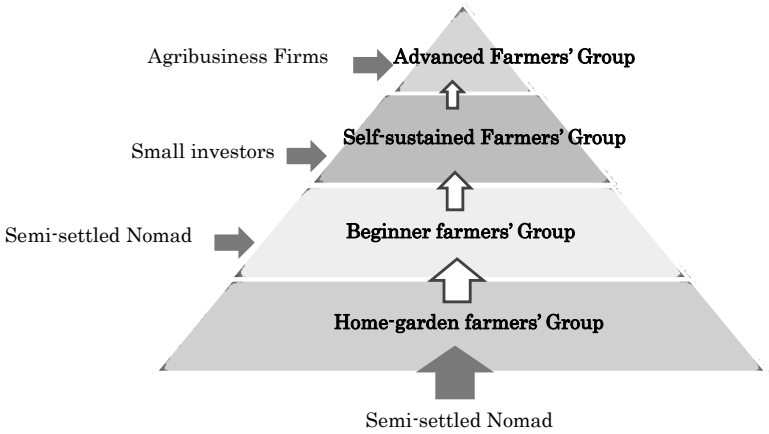
Note: Ac is catchment area, Ai is possible irrigated area

5.3 Economic Evaluation on Sustainable Irrigation Farming Models

5.3.1 Establishment of Irrigation Farming Models

(1) Prospective Irrigation Farming Models

In terms of farming scale and agricultural techniques level, the current farming styles in Djibouti are classified into four farmers' groups: Home-garden farmers' group, Beginner farmers' group, Self-sustained farmers' group, and Advanced farmers' group as shown in the figure below. Most participants of the pilot project are in the Beginner farmers' group.



Farmers' Group in Djibouti

Besides, with the combination of water resources (shallow well and pond), the irrigation farming models are classified into seven groups mentioned in the table below.

Prospective Irrigation Farming Models in Irrigated Agriculture Development Project

Water Source / Facility		Farmers' Group			
		Home-garden Farmers' Group	Beginner Farmers' Group	Self-sustained Farmers' Group	Advanced Farmers' Group
Groundwater	Shallow Well	**SW-H**	**SW-B**	**SW-S**	**SW-A**
Surface Water	Pond	**P-H**	**P-B**	**P-S**	-

5.3.2 Economic (Benefit) Evaluation of Irrigation Farming Models

(1) Conditions to Considerate Benefit of Irrigation Farming Models

The table below describes the assumed conditions to evaluate the benefit of each irrigation farming model. Every irrigation farming model is assumed to engage in multiple farming consisting of crop cultivation and animal husbandry.

		Home-garden Farmers' Group (SW-H, P-H)	Beginner Farmers' Group (SW-B, P-B)	Self-sustained Farmers' Group (SW-S, P-S)	Advanced Farmers' Group (SW-A)
Scale		0.025 ha	0.25 ha	1 ha	2 ha
Initial cost	Public investment	Water source, Irrigation facilities	Water source, Irrigation facilities	Pond construction (Only for P-S)	N/A
	Self investment	treadle-pump	N/A	Water source, Irrigation facilities	Water source, Irrigation facilities
Maintenance cost		Maintenance fee for the water source facilities		Maintenance fee for the water source and irrigation facilities	
Fuel cost		N/A		Fuel cost for engine pump	
Crop cultivation		Well: Winter & Summer cropping, Pond: Winter cropping only		Well: Winter & Summer cropping, Pond: Winter cropping only	
Livestock		Goat 20 head	Goat 25 head	Goat 30 head	Goat 40 head

(2) Result of Benefit Consideration relating to the Irrigation Farming Models

In case of SW-H and P-H, the income deriving from crop cultivation is low since the cultivation area is small and the production low. Although both the total income and total cost are low, income is higher than cost. The expected annual benefit is 70,000-90,000DJF.

In case of SW-B and P-B, although the fuel cost is required, it can be covered by selling the surplus agricultural products and livestock products. The total income is higher than the total cost, and the expected annual benefit is 210,000 DJF in SW-B while that in P-B is about 170,000 DJF.

The expected annual benefit is about 500,000 DJF in SW-S and P-S, while that in SW-A accounts for 1,700,000 DJF.

5.4 Sustainable Irrigated Agriculture Development Plan in Southern Djibouti

5.4.1 Expansion of Sustainable Water Resources Development and Water Uses

Two approaches of water source development are proposed in this development plan: one is new water source development; and the other is restoration through rehabilitation of the existing water source facilities. In formulating the irrigated agriculture development plan, the project sites are categorized according to the types of water sources; shallow well site where the water source is shallow groundwater or sub-surface water of the wadi; pond site where the water source is pond storing surface water; and sub-surface dam site where the water source is groundwater.

In regard to the water resources development for sustainable irrigated agriculture development plan in southern Djibouti, the conservation of these resources is a fundamental issue as they exist in specified forms and locations in the arid area. To avoid the depletion of these water resources, and also to ensure their permanent use for irrigation, the irrigable area of each project site is determined in accordance with the scale of the catchment area by water resources (**5.2.2** Potential Volume of Water and Possible Irrigable Area).

In the cases that water sources are shallow groundwater or sub-surface water, the irrigable area is limited to around 1 to 2ha for one shallow well that would supply the water throughout the year. In the case that the water source is a pond, the irrigation is available in winter season exclusively. A pipeline network is applied from the water source to the farm instead of the traditional earth lining canal in order to reduce conveyance water loss. A solar pump is applied to the irrigation system, which draws water from a shallow well managed by Beginner farmers' group in consideration of long term economic advantage relating to the free operation cost. Considering that further expansion of drip irrigation is contemplated as a water saving method in Djibouti, drip irrigation is applied to the irrigation system for Beginner farmers' group using shallow groundwater as a water source because water quality of this water source is fairly good (less soil contamination). Since a farm managed by

Home-garden farmers' group is small, a treadle pump and a small size hose are applied as the irrigation method.

5.4.2 Establishment of Sustainable Farming Systems

The target group of the M/P is nomads. Therefore, the irrigation farming models to be disseminated are formulated on the premises of agro-pastoral system which is a mix of pastoralism and agriculture. In each project site, an irrigation farming model (Home-garden farmers' group or Beginner farmers' group) is disseminated in accordance with the farming scale and the farming technical level.

The following countermeasures are applied to establish sustainable irrigated agriculture based on the irrigation farming models. First, the minimum and necessary agricultural materials are supplied to the beneficiaries for the startup of farming in the project sites. Meanwhile, on-farm instruction provided by the farming instructors and study tours to the advanced farms are implemented for the extension of agricultural techniques to the beneficiaries. Moreover, the beneficiaries receive support regarding study tours to existing agricultural cooperatives, leader trainings and official registration of agricultural cooperatives.

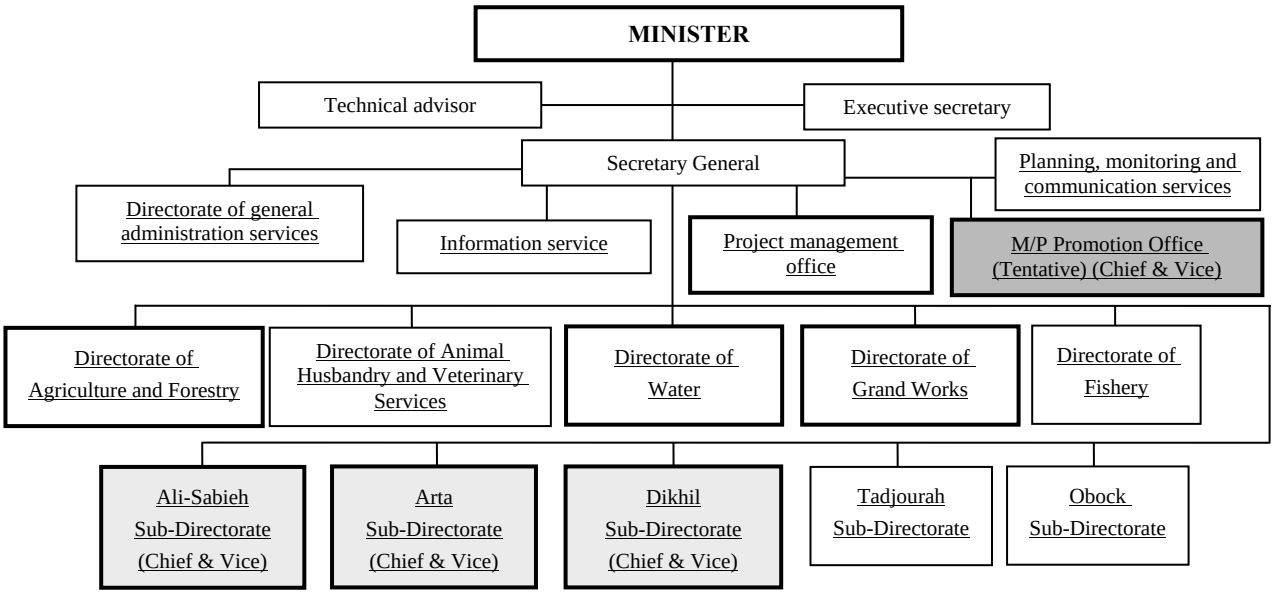
5.4.3 Empowerment and Capacity Development of the MAEPE-RH's Organization and the Supporting System for the Farmers

However, only hard components (development of agricultural infrastructures) are not sufficient to achieve the establishment of the proposed irrigation farming models. Thus, this M/P includes soft components such as the improvement of the supply system of agricultural materials, the empowerment of agricultural cooperatives, and the development of the support and training system for the extension services on farming techniques. Meanwhile, although such irrigated agriculture development is managed by the MAEPE-RH, the organizational structure and support system for the farmers are not sufficient. Thus, to implement the project successfully, the capacity development of the MAEPE-RH is included in the M/P.

(1) Empowerment of the MAEPE-RH's Organization

The MAEPE-RH controls the following five Directorates, namely Directorate of Agriculture and Forestry, Animal Husbandry and Veterinary Services, Water, Grand Works and Fishery under the control of a secretary general. Permanent staffs of the MAEPE-RH are about 90 people. The national level administration for the primary industry sector is run by this limited number of staffs. Besides, the number of staffs in each five branch office (Sub-Directorate) is only 1 to 2 persons, which is apparently insufficient for the administration activities.

It is suggested that the Directorate of Agriculture and Forestry, Grand Works, Water, the Sub-Directorates and a project promotion office under the control of a secretary general are related to this project. The effort to establish the coordination system of these related Directorates is essential to promote this M/P as an important project of the MAEPE-RH. Therefore, it is proposed to establish a "project promotion office for sustainable irrigation agriculture development project in southern Djibouti (tentative)" (M/P promotion office) placed at a higher level than the existing Directorates as shown in the figure below. According to the past examples, the implementation of this project may need financial support from international organizations or donors of foreign countries. It is also essential to assign a vice-director in the M/P promotion office to support the chief director since frequent meetings for discussion, reporting etc. with the donors and other related administrative agencies are required of this office.



Position of the M/P Promotion Office

On the other hand, the assignment of staffs in the Sub-Directorates is also necessary to implement the project in Arta, Ali Sabieh and Dikhil regions. At least two staffs (chief and his vice) in each Sub-Directorate are required. As there may be many occasions to meet local farmers for the extension of agricultural techniques, the newly assigned staffs in the Sub-Directorates are recommended to be engineers who belong to the Directorate of Agriculture and Forestry or are newly employed.

(2) Capacity Development of MAEPE-RH

Although the MAEPE-RH has implemented small-scale agricultural projects based on the support of donors, successful cases are not many due to the lack of appropriate project management and support on farming techniques for the beneficiaries after the completion of facility construction. Based on the verification of the past results and the pilot project in this Study, it is concluded that a comprehensive capacity development in terms of the project implementation is indispensable for the staffs of the MAEPE-RH.

One approach of capacity development for the staffs of the MAEPE-RH is to improve their skills as related to administration, farming and cultivation, and civil engineering works through the actual project implementation as On-the-Job-Training. Another approach is to implement trainings for the related contents of project implementation.

Furthermore, it is necessary to improve the agricultural extension skills of farming instructors assigned in the project sites. The trainings for the farming instructors are planned by the M/P promotion office, while it is implemented by the technical staffs of the Directorate of Agriculture and Forestry.

(3) Establishment of a Supply System for Agricultural Materials

The capacity of the management system for agricultural materials in the Directorate of Agriculture and Forestry is enhanced for the establishment of a proper supply system for agricultural materials to farmers. Besides, the establishment of the supply system for the agricultural materials in the private sector is promoted through the introduction of a subsidization scheme.

(4) Support for Agricultural Cooperatives

To promote organizing farmers, the M/P promotion office and the Directorate of Agriculture and Forestry introduce a policy giving priority to the registered cooperatives. For example, the registered agricultural cooperatives can be preferentially selected as the destination of agricultural materials

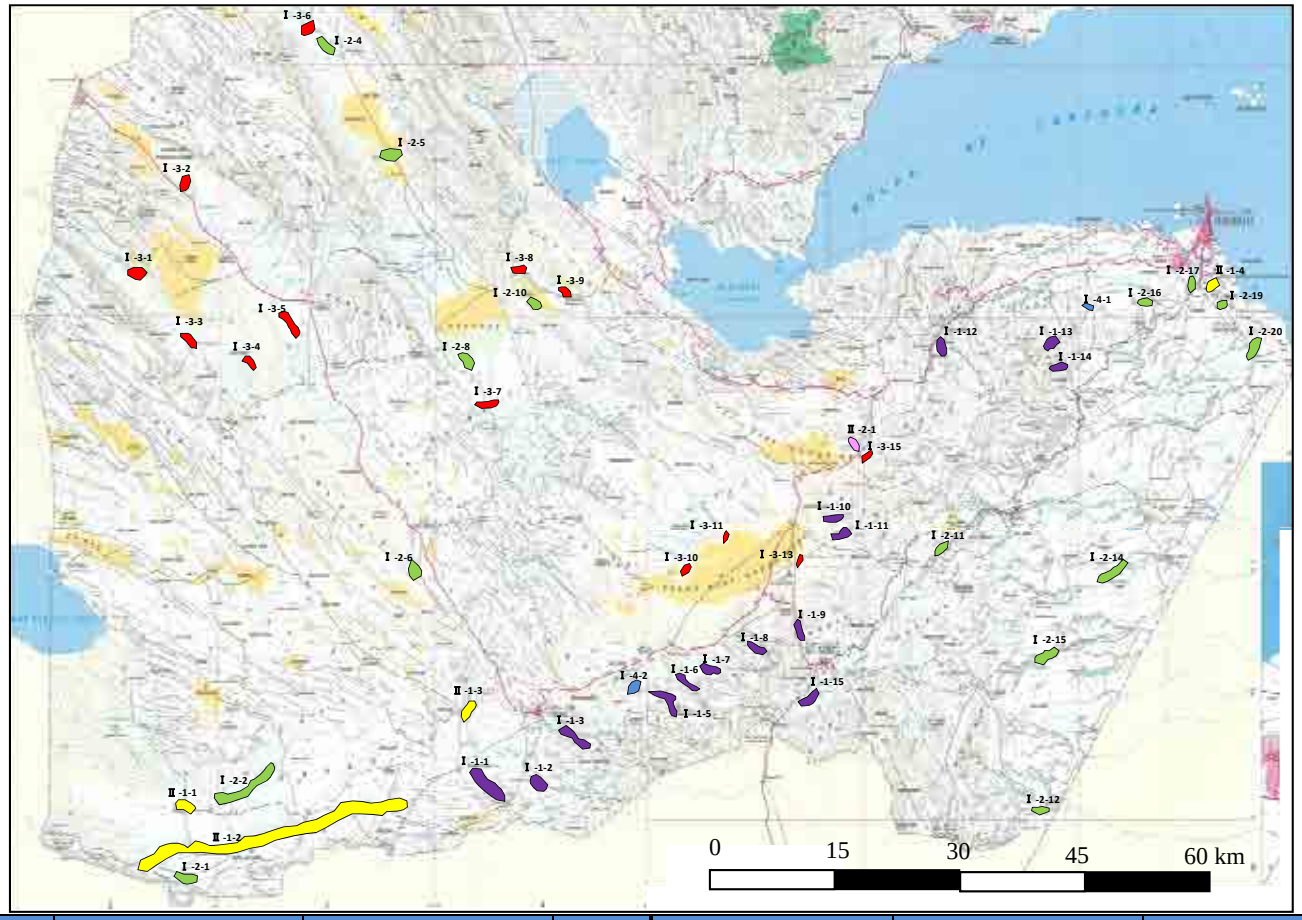
granted by donors or the various farming support provided by the Government of Djibouti.

5.5 Project Site Selection for the Sustainable Irrigated Agriculture Development in Southern Djibouti

Based on existing data and field survey, 49 project candidate sites are selected for the sustainable irrigated agriculture development in southern Djibouti. Each candidate site is evaluated based on criteria such as the availability of the water sources, water quality and socio-economic aspects. Based on this evaluation, the total evaluation points of each candidate site are calculated, which become the basis for the judgment of project site priority. The priority rank is classified into four groups, which are from rank-A for the highest priority to rank-D for the lowest priority. The number of candidate sites in rank-A is 16 sites including the project sites planned for rehabilitation, while that in rank-B, C and D is 10 sites, 17 sites and 6 sites, respectively.

List of Project Implementation Sites

Type of Development	Water Source Facility	Water Resources	Site Number	Site Name	Evaluation Rank	Irrigation Farming Model	Catchment Area (km^2)	Farmland to Area be Developed (ha)	Number of Beneficiaries (households)
New development	Shallow well (A)	Shallow groundwater	I-1-1	Bondara	A	SW-B	84.0	17	68
			I-1-2	Chinnile	A	SW-B	118.8	24	96
			I-1-3	Afka-Arraba	A	SW-B	50.9	10	40
			I-1-5	Mouloude Ouein tributary up-st.	A	SW-B	64.1	13	52
			I-1-6	Arouo down-st.	A	SW-B	20.9	4	16
			I-1-7	Gablalou	B	SW-H	18.0	4	160
			I-1-8	Aour adussa	D	SW-H	19.5	4	160
			I-1-9	Hambokto	A	SW-B	18.2	4	16
			I-1-10	Garaslei	D	SW-H	8.4	2	80
			I-1-11	Boelei	D	SW-H	12.3	2	80
			I-1-12	Kalaloho	C	SW-B	36.9	7	28
			I-1-13	Boulle biyale	B	SW-H	16.7	3	120
			I-1-14	Gachan	C	SW-H	21.7	4	160
			I-1-15	Darka Doun Yar	A	SW-B	66.9	13	52
	Shallow well (B)	Sub-surface water (wadi retaining water)	I-2-1	Bakkirre	C	SW-H	43.4	17	680
			I-2-2	Agobarre	B	SW-B	201.2	16	64
			I-2-4	Kerora	C	SW-H	83.6	33	1,320
			I-2-5	Boukboukto	C	SW-H	48.1	19	760
			I-2-6	Sek Sabir	A	SW-B	50.2	20	80
			I-2-8	Gaggade	C	SW-H	445.4	15	600
			I-2-10	Dika	C	SW-H	192.7	15	600
			I-2-12	Guistir	D	SW-H	155.5	12	480
			I-2-11	Dhourreh	B	SW-B	106.9	43	172
			I-2-14	Hidka Beyya Adde	B	SW-H	332.9	26	1,040
			I-2-15	Midgarra	A	SW-H	78.2	31	1,240
			I-2-16	Dihda Quead	D	SW-H	69.7	28	1,120
			I-2-17	Ambouli down-st.	C	SW-B	-	10	40
			I-2-19	Damerdjog	C	SW-B	44.6	18	72
			I-2-20	Goum-Bourta	C	SW-B	266.8	21	84
	Pond	Surface water	I-3-1	Agan south	B	P-H	90.2	6	240
			I-3-2	Dahhoto	D	P-H	114.4	7	280
			I-3-3	Gara Abbouri	C	P-H	56.0	4	160
			I-3-4	Dawwano	C	P-H	37.2	2	80
			I-3-5	Yoboki	B	P-B	113.2	7	28
			I-3-6	Soulaitou	C	P-H	67.4	4	160
			I-3-7	Guidoli	C	P-H	153.0	10	400
			I-3-8	Dika	C	P-H	106.6	7	280
			I-3-9	Koussour	B	P-H	95.2	6	240
			I-3-10	Safarie Golla	C	P-H	37.7	2	80
			I-3-11	Gabla Oalan	C	P-B	44.4	3	12
			I-3-13	Elka Hadad	A	P-B	64.6	3	12
			I-3-15	Didjan Der tributary	A	P-B	37.0	2	8
	Sub-surface dam	Surface water	I-4-1	Boulle middle-st.	B	SW-B	46.0	38	152
			I-4-2	Mouloude Ouein tributary middle-str	B	SW-B	27.4	26	104
Rehabilitation	Shallow well (B)	Sub-surface water	II-1-1	Kouta Bouyya	A	SW-B	255.7	5	7
			II-1-2	Gobaad As-Ela	A	SW-B	428.0	224	132
			II-1-3	Chekheiti	A	SW-B	245.1	4	6
			II-1-4	Douda	A	SW-B	67.0	27	40
	Pond	Surface water	II-2-1	Didjan Der	A	P-B	116.0	7	28
Total								829	11,929



Type of Development	Water Source Facility	Water Resources	Color
New development	Shallow well (A)	Shallow groundwater	**I-1**
	Shallow well (B)	Sub-surface water (wadi retaining water)	**I-2**
	Pond	Surface water	**I-3**
	Sub-surface dam	Surface water	**I-4**

Type of Development	Water Source Facility	Water Resources	Color
Rehabilitation	Shallow well (B)	Sub-surface water (wadi retaining water)	**II-1**
	Pond	Surface water	**II-2**

Project Candidate Sites for the Sustainable Irrigated Agriculture Development in Southern Djibouti

5.6 Project Plan for the Sustainable Irrigated Agriculture Development in Southern Djibouti

5.6.1 Project Plan

(1) Objectives of the Project

To improve livelihood and to reduce poverty of nomads in southern Djibouti, the project aims at developing and establishing sustainable irrigated agriculture based on the irrigation farming models, which are well applied to the site conditions, by developing new water sources or rehabilitating existing water sources. In addition, the project includes capacity development of the MAEPE-RH which has a responsibility in providing administrative support to achieve the project goals.

(2) Target Groups of the Project

Semi-settled nomads and small farmers living in the rural areas of the target regions and the staffs of the Government of Djibouti

(3) Project Period

The project implementation in the project sites continues for 20 years. The first five years (short term) is for the development of sites evaluated as rank-A, while the second five years (middle term) is for the rank-B. Another 10 years (long term) is for the rank-C and D. However, the development period of each project site is three years. It is possible to develop each project site separately.

(4) Management Organizations and their Roles for the Project Preparation and Implementation

The administration of this project is managed by the MAEPE-RH, which means that the MAEPE-RH also takes a responsibility on the preparation activities to launch the project. Thus, the MAEPE-RH plays important roles in the preparation process of the project to address and promote the activities of the inside and outside of the ministry.

For the certain launching of the project, first, the MAEPE-RH should establish a preparation office of this project as an internal organization under the authority of the Minister of agriculture. The preparation office conducts the publicity and public relations activities (preparation of written request, consultation) to get support from donors in order to promote this M/P in cooperation with related governmental organizations. Besides, in accordance with the donors' interest towards this project, the MAEPE-RH proceeds to adding up the portion of project budget defrayed by Djibouti side in coordination with related governmental organizations.

Subsequently, when launching of the project is decided, the preparation office is upgraded to the '*Project promotion office for sustainable irrigated agriculture development project in southern Djibouti (tentative)'* (M/P promotion office). Besides, the Sub-Directorates are also reinforced in terms of the human resources to establish the certain project implementation structure. Thereafter, the M/P promotion office conducts project implementation and management in accordance with the project implementation schedule. The M/P promotion office should also carry out the project evaluation at each end of the project implementation term to share the results and lessons and to feed back them to the following project implementation in cooperation with the related governmental organizations, donors and experts.

(5) Irrigation Farming Models to be Applied in the Project

Since the target groups are semi-settled nomads and small farmers who have little experience in farming, lower level of the irrigation farming models are applied in the plan; SW-H (Shallow Well, Home-garden farmers' group), SW-B (Shallow Well, Beginner farmers' group), P-H (Pond, Home-garden farmers' group), and P-B (Pond, Beginner farmers' group). The farming area of

Home-garden farmers' group (SW-H, P-H) is assumed to be 0.025 ha per family, while that of Beginner farmers' group (SW-B, P-B) is 0.25 ha per family.

(6) Project Implementation Sites and Farmland Area to be Developed

The entire project candidate sites, namely A, B, C, and D in the priority rank, are included into the target sites for the project implementation. The farmland area to be developed within this project is basically the same as the estimated irrigable area, which is calculated based on the types of water source facilities and catchment area of each project site. Besides, the available human resources that are expected to continue farming into the future are also taken into the consideration. In the cases that the water sources are shallow wells at the rehabilitation sites, the farmland area to be rehabilitated supposes that half of the farmers who stopped farming before restart it in an average cultivation area of a household in each site. The table below shows the number of sites, farmland area, and number of beneficiaries of each priority rank.

Summary of the Project Implementation Sites

Priority Rank	Number of Sites	Farmland Area (ha)	Number of Beneficiaries (households)
Rank-A	16	408	1,893
Rank-B	10	175	2,320
Rank-C	17	191	5,516
Rank-D	6	55	2,200
Total	49	829	11,929

(7) Contents of the Project

The contents of this project consist of the following two components.

Component 1: Development and establishment of sustainable irrigated agriculture for the beneficiaries in the project sites

Component 2: Capacity development of the staffs and empowerment of farming support system of the MAEPE-RH

The table below shows the objectives, countermeasures and activities of each component.

Component	Objective	Countermeasure	Activity
1.Development and establishment of the sustainable irrigated agriculture	To establish the sustainable irrigated agriculture in the project sites by preparation of the irrigation facilities, supply of agricultural materials and technical support.	1.1 Construction of facilities and land preparation in the project sites	1.1.1 Construction of water sources & irrigation facilities and land preparation
		1.2 Supply of agricultural materials	1.2.1 Supply of seeds and farming tools to the beneficiaries
		1.3 Implementation of the trainings of farming techniques to the beneficiaries	1.3.1 On-farm instruction in the project sites 1.3.2 Implementation of study tours to advanced farms for the beneficiaries
		1.4 Support for organizing farmers	1.4.1 Implementation of study tours to existing agricultural cooperatives for the beneficiaries 1.4.2 Implementation of leader trainings 1.4.3 Support for application of official registration of agricultural cooperatives.

Component	Objective	Countermeasure	Activity
2. Capacity development of the staffs and empowerment of farming support system of the MAEPE-RH	To enhance the farming support for the beneficiaries of this project, existing famers' cooperatives and farmers by developing the capacity of the MAEPE-RH for project implementation	2.1 Capacity development of the staffs in the MAEPE-RH for project implementation	2.1.1 Implementation of trainings in terms of project implementation and management for the staffs of the MAEPE-RH
		2.2 Capacity development of the farming instructors	2.2.1 Implementation of trainings in terms of technical instruction for the farming instructors
		2.3 Preparation of the supply system of agricultural materials	2.3.1 Preparation of supply system of agricultural materials in the Directorate of Agriculture and Forestry 2.3.2 Establishment and operation of a subsidization scheme for the preparation of supply system of agricultural materials
		2.4 Clarification of the support for organizing farmers	2.4.1 Clarification and official announcement of the support policy for agricultural cooperatives

Component1: Development and Establishment of Sustainable Irrigated Agriculture

Component 1 consists of hard aspect and soft aspect. The hard aspect is defined as the infrastructure development for sustainable irrigated agriculture, which includes the construction of water sources, irrigation facilities and land preparation. Meanwhile, the soft aspect is defined as the dissemination and establishment of sustainable irrigated agriculture, which includes support and training activities for the beneficiaries. The hard aspect (design study, construction) for 1 year and the soft aspect (farming support and trainings) for 2 years are conducted as one package in each project site.

Schedule of the Activities in Each Project Site

Activity	1st year	2nd year	3rd year
1.1.1 Construction of water sources & irrigation facilities and land preparation	■		
1.2.1 Supply of seeds and farming tools to the beneficiaries		▲	
1.3.1 On-farm instruction in the project sites		■	■
1.3.2 Implementation of study tours to the advanced farms for the beneficiaries		▲	
1.4.1 Implementation of study tours to existing famers' cooperatives for the beneficiaries			▲
1.4.2 Implementation of leader trainings			▲
1.4.3 Support for application of official registration of agricultural cooperatives			■

Activity 1.1.1 Construction of water sources and irrigation facilities and land preparation (Timing of implementation: 1st year)

[Development of Water Source Facilities]
- Construction of shallow wells, ponds and sub-surface dams

[Field Improvement]
- Field improvement using heavy construction machines

[Establishment of Irrigation Facilities]
- As for the Home-garden farmers' group, a treadle pump is proposed to be used.

- As for the Home-garden farmers' group, a small-bore tube is planned to be used.
- As for the Beginner farmers' group with a pond, an engine pump is proposed to be used.
- As for the Beginner farmers' group with a shallow well, a solar pump is proposed to be used.
- As for the Beginner farmers' group, an irrigation network consisting of water tank, pipeline, and hydrants is planned to be established.
- As for the Beginner farmers' group with a shallow well (A), drip irrigation is proposed to be applied.

Activity 1.2.1 Supply of seeds and farming tools to the beneficiaries (Timing of implementation: 2nd year)

- The beneficiaries of the project are selected after the completion of the facility construction.
- The agricultural materials such as seeds and farming tools are supplied to the beneficiaries.

Activity 1.3.1 On-farm instruction in the project sites (Timing of implementation: 2nd – 3rd year)

- The farming instructors are assigned following a ratio of one person per 50 ha of the project sites. These persons go around the farmlands in the project sites and provide the farming instruction such as land consolidation, irrigation and cultivation management to the beneficiaries directly.

Activity 1.3.2 Implementation of study tours to advanced farms for the beneficiaries (Timing of implementation: 2nd year)

- The one day study tour to advanced farms is conducted for the beneficiaries to enhance their motivation towards agriculture.

Activity 1.4.1 Implementation of study tours to existing agricultural cooperatives for the beneficiaries (Timing of implementation: 3rd year)

- The one day study tour to existing agricultural cooperatives is conducted for the beneficiaries to deepen their understanding of the agricultural cooperatives.

Activity 1.4.2 Implementation of leader trainings (Timing of implementation: 3rd year)

- The one day leader training is conducted for the selected leaders of the beneficiaries to learn the basic knowledge regarding activities, regulations and procedures for the official registration of the agricultural cooperatives.

Activity 1.4.3 Support for application of official registration of agricultural cooperatives (Timing of implementation: 3rd year)

- The beneficiaries in each project site are asked whether they have the intension to establish a agricultural cooperative and to register it officially. If they have, the staffs of the MAEPE-RH and farming instructors support the beneficiaries for the official registration of the agricultural cooperatives.

Component 2: Capacity Development of the Staffs and Empowerment of Farming Support System of the MAEPE-RH

Component 2 focuses on the capacity development for the staffs of the MAEPE-RH in terms of project implementation and management and the empowerment of the support system for the beneficiaries in the project sites, existing farmers and agricultural cooperatives. As countermeasures of these issues, the following four points are indicated, which are 2.1) Capacity development of the staffs in the

MAEPE-RH for project implementation, 2.2) Capacity development of the farming instructors, 2.3) Preparation of the supply system of agricultural materials, 2.4) Clarification of the support for organizing farmers.

Activity 2.1.1 Implementation of trainings in terms of project implementation and management for the staffs of the MAEPE-RH

- Trainings are carried out for the staffs of the M/P promotion office, Directorate of Water, Agriculture and Forestry, Grand Works and Sub-Directorates for about 2 weeks in total.
- Third Country Training Program (North-Africa, Mideast, etc.) is included in the trainings in the subjects relating to facilities and agricultural techniques.
- Monthly meetings are to be held in the M/P promotion office to share and discuss the monitoring results of activities and progress of the project. This activity also contributes to the capacity development for the staffs as an On-the-Job-Training.

Activity 2.2.1 Implementation of trainings in terms of technical instruction for farming instructors

- Practical trainings regarding land consolidation, irrigation and cultivation management are carried out for the farming instructors assigned in the project sites.

Activity 2.3.1 Preparation of supply system of agricultural materials in the Directorate of Agriculture and Forestry

- First, it is necessary to check the stock status, and to prepare an inventory of the received materials. Besides, the list of registered agricultural cooperatives is also prepared for reference to the deciding destinations of these materials.
- The Directorate of Agriculture and Forestry in the MAEPE-RH clearly regulates the management method of agricultural materials in order to enhance the system capability for a proper materials management.
- A database of the quantity and kinds of demanded materials is prepared based on the list of agricultural cooperatives and requests from the cooperatives.
- Based on the inventory and the database mentioned above, the Directorate of Agriculture and Forestry in the MAEPE-RH makes the distribution plan of the agricultural materials. The Directorate of Agriculture and Forestry in the MAEPE-RH distributes the agricultural materials in cooperation with the staffs of the Sub-Directorates.

Activity 2.3.2 Establishment and operation of a subsidization scheme for the preparation of supply system of agricultural materials

- In addition to the supply system of the agricultural materials by the Directorate of Agriculture and Forestry in the MAEPE-RH, a subsidization scheme for opening and managing shops dealing in agricultural materials is established to promote the easier procurement of those materials by local farmers. Operation of this scheme starts from the end of implementation in the project sites of rank A and continues for 10 years.
- The NGOs or agricultural cooperatives or private suppliers that are willing to open shops dealing in the agricultural materials in the Arta, Ali Sabieh and Dikhil regions, are invited and selected. The selected organizations receive subsidies from the government for the rent, utility cost and the portion of labor cost. These organizations can receive subsidies for five years per shop. After the end of the subsidy from the government, these organizations receive support such as tax exemption, if necessary.

Activity 2.4.1 Clarification and official announcement of the support policy for agricultural cooperatives

- The staffs of the Sub-Directorates give support for the application of official registration of the agricultural cooperatives.
- The M/P promotion office and the Directorate of Agriculture and Forestry clarifies the support policy, giving registered cooperatives priority in terms of providing the agricultural materials given by donors or the farming support from the Government of Djibouti. The publicity documents of the policy are put up on the notice boards in each region. Besides, mass media such as radio or television are utilized for the publicity of the support policy.

5.6.2 Project Implementation Structure

For the implementation of this project, the preparation office is upgraded to the M/P promotion office after the decision of project launching described in 5.6.1 (5) 'Management Organizations and their Roles for the Project Preparation and Implementation'. Thereafter, the M/P promotion office carries out the management of this project. In addition, the regional Sub-Directorates under the MAEPE-RH are involved into the project office in order to coordinate with local authorities, and monitor the progress of the project at the sites that are widely spread out in the rural areas of southern Djibouti. Taking these points into consideration, the project implementation structure is proposed as shown in the table below. Besides, the farming instructors taking charge of the farming instruction to the beneficiaries are to be assigned at a ratio of one person per 50 ha of farmland in the project sites.

Project Implementation Structure (Draft)

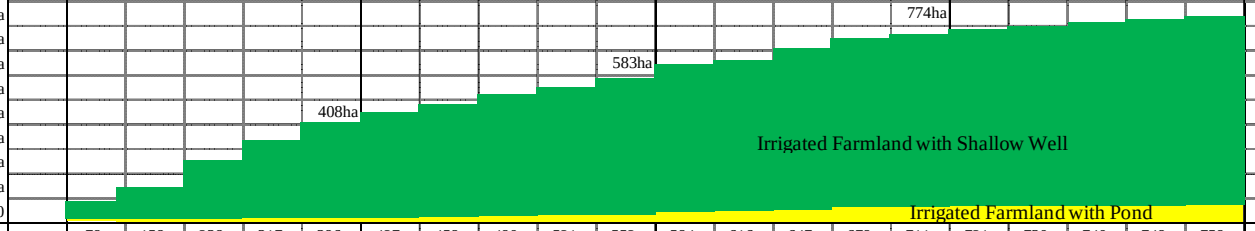
<table>
<tr><th colspan="2">Organization</th><th>Number of Members</th><th>Work Contents</th><th>Concerned Agency</th></tr>
<tr><td colspan="2">MAEPE-RH
Project promotion office for sustainable irrigated agriculture development project in southern Djibouti</td><td>2 persons
(Director, Assistant)</td><td>Allocation and execution of the project budget, management of the project implementation, coordination with donors and the concerned agencies, and etc.</td><td>Ministry of Environment, Ministry of Education, Ministry of Interior</td></tr>
<tr><td rowspan="3">Regional Sub-Director ate under the MAEPE-RH</td><td>Arta</td><td>2persons
(Regional director, Assistant)</td><td rowspan="3">Confirmation of the implementation contents at each project site.
Coordination and consultation with local authorities and concerned personnel
Monitoring of the project implementation of each project site
Selection of the participants
Training of farming techniques and maintenance of the facilities, and etc.</td><td rowspan="3">Regional Government</td></tr>
<tr><td>Ali Sabieh</td><td>2persons
(Regional director, Assistant)</td></tr>
<tr><td>Dikhil</td><td>2persons
(Regional director, Assistant)</td></tr>
</table>

5.6.3 Implementation Schedule of the Project

The activities establishing the project implementation structure are carried out in the 1st year, while the development activities in the project sites are implemented from the 2nd to 20th year in accordance with the priority of the project sites. The 16 project sites of rank-A, 10 project sites of rank-B, 17 project sites of rank-C, and 6 project sites of rank-D are implemented in every five years, respectively. The interim evaluation is conducted at the end of the short and middle term development of the project sites to check the results and lessons learned as reference to the next development term. Besides, the final project evaluation is carried out at the end of the project.

Overall Schedule of the Project Implementation

	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year	11th Year	12th Year	13th Year	14th Year	15th Year	16th Year	17th Year	18th Year	19th Year	20th Year	21st Year	22nd Year
Sustainable Irrigated Agriculture Development Project in Southern Djibouti																						
Preparation Period																						
Establishment of Project Implementation Structure	■																					
Component1: Development and Establishment of the Sustainable Irrigated Agriculture																						
Countermeasure 1.1～1.4：Short Term Implementation (A rank)		■	■	■	■	■																
Countermeasure 1.1～1.4：Middle Term Implementation (B rank)							■	■	■	■	■											
Countermeasure 1.1～1.4：Long Term Implementation (C,D rank)												■	■	■	■	■	■	■	■	■	■	
Component 2: Capacity Development of the Staffs and Empowerment of Farming Support System of the MAEPE-RH																						
【Countermeasure 2.1】Capacity Development of the Staffs in the MAEPE-RH for Project Implementation																						
Activity 2.1.1 Implementation of trainings in terms of project implementation and management for the staffs of the MAEPE-RH	■																					
【Countermeasure 2.2】Capacity Development of the Farming Instructors																						
Activity 2.2.1 Implementation of trainings in terms of technical instruction for farming instructors		■	■	■			■	■	■			■	■	■			■	■	■			
【Countermeasure 2.3】Preparation of the Supply System of Agricultural Materials																						
Activity 2.3.1 Preparation of supply system of agricultural materials in the Directorate of Agriculture and Forestry	■																					
Activity 2.3.2 Establishment and operation of a subsidization scheme for the preparation of supply system of agricultural materials		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■						
【Countermeasure 2.4】Clarification of the Support for Organizing Farmers																						
Activity 2.4.1 Clarification and official announcement of the support policy for agricultural cooperative	■																					
Project Evaluation						■					■											■
Irrigated farmland to be developed (Cumulative total value)																					829ha	
800ha																774ha						
700ha																						
600ha											583ha											
500ha																						
400ha						408ha																
300ha																						
200ha																						
100ha																						
0																						
Irrigated Farmland by Shallow Well (Perennial Farming) ha		79	158	238	317	396	427	458	490	521	552	584	616	647	679	711	721	730	740	749	759	
Irrigated Farmland by Pond (Winter Season Farming) ha		2	5	7	10	12	16	20	23	27	31	37	44	50	57	63	64	66	67	69	70	
Total Irrigated Farmland ha		82	163	245	326	408	443	478	513	548	583	621	659	698	736	774	785	796	807	818	829	
No. of Beneficiaries (Households) (Cumulative total value)		379	757	1,136	1,514	1,893	2,357	2,821	3,285	3,749	4,213	5,316	6,419	7,523	8,626	9,729	10,169	10,609	11,049	11,489	11,929	



5.6.4 Project Cost

Breakdown of the Project Cost (Unit: DJF)

Components	Items	Short term	Middle term	Long term		Total
		A rank (16 sites)	B rank (10 sites)	C rank (17 sites)	D rank (6 sites)	49 sites
Development and establishment of the sustainable irrigated agriculture	Construction cost	3,049,382,000	1,361,936,000	1,326,775,000	185,126,000	5,923,219,000
	Supporting cost for farming	137,075,000	73,117,000	106,764,000	36,554,000	353,510,000
	Training cost	31,920,000	14,160,000	20,640,000	7,920,000	74,640,000
	Project management cost	249,004,000	111,564,000	109,947,000	16,139,000	486,654,000
	Sub-total	3,467,381,000	1,560,777,000	1,564,126,000	245,739,000	6,838,023,000
Capacity development of the staffs and empowerment of farming support system of the MAEPE-RH	Training cost for the project operation and management	7,060,000	4,410,000	7,500,000	2,650,000	21,620,000
	Training cost for the capacity development of the farming instructors	4,191,000	1,873,000	3,123,000	1,339,000	10,526,000
	Operation cost of the subsidization scheme for the preparation of supply system	0	23,400,000	23,400,000	0	46,800,000
	Sub-total	11,251,000	29,683,000	34,023,000	3,989,000	78,946,000
Total		3,478,632,000	1,590,460,000	1,598,149,000	249,728,000	6,916,969,000

5.6.5 Project Effects on Vegetables and Fodder Production

(1) Project Effects on Vegetables Production

Fruit vegetables such as tomato and okra and leaf vegetables such as onion are designed to be cultivated in the farmlands developed in this project. The vegetables production is expected to increase through the implementation of the project. The self-sufficiency rate of vegetable is expected to reach 13.4%, which is about 2.4 times as much as that in 2007.

(2) Project Effects on Fodder Production

In regard to fodder, expected production is estimated from the present period to the end of the project. According to the data of PDDSP, fodder production was only 216tons in 2007. With the implementation of this project, annual fodder production is expected to increase to 18,019ton by the end of the project. It is confirmed that 50% of annual fodder consumption by livestock could be covered by fodder production of this project, especially in the case of the Beginner farmers' group, irrigating their farmlands with shallow wells. The increase of fodder production due to the project implementation helps enhance the resilience against drought.

Chapter 6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

(1) All the three shallow wells constructed in the pilot project can supply irrigation water throughout the year although more time and labor works than expected are required. Moreover, it is proved that the surface water stored in the pond can be a source of irrigation water for winter cropping. Lands can be developed into farmlands after good honest effort of removing gigantic stones and gravels from the ground surface. It is possible to harvest vegetables and fodder in all pilot farms without utilizing chemical fertilizer, but organic fertilizer made of livestock dung. According to the results mentioned above, it is verified that farming could be extended in southern Djibouti despite the severe environmental conditions.

(2) The pilot project participants in the three sites are former nomads. Thus, this was the first time for them to engage in farming activities. However, within this two years pilot project, they have learned elementary farming techniques, and could produce crops in their farm. Generally, while male participants take charge of the heavy works such as plowing and ridge making, female participants mainly work in irrigation, weeding and harvesting, which indicates that the farming becomes a family activity. Especially, women showed a positive attitude towards farming. By the last year of this Study, two agricultural cooperatives were established in two pilot project sites, indicating that the participants groups are about to be gradually well organized. They started collecting cooperative fees to buy fuel for the engine pumps, which is a first step for a sustainable agriculture. However, the farming activities in Kourtimalei were not well managed since their leader was not honest and the participants were not serious in carrying out cooperative activities.

(3) Taking into account the income and expenditure for farmers classified into groups based on skill and financial abilities, it is proved that each farmers' group can benefit from farming activities. Moreover, if farming skills are improved further and farmland is expanded, farmers can make enough profit to enable them to develop their shallow wells for production on their own. In fact, several participants of the pilot project have already started selling their harvested crops in nearby markets. In addition, because of profit made, some have opened small business shops to sell daily commodities and food near the pilot farm. Therefore, one can conclude that even if it is a small scale farming, it can stimulate the nomad people and the local society, which is proving the validity of this project.

(4) Several criteria, including water resources availability and accessibility, were selected to evaluate each project candidate site. Eventually, the study team selected 49 potential sites in southern Djibouti. Moreover, the study team calculated the size of the farmland that could be developed based on the scale of catchment area and the type of water resource. As a result, approximately 800ha of farmland is planned to be developed in the M/P. By implementing the M/P, the self-sufficiency rate of vegetables would increase from 5.6% (2007) to 13.4% (2035). Besides, the amount of forage production would also increase from 206t (2007) to 18,019t (2035).

6.2 Recommendations

(1) The beneficiaries are poor local residents who have none or little farming experience. Since the M/P is formulated to improve the livelihood and stimulate the local society, its implementation is urgently expected. However, this project of the M/P will be managed by the MAEPE-RH which does not have enough budget. Therefore, the M/P is formulated in consideration with the order of priority for project sites. These sites were fairly evaluated based on several criteria such as the demand from local residents, accessibility and reliability of the project. Thus, starting the implementation from the high priority sites would be appropriate.

(2) It is impossible for poor nomads or small farmers to pay initial costs for developing water sources, irrigation facilities and farmlands. Thus, public support is expected for the preparation of the

necessary facilities for farming. These facilities can be established through the existing techniques typically utilized in Djibouti. After its completion, approximately 12,000 households in southern Djibouti, where the population is 218,000, can benefit from it. Since this project has also high potential to develop sustainable agriculture, it is recommended that the MAEPE-RH implements it with the highest priority in the ministry.

(3) When implementing the project, only establishing the facilities is not enough. In previous projects supported by donors, the technical support for the farming activities was not well taken in account. Therefore, there are many cases where the on-farm technical support for farming activities was not enough after provision of the facilities and equipment. On-farm instruction is essential to enable farmers to acquire necessary farming techniques.

(4) Using pumps to intake water is necessary for agricultural production in Djibouti. Fuel is used as pump energy in Djibouti at present, while fuel procurement requires much time and money, which is a heavy burden for local farmers. However, solar power generation system has been recently established in several farms. This system has the advantage of being economically efficient considering service life, though it requires high initial cost. Thus, the further extension of the solar power generation system to the agricultural sector is recommended. However, it is not easy for local farmers or cooperatives to operate and maintain the system. Thus, support and instruction for the operation and maintenance of the solar power generation systems should be provided by the MAEPE-RH. For this purpose, trainings of concerned staffs of the MAEPE-RH and securing equipment and budget are required.

(5) The drip irrigation system is a promising irrigation method for water saving in Djibouti. Drip tubes are not expensive. However, the extension of the drip irrigation system depends highly on the domestic procurement of drip materials.

(6) The total number of project sites is 49, while the size of each site is small. It is obvious that the MAEPE-RH will not be able to manage securely the project proposed in the M/P based on its actual organization. It is indispensable to establish an M/P promotion office under the direct control of the secretary general and add several staffs in charge of this project to the M/P promotion office and Sub-Directorates in the regions. For this purpose, it is strongly recommended to increase the number of staffs. Also, it is important that this project contributes in developing capacities of the MAEPE-RH staff

THE REPUBLIC OF DJIBOUTI

THE MASTER PLAN STUDY FOR SUSTAINABLE IRRIGATION AND FARMING IN SOUTHERN DJIBOUTI

FINAL REPORT

Table of Contents

Attachment

Appendix

Annex

List of Figures

List of Tables

Chapter 1 INTRODUCTION

1.1 Background of the Study

Republic of Djibouti, with population of 820,000, holds very important trading location between Arab and Africa nations. Its service sector such as intermediate trading, service activities at Djibouti port and others covers more than 80% of Djibouti GDP. Although primary industry sector employs abundant engaging people, GDP from agricultural production does not reach to 5% of GDP because of very severe natural dry condition, which shows 30°C of mean temperature in March to October and 50-200mm of annual precipitation. A rate of the food self-sufficiency is very low to be the level of only 13% (2008) based on the value of production and then most of food for the population depends on importing.

More than a half of the population makes a livelihood on pastoral activities with goats, sheep, cattle cows and camels in scarce grassland. Recent meteorological change and draught reduce the product of the natural grass and make the pastoral activity more severe. Many livelihoods of pastoral people are supported by labor workings of family members such as works at the port in Djibouti City. Its chance and income of labor working, however, are not stable. To make matters worse, the nomads who lost most of their livestock due to the continuous severe drought starting from 2007 became refugee.

To improve above situation, the Government of Djibouti has set a policy that livelihood of the local pastoral people has been improved through agricultural activities. In National Initiative for Social Development (INDS), which was established in 2009 as a basic national development plan, development of basic condition of local nomad people is considered to be highly import policy. Based upon the policy of INDS, the Ministry of Agriculture, Water, Fisheries, Livestock and Marine Resources (MAEPE-RH) has commenced the projects following instruction of Food Security Program (PNSA) and Development Plan for the Primary Sector (PDDSP). The PDDSP includes increase of products for dates, fruits and vegetables and puts priority on use of surface flow water resource and construction and rehabilitation of wells.

MAEPE-RH also instructs project formation of irrigation and agriculture development in southern regions, namely Dikhil, Ali Sabieh and Arta, where half of pastoral population in Djibouti settle. In these southern regions, water resources for agriculture products are not abundant. However, water resources for the agriculture are only shallow wells around wadi, deep wells and three trial small ponds constructed by the Government of Djibouti. Agricultural technology using the above water resources is also very limited. Therefore, obtaining stable water resources and establishing farming system applicable to the local condition are very urgent to establish and develop sustainable irrigation farming.

Under such background and circumstance, the Government of Djibouti has required formulation of a master plan regarding sustainable irrigation and farming in southern Djibouti and requested the project to the Government of Japan. Responding the Djibouti request, JICA dispatched the project organization team for detailed project planning from October to November 2010 and made the agreement for basic framework with the MAEPE-RH. The both governments signed the document of Scope of Work (S/W) for the study project in August 2011.

Based on this S/W, the study team of "The master plan study for sustainable irrigation and farming in southern Djibouti" project has implemented the survey over a period from January 2012 to December 2014.

1.2 Objectives of the Study

Objectives of the Study are as follows.

- To formulate a master plan of sustainable agriculture development with water resource development in the arid area through verification of the pilot project
- To develop capacity of concerned government organizations on planning and project implementation through the master plan study and the implementation of the pilot project

1.3 Study Area

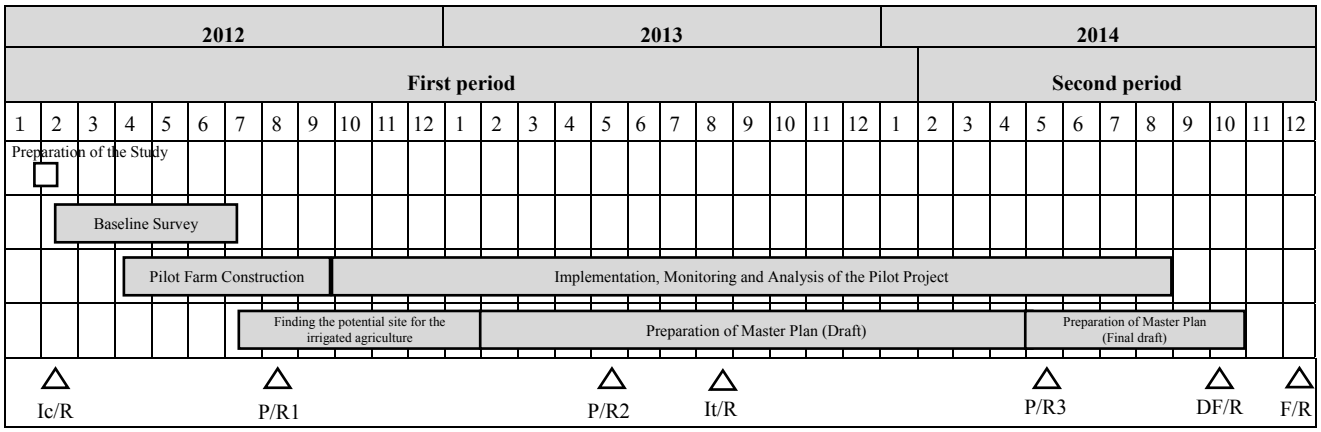
The study area covers the southern three regions of Djibouti, namely Arta, Ali Sabieh and Dikhil regions. The pilot project was implemented at Kourtimalei in Arta region, Hambokto in Ali Sabieh region, Afka Arraba in Dikhil region.

1.4 Contents of the Study

With the aim of improving the livelihood and reducing poverty of nomads in the rural areas, farming models were considered from the viewpoints of sustainable water resource management, efficient irrigation method, and proper cultivation system. Moreover, the pilot project was conducted to verify their adaptability and sustainability of the farming models. As for formulation of the master plan, the development potential was studied and development methodologies and subjects in the study area were considered in order to propose the development plan for sustainable irrigated agriculture.

1.5 Study Period

The Study was implemented by the following process.



Ic/R: Inception Report, P/R: Progress Report, It/R: Interim Report, DF/R: Draft Final Report, F/R: Final Report

1.6 Counterpart Agency

A counterpart agency of the Study is the MAEPE-RH including central main office and three Sub-Directorates in southern regions.

Chapter 2 BACKGROUND OF THE SOCIOECONOMY AND AGRICULTURE DEVELOPMENT

2.1 Socioeconomic Background

The Republic of Djibouti has gained its independence from France in June, 1977. Thereafter domestic struggles between tribes have continued quite a while. In September of 1992, a new constitution that included operation of government by plural party politics was established on the line of democracy driven by the president, Hassan Gouled. In April of 1994, Ismail Oman Guelleh became a president as a successor of Hassan Gouled. To this day, Hassant Guelleh continuously operates democratic administration for three presidencies.

The Republic of Djibouti is Muslim country located on the one corner of 'Horn of Africa', and has a land of 23,200km^2. It borders on Eritrea to the north, Ethiopia to the west and the southwest and Somali to the southeast. The Gulf of Aden that is the gateway of the Red Sea is on the east of Djibouti. As Djibouti is located in geopolitically very important position, France and United State of America have military bases in Djibouti. In June of 2011, Japan also opened the base of the Self-defense Force for anti-pirate mission after obtaining acceptance of the Government of Djibouti.

The Djibouti Bay facing the Gulf of Aden is an important strategic position for transportation and also a hub of economic activities. The activities and services in/around the port such as transportation, communication, construction, hotel lodging, banking and insurance, use of military base, etc. are main industries contributing 80% of GDP of Djibouti. This shows that Djibouti is a typical nation depending on transit trade economy. Transportation activities between Djibouti and Ethiopia are very frequent since Ethiopia has no connecting seaport necessary for conveying mass volume of mechanical equipment and materials. On the other hand, the primary and secondary sectors of Djibouti cover only 4% and 16% of GDP, respectively. However, the primary sector, mainly agriculture and pastoral activities is the important economic industry for rural people although it holds a low share of the GDP. Although the rate of GDP of the sector has been low at 3% for a long period, presently it became 4.3% (African Economic Outlook, 2013). However, recent long-term droughts and occasional flooding gave severe damages to rural life and productivity of agro-pastoral activities.

The population of Djibouti is reportedly about 820,000 (national census in 2009). The main tribes are Issa of Somali line and Afar of Ethiopia line, at 50% and 37% of the population, respectively.

Table 2.1.1 Economy of Djibouti

1. Major industry	Djibouti port service
2. GNI	1,049 million US$ (WB, 2009)
3. GNI per capita	1,270US$ (-do-)
4. Rate of economic growth	5.0% (-do-)
5. Rate of inflation	4.4% (-do-)
6. Total trade amount	Export; about 39.9 million US$ (EIU, 2009) Import; about 57.8 million US$ (EIU, 2009)
7. Main trading items	Export; re-export goods, local products Import; food, petroleum products, carts, machines & electric apparatus
8. Major trading country	Export; Somali, UAE, Yemen, Oman Import; Saudi Arabia, India, China, USA
9. Currency	Djibouti Franc (DJF)
10. Exchange rate	1US$ = 177.7DJF (fixed rate)
11. Major aid-giving country (2010, million US$)	1.France (46.22), 2.Japan (37.98), 3.USA (13.29), 4.Italy (0.44), 5.Norway (0.33)
12.Aid by Japan (till 2009, billion Yen)	1.Repayable aid of loan, E/N base (0), 2.Grant aid E/N base (27.228), 3.Technicalcooperation by JICA (3.674)

Source: Report document by Japanese Ministry of Foreign Affairs

2.2 National Development Plan

2.2.1 National Initiative for Social Development (INDS)

The basic plan for the national development of Djibouti was the Poverty Reduction Strategy Paper (PRSP), which started in 2009. The National Initiative for Social Development (INDS) is the plan succeeding to the PRSP. The INDS shows four pillars mentioned below.

Pillar 1 Accelerating growth and preserving the major macroeconomic balances
Pillar 2 Developing human resources and ensuring universal access to basic services
Pillar 3 Promoting harmonious, balanced local development and preserving the environment
Pillar 4 Anchoring the principles of good governance and building capacities

The agricultural sector in Djibouti strongly relates to Pillar 3. One of the key areas of Pillar 3 is "Agriculture and Rural Water Management" which shows the following five priority actions.

Table 2.2.1 Purpose, Strategy and Priority Actions Determined in the Agricultural Sector of INDS

Purpose & Strategy	Priority Actions
Alleviating the effects of drought and improving conditions of life for the rural populations	National Food Security Program (PNSA) Program to promote date palm cultivation
Promoting agriculture and improving the sustainable production of food based on the ecological and economical standpoint to contribute to food security	Special Food Security Program
Extending cultivated areas of market garden, promoting date palm cultivation and strengthening the capacities of national stakeholders	Medium-term national investment program New Partnership for Africa's Development
Combating desertification and promoting reforestation by planting windbreak and multiuse trees	Launch of a national project to promote reforestation
Mobilizing surface water, combating erosion, promoting planting and agro-pastoral	Project to mobilize surface water for agro-pastoral development and sustainable natural resource management

Source: National Initiative for Social Development (Strategic Framework), 2008

2.2.2 National Food Security Program 2012-2017 (PNSA)

The Government of Djibouti assisted by FAO and USAID formulated the PNSA in 2007 for the first time. In December 2011, a new program focusing on the successive 5 years was formulated and is currently managed by the MAEPE-RH and FAO. The program contains following 4 priority subjects, and each subject contains several projects to overcome problems.

(a) Ensuring Food Security
(b) Assistance to Vulnerable groups
(c) Introduction of Modern Technology and Export Support
(d) Support for the Implementation of PNSA

It is expected that the budget will be allocated by the Government of Djibouti (20% of total cost) and assist from several donors (80% of total cost).

The Study has relevance mainly with the priority subject "(a) Ensuring the food security" and "(b) Assistance to vulnerable groups" in the PNSA. The projects showed in the PNSA to overcome the both subjects are as follows.

Table 2.2.2 Projects Showed in PNSA

Main Subject	Name of Project
(a) Ensure Food Security	Production of staple foods in the agricultural farms conceded to Djibouti in Ethiopia and in Soudan
	Detailed study of the financial and economic profitability of the agricultural concessions
	Proposed establishment of a strategic food reserve in Djibouti
	Development program of a rural water supply - groundwater studies of underflows and resurgences in the regions of Dikhil and Tadjourah
	Draft study of 11 watersheds in the mobilization of surface water for hydro-agricultural development (study of hydro-agricultural watershed)
(b) Assistance to Vulnerable Groups	Support for Vulnerable groups, small farmers, herders, fishermen in the Republic of Djibouti
	Promotion of poultry production for rural women
	Project for the promotion of Beekeeping
	School garden project
	Capacity building of veterinary and animal health security
	Project Implementation of a Production Plant Food Livestock
	Development of deep groundwater in Djibouti - achieving 21 deep wells
	Development program for rural water 2 - Studies of ground underflows and resurgences in the regions of Arta, Ali Sabieh and Obock
	Project study for water supply from Lake, Region Afambo to Dikhil
	Project to create a Regional Centre of Excellence for the development of arid, semi-arid and Climate Change research

Source: PNSA

2.3 Outline of the Agriculture Sector of Djibouti

2.3.1 Agriculture

(1) Type of Agricultural Production

The main constraint in terms of performing agriculture in Djibouti is to ensure the source of irrigation water. The supply capability, sustainability and stability of irrigation water vary greatly with the type of water source. Therefore, farmers usually form their farms from the perspective of the type of water source. The source of irrigation water in Djibouti is classified into 3 types, namely, deep groundwater, shallow water (or shallow groundwater) and surface water.

In general, the farms with the water source of deep groundwater have relatively large areas and have potential to cultivate the crops throughout the year since the deep groundwater has higher potential of the supplying volume and stability. The date palm trees and tomatoes are often cultivated under the monoculture system in the farms using the deep groundwater established by private enterprises and the MAEPE-RH.

The farms with the shallow water or the shallow groundwater are relatively small and they are around 0.5 - 2 ha per each water source point because of limitation of supply capability and stability of the irrigation water. The main cultivation season in this type of farm is winter season starting from October - November. In general, several annual crops are cultivated in small scale. However, there are several farms possessing the water source providing enough volume of irrigation water. Crops are also cultivated in summer season starting from April - March in these farms. In addition, annual crops such as fruit trees are sometimes cultivated.

The Government of Djibouti has currently constructed ponds with excavation form in order to develop and utilize the surface water. However, the water volume in the ponds depends greatly on the rainfall. Thus, successive drought might lead to drying up of the ponds. Under this unstable circumstance, crops are cultivated only in winter season.

(2) Agricultural Production

According to PDDSP, the most of farmers in Djibouti engage in irrigated vegetable cultivation. The cultivated area is only 1,250 ha and the number of farmers is low, at approximately 1,700 people in entire country. The average cultivated area per person is 0.7 ha. Moreover, there are many farmers stopping their farming activities due to the severe drought or damage of farmlands and irrigation facilities by floods. Regarding the situation of regional agricultural production, more than 50 % of total cultivated area is located in Dikhil due to the existence of Gobaad and Hanle watershed producing a considerable amount of vegetables. There are other farmlands in Djibouti such as Ambouli located near Djibouti city, Damerdjog located in the watershed of Atar, Mouloud located in Dikhil region and Assamo located in Ali Sabieh.

Table 2.3.1 Cultivated Area and Number of Farmers by Region

Region	Cultivated area (ha)	Number of farmers	% of cultivated areas by region
Djibouti	204	250	16.4
Arta	148	230	11.8
Ali Sabieh	74	128	5.9
Dikhil	699	525	55.9
Tadjourah	108	452	8.6
Obock	17	115	1.4
Total	1,250	1,700	100.0

Source: PDDSP

The cultivated crops in Djibouti are varied. Tomato shows the highest production in Djibouti, while other vegetables such as pepper, melon and onion are also produced much more than other crops. As for fruit trees, the production of citrus and guava are large. However, due to the difficulty of grain cultivation in the country, the Government of Djibouti attempts to ensure the stable food supply to the country by the grain cultivation in 5,000 ha of leased farmland in Sudan and Ethiopia.

Table 2.3.2 Production of Vegetables, Fruits and Forages (tones)

Products	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07
Tomato	1,300	1,650	1,708	1,512	1,710	1,816	1,940
Auvergne	40	35	42	38	41	43	46
Beets	11	11	12	9	11	13	13
Carrots	8	8	9	5	7	9	11
Cabbage	11	8	9	6	5	6	6
Melon	100	130	136	97	151	176	194
Onion	108	128	139	112	116	119	121
Watermelon	80	70	78	63	69	78	78
Pepper	359	370	375	216	210	223	235
Lettuce	8	8	8	4	6	7	7
Mango	600	653	630	423	510	560	650
Guava	1,075	1,250	1,290	955	980	995	1,020
Citrus	1,800	1,900	1,980	1,385	1,215	1,230	1,250
Date	80	80	124	105	113	115	118
Fodder	250	390	295	195	225	210	216
Total	5,830	6,691	6,835	5,125	5,369	5,600	5,905

Source: PDDSP

As shown in the table above, the agricultural production is very low in Djibouti. According to FAOSTAT, the total food self-sufficiency rate in terms of the production value in Djibouti was in the range of between 13 - 42% in 1998 to 2008. The self-sufficiency rates of agricultural products are

quite low, ranging from 1 - 6%, while that of livestock product ranges from 51 - 80%. In case of the self-sufficiency rate of sheep and goat meat reaches nearly 100%. The self-sufficiency rate shows a decreasing trend from the year of 2002. However, the amount of domestic production has not changed in these 10 years, meaning that the sudden increase of domestic consumption corresponds to the decreasing trend of self-sufficiency rate in Djibouti.

2.3.2 Land Ownership System

Basically, all the land in Djibouti is owned by the government. While the right of land ownership is accepted officially in the urban areas, the land use in local areas is accepted by the regional customary system.

Issa tribe of Somalia clan lineage usually releases all the land as a common land. However, there are some residents claiming the customary right of land use especially in the land possessing high potential of water resource development such as the terrace plain of wadi. In case of Afar tribe of Ethiopia clan linage, on the other hand, it is necessary to obtain the permission of traditional chief (which is called Sultan) to take the ownership of land, since Sultan controls the right of land use in his territory. While the individual use of the land is accepted without compensation, the right of land acquisition or land trading does not exist.

Thus, it is indispensable to understand the traditional customary system and to consider the local residents in order to promote the agricultural development in the regional area. However, the complicated process such as the registration of farmland acquisition in the official institution is hardly required in the regional area.

2.3.3 Animal Husbandry

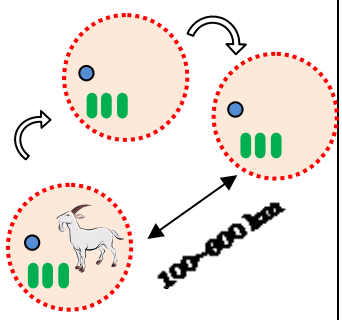
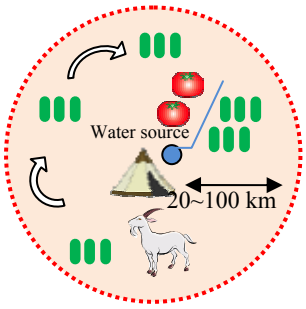
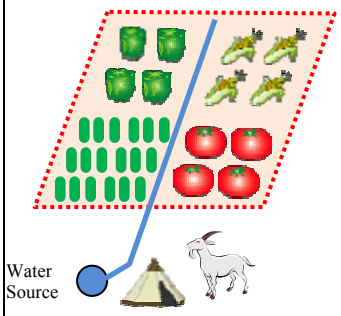
(1) Type of Livestock Raising

In Djibouti, the livelihood of local people depends mainly on animal husbandry. The livelihoods are categorized into three types as follows;

- Nomadic type: Total animal husbandry through roaming during the whole year from one field to another where natural forage is obtainable
- Semi-settled-and-semi-nomadic: Making base camp for family while males undertake nomadic life, spending life with livestock
- Settled type: Totally settled with livestock, roaming near the house or farming / purchasing forage for livestock.

The table below shows the characteristics of each type of livestock farming. Recently, the Nomadic type decreases because of continuous drought, which causes the reduction of natural pastures in the grazing land. In contrast, the Semi-settled-and-semi-nomadic type is increasing due to the assist regarding water resources and agriculture development from donors. The Settled type is also increasing by the support of the government and donors. However, there are still several constraints for the local residents to be settled since it requires farming skills and high initial cost to start farming.

Table 2.3.3 Characteristics of Type of Livestock Raising

	Nomad Type	Semi-settled-and-semi-nomad Type	Settled Type
Conceptual Diagram			
Rate	40 - 50 %	40 - 50 %	0 - 5%
Increase & Decrease	Decrease	Increase	Slightly increase
Number of Livestock	Large number	Small-Large Number	Small number
Range of Grazing	100 - 300 km	20 - 100 km	No grazing
Form of Livestock Raising	Households move to the place appropriate for the grazing. They cross the border if necessary.	Men usually engage in grazing activity. In contrast, women and children stay in the base camp. They sometimes work on the cultivation of vegetables in the small farm.	No grazing activity
Source of Food	Milk and meat from the livestock. Purchase in markets. Assist from donors.	Milk and meat from the livestock. Vegetables planted in their farm. Purchase in markets. Assist from donors.	Milk and meat from the livestock. Vegetables planted in their farm. Purchase in markets.
Source of Cash	Sale of livestock Sale of firewood, charcoal and salt	Sale of livestock Sale of milk Sale of firewood, charcoal and salt Sale of vegetables and fruits	Sale of livestock Sale of milk Sale of vegetables and fruits

Source: FEWSNET, 2011, The political economy of livestock policy: The case of Djibouti

(2) Species of Livestock

According to United Nations Data Retrieval System (2007), 512,000 heads of goats, 466,000 heads of sheep, 297,000 heads of cattle, 69,000 heads of camels and 8,800 heads of donkeys are reared in Djibouti. However, damage caused by the severe drought in the area of horn of Africa should be considered to estimate present number of the livestock. The numbers could decrease after the severe drought. Poultry is not active in Djibouti.

2.3.4 Strategy of Agricultural Development and Administrative Organizations

(1) Policy of Agricultural Development

Based on the concept of the national plan and the strategy (INDS and PNSA), the MAEPE-RH has formulated PDDSP as a basic strategy for the primary sector. The main target is to develop the environment for sustainable food security of the country. The measures should be comprehensive to contribute poverty reduction, promote economic development and spread it to rural areas.

In the PDDSP, the primary sector is divided into four (4) sub-sectors, as sub-sector of water, agricultural production, animal husbandry and fishery. The strategies for each sub-sector are mentioned in the PDDSP.

Project for agricultural development is concerned to the sub-sector of water and agricultural production. The potentialities and items of strategy are shown in the table below.

Table 2.3.4 Outline of Strategy in Sub-sector of Water and Agricultural Production in PDDSP

	Sub-sector of Water	Sub-sector of Agricultural Production
Potentiality	Despite difficult weather condition, the country has precious groundwater resources. Around 30 million m^3 are already used annually. To meet water needs of population, establishment of new water points are in progress (boreholes and cemented wells). In addition, the country strategy is focused on the development of surface water. Possible quantity to be used is estimated at 345 million m^3/year.	Despite severe agro-climatic conditions, the country has potentiality of agricultural development, particularly in terms of development of vegetable, fruit trees and forage grass. In possible irrigable area of 10,000ha, only 12% has been cultivated at present. The establishment of new water points, introduction of solar energy pump and investment to agriculture will promote agriculture development in the remaining irrigable area.
Items of Strategy	- Strengthening capacity of staff of the MAEPE-RH - Construction of access tracks - Mobilization of surface water - Educating of users and beneficiaries for the use of water resources - Creating new water points - Development and rehabilitation of drinking water supply in rural area - Management of natural source - Rehabilitation of water points - Promotion of solar energy pumping - Application of regulatory standard on water use	- Extension of irrigation system effectively using water - Application of quality seed and other appropriate inputs - Extension of agricultural techniques to farmers - Introduction of resistant crops to salinity and dry - Introduction of vegetable cultivation in greenhouses - Appropriate usage of existing water sources and development of new water sources

Source: PDDSP

(2) Administrative Organizations

The Government of Djibouti has 15 ministries. MAEPE-RH takes responsibility for the primary sector such as agriculture, animal husbandry, fishery, etc. and has duties of planning, implementing and evaluating the development projects. The number of staffs of the MAEPE-RH is 91 permanent staff and 162 temporary staff (as of 2009), total 254 persons. Annual budget of the MAEPE-RH is 1,355 million DJF (as of 2009), which accounts for only 3% of total national budget.

MAEPE-RH has five Directorates under the general secretary as shown in the figure below. Directorate of Agriculture and Forestry takes charge of matters of agricultural production, irrigation support, technical extension, etc. Directorate of Water is in charge of wells for water sources. And Directorate of Grand Works is in charge of establishment of ponds, recharge dams, etc. Five Sub-Directorates exist in the regions to conduct administrative activities and follow-ups in the regions for the MAEPE-RH in cooperative with the governors of the regions.

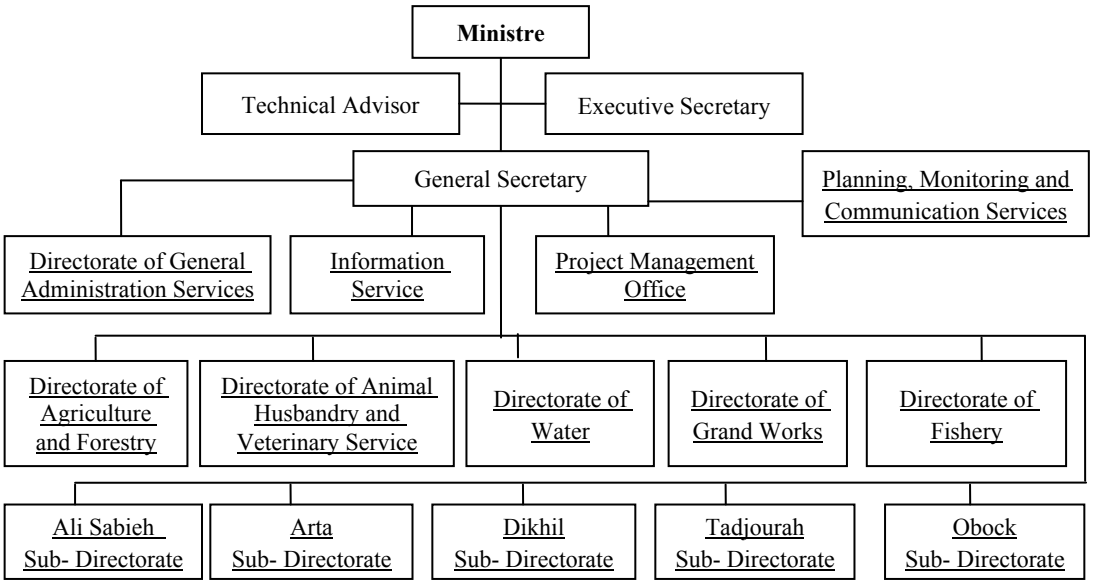


Figure 2.3.1 Organization Chart of the MAEPE-RH

2.3.5 Assist by International Organizations

Many international organizations have their offices in Djibouti. FAO and WFP assist the agriculture sector and AFD, UNICEF, EU and UNDP assist the water resource sector.

Outlines of the assist of the international organizations are shown in the table below. It can be said that most international organizations put emphasis on water resources matters. FAO, UNDP and WFP engage in assist for farmland development, agriculture and animal husbandry technologies.

Table 2.3.5 Assist in Agriculture Sector from Donors in Djibouti

Donor	Water Source	Materials for Production	Agricultural Technique	Assist for Nomad	Infrastructure
JICA	· Excavation of deep wells		· Training of agricultural techniques · Power plant for research institute	· Creation of education plan	· Road construction · Providing construction machineries for ponds
FAO	· Excavation of wells · Creation of water source map	· Establishment of farms · Providing agricultural tools and seeds	· Assistance of livestock technique · Training of agricultural technique	· Development of accessibility to water · Support for livestock health	· Formulating local organization
WFP	· Establishment of reservoirs (Food for Work)	· Providing agricultural tools	· Afforestation and tree planting · Development of vegetables/fruits production	· Establishment of school (Food for Work) · Food support	· Development of micro dams and protection for flood · Development of local road (Food for Work)
AFD	· Excavation of well (deep and shallow wells) · Rehabilitation of wells · Development of underground reservoirs		· Establishment of water management committee	· Support for education	· Development of protection for flood · Construction of micro dams · Rehabilitation of ponds
UNICEF	· Excavation of wells (deep and shallow wells) · Creation of the manual for water use management				
EU	· Planning of dam · Planning of flood control				
UNDP	· Development of surface water · Development of sub-surface dam	·	· Extension of agricultural techniques · Extension of chicken raising and bee keeping	·	· Strengthen the local organization · Development of irrigated farmland

The donors' projects highly concerning the Study are the following. Contents of the projects are mentioned in the Appendix.

Donor	Project
UNDP	Agro-Pastoral Pilot Farms Development Project (PACCRAS)
	Developing Agro-Pastoral Shade Gardens as an Adaptation Strategy for Poor Rural Communities
FAO	Emergency Assistance in Pastoral Areas of Djibouti
WFP	Food Assistance Activities (Food for Work)

Chapter 3 PRESENT CONDITION OF THE STUDY AREA

3.1 Location and Regional Administrative Organizations

3.1.1 Location and Outline of the Study Area

Figure 3.1.1 shows an administrative district of the study area, namely southern Djibouti which includes Arta, Ali Sabieh and Dikhil region. Although the area of Arta region is small, the wadi area of the east coast has a locational advantage for agriculture in suburban areas because it is very close to the huge consumption area; Djibouti city. Ali Sabieh region is bounded by Somalia and Ethiopia, having area of around one third of Dikhil region. In Ali Sabieh region, both farmland area and farmers' number are small. However, the number of population and livestock is fairly large. At present, nomadic grazing is more dominating than agriculture. Dikhil region is bounded by Ethiopia in the west and in the south, having largest farmland area and farmers' number among the three southern regions of Djibouti. Dikhil region is recognized to have a potential in developing agriculture and nomadic grazing from the viewpoint of large number of local population and livestock.

Figure 3.1.1 Location of the Study Area and Administrative District

Provincial capitals of each region, Arta, Ali Sabieh, and Dikhil are big consumption areas for agricultural products. In addition, local towns such as Damerdjog of Arta region, Ali Adde, Holhol of Ali Sabieh region and As Ela, Yoboki of Dikhil region are also recognized as consumption areas.

Table 3.1.1 Outline of the Study Regions

Region	Area* (km^2)	Population**		Agriculture***		Livestock****
		Whole Region (person)	Local Area (person)	Farmland Area (ha)	Number of Farmers (person)	Number of Livestock (head)
Arta	1,800	42,380	29,120 (69%)	148	230	25,854
Ali Sabieh	2,200	86,949	47,010 (56%)	74	128	98,708
Dikhil	7,200	88,948	64,062 (72%)	699	525	223,853

Source * : Wikipedia
** : 2nd Survey Result of Population Census 2009
*** : Development Plan for the Primary Sector 2010 - 2020
**** : National Survey for Livestock 2009

3.1.2 Administrative Organization in Region and in Village

(1) Administrative Organization in Region

Based on decentralization and administrative reform policy of the Ministry of Interior, five (5) regions of Djibouti have same organization form with regional government and regional council.

Regional government is composed by vice governor, election department, nationality department and administrative district chiefs under the supervision of the governor. The governor of regional government is justified by the Djibouti president order based on the recommendation from the Ministry of Interior.

The regional council is a legislative body having the legal authority in the region, which is composed by elected member and appointed member. The regional council has also authority for sale, money exchange, sharing, donations or bequests, succession of property, business transaction, etc. to be dealt by the regional residents. The chairperson of the regional council is elected among the regional council member. The chairperson has authority not only for preparation, operation and management of the regional council, but also for control of the regional budget.

(2) Organization in Region and in Village

The smallest unit for local administration is the village. The village heads of the pilot project sites are selected in various procedures depending on each village. The village heads are person in contact in the villages for regional administration. In Hambokto, the village head is selected by the governor of Ali Sabieh region, and he receives the reward as a village head. In Afka Arraba, the village head selected by the local residents is appointed by the governor of Dikhil region, and he receives the reward from the Ministry of Interior. In Kourtimalei, the village representative was selected when the distribution of the food assistance was started in 2008 by WFP, and he has been recognized as a village head until now.

3.2 Natural Conditions

3.2.1 Meteorology and Hydrology

(1) Meteorology

The climate of Djibouti is characterized as typical arid type with fluctuating and low rainfall and continuous high temperature in summer.

Meteorological observation had been conducted at 38 stations in the whole country since 1936. However, the meteorological data of most stations had not been collected after the early 1990s. The meteorological observation has been continued only at Djibouti airport. The installation of meteorological observation stations was started again on the whole country in 2013, and collecting and compiling of the meteorological data were restarted.

Annual mean precipitation of the southern Djibouti is extremely low, around 100 - 200mm, as shown in **Table 3.2.1.** It has two peaks of monthly rainfall in March and during the period from August to September. Precipitation is low in any months, so that it is obvious that precipitation is not enough for crop cultivation in Djibouti. In addition, the Horn of Africa region are experiencing consecutive drought since 2007. As shown in **Table 3.2.2**, the meteorological data of Djibouti reveals the fact that annual precipitation during the period of 2007 to 2010 was drastically low 50mm more or less, which is around one third of the past annual mean precipitation.

Despite of low annual rainfall, intensive rainfall has sometimes caused abrupt runoff on bare land surface, resulting in heavy flood damages along the wadi.

Table 3.2.3 shows other meteorological data. The maximum temperature rises over 40°C, and the minimum relative humidity is below 40% during summer season (June to August). The maximum wind speed rises in these months as well. In contrast, the temperature drops, and relative humidity rises during the winter season (October to April). Under such climate conditions, crop cultivation has been mainly made during winter season that is relatively cool.

Table 3.2.1 Monthly Precipitation in the Study Area (2013) Unit: mm

Site	Jan	Feb	Mar	Apr	Mar	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Arta	**2.5**	0.0	**136.7**	**5.2**	0.0	0.0	0.0	**5.0**	**12.0**	**17.0**	**1.0**	0.0	179.4
Ali Sabieh	**4.0**	0.0	**13.2**	**2.0**	**15.0**	0.0	**4.5**	**74.5**	**47.0**	**23.0**	**7.0**	0.0	190.2
Dikhil	0.0	0.0	**24.6**	**0.5**	**3.0**	0.0	**17.6**	**54.5**	**12.5**	**11.0**	**6.0**	0.0	103.2

Table 3.2.2 Annual Precipitation in Djibouti (2000 – 2011) Unit: mm

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Precipitation	143.8	48.2	201.4	90.7	207.6	96.2	182.5	**33.8**	**66.5**	**33.5**	**55.5**	**88.8**

Table 3.2.3 Monthly Relative Humidity, Temperature, Sunshine Hour and Wind Speed in Djibouti (2006 – 2010)

Item	Unit	Jan	Feb	Mar	Apr	Mar	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Maximum relative humidity	%	86	87	84	86	82	68	58	61	79	81	82	83
Minimum relative humidity	%	59	61	58	59	53	36	26	32	44	54	55	56
Maximum temperature	°C	29.4	29.9	31.0	32.7	35.7	40.8	42.2	40.7	37.4	33.9	31.5	30.1
Minimum temperature	°C	22.3	22.8	24.6	25.8	27.6	30.2	32.0	30.3	29.0	26.3	23.9	22.7
Sunshine hour	hr	217	203	250	231	273	258	273	254	276	261	225	237
Maximum wind speed	m/s	11.0	11.6	12.2	11.2	11.4	12.4	19.8	20.0	14.4	12.2	10.4	11.8

(2) Hydrology

Although hydrological data such as discharge of surface water and groundwater level are basic data for formulating water resources development plan, these data are not available in Djibouti at present. Thus, development of hydrological and meteorological observation station network has been proposed in the action plan of PNSA (2012 - 2017) or World Hydrological Cycle Observing System (WHYCOS) project of IGAD.

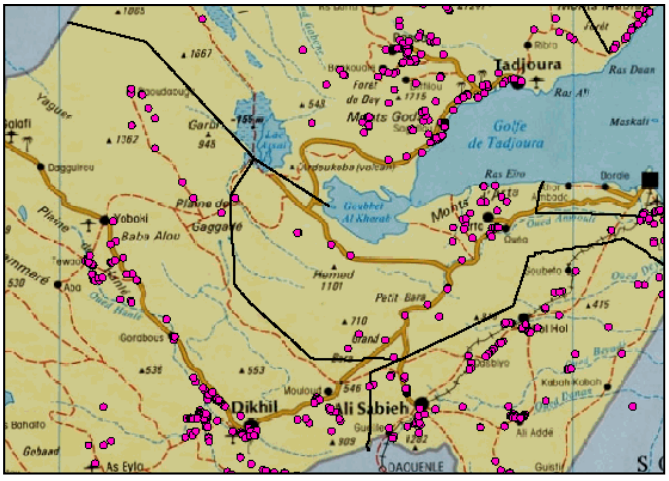


Figure 3.2.1 Location Map of Existing Shallow Wells and Deep Wells in Djibouti

Source: Preliminary Study Report on Water Sector in Djibouti, 2009, JICA

As localized hydrologic data, the contour map of groundwater level in Hanle basin was prepared with technical assist of Germany in 1980's. The location map of existing wells covering whole Djibouti was also prepared with assist of UNICEF as shown in **Figure 3.2.2**. This map was made by means of GPS software (ArcView) based on the field survey result.

3.2.2 Topography and Geology

(1) Topography

Djibouti is contained in south of the Afar triangle geological zones where Africa, Arabia and Somali tectonic plates contact each other. In the Afar triangle zone, the Great Rift Valley was formed by the expanding tectonic plates. This action reflects on a specified configuration of Djibouti. The center of Djibouti is undulating topography such as salty Assal Lake with an elevation of minus 157m to Moussa Mountain with elevation of 2021m in the northern area. Most area of Djibouti is mountainous topography characterized by lava of volcanic effusion except the coast area with alluvial deposit.

In the South of the study area, there is Abeh Lake that is lower end of Gobaad wadi flows. In the Southwest of the study area, there are ends of wadis of Hanle, which has large watershed, and Gaggade. In the ends of the wadis, flat and wide dry plains are formed and they are covered with water only in the rainy season. Elevations of the plains are 172m and 191m, respectively. In the center of the southern area, there are wide deserts, namely Grand Bara (El. 548m, Dikhil region) and Small Bara (El. 528m, Arta region).

In the Southeast of the study area, most wadi are running to Somalia and in the East of the study area, most wadi including Ambouli wadi are running to Aden Sea.

Up and middle stream of the wadis are in mountainous ranges of lava and supply sandy deposits to the middle and down-stream flat zones.

(2) Geology

Geology of southern part of Djibouti mainly consists of Basalt formation in/after Neogene except one part of southwest (south of Ali Sabieh region, Beyya Adde wadi watershed, etc.). Direction of fault and graben are NW-ES in north and NWW-ESS in south. Partially valley is covered with the Quaternary sedimentation.

The geology of Dikhil region, the western part of the study area including the watershed of Gobaad and Hanle wadi, is mostly characterized by basalt formation in Pliocene. A small part of Hanle watershed nearby Yoboki exposes Rhyolite in the same era. In the beds of both wadis, Quatenary sedimentation rock is distributed and a sediment layer of lime deposit is distributed between the sedimentation rock and bottom of Basalt. The lime layer sometimes contains mass of small snail fossils. The geologist of CERD says that the snail fossil is of lake deposit.

The geology in Beyya Adde watershed is of older era than Hanle and Gobaad watershed. In the upstream part of Beyya Adde, sedimentation rock of Jurassic to Cretaceous era is distributed. In the downstream side, Rhyolite of Neogene era (15M years) and Basalt of Neogen era (9 - 3.4M years) are distributed. In the middle-stream of Beyya Adde, Basalt of younger era (before 1M years), which is still older than that in Hanle and Gobaad watershed, is also distributed. The geological stratum of the southern Djibouti is shown in the table below. Geology covered whole of Djibouti is shown in Figure below.

Table 3.2.4 Geological Stratum

Era		Year	Geology
Quaternary	Pleistocene - Holocene	1.2M - Present	Alluvial Deposits Flood Plain Deposits, Deltaic Deposits, Alluvial Fan Deposits, Littoral Sediment, Coral Reef Limestone
Neogene	Pliocene - Pleistocene	3.3M - 1.0M	GOLF Basalt Rhyolite
	Miocene - Pliocene	7.0M - 4.3M	SOMALI Basalt
	Miocene - Pliocene	9.0M - 3.8M	DAlHA Basalt
Mesozoic	Jurassic - Cretaceous	- 64M	Sedimentary Rock、Ali Sabieh region

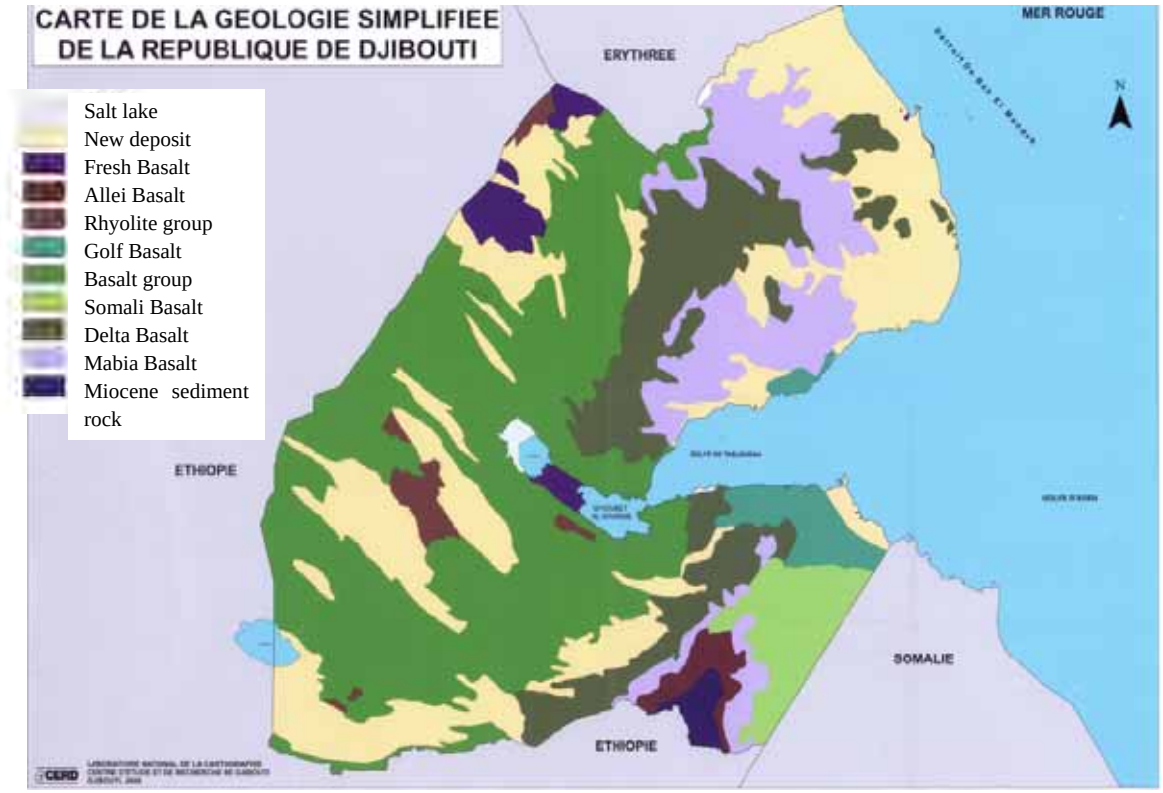


Figure 3.2.2 Geology of Djibouti

3.2.3 Groundwater and Water Quality

(1) Groundwater

In Djibouti, an aquifer exists in cracks and fissures of wide spreading volcanic rock (basalt and Rhyolite) and also in the layer of scoriae and/or fracture zone of fault. Cracks in the volcanic rock are formed during the cooling stage of erupted rock and by the movement of the rift valley. Along the wadi, where surface flow water after rain come, pervious sand and gravel deposit layer is formed and it is an aquifer of surface water.

Djibouti has scarce rainfall and high rate of evaporation. Therefore, rainfall cannot supply much water to aquifer in the rock foundation. If salty ingredients are accumulated by repetition of the evaporation, the salinity of the water in the aquifer increases. Under these natural conditions, development of abundant volume of the water in the aquifer is not easy for drinking. Most wadis in the study area flow to low elevation inland lakes. Salt is accumulated in the inland lakes by repetition of impoundment and evaporation.

(2) Water Quality

1) Electrical Conductivity (EC) and pH

Based on the guideline of WHO, the standard value of salinity for drinking water is determined as an EC value less than 1,500μS/cm. In contrast, "Water Quality for Agriculture" (FAO Irrigation and Drainage paper 29 Rev.1, Reprinted 1989, 1994) indicates the standard EC value of irrigation water as follows. The irrigation water exceeding 3,000μS/cm could cause the accumulation of salinity in farmland and impede the growth of agricultural crops.

Less than 700μS/cm: No restriction
700-3,000μS/cm: Slightly restricted to use
More than 3,000μS/cm: Strictly restricted to use

The table in the right shows the value of EC of irrigation water using in existing farmlands in Dikhil and Ali Sabieh regions. The irrigation water only at Ali Adde is over 3,000μS/cm. Others are lower than the standard value.

The pH value of irrigation water is an important factor in the selection of crops. Since the groundwater in Djibouti tends to be alkaline, high pH, it is necessary to select crops that can be grown in high pH conditions.

Table 3.2.5 The Value of EC and pH of Well Water in Existing Farmland

Area	EC (μS/cm)	pH
Assamo	1,700	7.83
Ali Adde	4,300	8.36
Dhourreh	1,800	8.07
Hambokto	2,200	8.12
Holhol	2,370	8.12
Afka Arraba	1,760	8.32
As Ela	951	8.16
Hanle	328	8.36
Mouloud	2,800	8.24

2) Other Chemical Matters

According to the "Preliminary Study Report on Water Sector in Djibouti", the chemicals of the groundwater such as Fluorine, Arsenic, Sulfate ion and Nitrate ion were examined. The Arsenic is a carcinogenic substance.

If the water containing considerable amount of Arsenic is used for irrigation, the Arsenic is adsorbed to the soil. It finally leads to the absorption of Arsenic by the crops irrigated. According to the report mentioned above, Arsenic contamination exceeding standard limits was found from the groundwater of the wells located in the rhyolite-distributed region in Hanle wadi and the traditional wells near Kouta Bouyya. Thus, it is necessary to examine the water quality before using the water for irrigation.

3.2.4 Soil

(1) Outline of Soil in Djibouti

Although a national scale soil survey was conducted at the beginning of the 80's in Djibouti, other soil survey has not been conducted after that. According to the PDDSP, the soils in Djibouti are classified as mentioned below.

- Leptosols (Lithosols): This type of soil is immature soil, which has thin surface layer (less than 10 cm). The rock bed (basalt) is observed within the 25cm from the surface. This type of soil is the most represented soil in the country and is found on plateaus and slope lands. The basalt is sometimes observed on the surface soil.
- Fluvisols: This type of soil is called alluvial soil. These soils are formed on the accumulations of brown or reddish soils derived from the basalt located in the upstream area. These are the soils covering most of the farmlands in Gobaad and Hanle watersheds and around Baras. The soils in the terrace surfaces of wadis are usually covered by the basalt rocks.
- Brown Tropical Soils and Kasanozems: These types of soils are usually found in the mountainous

areas such as Goba and Mabla. Although the soil fertility is high, the soil structure is weak and erosion is a problem.

- Except for the soils mentioned above, soils with weathering materials of coral and shale mixed with sand are found in the coastal plains.

The climate in the study area is a desert climate characterized as poor vegetation. Thus, the soil usually does not contain organic matters. The soil textures in the farmlands are usually sandy loam or loamy sand. Fluvisols are distributed around wadis while Leptosols are found in plateau areas. Fluvisols are the type of soil that is suitable for the cultivation of vegetables and fruit trees.

(2) Soil Fertility

The simplified analysis of the virgin soils in the pilot farms was conducted with the soil analysis kit. The results of the soil analysis are shown in the table below. The soil pH (H_2O) is more than 7.5, indicating that the original soil is high alkaline. Nitrate nitrogen and water-soluble potassium are considerably small in quantity. Therefore, the application of manure or chemical fertilizer is indispensable for the cultivation in newly established farmlands. Since the source of phosphorus such as rock phosphate or the accumulation of organic matter is not found in Djibouti, application of the phosphorus is necessary for the cultivation in newly established farmlands.

Table 3.2.6 Results of Soil Analysis

Soil pH (H_2O)	> 7.5
Nitrate nitrogen (kg/10a)	0-5
Water soluble potassium (kg/10a)	5-10

3.3 Water Resources

3.3.1 Classification and Characteristics of Water Resources

(1) Classification of the Water Resources

In Djibouti, fresh water resources are obtained from deep groundwater, surface flow water and seepage of rainfall. While 83.5% of rainfall evaporates to the air, the rest flows surface (6%), penetrates into sub-surface (5.5%) and ground (5%) (PDDSP). Water volume penetrating into sub-surface and ground is roughly estimated to be 345Mm^3/year (= 11.5% of total rainfall). This would be 3,000Mm^3 in volume and 130mm in intensity of the mean annual rainfall in Djibouti.

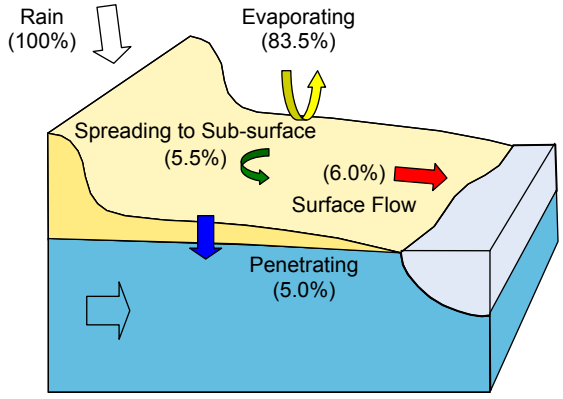


Figure 3.3.1 Conceptual Figure of Rainfall and Outflow

Since the Southern Djibouti has about 50% of total land, the roughly estimated maximum potential volume of the fresh water in the study area is shown in the table below.

Table 3.3.1 Rough Volume of Fresh Water in Southern Djibouti

Water	Volume (Mm^3/year)	Note
Surface flow	90	(3000M × 0.5) × 0.06
Spreading to subsurface	80	(3000M × 0.5) × 0.055
Penetrating to ground	75	(3000M × 0.5) × 0.05

On the other hand, there is deep aquifer in the rock basement that water originates in Ethiopia and Somali. According to the CERD report studying aquifer movement in the Hanle watershed in Dikhil region, penetration flow in Hanle watershed is roughly analyzed to be 37Mm^3/year.

(2) Characteristics of the Water Resources

From the viewpoint of usage of water, water resources are categorized and summarized as below.

1) Surface Water

This is water flowing surface and wadis. At the time of floods, water is diverted from a main stream to ponds and dams and stored. In Kourtimalei and Doudoub Bolole, ponds were constructed by the Directorate of Grand Works of the MAEPE-RH to impound floodwater. The characteristics of impounded water are as follows.

- Water is somewhat muddy and contains less salt.
- The impounded water volume varies every year depending on the amount of rainfall. There is loss caused by evaporation and penetration. Therefore, it is not stable water source for all year round.

2) Sub-surface Water

This is water retained in or seeping from wadi deposits. In the study area, many traditional simple shallow wells supply this water for domestic use. The water is fetched on manual or by a pump for domestic use, livestock and agriculture.

- Water is not necessarily fresh, but the content of salty ingredients is low.
- The water sometimes dries up in relatively short time, although it depends on scale of the wadis and depth of the wells.
- Wells in or nearby wadis can be potentially damaged by floods.

3) Shallow Groundwater

This is water retained in the foundation of Diluvium deposit and a top layer of rock foundation. Also the water naturally seeping from deep rock foundations is included in this category. In the study area, the water is frequently taken from shallow wells by pumps that are excavated in beds or in terraces of wadis and 5 - 7m deep (Gobaad wadi watershed). On the other hand, some wells about 10m deep that are excavated into the rock foundation along wadis can partially give the shallow groundwater in the rock foundation. Generally, the water in the rock foundation is used all year round since it does not dry up. In these cases, the water is very clean with a good quality. Characteristics of the shallow groundwater are as follows.

- Seasonal changes of water level and water volume are not large except in very severe series of drought. Constant use of the water for irrigation may be possible.
- If the water in rock foundation is found, the water is generally clean and good quality. However, excavation is tough and requires relatively more labor works and cost.

- Well points where the water is accumulated need to be selected based on geological and geographical condition. If a fault exists in the rock foundation, the fault forms boundary of a impermeable layer. And also, water paths to ground surface are easily formed. If the wells are established around the points, the water volume is often high.

4) Aquifer in the Middle Depth of Sediment Rock

Since the water in Quaternary sediment rock foundation is affected by marine deposit, the water has high salt content. Generally, the water cannot be used for domestic and irrigation purpose.

5) Aquifer in the Deep Rock Foundation

This is water penetrating into the rock foundations of Basalt and/or Rhyolite. Rainfall in distant places (Ethiopia) and in Djibouti penetrates into the rock foundations and reaches to the aquifer. In the study area, many deep wells are excavated and utilized mainly for rural society. In case of wells with abundant water volume, the surplus water is utilized for agriculture. Characteristics of the water are as follows.

- Aquifer is under confined condition.
- It is the most abundant water among usable water resources. However, it sometimes contains salt more than limitation of usage (EC=3,000μS/m). In this case, the water is not suitable for agriculture. (There are many cases in Ali Sabieh region.)
- There is a possibility that over establishment of deep wells cause environmental damages such as decrease of water level in a large area. There is a high possibility that using the aquifer for agriculture causes the damage since agriculture requires much volume of water.
- Since the initial construction cost for deep wells is considerably high, constructing deep wells only for agriculture would not be economically profitable.

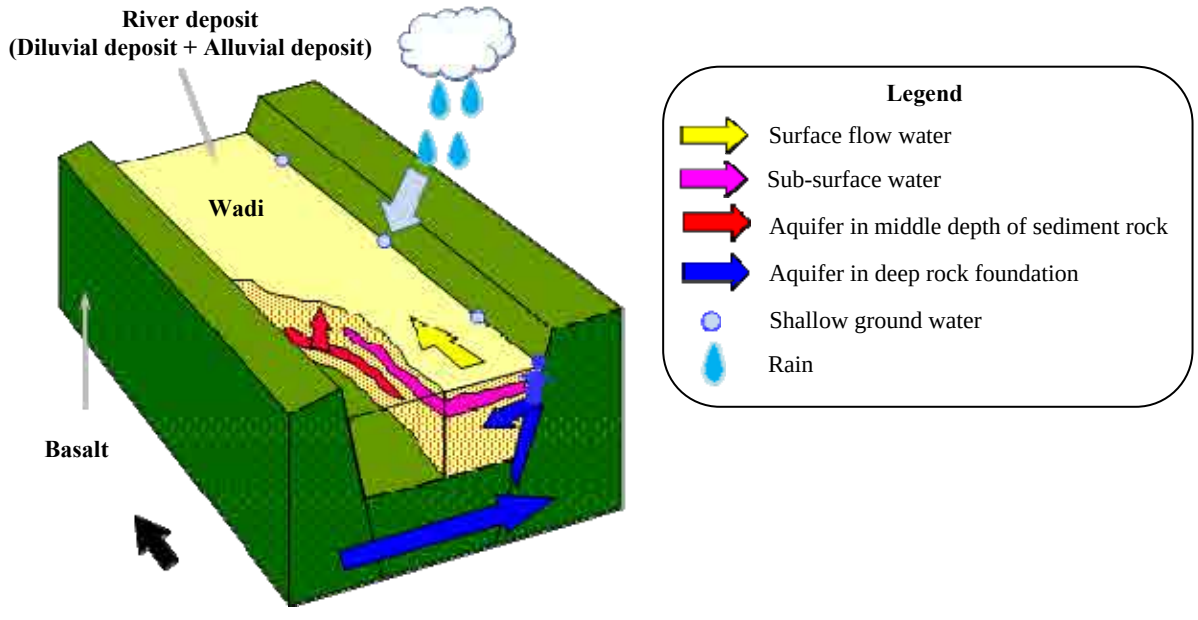


Figure 3.3.2 Conceptual Figure of Water Resources in Djibouti

Since this Study is in line with a program of surface and subsurface flow water development, the Study does not include deep wells as water resources. Then, mainly ① surface flow water, ② sub-surface water and ③ shallow groundwater are targeted as water resources in the Study.

(3) Facility of Water Source

Facilities of the water sources for agricultural development are shown in the table below.

Table 3.3.2 Facilities for Water Sources

Water resource	Facility	Location	Note
Surface flow water	Dam	Down-stream side of wadi	
	Sub-surface dam	Wadi	*reference
Sub-surface water	Shallow well	Edge of wadi bed, Terrace of wadi deposit	
Shallow groundwater	Shallow well	Edge of wadi bed, Foundation rock of terrace of wadi	

***Reference: Sub-surface dam**

Sub-surface dam is a facility to stop water in the foundation of wadi deposit. After the excavation of the wadi foundation, an impervious wall with clayey soil or concrete is placed in the foundation. The water is stored in the void of gravel and sand of sediment. As water surface is not exposed in the open air, it is effective in the high evaporation area such as Djibouti. Two or three candidate sites are identified in the study area.

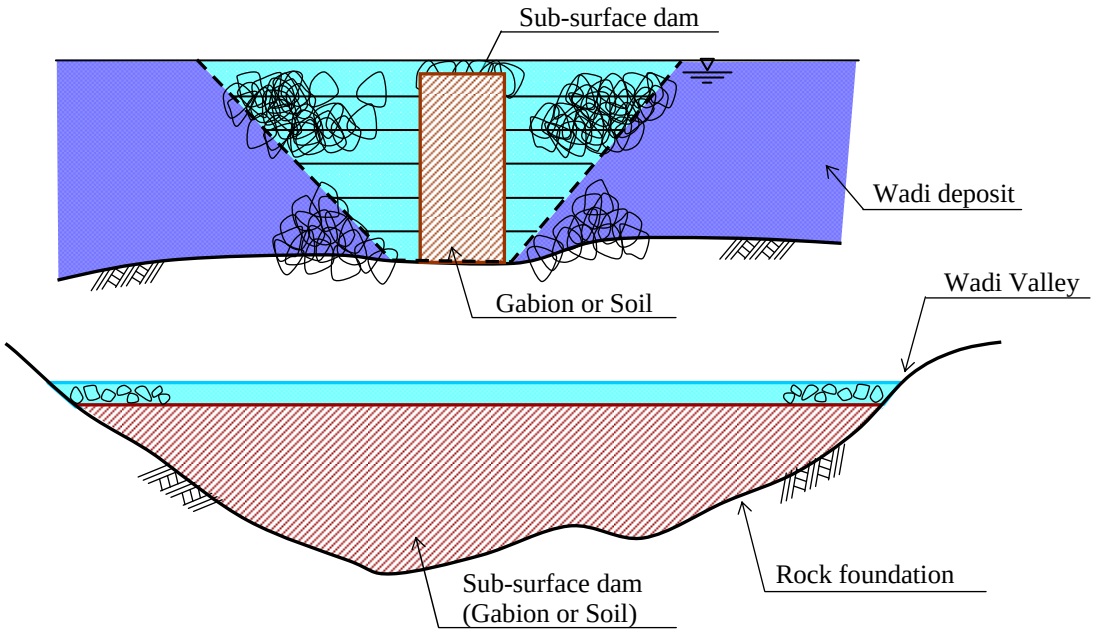


Figure 3.3.3 Illustration of Sub-surface Dam

There is another method that the dam is established both as a sub-surface dam and as a surface dam by establishing higher impervious wall. In this case, it is an advantage that the surface flow water also can be stored. However, a careful geological survey is required to select the sites.

3.3.2 Issues of Water Resources Development

During the field survey, the study team conducted site observation, collection of data, discussion with persons concerned, etc. Based on these, issues regarding water resource development are summarized as follows.

(1) Water Resources Development

(a) In case of pond development in Djibouti, bases of scale of ponds are not clear although the

purpose is recognized. Developed area and place to use the water were decided after observing water stored. Although such development is one of the methods, the facilities established may be useless scale or over scale. Development of ponds should be planned based on the information such as topography map of ponds and geology and runoff analysis in consideration with size of the watershed etc. However, precipitation data and data to estimate evaporation volume and rate of outflow of flood, etc. are not available. Development of these data is expected.

(b) The sub-surface water in/around wadis is the most easily developing water resource among the target water resources in the Study. However, the facilities for water sources may be damaged by floods many times, and the durability as sustainable water source may be low. Repairing or resettling the wells should be supposed for long term use.

(c) Shallow groundwater is the resource of good quality water and the comparably convenience resource for year-round use. Although some water sources are deep aquifer which may penetrate to sub-surface through cracks, mainly the water is the mixed water that includes rainfall penetrated into and seeped from rock foundation and the water penetrated into wadi bed. Identifying the water points for the shallow groundwater is not easy since the points are related to geology and fault formation. Although information that old people in the areas have may be useful to identify the points, there are not so many water points in the study area.

(2) Development of Water Resources Facilities

(a) Many shallow wells along wadis were damaged by floods and abandoned. These shallow wells can be relatively easily rehabilitated and used immediately. In order for local people, who have experience of farming before, to restart farming, rehabilitation of the existing shallow wells is one of the priorities and prompt implementation is required.

(b) In Small Bara Desert, one small dam which established in French era was abandoned because of the damaged embankment. It is required to study the causes and to plan the dam that would not be damaged frequently. However, it should be considered that the investment cost would not be too high. For example, a device is needed to be damaged only at a certain point and to be rehabilitated easily even if the dam would be damaged.

(c) Recently, the Directorate of Grand Works in the MAEPE-RH has constructed micro recharge dams to recharge water for water sources. In 2013, one recharge dam was constructed in the up-stream vicinity of Hambokto pilot project site. As a result, positive effect that wells in the down-stream keep higher water level is perceived. The recharge dams are very attractive method for Djibouti that has severe water condition. The structure in Djibouti is that an impervious wall made from cemented stones is established in upper part of wadi deposit (2 - 3m depth). By the recharge dams, floodwater is temporarily stored, gradually penetrates into the bed and down-stream, and recharges the groundwater around the dams. Since the recharge dams don't require deep impervious wall reaching to foundation rock, the cost of construction is usually not so high. In the down-stream of a section for floodwater to flow out, stone-pile is set and covered with concrete. During flood, massive water flows over the section with high velocity. As a result, heavy erosion of wadi was caused in existing dams and the stone-pile and the concrete were damaged. Therefore, adequate protection such as wide placement of gabion against water-flow impact is necessary.

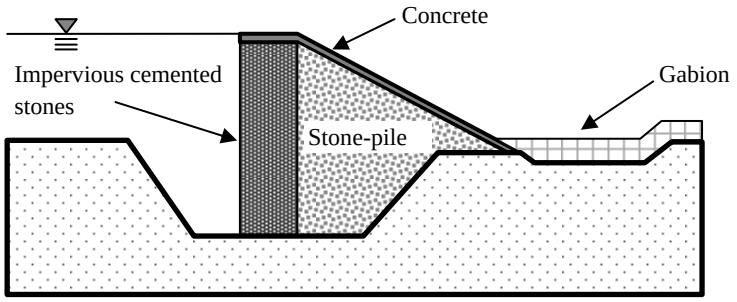


Figure 3.3.4 Micro Recharge Dam

(d) In case of development of any water sources, initial cost cannot be covered by poor local people. Obtaining the budget or clarifying role of official assist is important subject to be considered.

3.4 Agriculture and Animal Husbandry

3.4.1 Agricultural Land Use

The figure below shows the distribution and size of existing farmlands in the study area. Although there are some very small farms like home-garden in the study area, such farms are not included in the figure. Areas which have the major farmlands are quite limited and also the size of existing farms in each area is generally small. Since the farmlands are established in areas where irrigation water is available, most of the farmlands exist along wadis. The farms established by individual residents are usually small scale and have shallow wells as irrigation water sources. On the other hand, the farms established by assistance of donors or MAEPE-RH exist near wadis and also in low and flat areas since the farms have deep wells and irrigation systems.

1) Arta Region

In Arta region, farmlands were confirmed in Douda, Damerdjog and Atar. The irrigated farms in these areas are located in 200 - 300m far from the coast of the Gulf of Aden and the altitude is low; 20 - 50m. The farms are established along wadis which have relatively large watershed. Size of each farm is around 1 - 2ha. Although water sources of the farms are mainly shallow wells, salinity of the water tends to be high due to the location. Water flows in the wadis only when it has rainfall which happen several times in a year. The farms in these areas have been damaged by the floods when the rainfall is heavy.

2) Ali Sabieh Region

In Ali Sabieh region, farmlands were confirmed in Holhol, Hambokto, Assamo, Ali Adde and Dhourreh. However, size of the total farmlands of each area is relatively small, which is less than 50ha. The altitude of each area is around 400 - 650m. Although the farms in these areas are usually established on the terraces of wadis, some farms are established in the slope land along the wadis.

3) Dikhil Region

Farmlands in Dikhil region were confirmed in Hanle, As Ela, Afka Arraba and Mouloud. The altitudes of As Ela and Hanle are 300 - 400m and 150 - 200m, respectively. As Ela and Hanle are prominent vegetable production areas in Djibouti. The sizes of their farmlands are approximately 343ha and 120ha, respectively. Most of the farms in these areas are located on terraces along the big wadis such as Gobaad and Hanle. The general farm size is approximately 0.5 - 1ha in both areas. Irrigation water sources in these areas are mainly shallow wells excavated on the terrace along the wadis. The farms, shallow wells and irrigation facilities in As Ela and Hanle were damaged by the excessive floods in 2010.

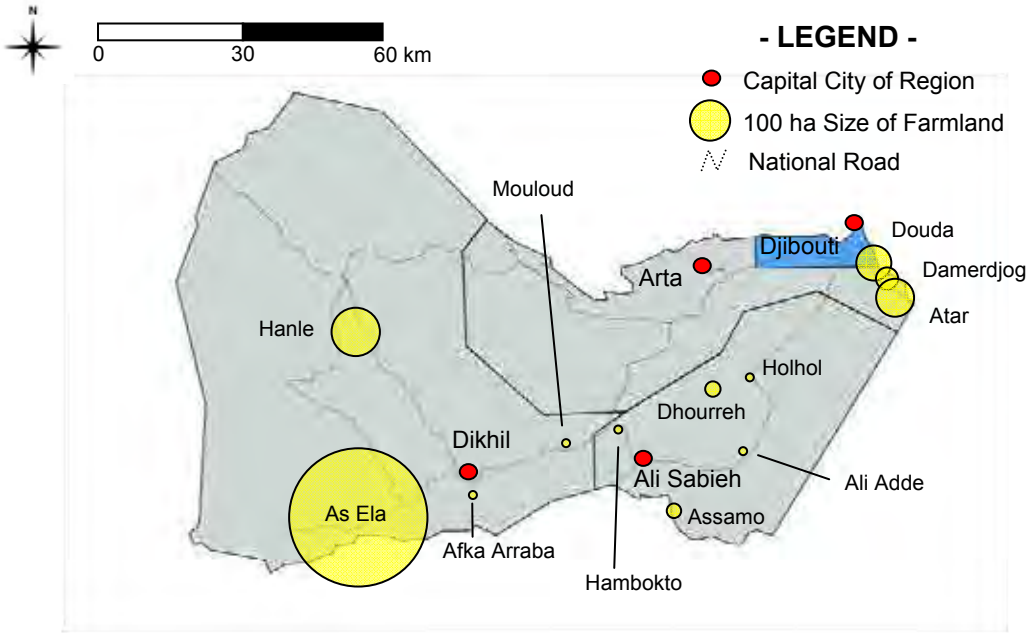


Figure 3.4.1 Spatial Distribution and Size of Major Existing Farmlands in the Study Area

3.4.2 Agricultural Production and Farm Management

(1) Study Area

Farmers in the study area generally cultivate some annual crops (vegetables and fodders) and tree crops (fruit trees and fodder trees). In addition, they raise livestock, mainly goat and sheep, and use the dung as manure for the cultivation. Therefore, their farm management is multiple farming.

It is suggested that agricultural production in Dikhil region is the largest, since the cultivation area in this region is the largest in Djibouti. There are many farmers cultivating fruits in Assamo, Ali Sabieh region. And there are many farmers cultivating vegetables in Damerdjog, Arta region that locates near Djibouti city.

1) Cultivated Crops

Based on the field survey and documents, the major crops cultivated in the study area are shown below. However, kinds of the crops are not many. Cultivation of tomato, onion and melon is major among the crops below while almost no major grain is cultivated in the study area.

Vegetables	Tomato, Onion, Green pepper, Okra, Eggplant, Table beet, Melon, Watermelon
Fruits	Guava, Mango, Date palm, Citrus, Papaya
Fodders	Sorghum, Guinea grass, Rhodes grass, Moringa, Leucaena

Generally, farmers divide their farms into small plots. They select some crops from the above mentioned crops and cultivate one crop in the one plot. Simultaneously, they cultivate fruit and fodder trees between the plots. However, there are both farmers who cultivate crops in small scale like a home-garden and who commercially cultivate crops with advanced management.

It is suggested that there are few farmers who have more than ten years' experience in crop cultivation except the advanced farmers. And also it is difficult for farmers to get information and materials regarding the cultivation. Therefore, cultivation techniques of most farmers are still in elementary level. However, number of farmers is increasing in recent years. They watch the advanced farmers and start small scale cultivation like a home-garden by themselves.

2) Agricultural Inputs

Suppliers of agricultural inputs are very few and most agricultural inputs are sold only in Djibouti city. Although farmers can buy seeds and tools in Djibouti city, it is difficult to buy chemical fertilizers and pesticides even in Djibouti city because of their availability. Therefore, they usually don't use the chemical fertilizers and the pesticides. In addition, once they get the seeds, many farmers collect seeds from the fruits harvested and use them for the next cultivation. The farmers use manure for the cultivation as a fertilizer. In the case of large scale farmers, they sometimes get additional manure from their neighbors who have livestock. The difficulty to get the agricultural inputs is one of the causes of low yields. However, buying the agricultural inputs increases the production cost and they require proper techniques to be used. Therefore, the farming style needs to be decided in consideration with production purpose (for self-consumption or sales), level of cultivation techniques and so on.

3) Sale

Small scale farmers consume their products and also sell them to neighbors and in nearby markets individually. On the other hand, a few farmers, who commercially cultivate in relatively large scale, transport their products to Djibouti city, which is a large consumption area, and sell them there.

(2) Pilot Project Area

Since the documents and the statistical data are not sufficient, detailed information regarding agricultural production and farm management were not obtained. Therefore, the present situation of the agricultural production and the farm management in the pilot project areas are described below based on the results of questionnaire survey targeted small scale farmers in the pilot project areas.

1) Size of Farmland

Although the data of exact size could not be collected, the average size of farmland is around 3,400m^2 and 15,000m^2 is the largest.

2) Cultivation Area, Harvested Quantity and Yield

Each farmer cultivates several kinds of vegetables in small scale. The cultivation area of each major crop in each farmer seems to be about several hundred m^2. However, cultivation area of tomato, onion, melon and watermelon are relatively larger.

Regarding production quantity, one farmer harvests about 160 - 200kg of tomato, 150 - 270kg of onion and 35 to 60kg of green pepper in a year. Regarding the yields, tomato is 1 - 3tons/ha, onion is 1 - 2tons/ha, melon is around 0.7tons/ha. The yields are very low in comparison with general yields.

3) Cropping Season

The major cropping seasons are summer cropping season (March to August) and winter cropping season (September to February). Because of high temperature, kinds of crops cultivated in summer are limited and melon, watermelon, okra and fodder crops are major crops in the summer cropping season. On the other hand, other crops and the crops of summer cropping are cultivated in winter.

The harvest seasons of fruit trees are May and April for guava, June and July for mango and July and August for date palms.

4) Consumption and Sale

About 10 - 20% of the harvested quantity of vegetables is consumed at home and the remaining vegetables are sold. The vegetables harvested are mainly sold to neighbors and in the nearby markets. The selling prices of tomato, onion, green pepper and watermelon are about 100 - 160DJF/kg and that of melon is about 150 - 200DJF/kg.

3.4.3 Animal Husbandry

Most residents in rural areas are semi-settled nomads or former nomads who are target groups of the Study. Therefore, almost all of the households have some livestock. Number of livestock by region in the study area is shown in the table below.

Table 3.4.1 Number of Livestock by Region in the Study Area (2009)

Region	Sheep	Goat	Cattle	Camel	Poultry	Donkey	Total
Arta	3,205	18,405	600	1,317	1,789	538	25,854
Ali Sabieh	15,715	70,537	156	10,374	275	1,651	98,708
Dikhil	46,624	143,251	13,304	18,579	446	1,649	223,853
Total	65,544	232,193	14,060	30,270	2,510	3,838	

Source: National Livestock Survey, 2009

In the study area, the number of goat is the highest followed by sheep and camel. On the other hand, number of poultry is very low. Among the regions, the number of livestock is the highest in Dikhil region and the lowest in Arta region.

However, documents and statistical data to understand the detailed situation regarding animal husbandry are not sufficient. Therefore, the present situation of animal husbandry is described below based on the results of the questionnaire survey targeted residents in the pilot project areas.

1) Households Raising Livestock

Although 96% of the households are raising livestock, they raise livestock by using natural grass with nomadism or pasturing. They don't raise livestock in barns. About 30% of the households raising livestock continue complete nomadism in 2011. However, most of the nomads are semi-settled nomads that only some parts of the family members move with the livestock.

2) Kinds and Number of Livestock

The livestock raised are goat, sheep, donkey and camel. The number of goat is the highest at present and it is 23 heads per household on average. Following that, the number of sheep is second and it is 3 heads per household on average. However, the number of livestock has decreased drastically due to the drought in recent years. In case of goat which is the most popular in the study area, the number decreased from 96 heads before the drought to 23 heads per household after the drought on average. It means that the number decreased by 76%.

3) Consumption and Sale of Livestock

A household annually consumes or sells about six goats and two sheep on average. Within the numbers, about 60% of goat and sheep are sold. Generally, they sell the livestock directly to residents in adjacent towns.

3.4.4 Farm Household Economy

Based on the results of questionnaire survey conducted in the pilot project areas, annual income and expenditure of farm households is estimated.

1) Income

The biggest income source is "sales of livestock", which accounts for 28% of the total income. The percentage of "others (including the food assist from WFP)" is also a relatively bigger income source, which accounts for 20%. The third biggest income source is "salary of part time job" (20%). The percentage of "sales of agricultural products" is 8% and it is not so high. These results show that a farm household has several income sources including the sales of livestock to maintain their life. The average annual income per farm household is 247,000DJF/year approximately.

2) Expenditure

Engel's coefficient which shows a proportion of food expense to total expenditure is 78%. Therefore, expenses of clothes and education are limited. In addition, the food expense includes the food assisted by WFP even though the households cultivating crops need to spend a large proportion of income on food which is indispensable to life. The average annual expenditure per farm household is approximately 236,132DJF/year.

Since average number of people in a household is 5.5 persons in these areas, the daily expenditure per person is 118DJF (0.66US$). Therefore, it shows that they live on less than 1US$ a day that is generally said below poverty line.

3.5 Irrigation

3.5.1 Current Situation of Irrigation System

Various types and levels of irrigation system from traditional irrigation to modern irrigation are observed in Djibouti, and those can be categorized in terms of types of water sources and levels of irrigation modernization.

Three types of water source are available for irrigation purpose: 1) deep wells having use of deep groundwater, 2) shallow wells having use of shallow groundwater, and 3) ponds having use of surface water. In term of stable water supply, the deep wells have the highest stability, followed by the shallow wells and the ponds. In regard to irrigation modernization, it is classified into the following three stages: 1) traditional irrigation characterized by surface irrigation and earth canal, 2) surface irrigation improved by adopting concrete lining canal or pipeline network to improves water distribution efficiency, and 3) advanced irrigation modernized by adopting drip irrigation to improve water use efficiency and irrigation workability further more. Irrigation system in Djibouti is therefore categorized as shown in **Figure 3.5.1**. Typical examples of each irrigation system are shown in parentheses on the figure.

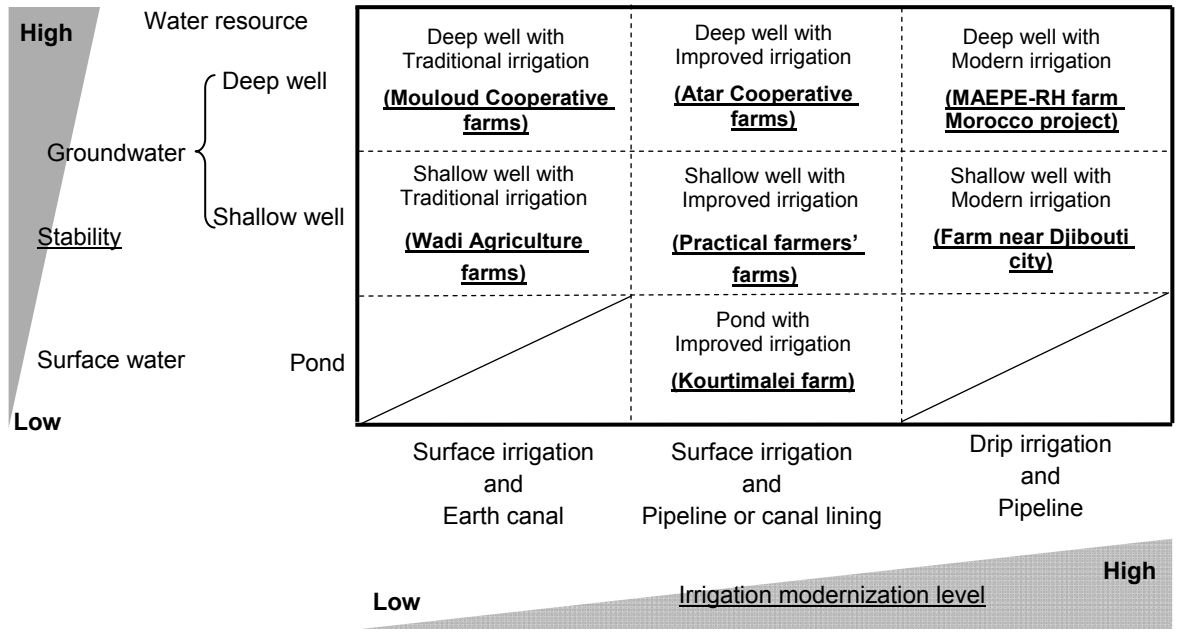


Figure 3.5.1 Classification of Irrigation Systems in Djibouti

Each irrigation system is outlined below.

(1) Irrigation System Using Deep Wells

In 1980s, irrigation systems having use of deep wells have been introduced by agricultural development projects of the Government of Djibouti. Group irrigation of Mouloud and Atar agricultural cooperatives is cited as examples of those projects. Traditional surface irrigation is applied at on-farm level, and distribution canal network with earth or concrete lining is developed at these project sites.

In recent years, modern irrigation systems combined with drip irrigation and pipeline networks are highlighted in Djibouti. Typical case example is the Damerdjog farm which was established with support by the Government of Morocco. Meanwhile, the Government of Djibouti has hammered out a policy in order to encourage private investors to accelerate investment for agricultural development. So that agribusiness farms equipped with modern irrigation system have been developed in PK20, Ali Sabieh and other sites. This type of irrigation system is substantially contributing to boost the production of vegetables and fruit trees.

In regard to this type of irrigation system, the biggest constraint is high initial cost for the development of deep well. Therefore, financial support from the Government of Djibouti or donors is expected to be provided. Deep groundwater is recognized as the most stable water source in supplying irrigation water. In reality, irrigation system having use of deep well is considered as a prospective agricultural development model to realize crop production with high productivity and quality.

(2) Irrigation System Using Shallow Wells

Irrigated agriculture using shallow well was initiated by Yemeni immigrant in 1870s, and then has been gradually spread on the side among the nomads. This type of irrigation systems is employed by most of agro-pastoralists and farmers in Djibouti. It is widely observed that they lift water up using small engine pumps from the shallow wells constructed along wadis, and irrigate their farms in surface irrigation manner. It needs laborious work especially for excavation of the shallow wells. However, it is low cost water source development approach because the work can be done by farmers themselves.

As for stability of water source, it depends on the site condition. It is acknowledged that the farmers

owning stable shallow wells are making high profit by means of improving irrigation and farming manner. Moreover, some farmers had modernized their irrigation equipment with a set of drip irrigation and sunshine shade under the assisting scheme of the donors.

The biggest challenges of this irrigation system having use of shallow wells are 1) high cost of fuel for pump operation, 2) damage by floods. For the meantime, revival of financial assist by the Government of Djibouti is expected, for example tax exemption for the fuel for irrigation purpose. Meanwhile, it is also possible to rehabilitate some of the shallow wells damaged by flood. With that background, the irrigation system having use of shallow wells is recognized to have high potential as a prospective agricultural development model targeting nomads, agro-pastoralists and farmers.

(3) Irrigation System Using Surface Water

Despite annual precipitation is extremely low, about 150mm, in Djibouti, intensive rainfall has sometimes caused abrupt runoff on bare land surface and results in flood damage along the wadis. In consideration of limited water resource, the Government of Djibouti positively launched to utilize the surface water for agriculture. In recent years, MAEPE-RH had constructed three ponds by excavation and filling work. Kourtimalei pond is one of them, and crop cultivation has been undertaken in small scale by one farmer there.

The biggest constraint of this irrigation system is instability of the water amount impounded in the pond. To establish this irrigation system as new agricultural development model, potential of the water resource development by utilizing surface water was carefully examined in the pilot project, and also adoptability of this irrigation system was verified in a practical manner.

3.5.2 Water Pumping Facilities

Any irrigation systems need water pumping in Djibouti.

In regard to deep wells, water is pumped up to the water tank with the submergible motor pump installed inside the well. After that, water is distributed to farm plots by gravity in the case of surface irrigation, or by pressure added with booster pump in the case of drip irrigation. Electricity is generally in use as power source of these pumps. For the group irrigation managed by agricultural cooperatives, electricity is free of charge with governmental support.

In regard to shallow wells, small engine pumps are commonly used in different manners: water is distributed directly to farm plots, or distributed by gravity once water is stored into the water tank. In the few cases, foot pumps are in use for small home garden farming. In this case, it does not require any fuel cost, so that economic burden on farmers is small. Engine pumps are classified into two types, gasoline pump and diesel pump. Gasoline pumps are widely in use because its purchase price is cheaper, and diesel pumps are not common in use because its purchase price is higher. In contrast to purchase price of the fuel, gasoline price is 315 DJF per litter, and diesel price is 215DJF per litter. Namely, gasoline price is approximately 1.5 times of diesel price. In fact, fuel cost for pump operation is extremely high, so that it hinders sustainability of farm economy. In past days, As Ela cooperative received tax exemption of the fuel for irrigation; however, it was suspended due to a management problem.

Solar energy generation becomes popular in Djibouti especially for rural drinking water supply. Meanwhile, it is a rare case that solar energy generation is used as power source for irrigation water supply. In consideration of the advantage that the operation cost is free, the Government of Djibouti is enhancing the dissemination of solar energy generations for irrigation water supply as well. In line with such governmental strategy, FAO launched the support in installing solar pumps for irrigation purpose in 2013.

In the Study, economic comparison between engine pumps (diesel and gasoline) and solar energy

generations (solar pump) was made under the following condition for the period of twenty years.

- Irrigated area covered with one shallow well is assumed 1.5ha.
- Irrigation water amount for the irrigation farming model which is defined as Self-sustained farmers' group (SW-S) in the M/P is applied as consumed water amount.
- Capacity and fuel consumption of the engine pump are assumed 30m^3/hr and 1.25ℓ/hr, respectively.
- Purchase cost in Djibouti is applied to the initial cost of solar pump system and engine pump.
- Replacement cost is also considered in elapsed 10 years: 30% of initial cost for replacing electric parts of solar pump system, and 100% of initial cost for replacing whole set of engine pump.
- As for fuel cost, 215DJF/ℓ for diesel, and 315DJF/ℓ for gasoline (as of 2014 August)

The result of economic comparison is shown in **Figure 3.5.2**, and summarized as follows;

- In long term, solar pump system is much cheaper than engine pumps.
- In regard to engine pumps, diesel pump is more economical than gasoline pump.
- In any cases of engine pump, fuel cost accounts for the big portion of total cost.

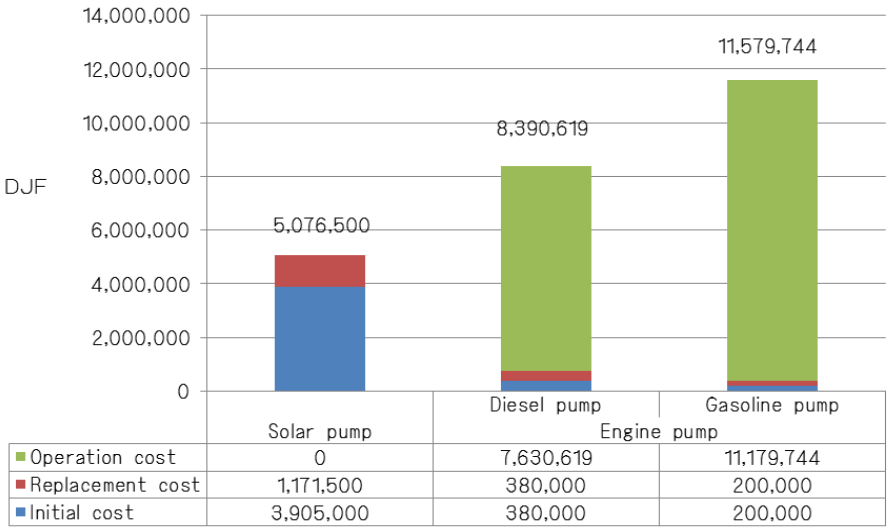


Figure 3.5.2 Economic Comparison for 20 Years among Solar Pump, Diesel Pump and Gasoline Pump

3.5.3 Irrigation Methods

Existing status of irrigation method can be overviewed by two parts: one is distribution method of irrigation water from a well to farmland, and the other is irrigation method at farm level.

In regard to distribution methods, earth lining canals are dominating, but some farmers have taken remedy in reducing seepage loss from irrigation canals by making concrete linings or replacing with pipelines. In regard to irrigation methods at farm level, surface irrigation such as basin irrigation and furrow irrigation is dominating, but various means have been taken to enhance efficient water use. For examples, small size of plots is adopted to improve equality of water distribution on the plots, or length of the furrows is kept within 10m to increase application efficiency.

Meanwhile, modern irrigation methods such as drip irrigation have been introduced in recent years. Drip irrigation is a promising irrigation method under the condition of limited water resource like

Djibouti, because it is regarded as the most water saving irrigation method. It is noted that water consumption with the drip irrigation would be reduced to one third or half of that with the surface irrigation. In fact, drip irrigation system has been already applied to the modernized large scale farmlands in the study area such as Al Gamil farm in Ali Sabieh region and Damerdjog farm in Arta region, and high quality vegetable production has been achieved there. The Government of Djibouti has a policy to disseminate the drip irrigation. A number of drip irrigation systems have been installed on the practical farmers' farmland with financial and technical assist of FAO in 2011 to 2012. However, there are some challenges in disseminating drip irrigation, 1) Drip irrigation equipment is not available in Djibouti markets, so that all of the equipment must be imported from overseas, 2) Durable year of drip tubes is supposed to be about five years, so that the replacement cost must be considered. It seems to be difficult for small scale farmers and nomads to cover such expenses.

3.6 Rural Infrastructure

3.6.1 Water Supply

In urban areas of Djibouti, 92% of the population has access to safe water. On the other hand, it is 54% in rural areas and the water supply coverage rate is low. The residents in rural areas spend much time and make effort to obtain their domestic water.

In case of regional capitals in southern Djibouti, ONEA (Office National de l'Eau et de l'Assainnissement) maintains and operates the water supply system and supplies water to each house. In case of rural areas, MAEPE-RH has responsibility for water supply and mainly establishes deep wells and water tanks as water supply facilities. Since the maintenance and operation of the water supply facilities in the rural areas are recognized as public works, the water charge is free.

In the areas where official water supply doesn't cover or the population is scattered, most residents and nomads get domestic water from traditional shallow wells in wadis by pumps or on manual. The traditional shallow wells are often damaged by floods and the users repair or remake them by man-power. Although salinity of the water of the wells in wadis is generally low, the water is not hygienic since livestock also gather around the wells. Women and children carry water from the wells to their houses and the work is heavy burden for them. In existing farmlands along wadis, water of shallow wells is used for irrigation and also for home and livestock.

In order to improve this severe water supply situation in rural areas, international organizations and donor countries are implementing water supply projects in rural areas based on the requests from the Government of Djibouti. The projects include many activities such as excavation of deep and shallow wells, construction of dams, ponds and water points, rehabilitation of well facilities, installation of water tanks, etc.

3.6.2 Power Supply

(1) Source of Electricity

EDD (Électricité de Djibouti) takes responsibility to supply the electricity in Djibouti. The supply sources exist in the following areas.

- Djibouti city
- Northern area including Tadjourah and Obock
- Southern area including Dikhil and Ali Sabieh

The scale of electricity supply service in Djibouti city is estimated as 58.4MW, approximately. On the other hand, those in the northern and southern areas are relatively small, which are 0.9MW and 1.3MW, respectively. The electricity is mainly generated by a steam power plant using crude petroleum or light oil. In addition, EDD has imported the electricity from Ethiopia since 2011.

(2) Access to Electricity in Southern Area

At present, Dikhil and Ali Sabieh regions meet almost all demand for the electricity by importing it from Ethiopia. However, there are small-scale electricity power plants in these regions for security purpose. Therefore, both regions can temporally generate electricity in emergency cases such as breaking off the electricity from Ethiopia.

The electricity cost for ordinary household is as follows in April 2012.

- Unit price (used amount is from 0 - 407kWh for 2 months) : 40DJF/kWh
- Unit price (used amount is more than 407kWh for 2 months) : 58DJF/kWh

Several agricultural cooperatives use public electricity for pumping water. For example, Agro-Pastoral Cooperative of Mouloud is given free public electricity to pump water up from the deep well by the government.

3.6.3 Education

The statistics document of Ministry of Education in Djibouti in 2009 - 2010 reports that total number of primary schools is 112, total number of students is 52,991 and total number of teaching stuff is 1,545. It also reports the situation about the primary school in southern Djibouti. Arta region holds total 10 schools, 2 school in urban area and 8 schools in rural area. Ali Sabieh region holds total 13 schools, 4 in urban area and 9 in rural area. And Dikhil region holds total 17 schools, 4 in urban area and 13 in rural area.

Table 3.6.1 State of Primary School in the Study Area

Region	Number of Primary Schools	Number of Students	Number of Teaching Stuffs
Arta	10	2,189	85
Ali Sabieh	13	4,078	130
Dikhil	17	4,687	157

Figure 3.6.1 Distribution of Primary School

Source: Annual Statistics 2009 - 2010, Ministry of Education

3.7 Rural Society

3.7.1 Life Style

Most residents in rural areas are nomads, semi-settled nomads and former nomads. Therefore, taking care of livestock is essential and all family members take part in this work. In addition, adult men have part time jobs and cultivation activities if they have farms. Based on the results of questionnaire

survey in the pilot project areas, the life style is described below.

Their family structure is 5.5 persons in a household on average. The break down is 2 - 3 children, 2 - 3 adults and one old person.

37% of the households have already settled life. 53% of the households are semi-settled nomads and 10% are nomads. However, the percentages change by the area. In case of the semi-settled nomad, someone of the family moves with livestock when they cannot feed enough natural grasses to their livestock. Most of the settled households and the semi-settled households are still using tents as their houses. And they keep a life style that they can easily move. Although few households started settled life or semi-settle life before independence of Djibouti in 1977, relatively most households started the settled life or the semi-settled life after 1990.

Regarding food consumption, they consume remarkably much goat milk, which is estimated about 102ℓ/year/person. Out of the 102ℓ, about 86ℓ come from own livestock while another part is bought. Following the goat milk, quantity of cereal consumption is large, which is about 70kg/year/person. However, about 73% of the cereals are obtained through the food assist from WFP. And they buy remaining part. Sugar is consumed about 44kg/year/person. Almost all of the sugar is bought by them. On the other hand, quantity of vegetables consumed is about 17kg/year/person. About half of the vegetables are bought. Consumption quantity of meat and eggs is little, 2kg/year/person.

3.7.2 Role of Women

Generally, women take main roles in raising goats, sheep and donkeys. On the other hand, women assist men in raising camels. In the case of semi-settled nomads, men generally move with livestock although women sometimes move with livestock if the men cannot move because of part-time jobs, sickness, etc.

Regarding farming activities, women generally assist men in tilling, seeding and irrigation although women take care prominently of harvesting and marketing. It might be the reasons that the works such as tilling require heavy labor while harvesting is strongly related to the daily cooking for the family. In addition, women generally have occasions to buy the daily foods in the market. It is a reason the marketing activities constitute a main role for women.

Regarding household chores, although women and children do drawing water, cooking and washing, men generally don’t take part in them.

3.8 Support Systems for Agriculture

3.8.1 Agricultural Cooperative

According to the list of agricultural cooperatives collected in the Study, although 26 agricultural cooperatives are registered in Djibouti, the number is very small. Out of the cooperatives, 8 cooperatives below manage relatively good activities in the study area.

Region	Name of Agricultural cooperative
Arta	Association de Périmètre Paysan d'Atar
	Coopérative Agricole d’Atar/Damerdjog
Ali Sabieh	Groupement Paysans Agricoles d'Assamo
	Association Agro-pastorale d'Ali-Addé
Dikhil	Coopérative Agro-pastorale de Dikhil
	Association pour le Dévelopment Agro-pastorale de Hanle
	Coopérative Agro-pastorale de Gobaad
	Coopérative Agricole de Mouloud

Based on the results of the questionnaire survey targeted these agricultural cooperatives, outline of agricultural cooperatives is described below.

(1) Established Year of Agricultural Cooperatives

The established year of the agricultural cooperatives varies. Two cooperatives were established before 1985 while 4 cooperatives were established from 1986 to 2000. The other 2 cooperatives were established after the year of 2000. Therefore, new cooperatives are registered any time and the number is increasing little by little.

(2) Activity of Agricultural Cooperative

Major activities of the agricultural cooperatives are “collective selling of agricultural products”, “supplying agricultural inputs”, “extension of agricultural techniques”, “credit”, etc. However, actually performed activities are “distributing agricultural inputs supported by the government or donors”, “buying and distributing agricultural inputs”, “digging shallow wells”, “rehabilitating shallow wells”.

(3) Major Problem of Agricultural Cooperative

Major problems of the agricultural cooperatives are as follows.

- Problems related irrigation water such as lack of irrigation water, rehabilitation of the wells and pumps, salinity of irrigation water, etc.
- Unavailability of agricultural inputs; agricultural inputs don’t exist in shops.
- Damage of farmlands along wadis by floods
- Lack of technical trainings for farmers

3.8.2 Agricultural Extension

(1) MAEPE-RH

Sub-Directorates of the MAEPE-RH take charge of agricultural extension in each region. However, the number of extension staffs in the Sub-Directorates is limited and each Sub-Directorate has only one agricultural extension staff. Besides, agricultural extension in Arta region is conducted by an extension staff of animal husbandry. Therefore, the MAEPE-RH cannot provide sufficient extension services at present.

(2) Ministry of National Education and Vocational Training

The Ministry of National Education and Vocational Training has vocational training schools. The schools provide technical trainings regarding agriculture, animal husbandry and fishery for agro-pastoralists and fishermen.

(3) Donors

The donors implementing agricultural extension activities in southern Djibouti are mainly FAO, UNDP and WFP. The situation of agricultural extension activities by the donors is shown in the table below. As shown in the table, the donors provide facilities and materials for agricultural activities to farmers in southern Djibouti while they don’t generally undertake the extension activities of agricultural techniques.

Table 3.8.1 Situation of Agricultural Extension Activities by Donors in Southern Djibouti

	Type of Agricultural Extension Activities		
	Distribution of Agricultural Materials	Construction and Distribution of Irrigation Facilities and Materials	Extension of Agricultural Techniques
FAO	• Distribution of seeds and agricultural tools	• Distribution of irrigation materials such as drip tubes and solar pumps • Rehabilitation of shallow wells	-
UNDP	• Distribution of seeds and agricultural tools	• Construction of sub-surface dams • Installation of wells and irrigation facilities	-
WFP	-	• Installation of wells and irrigation facilities (Food for Work)	-

3.8.3 Agricultural Finance

Out of the cooperatives in southern Djibouti, the following 4 cooperatives opened community funds or bank accounts.

- Coopérative Agricole de Petit et Grand Douda
- Coopérative Agricole d'Atar/Damerdjog
- Coopérative Agro-pastorale de Gobaad
- Coopérative Agro-pastorale de Dadahalou et d'Arwo

The "Coopérative Agro-pastorale de Gobaad" has an experience of purchasing an engine pump and a truck for collective shipment by a bank loan. The "Coopérative Agricole de Petit et Grand Douda" manages a micro-credit activity which gives opportunities for receiving 50,000 - 100,000DJF to tens of the cooperative members every year. However, these activities are regarded as exceptional cases in Djibouti. Most cooperatives and farmers have not received any financial services as mentioned above.

3.9 Environmental and Social Consideration

3.9.1 General Outline

The Study for the local people in southern Djibouti is for formulation an agricultural development plan which includes small scale farmlands utilizing surface flow water and shallow groundwater through wells or ponds.

Characteristics of the development of water resources are as follows.

- Scarce rainwater vanishes mostly in temporary ineffective wadi flow or evaporation into the air. The temporary wadi flow causes commonly floods which can damage public transportation and facilities along the wadis. Ponds store the flow water and make it an effective use. The ponds should be located in an area where there is no residence and no public facility. The water in the ponds penetrates into the ground and contributes to the growing of vegetation for livestock. This constitutes a positive environmental impact.
- Shallow groundwater in wadi sediment layer or foundation rock is pumped up through excavated wells, which is less than around 10m deep. Volume of the water pumping up for irrigation is decided based on the availability of the shallow groundwater. In case of deep wells, water over pumping sometimes causes a big draw-down of the aquifer. However, the shallow wells considered here are not a cause of harmful changes of the aquifer level.
- Sub-surface dams in wadi streams are selected at several candidate project sites. It impounds water under the ground surface without the issue of land inundation and contributes to water recharge of surrounding aquifers.

Characteristics of the agricultural development are as follows.

- The agricultural development depends on the above mentioned water resources. The size of newly developing farmlands of every water resource is small and less than few ha, that is verified size in the implementation of the pilot project. Every farmland of the project is mostly located on terraces along wadis and not on the areas protected for natural vegetation and animals.

- Besides the new sites of the project, rehabilitation sites which are former farmlands such as the ones in Gobaad watershed are also included in the project. Such sites are damaged by the floods and are expected to be rehabilitated for agricultural purpose.

As shown in the above characteristics, the project will be small scale and gentle to nature; it will not actually give negative impacts to the natural and social environment.

3.9.2 Initial Environmental Study

Along JICA guidelines for environmental and social consideration, an impact assessment is conducted. The results of the initial environmental study are summarized as below.

(1) Impact Assessment on the Natural Environment

The impact assessment on the natural environment is analyzed on both phases of "during construction of project facilities" and "in operation". The results are summarized in the table below.

Table 3.9.1 List of Impacts on Natural Environment

Environmental Items		Impacts	Ranking of Assessment	
			during Construction	in Operation
1.	Air Quality	During construction, trucks and heavy equipment will produce exhaust gas. As construction does not contain big works, it is far beyond the level of contamination of public air.	*	*
2.	Water Quality	During construction work, murky water by cleaning of heavy equipments and others will be produced. As total volume of murky water is quite limited, it will not be a cause of contamination of aquifer and farmland soil. As project area is dry condition through a year, even if disposal of residue oil and fuel happens, the residue will not infiltrate into aquifer.	-/C	*
3.	Wastes	Even if plant and grass were removed, those will serve for domestic use for livestock or family. Mass waste from rehabilitation and construction works will not be anticipated. If small amount of waste happens such as soil and rock, it will be utilized for embanking of mounds and others.	*	*
4.	Soil Contamination	Sometimes water resource contains salty component. During many years of farming, the accumulation of salt will be anticipated. It will affect agricultural productivity. This issue will be resolved with related farmers by using organic fertilizer or exchanging the soil in the farms.	*	-/C
5.	Noise and Vibration	As most project sites are remote with a small population, there is no problem about noise and vibration. When materials are carried in the project sites, some trucks will pass by residence areas. As road is non-paved condition, vehicle cannot make a swift pass causing traffic accidents	-/C	*
6.	Subsidence	It contains no big facility which may cause subsidence of the dry foundation.	*	*
7.	Odor	No odor is considered.	*	*
8.	Protected Area	No sanctuary is contained. (In Ali Sabieh region, one protected area is observed. However, the project does not select the site there.)	*	*
9.	Ecosystem	Every site has no special and valuable species for flora and fauna.	*	*

Environmental Items	Impacts	Ranking of Assessment	
		during Construction	in Operation
10. Hydrology	Water decline of aquifer by pumping is limited around shallow wells.	-/C	-/C
11. Topography and Geology	Construction of ponds will increase sand silt sedimentation along wadis. This sedimentation will contribute in new vegetation, which means being a positive impact.	*	+C
12. Biological Resource	No valuable biological resource exists.	*	*

Assessment Mark (left side): +; Positive Impact, -; Negative Impact

Ranking: A; Relatively Significant, B; Relatively Medium, C; Relatively Small, D; Unknown so far, *; No Impact or No Corresponding

(2) Impact Assessment on the Social Environment

Impact assessment on the social environment is analyzed on both phase of "during construction of project facilities" and "in operation". Results are summarized in the table below.

Table 3.9.2 List of Impact on Social Environment

Environmental Items	Impacts	Ranking of Assessment	
		during Construction	in Operation
1. Resettlement	There are no settled people to evacuate. On the contrary, people will settle around/in project site to participate to the project work.	*	+C
2. Life and Livelihood	By improving the facilities of education and hygiene, increase of literacy and decrease of morbidity rate will be expected.	*	+A
3. Cultural Heritage	There is no cultural heritage in the project sites.	*	*
4. Landscape	As no huge construction work is contained in the project, a change of landscape will not be anticipated.	*	*
5. Ethnic Minorities and Indigenous Peoples	As people there are basically nomads, treatment for ethnic minority and indigenous people will not be considered.	*	*
6. Working Environment	During construction stage, creation of jobs will be expected.	+/A	+A
7. Land Use and Local Resource Utilization	Land use for farming and marketing will be developed through agriculture.	+B*	+B
8. Accident	During construction stage, a risk of traffic accident will somewhat increase more than before.	-/C	*
9. Sanitation	The project implementation will accelerate settlement of local people in/around the site. This will increase the opportunity for governmental arrangement of primary school and health center nearby the site.	*	+/A
10. Culture	There is no specific zone for culture to be considered in the project sites.	*	*

Assessment Mark (left side): +; Positive Impact, -; Negative Impact

Ranking: A; Relatively Significant, B; Relatively Medium, C; Relatively Small, D; Unknown so far, *; No Impact or No Corresponding

Chapter 4 PILOT PROJECT

4.1 Outline of the Pilot Project

4.1.1 Objective of the Pilot Project

The objectives of the pilot project are the following two.

- To verify applicability of irrigation and cultivation techniques to be applied in the M/P
- To extract lessons learned and items to be considered for the formulation of the M/P

4.1.2 Duration of the Pilot Project

The pilot project was implemented from May 2012 to August 2014.

4.1.3 Duration of the Pilot Project

(1) Site of the Pilot Project

The pilot farms were established in the tree sites mentioned below, and the activities including farming and training were undertaken in the pilot farms.

- Kourtimalei in Arta region
- Hambokto in Ali Sabieh region
- Afka Arraba in Dikhil region

(2) Contents of the Pilot Project

The pilot farms were established at the sites mentioned above through the development of the water sources and irrigation facilities in consideration with the situation of the sites. After that, 15 participants were selected in each pilot project site mainly from semi-settled and settled households around the pilot farms. The participants learned the farming and irrigation techniques for vegetables and fruits cultivation in the pilot farms. On the other hand, the study team and the counterparts (C/Ps) provided inputs and technical support to the participants. In addition, through the monitoring of the cultivation and the harvest by the participants, the study team and C/Ps confirmed the applicability of the farming and irrigation techniques and extracted the lessons learned and items to be considered for formulation of the M/P.

Table 4.1.1 Implementation Schedule of the Pilot Project

Contents	2012								2013												2014							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
Establishment of the pilot farms																												
Selection of the participants																												
Procurement and preparation of farming materials																												
Preparation of the fields																												
Cultivation in winter season																												
Cultivation in summer season																												
Monitoring and technical support																												
Analysis of the results																												

4.1.4 Irrigation Facility Plan Relating to the Pilot Project

Within the pilot project, the following major irrigation facilities were designed to be set up at each pilot farm.

Table 4.1.2 Outline of Irrigation Facilities within the Pilot Project

Pilot site	Kourtimalei	Hambokto	Afka Arraba
Water source	Surface water	Shallow groundwater	Shallow groundwater
Water source facility	Pond	Shallow well	Shallow well
Irrigation area	0.6ha	0.6ha	0.6ha
Pumping facility	Engine pump	Engine pump	Solar pump
Water tank	Existing water tank	New water tank	New water tank
Distribution pipe	PVC pipe	PVC pipe	PVC pipe
Hydrant	8 sets	8 sets	8 sets
Number of plots	16 plots	16 plots	16 plots
Irrigation method	Surface irrigation	Surface irrigation + Drip irrigation (partially)	Surface irrigation + Drip irrigation (partially)

4.1.5 Cultivation Plan for the Pilot Project

The pilot project aimed that the participants would learn basic cultivation techniques for several vegetables and fruits etc., and be able to cultivate them by themselves in the pilot farms. Thus, the study team and C/Ps provided technical support and trainings to the participants.

The participants practiced the cultivation three times: two times in winter seasons (from October to March) and one time in summer season (from March to July) in the plot of about 400 m^2 provided to each participant. Major crops to be cultivated in the pilot farms and the objectives are shown in **Table 4.1.3**.

In addition to the cultivation and irrigation methods, the participants learned the ways of making manure, using inputs, and managing the facilities and equipment by a group.

Table 4.1.3 Major Crops to be Planted at the Pilot Farm

Classification	Name of crops	Objective of cultivation
Vegetable	Tomato, Onion, Green pepper, Okra, Melon, Watermelon, etc.	Self-consumption, Sales
Fruit tree	Date, etc.	Self-consumption, Sales, Protection against sunshine
Fodder crop	Sorghum, Guinea grass, Alfalfa, etc.	Self-consumption, Soil improvement
Fodder tree	Moringa, Leucaena, etc.	Self-consumption, protection against wind and sunshine

4.2 Plan and Activities of the Pilot Project

4.2.1 Selection of the Pilot Project Participants

The pilot project participants should have enough energy to engage in agricultural activities. Moreover, they should have positive intension to continue the agricultural activities even after the termination of the pilot project. Thus, the study team selected the pilot project participants based on the selection criteria showed in the table below.

Table 4.2.1 Selection Criteria of the Pilot Project Participants

	Selection Criteria
1	The participants live near the pilot farms to manage the farms.
2	The age of participants should be 20 to 40 years old
3	It is better that the participants don't have enough experience of crop cultivation. This pilot project is for new farmers and beginners.
4	The participants should be interested in crop cultivation and they need to have strong will to continue the cultivation after the pilot project.
5	The participants need to understand, agree and perform the roles of participants mentioned below. ➢ The participants themselves cultivate and manage crops in the pilot farms. It is not allowed that third parsons (other persons) cultivate in the pilot farms. ➢ The participants attend the activities of the pilot project such as training seminars. ➢ The participants take away stones, level the ground, till the land and maintain the plots allocated. The participants maintain the irrigation facilities, other structures, tools, hedges etc. as common properties. ➢ Products cultivated and harvested by the participants belong to the individual participants. However, the study team doesn't take any responsibility and doesn't compensate for the harvested amount, even if the participants have low or no harvested amount. ➢ The participants cooperate with the study team in recording data such as harvested amount, sold amount, etc. ➢ The selected leader and sub-leaders become the contact persons to the participants. And they shall coordinate the participants and manage internal problems.

The study team selected 15 pilot project participants according to the procedure mentioned below. The lists of selected pilot project participants are attached in Appendix.

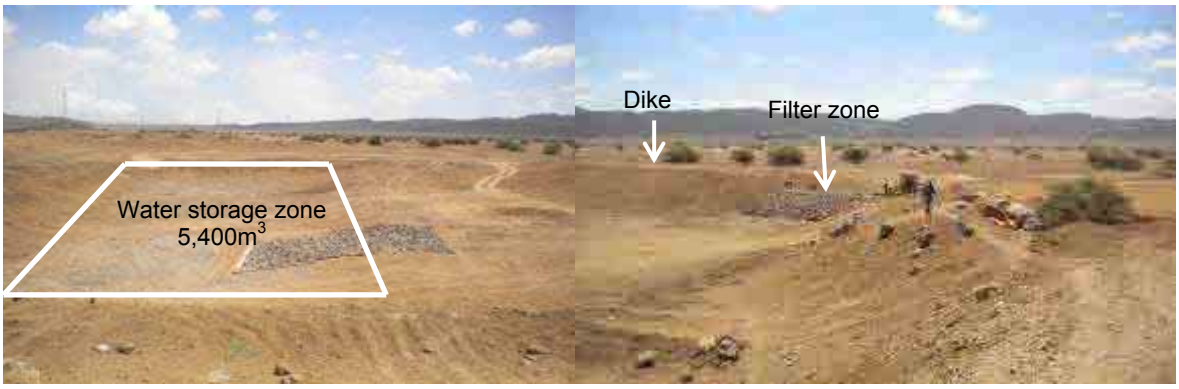
Table 4.2.2 Procedure to Select the Participants

Procedure	Contents
1.Explanation of the pilot project contents to each governor	➢ Explanation to the regional governors in terms of the pilot project ➢ Explanation to the chief of each pilot project site in terms of the pilot project ➢ Asking the chief of each pilot project site to cooperate in selection of the pilot project participants
2.Explanation of the pilot project contents to the residents of pilot project areas	➢ The governors shall visit the pilot project sites to explain contents of the pilot project to the local residents. ➢ The governors shall ask the chief of each pilot project sites to select 15 members of the pilot project participants.
3.Selection of the pilot project participants	➢ The participants are decided under consensus among the study team, the C/Ps, the governors and the residents in the sites ➢ The participants select one leader and two sub-leaders. The leader and sub-leaders shall become the contact persons of the participants. Moreover, they shall solve all the internal problems causing among the participants.

4.2.2 Establishment of the Water Sources and Irrigation Facilities

(1) Kourtimalei Pilot Project Site

The existing pond was planned to be used as water source for the pilot farm in Kourtimalei. To utilize the pond more effectively, improvement works including excavation of the pond bed and construction of filter zone were implemented as a part of the pilot project. The excavation of the pond bed (2.5m in depth and 5,400m^3 in volume) was aimed at reducing the evaporation from the water surface by collecting the water into the excavated portion when water volume of the pond becomes small. On the other hand, construction of the filter zone was aimed alleviating soil inflow during floods.



Improvement Work of Kourtimalei Pond (June 2012)

A pilot farm of about one (1) ha was established just beside an existing farm constructed with financial assistance of FAO. Irrigation network was also set up in the pilot project. Intake work was newly built inside the pond. Water is pumped up from the pond to an existing water tank with an engine pump which was placed on the intake work. After that, the water is conveyed by gravity through the pipeline from the water tank to the pilot farm. For the monitoring of water amount consumed at the pilot farm, a flow meter was installed close to the water tank downstream.

The pilot farm has 0.64ha in total and 16 plots with an area of $400m^2$ (10m × 40m) each, and one hydrant was set up every two plots. In regard to the irrigation method, furrow irrigation was applied to Kourtimalei pilot farm. The construction work of Kourtimalei pilot farm was completed in September 2012.

In order to monitor the fluctuation of water level of the pond, pressure type of water level sensors with data logger were placed in Kourtimalei pond. Water depth could be traced on a time series basis by calculating the deference of water level recorded at intervals of 15 minutes by two water level sensor (one was for atmosphere pressure, and the another was for water pressure). Decrease of water level was estimated to be 24.5 to 42.0 mm/day (from August 2012 to December 2012) due to negative effect of pond bed excavation. After that, it was reduced to be 19.3 to 21.1 mm/day (from January 2014 to March 2012).

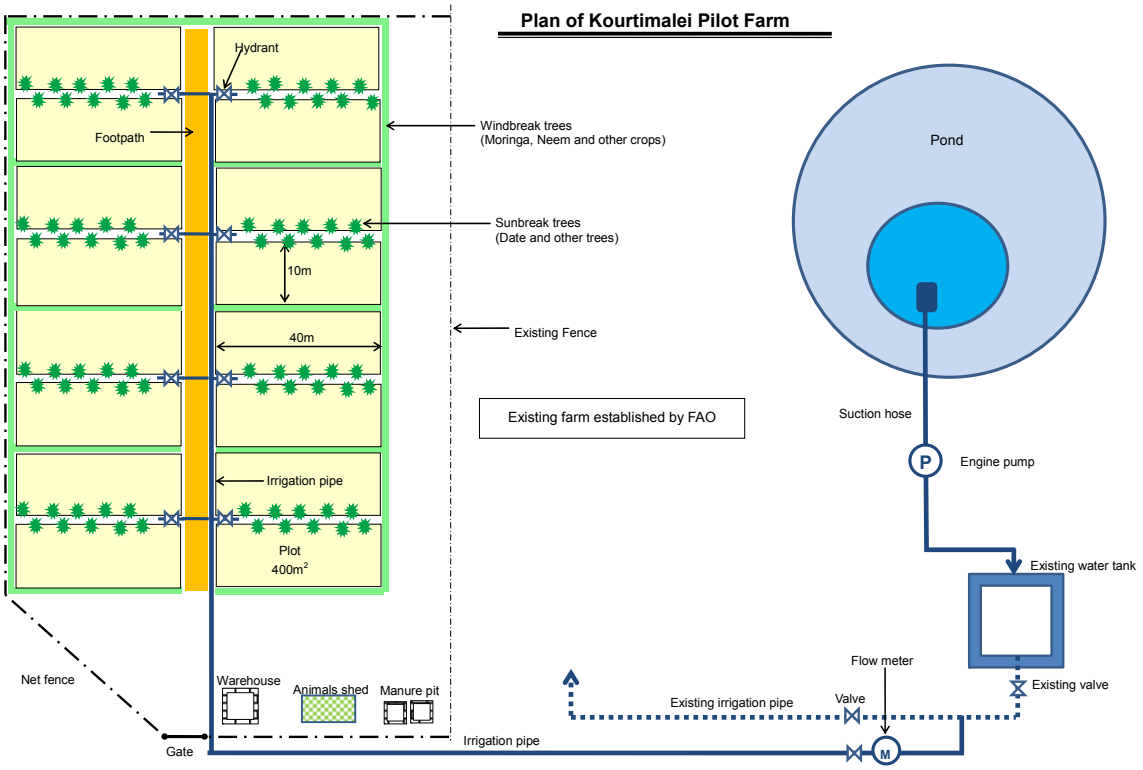


Figure 4.2.1 Layout of Kourtimalei Pilot Farm

(2) Hambokto Pilot Project Site

Water source of Hambokto pilot farm is a newly constructed shallow well at the upstream of the wadi which flows beside the pilot farm. Excavation work was started in September 2012. The foundation of the well was hard rock, so that the study team introduced an electrically-driven jackhammer in addition to man-power excavation to speed up the work. When the excavation depth reached 4m, outflow of water was found from cracks of weathered rock layers. Water amount of the well was confirmed to be sufficient at the excavation depth of 5.5m, and after that the study team had completed all construction work including the protection wall in October 2012. After completion of the work, notable rainfall was not observed for several months in term of recharging groundwater of the wadi basin. As a result, water depth of the well had decreased to 0.5m as of April 2013. To recover water amount of the well, additional excavation was executed to reach the depth of 6.5m as shown in **Figure 4.2.2** right.

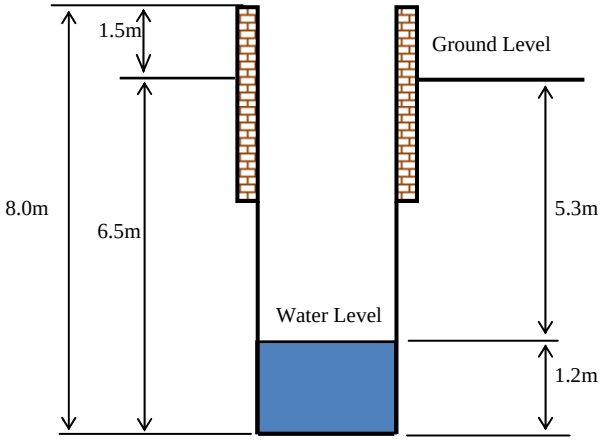


Figure 4.2.2 Shallow Well for Hambokto Pilot Farm

Prior to setting up irrigation facilities, land preparation work was carried out by heavy construction

machines belonging to the Directorate of Grand Works of the MAEPE-RH, because the site of Hambokto pilot farm was stony and irregular. The work was implemented in accordance with the following steps: 1) cutting and filling of the ground, and exposing stones by using a bull dozer attached with rippers, 2) removing the stones by using a loader and manpower, 3) grading ground surface by using a grader. In fact, the pilot project site having around 3m irregularity in height was skillfully improved to a certain level which ensures proper water distribution at farm level.

The irrigation system was designed as follows: water is pumped up from the well with a three inches engine pump, and then conveyed to the water tank constructed in the compound of the pilot farm. The well was constructed at the opposite bank of the wadi, so that construction of the pipe bridge was required to cross over the wadi. I-shape steal was used as a beam having sufficient clearance for floods, and conveyance pipe (PVC 90mm) was hanged by the beam.

All construction works for irrigation and other facilities were completed in November 2012.

After that, the study team installed water-level sensors at the well in order to trace the fluctuation of the water level. The monitoring result shows clear relevance between rainfall and the water level of the shallow well. When it is rain, rainfall recharges groundwater so that the water level goes up. On the contrary, when it is no rain, the water is continuously taken to irrigate the pilot farm by the pump so that the water level gradually goes down. For example, the water level went down 52cm in the period between 26 December 2012 and 12 March 2013.

Judging from the monitoring results of the shallow well, it is revealed that shallow groundwater, which is defined as water source for shallow wells, has a limitation in supplying water amount. To formulate irrigation project plan, it is essential to make a balance between available water amount and irrigated area.

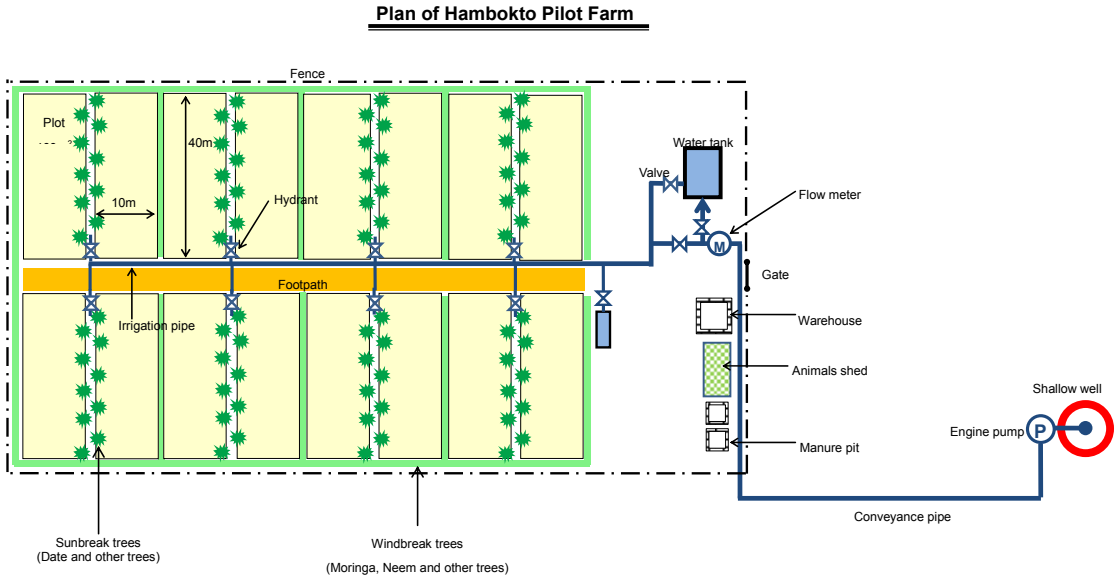


Figure 4.2.3 Layout of Hambokto Pilot Farm

(3) Afka Arraba Pilot Project Site

Water source of Afka Arraba pilot farm is a shallow well of shallow groundwater as same as that of Hambokto pilot farm. At first, excavation work of a well (called No.2 well) was started at the point adjacent to the pilot farm in July 2012. However, it was too difficult to continue the work by man-power excavation due to the solid rock layer. The study team decided to shift the well site to another point because of the limitation of the water amount of No.2 well.

The new excavation point of a well (called No.1 well) was selected along the wadi at around 120m

downstream of the pilot farm. The study team introduced the electrically-driven jackhammer in conjunction with man-powered excavation as well as Hambokto. Excavation work started in October 2012, and reached 9.8m in excavation depth and 1.8m in water depth in December 2012. Since a certain amount of water was recognized to get at the No.1 well, the study team decided to end excavation work for the No.1 well. After that, the protection stone masonry of the well was built, and the solar system for power source of a pump was installed at the well. Finally, a submergible pump was set up in No.1 well in January 2013.

According to a pumping test conducted at the No.1 well, pump discharge was around 20m^3 per day. It does not meet the required water amount to irrigate Afka Arraba pilot farm at a peak of the cultivation period. In order to ensure sufficient water amount throughout the cultivation period, the study team decided to utilize the No.2 well as supplementary water source. Excavation work of the No.2 well was started again, and ended in May 2013 when the available water amount reached a certain level.

No.1 Well

No.2 Well

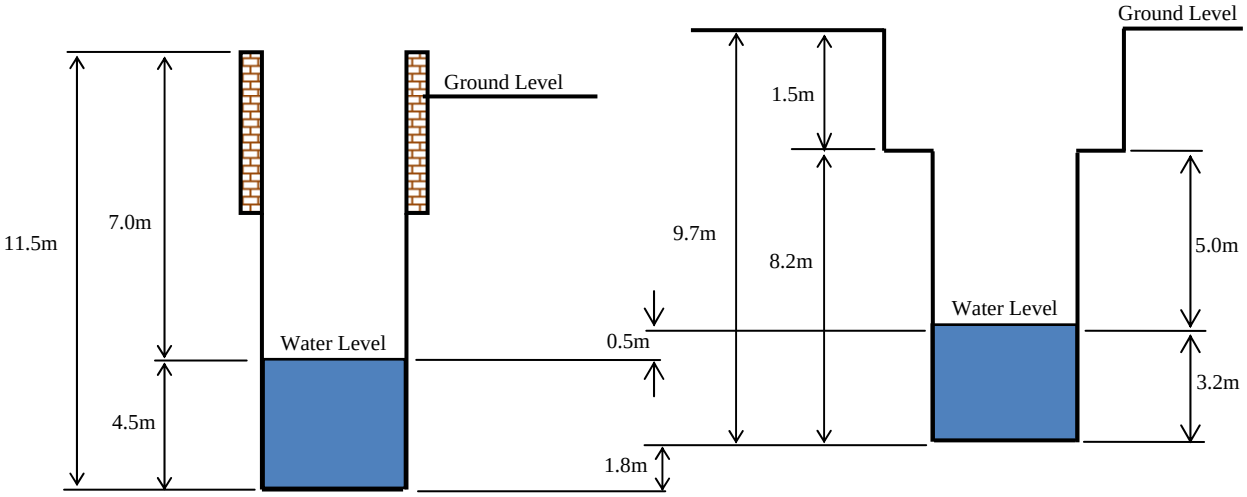


Figure 4.2.4 Shallow Wells for Afka Arraba Pilot Farm

Since Afka Arraba pilot farm site has mass of stones and irregularity, land preparation work was executed as well as Hambokto pilot farm site. It was verified through this experience that land preparation work of about one (1) ha stony land could be completed within two weeks by using heavy construction machines belonging to the Directorate of Grand Works of the MAEPE-RH.

The water distribution system of Afka Arraba pilot farm is basically same as that of Hambokto pilot farm. However, in regard to energy source for a pump, it is difference between the two pilot farms. A solar pump was applied in Afka Arraba, because a solar system is much economical in long term compared to an engine pump.

After the completion of the water source facility for Afka Arraba pilot farm, the study team installed water-level sensors at the well in order to monitor the water level. The monitoring result shows clear relevance between rainfall and the water level of the shallow well.

Meteorological observation systems have not organized well in Djibouti, so that the study team set up a meteorological observation station to collect meteorological data. The meteorological observation includes temperature, relative humidity, precipitation, atmosphere pressure, sunshine hour, wind speed and wind direction. These are recorded at intervals of 10 minutes by the data logger. According to the observed data, maximum temperature exceeds 40°C, and minimum humidity decreases less than 20 %. It is obvious that the climate condition is extreme against crop growth especially during summer season (May to July). In contrast, the climate condition is more suitable in other months (August to April) because the temperature and the humidity are opposite of summer season in trend.

To verify oasis effect, namely improvement effect of micrometeorological environment, the study team installed a temperature/humidity sensor inside practical farmers' farm in Afka Arraba in order to measure temperature and humidity under trees. It was concluded that forming oasis leads to reduction of evapo-transpiration according to the comparison with the observation result of the meteorological observation station.

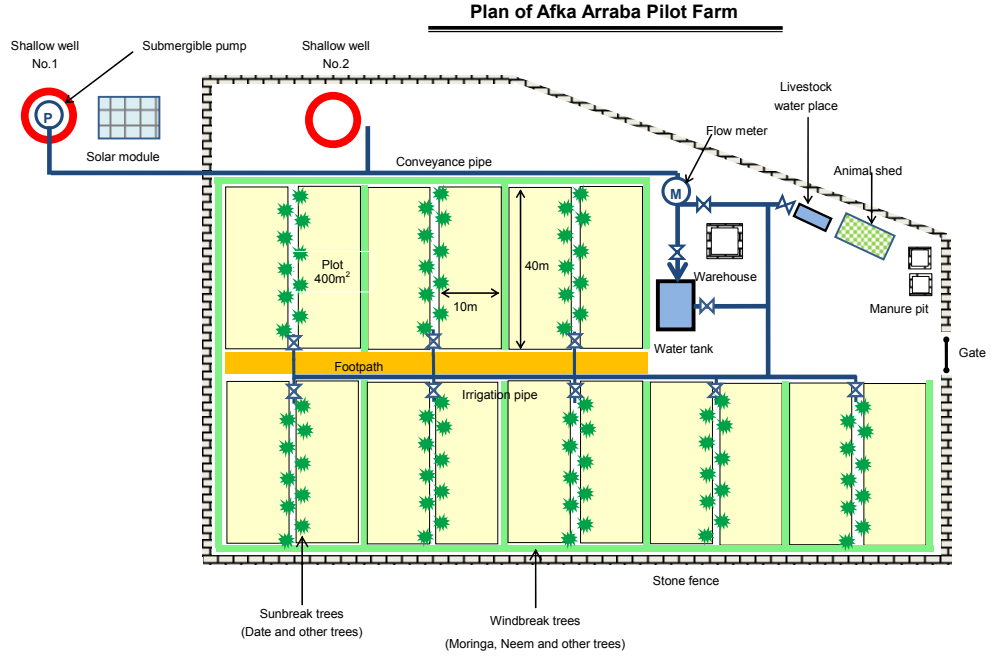


Figure 4.2.5 Layout of Afka Arraba Pilot Farm

4.2.3 Farming and Cultivation Activities

Regarding farming and cultivation activities, the activities were the participants' first experience since they have made their living by raising livestock. Therefore, the activities were implemented based on the four principles below.

- To choose crops cultivating easily
- To grow fodder crops for their livestock
- To apply low-input cultivation methods as much as possible that doesn't require expensive agricultural materials (chemical fertilizer, chemical pesticides, etc.).
- Under on-farm technical trainings, the participants learn the cultivation techniques through the activities.

The activities below had been conducted in the pilot farms from October 2012. The participants experienced 3 cropping seasons (two winter cropping seasons and one summer cropping seasons) by using a 400m^2 of plot per household. The study team periodically visited the pilot farms and guided them. In the winter cropping season in 2013, which was the third cropping season, the participants could independently cultivate in the most part.

1) Preparation of Fields

After installation of the facilities, the study team provided farming tools such as hoes, shovels, picks, wheel barrows, etc. The participants removed stones from the plots, leveled them, developed on-farm channels, tilled land and made ridges. However, it was difficult for them to prepare all part of the plots in a short period of time. Therefore, they started the cultivation in the prepared part and simultaneously continued the field preparation little by little to extend the cultivable part in the pilot project duration.

2) Manure Making

The manure was made from dung of the participants' livestock (mainly goat). The participants carried and put the dung into common manure pits in the pilot farms and mixed them with water. However, gap of quantity of dung provided and manure used caused discontent.

3) Sowing and Growing Seedlings

The study team provided seeds in each cropping season and the participants sowed them in nurseries or fields directly. The nurseries were owned jointly and they took care of the seedlings.

4) Transplanting and Crop Management

After growing the seedlings, the participants transplanted them to the fields and managed them. The crop management included irrigation, insects and diseases control, manure application, etc. The study team guided the participants in each activity. Although only manure was used as fertilizer, quantity of the dung collected was not sufficient. Therefore, spot application of the manure was adopted to increase effectiveness of the manure and to reduce the application quantity of the manure. Regarding the insects and diseases control, agricultural chemicals were used in some parts since the damage caused by insects was serious. Regarding irrigation, furrow irrigation technique was adopted.

5) Harvesting

The participants harvested, consumed and sold the products. The harvested products were weighted as much as possible to understand the quantities harvested and the yields.

6) Chicken Raising

For contributing toward improving livelihood by selling chickens and eggs, the possibility of chicken raising was considered. Hen houses were established in the pilot farms in Hambokto and Afka Arraba. In November 2013, two cocks and seven hens were provided to the participants and the participants started raising in cooperation. In both pilot farms, the hens have laid eggs and the chicks are growing although some of them were damaged by wild dogs, snakes, etc. Number of the chicks increase well in Hambokto and the participants started considering distribution and sales of the chicks. Therefore, the chicken raising and their sales could contribute to the improvement of the livelihood of the residents in regional area.

Due to the delay of construction work for the farming facilities, the 1st winter cropping in 2012, was started in October in Kourtimalei, November in Hambokto and January 2013 in Afka Arraba, while the other subsequent farming activities were conducted in similar timing at the three pilot farms.

Although the summer cropping was not intended in Kourtimalei, it was eventually conducted since water volume in the pond was enough due to the rainfall in August. Schedule of the activities performed in the pilot project is shown in the table below.

Table 4.2.3 Performed Schedule of Farming and Cultivation Activity

	2012								2013												2014							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8
1) Starting preparation of farm																												
2) Making manure																												
3) Winter cropping																												
4) Summer cropping																												
5) Chicken raising																												
6) Monitoring and technical support																												

Since the pilot farms were newly established on virgin soil, the soil condition etc. needed to be improved for the cultivation. Besides, due to the delay of starting cultivation, the winter cropping in 2012 was not actually performed in favorable condition. Moreover, for the most participants, this winter cropping is their first experience of crop cultivation. Thus, the winter cropping season in 2012 was used as a period of farm preparation and learning and practice of the cultivation. As a result, the participants who had been former nomads could have relatively good harvest and many participants sold surplus of the products in the winter cropping season in 2013. Therefore, it can be concluded that former nomads can understand cultivation techniques and get harvest if the applied cultivation method is designed as relatively extensive and requiring low input..

The crops cultivated in each pilot farm and summary of the results collected by the yield survey and the sample survey are as follows.

(2) Kourtimalei

The crops cultivated in the three cropping seasons in Kourtimalei pilot farm are shown below.

Table 4.2.4 Crops Cultivated in Kourtimalei Pilot Farm

Cropping Season	Vegetable	Fodder Crop	Fodder Tree
Winter Cropping in 2012	Tomato, Green Pepper, Okra, Melon	Sorghum	Moringa
Summer Cropping in 2013	Melon	Sorghum	
Winter Cropping in 2013	Tomato, Green Pepper, Okra, Onion,	Maize	

Average harvested quantity and yield in the winter cropping season in 2013 are shown below.

Table 4.2.5 Result of the Yield Survey in Kourtimalei Pilot Farm

Crop	Average Cultivated Area per Household (m^2)	Average Harvested Quantity per Household (kg)	Average Yield (t/ha)
Tomato	62.4	102.4	16.4
Green Pepper	19.5	1.6	0.8
Onion	-	-	27.6
Okra	27.3	32.3	11.8
Maize (Grain)	27.3	6.9	2.5
Sorghum	50.7	138.4	27.3

Notes: The yield of onion was calculated from the result of sample survey.
Sorghum is the result of summer cropping in 2013.

(3) Hambokto

The crops cultivated in the three cropping seasons in Hambokto pilot farm are shown below.

Table 4.2.6 Crops Cultivated in Hambokto Pilot Farm

Cropping Season	Vegetable	Fodder Crop		Tree	
		Annual	Perennial	Fodder	Fruit
Winter Cropping in 2012	Tomato, Okra Melon	Sorghum	Sudan Grass, Alfalfa	Moringa	
Summer Cropping in 2013	Melon	Sorghum			
Winter Cropping in 2013	Tomato, Green Pepper, Okra, Onion				Date Palm

Average harvested quantity and yield in the winter cropping season in 2013 are shown below.

Table 4.2.7 Result of the Yield Survey in Hambokto Pilot Farm (Vegetables)

Crop	Average Cultivated Area per Household (m^2)	Average Harvested Quantity per Household (kg)	Average Yield (t/ha)
Tomato	93.6	261.7	28.0
Green Pepper	62.4	19.3	3.1
Onion	11.7	-	-
Okra	19.5	-	-

Table 4.2.8 Result of the Yield Survey in Hambokto Pilot Farm (Perennial Crops)

Crop	Average Harvested Quantity per Harvest Time (kg/plant)	Estimated Harvest Times per Year (times/year)	Estimated Annual Harvested Quantity (kg/plant)	Number of Plants per Household (pant/household)	Estimated Annual Harvested Quantity per Household (kg)
Moringa	5.6	2	11.2	100	1,120

(4) Afka Arraba

The crops cultivated in the three cropping seasons in Afka Arraba pilot farm are shown below.

Table 4.2.9 Crops Cultivated in Afka Arraba Pilot Farm

Cropping Season	Vegetable	Fodder Crop		Tree	
		Annual	Perennial	Fodder	Fruit
Winter Cropping in 2012	Tomato, Okra, Melon	Sorghum	Sudan Grass, Alfalfa		
Summer Cropping in 2013	Melon	Sorghum			
Winter Cropping in 2013	Tomato, Green Pepper, Okra, Onion			Moringa	Date Palm

Average harvested quantity and yield in the winter cropping season in 2013 are shown below.

Table 4.2.10 Result of the Yield Survey in Afka Arraba Pilot Farm (Vegetables)

Crop	Average Cultivated Area per Household (m^2)	Average Harvested Quantity per Household (kg)	Average Yield (t/ha)
Tomato	39.0	103.0	26.4
Green Pepper	19.5	11.7	6.0
Onion	19.5	-	19.8
Okra	19.5	6.0	3.1

Table 4.2.11 Result of the Yield Survey in Afka Arraba Pilot Farm (Perennial Crops)

Crop	Average Cultivated Area per Household (m^2)	Average Harvested Quantity per Harvest Time per Household (kg/time)	Average Yield per Harvest Time per Household (t/ha)	Estimated Harvest Time per Year (times/year)	Estimated Average Yield per Year per Household (t/ha)
Sudan Grass	35.1	79.4	11.3	4	45.2
Alfalfa	-	-	5.5	6	33.0

4.2.4 Training Activities

The table below shows the training activities conducted in the pilot project. These trainings were conducted for the pilot project participants, while planning and management of those trainings were conducted mainly by the C/Ps and the agricultural extension workers to enhance their abilities to implement the training activities.

Table 4.2.12 Training Activities Conducted in the Pilot Project

Target	Training Title	No. of Times	Training Contents
Participants of the Pilot Project	• On-farm Training for Crop Cultivation	Year-round	Supervision on the crop cultivation in the farm
	• Study Tour on Advanced Farm Visit	3	Inspection on the advanced farmland and cooperative
	• Study Tour on Mutual Farm Visit	2	A mutual visit between the pilot farms
	• Training for Cooperative Leader	1	Classroom lecture and advanced farm visit for the leader of each pilot farm
	• Study Tour for Woman Participant	1	Inspection on the advanced farmland and existing women cooperative
Agricultural Extension Staffs	• Management of Pilot Farm	Year-round	• Supervision on the crop cultivation in the pilot farm • Planning and management of various training activities
C/Ps in the MAEPE-RH	• Administration and Management of Pilot Project	Year-round	Planning and administration of the pilot project

(1) Training of the Pilot Project Participants

1) On-farm Instruction for Crop Cultivation

It was a first experience for most of the participants to conduct agricultural activities, meaning that they need technical support in terms of cultivation techniques. In this pilot project, the study team gave instructions on crop cultivation techniques to the participants. Besides, a local advanced farmer also participated actively in the training as a farming advisor to transfer the necessary farming techniques to the participants.

The table below shows the results of technical instructions to the participants obtained through the monitoring of crop cultivation activities in the pilot farm.

Table 4.2.13 Results of Agricultural Instruction towards the Participants

Activity	Problems related to agricultural instructions	Countermeasure	Understanding level*
Leveling of farmland	Several participants refuse to conduct the proper leveling work.	•To instruct the importance and the method of leveling work of the farmland •The importance of this work could be understood by the participants after gaining experiences of cropping.	+-

Activity	Problems related to agricultural instructions	Countermeasure	Understanding level*
Removal of stones and gravels	Stone and gravels in several farmlands are not removed properly because it requires heavy works.	•To determine the minimum depth of a plowed layer •To instruct them to remove stones and gravels from the layer little by little	+
Ridge making	Leveling of ridges is not conducted properly.	•To instruct the importance and the method of ridge making work of the farmland •The importance of this work could be understood by the participants after gaining experiences of cropping	+-
Establishment of irrigation channel	The level of earth channels is not made properly, which causes inefficient irrigation.	•To check the cross-section and level of earth channels and to fix them if necessary •The importance of this work could be understood by the participants after gaining experiences of cropping	+
Adjustment of irrigation interval	Irrigation interval tends to increase. The volume of irrigation water for one time is too much.	•To determine irrigation interval and volume •To make the participants follow the rules.	+-
Manure making	They are not willing to make manure in cooperation with other participants while they understand its importance.	•To instruct them to make the manure individually	+
Fertilization technique	Several participants decide the fertilization amount by themselves.	•To determine the proper fertilization amount and make them follow the method.	+
Insects and diseases control	Insects and diseases control on manual is not realistic while the participants understand its importance.	•To determine the cheap methods of insects and diseases control •To prepare the healthy seedlings by maintain better cropping condition at the initial stage	+-
Establishment of nursery	Management of the nursery is sometimes not conducted properly.	•To determine the management method of the nursery •The importance of this work could be understood by the participants after gaining experiences.	+
Seeding	Several participants conduct seeding their own way.	•To determine the proper seeding method and make them follow the method	+-
Thinning	Most participants refuse to conduct thinning.	•It is not important if the farm scale is home garden level.	-
Bud picking Leaf picking	The work requires relatively higher techniques. Thus, several participants cannot conduct those works properly.	•To instruct them if necessary, as those works are not so important.	-
Harvesting	Several participants are not aware of the proper time to harvest.	•To instruct them to conduct harvesting in proper time	+-

* +; High, +-; Medium, -; Low

2) Study Tour on Advanced Farm Visit

To motivate the participants in farming, the study tour on advanced farm visit was conducted in each pilot site.

The purpose of this training is: 1) acquisition and improvement of cultivation techniques, 2) motivating for the agricultural activities and 3) Recognition of importance of agricultural cooperative. The study team had chosen three model areas described in the table below to meet the purpose of the training.

Table 4.2.14 List of the Advanced Farms & Cooperatives for the Study Tour

Name of Area	Contents	Reason of the selection
Abaito	Development of farmland	The lecturer obtained stable lifestyle and agricultural production by using shallow wells excavated on manual and large farmlands. It is expected that the participants are motivated on farming activities by observing this lifestyle.
Afka Arraba	Advanced agricultural technique	It is expected that the participants acquire and develop cultivation skills for several crops by observing the farm that is the advanced farm in Djibouti.
Mouloud	Activity of agricultural cooperative	Since establishment, Mouloud agricultural cooperative has continued cooperative activities for long time. Visiting the cooperative would help the participants to understand the importance of agricultural cooperatives.

According to the results of questionnaire survey to the participants of the study tour, followings were clarified.

- Most of the participants were satisfied of the field trips. Moreover, all regions demand more field trips. Therefore, it could be concluded that the field trips had contributed to increase the motivation of farmers.
- Most of the participants selected Afka Arraba as the most impressive site, where melon cultivation was conducted with advanced techniques. Thus, it is assumed that most of the participants are interested in cash crops.

3) Study Tour on Mutual Farm Visit

Study tours on mutual farm visit were conducted for the participants of Kourtimalei and Afka Arraba pilot sites. The participants visited Hambokto pilot farm. The objective of this study tour was to give the participants the opportunity to evaluate their farming skills each other and stimulate their motivation in farming.

On the visit, the participants of Hambokto gathered and guided the participants of Kourtimalei and Afka Arraba. Besides, the C/P of Ali Sabieh region answered the participants' questions regarding the farm.

According to the results of questionnaire survey to the participants of the study tour, followings were clarified.

- The participants were interested in methods of soil improvement.
- The participants thought that they needed to make efforts to develop their farm by themselves.
- The participants expect to improve their poultry productivity by introducing the method learned in Hambokto site.

Moreover, after these mutual visits, technical transfer between the pilot farms and activation of the farming activities were confirmed. Therefore, this type of training seems an effective training for improvement of farming techniques and motivation in farming.

4) Training for Cooperative Leaders

Training for cooperative leader was conducted for leaders of the three pilot farms. The objectives of the training were to 1) provide an opportunity to learn the basic information about cooperative activities and roles, 2) provide information regarding agricultural extension activities of the Directorate of Agriculture and Forestry of the MAEPE-RH. MAEPE-RH and the C/Ps of the Study took charge of arrangement of schedule, a meeting room and lecturers.

In the training, the lectures explained income from farming, activities of cooperatives and activities of the Directorate of Agriculture and Forestry of the MAEPE-RH. The lecturers orally explained and showed photos as much as possible, since the participants could not read.

After each lecture, participants were given time for questions and answers. They discussed well, especially about how to establish a cooperative and how to cope with a person who does not pay his cooperative duties. After that, the participants visited a farm managed by the Directorate of Agriculture and Forestry.

After the implementation of this training, collection of cooperative fees was discussed in all of the pilot sites. In addition, several participants started to collect the cooperative fees. Therefore, this type of training can lead to positive effect on the support of farmers' organization.

5) Study Tour for Woman Participants

Targets of this training were women who were actively working in the pilot farms. This study tour was conducted for Hambokto women participants (10 people attended). Two sites, Atar agricultural cooperative and Moroccan farm (advanced farm established by the Government of Morocco), were selected to visit.

The Atar agricultural cooperative is managed by mainly women. The woman president of the cooperative explained history of the establishment of the cooperative, activities undertaken at present, advantages of a cooperative, and so on. After that, the Hambokto participants and the members of the Atar agricultural cooperative exchanged their opinions and the participants learned the advantages and the management methods of cooperatives. At the Moroccan farm, an agricultural extension staff of Arta region explained about their farm. The Hambokto participants observed advanced cultivation techniques of vegetables.

According to results of questionnaire survey on the study tour, followings were clarified.

- The participants could learn many things regarding a agricultural cooperative.
- The participants expected to establish a agricultural cooperative managed by women president and vice-president.

After this study tour, the women cooperative was established and applied in Hambokto. Since the women tend to adopt the cooperative works in comparison with men, this type of training is expected to facilitate the farmers to organize cooperatives.

(2) Training for Agricultural Extension Staffs

The number of agricultural extension staffs of the MAEPE-RH is quite limited. Thus, these staffs do not generally have enough time to spend in extension activities due to the various duties held as public servants. Moreover, they do not have enough chances to develop their capacity as extension staffs as well. In this pilot project, the study team undertook administrative and managerial works in the pilot farms with the local extension staffs (C/Ps) in each region in order to strengthen their capacity and clarify problems in terms of agricultural extension activities.

The most important qualifications for an agricultural extension staff are: good knowledge of agricultural techniques, ability of planning, and administrative and managerial ability. The study team attempts to improve these abilities for local extension staffs through the pilot farm activities.

The table below shows the activity situation of each extension staff in the pilot farm administration and management.

Table 4.2.15 Activity Situation of Each Extension Staff

Region		Arta	Ali Sabieh	Dikhil
Good Knowledge of Agricultural Techniques	1.1 Instruction of various farm works	-	+-	-
	1.2 Implementation of cultivation experiments	-	-	-
	1.3 Implementation of various analysis for soil and water quality	-	+-	+-
Planning Ability	2.1 Planning of cultivation experiments	+-	-	-
	2.2 Planning of study tours for the participants	+-	+	+
Administrative and Managerial Ability	3.1 Selection of the participants and explanation of the pilot project	+	+	+
	3.2 Coordination with donors such as WFP	+-	+	+-
	3.3 To solve various problems related to management of the pilot farms	-	+	+-

+; Positive participation, +-;Participation, -; Not participating

The followings are indicated according to the activity situation mentioned above.

- Participation of the extension staffs in the pilot farm activities was not active.
- The extension staffs tended to participate in irregular activities such as planning and management. On the other hand, most periodical activities such as instructions on farm works were not well conducted in every region.
- This might be due to the limited number of extension staffs in each region. In addition, they do not have transportation to go to the pilot farms, causing the difficulties of spontaneous participation in the pilot farm activities.

(3) Training for the MAEPE-RH Staffs

In this pilot project, the study team implemented the entire administration and management of the pilot project in cooperation with the C/Ps in order to contribute in improving their project implementation ability and to clarify the problems of the MAEPE-RH as an implementation organization of agricultural projects.

The following activities related to the administration and management of the project were implemented by the study team and C/Ps.

Table 4.2.16 Contents of Activity Related to Administration and Management of the Pilot Project

	Contents of Activity
Project Planning	• Planning of steering committee • Planning of field survey • Planning of activities in the pilot farms • Selection of contractors for the pilot farm construction
Administration & management	• Approval and authorization of utilizing heavy machineries provided by JICA • Supervision of the pilot farm construction • Coordination with donors such as WFP • To solve various problems related to management of the pilot farms • Advertisement of the Study

The staffs of the MAEPE-RH showed positive attitude towards the Study. On the other hand, similar to the problem of extension staffs, the human resources of the MAEPE-RH are quite limited. In the Study, two staffs of the MAEPE-RH supported the study activities. However, both staffs could not spend enough time for the activities due to other duties as public servants. Thus, it is indispensable to allocate more human resources to the MAEPE-RH.

4.2.5 Organization of Agricultural Cooperatives

After termination of the pilot project, the participants need to collect operation and maintenance cost and to maintain the farm facilities. The participants started recognizing necessity and effectiveness of agricultural cooperative for the activities through the study tour on advanced agricultural cooperative, the training for cooperative leader and discussion with the study team.

As a result, the participants hoped to establish and register official agricultural cooperatives. Therefore, they tried to establish and register agricultural cooperatives in accordance with Djiboutian government procedure of cooperative registration. In the procedure, representatives of the participants, C/Ps and the study team discussed and made a draft statute and an internal regulation based on precedents of cooperatives. After that, general assemblies for establishment of the agricultural cooperatives were held on 23 June 2014 in Hambokto and 10 August 2014 in Afka Arraba to decide the statute, the internal regulation and member's fee (500DJF/month) and to select the board members. After the general assemblies, the necessary documents for Hambokto were submitted to Ministry of Interior and the necessary documents for Afka Arraba are under preparation.

In case of Hambokto, women are active in farming activities and the most women hoped to establish cooperative. Therefore, women's cooperative was to be established and women in each household of the participants joined the cooperative as the member. On the other hand, the participants in Kourtimalei still don't reach consensus on establishing a cooperative.

4.2.6 Workshop

To share the lesson learned from the pilot project with the stakeholders and donors concerned in agricultural sector of Djibouti, the study team held a workshop on 14 May 2014 in collaboration with the MAEPE-RH. The workshop was successfully carried out with attendance of 29 participants: the MAEPE-RH, Ministry of Environment, Djibouti University, CERD, FAO, UNDP, IGAD, WFP, participants of the pilot project, advanced farmers, JICA Djibouti Office and the study team.

After presentation of the study team for outline of the study activities, contents and outcomes of the pilot project, the workshop entered into a discussion. Some participants pointed out the fact that other similar agro-pastoral projects were so far unsuccessful in term of sustainability. Thus, the sustainability of the pilot project was focused on in the discussion. Finally, it was acknowledged that systematic support for irrigation and farming techniques to the project participants and organization and empowerment of agricultural cooperatives are essential in order to ensure the sustainability of such projects.

4.3 Analysis of the Problems Relating to the Pilot Project

4.3.1 Consideration on Adaptability of Surface Water for Irrigation

(1) Current Situation and Challenge on Usage of Surface Water for Irrigation

To store surface runoff water during floods, the MAEPE-RH constructed a number of dikes along the periphery of Bara desert. Most of the ponds formed with the dikes are in use as water place for livestock, and two ponds of Kourtimalei and Doudoub Bolele are in use for irrigation purpose. Based on the achievement of crop cultivation being undertaken at both ponds, it is recognized that the irrigation pond has adaptability as an irrigation water source. Therefore, irrigated agriculture having use of surface water with an irrigation pond is expected to be developed in other applicable sites.

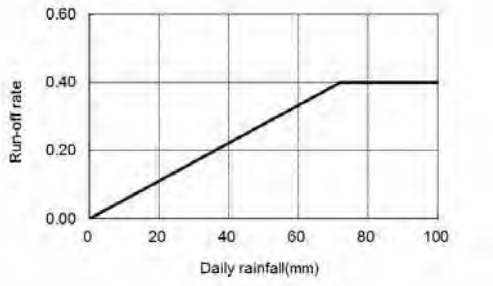
On the other hand, it is pointed out that the irrigation pond has a challenge in term of stability as a water source. Because, precipitation is not constant by year and season in Djibouti, and drought continues for some years as well. High-intensity rainfall in a short period of time, namely localized heavy rain is required to induce surface runoff water flow. In this section, irrigable area was estimated

in the case that an irrigation pond is a single water source under the condition of the catchment area and storage capacity of Kourtimalei pond.

(2) Water Balance Simulation on Irrigation Pond

To estimate the irrigable area with this irrigation system, water balance simulation was conducted by using daily rainfall data for 10 years. The condition of the simulation is assumed as follows;

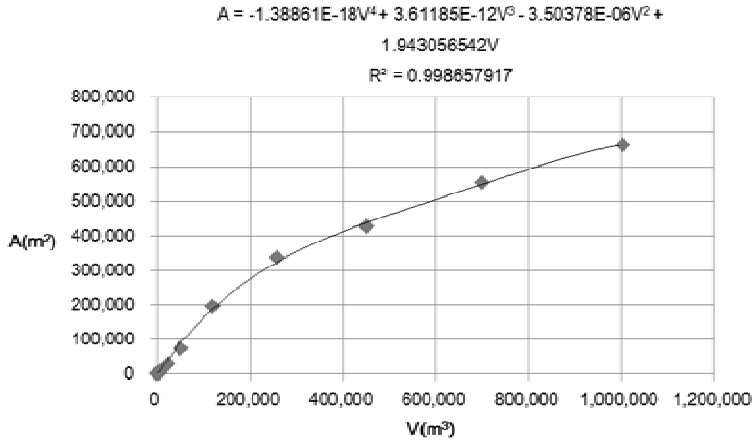
- Cropping pattern:
  Winter vegetable: 30%, winter fodder: 70%
  Starting month of cultivation is decided in consideration of impounded water amount.
- Irrigation water amount:
  Crop water requirement is calculated based on the cropping pattern of irrigated farming model (P-B) which is mentioned in the M/P.
  Irrigation efficiency: 60% (Surface irrigation)
- Livestock water amount:
  Goat or sheep: 650 heads
  Water consumption unit: 3ℓ/day/head
- Catchment area of the pond: 40km^2
- Daily rainfall data: 2000-2011 in Djibouti
- Run-off rate: see the graph below
  Daily rainfall more than 5mm is counted as effective rainfall.



- Evaporation from water surface:
  Estimated with FAO Penman-Monteith Method (mm/day)

Jan	Feb	Mar	Apr	Mar	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5.6	6.1	6.3	6.9	7.7	9.3	11.3	11.0	8.7	7.6	6.6	5.4

- Infiltration: 5mm/day (Assumption)
- Water surface area of the pond:
  Estimated with the correlation equation of storage volume (V) and water surface area (A)



In this water balance simulation, cultivable area is defined as maximum irrigable area when the volume of the pond does not reach zero during cultivation period by the year.

(3) Simulation Result

Table 4.3.1 shows the cultivable area calculated in accordance with the water balance simulation. It depends on amount and distribution of rainfall by the years. The table shows the maximum cultivable area 26.6ha during the year from June 2006 to May 2007; on the other hand, it shows that cultivable area is 0ha in the two years.

The simulation result concluded that the pond is not a stable water source for irrigation purpose. Accordingly, it is recommended that deep wells must be added as a supplemental water source to make up for this instability of the pond.

Table 4.3.1 Result of Water Balance Simulation of the Irrigation Pond

Starting Year/Month - Ending year/Month	Cultivable area (ha)	Cultivation period
2000 June - 2001 May	4.4	September 1st → March 10th
2001 June - 2002 May	2.5	August 1st → February 10th
2002 June - 2003 May	9.0	October 1st → April 10th
2003 June - 2004 May	0.5	September 1st → March 10th
2004June - 2005 May	2.4	October 1st → April 10th
2005 June - 2006 May	0	September 1st → March 10th
2006 June - 2007 May	26.6	September 1st → March 10th
2007 June - 2008 May	0.2	August 1st → February 10th
2008 June - 2009 May	5.1	November 1st → May 10th
2009 June - 20010 May	0	November 1st→May 10th
2010 June - 2011 May	0.4	September 1st → March 10th

4.3.2 Consideration of Proposed Irrigation Farming Model in the M/P

In the chapter 5, farmers are classified based on present farming systems in Djibouti and then water source classes are added to the farmer' group to propose the 7 irrigation farming models shown in the table below. (see chapter 5 for the detail of the irrigation farming models)

Table 4.3.2 Proposed Irrigation Farming Models in the M/P

Water Source / Irrigation Facility		Farmers' Group			
		Home-garden Farmers' Group	Beginners Farmers' Group	Self-sustained Farmers' Group	Advanced Farmers' Group
Shallow water	Shallow well	Shallow well (Home-garden farmers' group) **SW-H**	Shallow well (Beginners farmers' group) **SW-B**	Shallow well (Self-sustained farmers' group) **SW-S**	Shallow well (Advanced farmers' group) **SW-A**
Surface water	Pond	Pond (Home-garden farmers' group) **P-H**	Pond (Beginners farmers' group) **P-B**	Pond (Self-sustained farmers' group) **P-S**	Pond (Advanced farmers' group) -

Based on the results of the pilot project, the analysis is conducted to check the validity of each irrigation farming model. In this section, the following three items are considered in detail.

- Forage production and consumption of each irrigation farming model
- Vegetable production, consumption and sales of each irrigation farming model
- Suitable crops for each irrigation farming model

(1) Estimation of Forage Production and Consumption in Each Irrigation Farming Model

1) Annual Forage Consumption of Livestock

The major livestock in Djibouti is goats. The table below shows the estimation of annual forage consumption in each farmers' group. Based on the baseline survey, the number of goats in Home-garden farmers' group is 20 heads, while that in Advanced farmers' group is 40 heads. Besides, 25% of the total number of goats is assumed to be young or baby goats which cannot move long distances with adult mature goats. As a result, it is estimated that Home-garden farmers' group requires 23t of forage annually, which includes the 3t of forage consumed by the young goats.

Table 4.3.3 Annual Forage Consumption in Each Irrigation Farming Model

	No. of Livestock*		Annual Forage Consumption (kg)**		
	Mature Goats	Young Goats	Mature Goats	Young Goats	Total
Home-garden farmers' group (SW-H, P-H)	15	5	19,710	3,285	22,995
Beginners farmers' group (SW-B, P-B)	19	6	24,966	3,942	28,908
Self-sustained farmers' group (SW-S, P-S)	23	7	30,222	4,599	34,821
Advanced farmers' group (SW-A)	30	10	39,420	6,570	45,990

* No. of livestock is decided based on the baseline survey.

** Calculation formula is as follows.

Annual Forage Consumption (Matured goat) = (30kg (Goat weight) × 0.024 (Forage Consumption Coefficient)) / (100 – 80 (Water content of Forage)) *100 × No. of goat × 365 days

2) Comparison between Annual Forage Production and Consumption

By using the results of yield survey of fodder crops in the pilot project as much as possible, annual forage production quantity in each irrigation farming model is estimated. Besides, the annual forage production and the annual forage consumption mentioned above is compared, which is shown in the table below.

Table 4.3.4 Annual Forage Production and Consumption in Each Irrigation Farming Model

	Annual Forage Production (kg)	Annual Forage Consumption of Young Goat (kg)	Annual Forage Consumption of Matured Goat (kg)	Annual Forage Consumption In Total (kg)
SW-H	1,621	3,285	19,710	22,995
SW-B	15,727	3,942	24,966	28,908
SW-S	40,700	4,599	30,222	34,821
SW-A	85,600	6,570	39,420	45,990
P-H	326	3,285	19,710	22,995
P-B	3,255	3,942	24,966	28,908
P-S	18,000	4,599	30,222	34,821

1,621kg of forage is produced in SW-H, which is nearly half (49%) of the forage consumption of young goats (3,285 kg). In case of SW-B, it is possible to produce 17,984kg of forage annually, which is more than half (54%) of the total consumption (28,908 kg). Thus, it can be concluded that forage cultivation in the farm could contribute to the improvement of livestock grazing activity in terms of feeding livestock. Moreover, the irrigation farming model SW-S and SW-A can produce more than the necessary amount of forage in their farm. On the other hand, the forage production in the irrigation farming models depending on pond water is generally small due to no summer cultivation. For example, the irrigation farming model P-S can produce 18,000 kg of forage, which is more than half (51%) of the total consumption (34,821 kg).

(2) Estimation of Vegetable Production, Consumption and Sale in Each Irrigation Farming Model

1) Estimation of Vegetable Production and Consumption

In this section, the vegetable production and consumption is estimated based on the results of the pilot project. The table below shows the average vegetable production and self-consumption of the households who participated in the pilot project. The self-consumption ratio is decided as 23.3% of the total crop production according to interview with the pilot project participants.

Table 4.3.5 Crop Production and Consumption per Household

	Average Yield (t/ha)	Average Cultivation Area (m^2)	Average Production (kg)	Self-consumption ratio (%)*	Average Self-consumption (kg)
Tomato	24.0	65.0	155.7	23.3	36.3
Hot pepper	3.2	33.8	10.9	23.3	2.5
Onion	22.4	20.8	46.6	23.3	10.9
Okra	8.2	23.4	19.2	23.3	4.5

* Based on the interview with the pilot project participants

2) Vegetable Production and Sales in Each Irrigation Farming Model

Based on the results mentioned above, vegetable production and sales in each irrigation farming model are estimated. Sales is estimated on the assumption that all surplus crops (subtraction of self-consumption from total crop production) are sold in the market. In this section, only the results of tomato and hot pepper are shown in the table below, although the results of other crops also show a similar tendency. For example, tomato production in SW-H and P-H is 36kg, which is similar to the amount of self-consumption (36.3kg). In case of hot pepper, these groups can produce 5kg of hot pepper in their farm, which is higher than that of self-consumption (2.5kg). Therefore, it is possible to produce crops at least for self-consumption even in the irrigation farming model SW-H and P-H, which have minimum farming area. In contrast, other irrigation farming models can get some income through sales of the surplus crops produced in the farm.

Table 4.3.6 Tomato Production and Sales of Surplus Products in Each Irrigation Farming Model

Farming Model	Production (kg)	Self Consumption (kg)	Surplus amount (Sales amount)(kg)	Sales (DJF)*
SW-H	36	36.3	0	0
SW-B	360	36.3	324	32,370
SW-S	1,440	36.3	1,404	140,370
SW-A	4,800	36.3	4,764	476,370
P-H	36	36.3	0	0
P-B	360	36.3	324	32,370
P-S	1,440	36.3	1,404	140,370

*Unit sales price is 100DJF/kg

Table 4.3.7 Hot Pepper Production and Sales of Surplus Crop in Each Irrigation Farming Model

Farming Model	Production (kg)	Self Consumption (kg)	Surplus Amount (Sales amount) (kg)	Sales (DJF)*
SW-H	36	36.3	0	0
SW-B	360	36.3	324	32,370
SW-S	1,440	36.3	1,404	140,370
SW-A	4,800	36.3	4,764	476,370
P-H	36	36.3	0	0
P-B	360	36.3	324	32,370
P-S	1,440	36.3	1,404	140,370

*Unit sales price is 100DJF/kg

(3) Considerations on the Suitable Crop for Each Irrigation Farming Model

Based on the results of the pilot project, suitable crops for each irrigation farming model are considered in terms of 1) Cultivation difficulty, 2) Seed procurement difficulty and 3) Market price.

1) Cultivation Difficulty

The table below shows the average yields of each crop produced in the pilot farm, that of advanced farmers in Djibouti and that from statistical data in East Africa.

Table 4.3.8 Comparison of Crop Yield and Evaluation of Cultivation Difficulty

Crops	Average Yield in the Pilot Farm (t/ha)	Yield in the Farm of Advanced Farmer (t/ha)	Statistical Data of East Africa (t/ha)	Cultivation Difficulty
Tomato	24.0	35.2	10.0*	Easy
Hot pepper	3.2	19.7	2.9*	Slightly Easy
Onion	22.4	38.5	5.2*	Easy
Okra	8.2	18.9	11.0*	Slightly Easy
Eggplant	ND****	31.2	12.1*	Slightly Difficult
Niebe	ND	ND	ND	Easy
Melon	5.3***	17.5	15.0*	Difficult
Watermelon	ND	ND	11.0*	Slightly Easy
Sorghum	27.3	ND	ND	Easy
Sudan glass	45.2	ND	40.0**	Easy
Alfalfa	33.0	ND	ND	Easy
Crotalaria	ND	ND	ND	Easy
Moringa	11.2	ND	ND	Easy
Leusanea	ND	ND	ND	Easy

*FAOSTAT (2012), **FAO Cultivation Manual, *** Result of 1st winter cropping, **** No data

The yields of tomato and onion in the pilot farms are higher than that in the statistical data of East Africa, indicating that the cultivation difficulty of tomato and onion may be low. As for hot pepper and okra, although the yields data varied in the three pilot farms, these were similar or slightly higher than that in the statistical data of East Africa. Thus, it could be concluded that the cultivation difficulty of these crops may not be so high. On the other hand, the cultivation difficulty of eggplant and melon would be comparatively high since these crops are vulnerable to insects and diseases. The yield data of niebe and watermelon were not available, not being produced in the pilot farms. However, taking the data obtained from existing farms in Djibouti into consideration, it could be concluded that the cultivation difficulty would be low. The cultivation difficulty of forage is also considered to be low.

2) Seed Procurement Difficulty

Seed procurement in Djibouti is quite difficult for general farmers since there are few extension organizations for agriculture or private agencies stably supplying crop seeds with low price. The table right shows the difficulty of the seed procurement in Djibouti.

The seeds of niebe and sorghum are sold in the local market, meaning that procurement of these seeds is relatively easy. In case of tomato and hot pepper, they are generally grown in Djibouti. Thus, it could be possible to get them through the cultivating farmers who collect seeds from their products although it is difficult to procure these seeds in the local market. On the other hand, Sudan glass and alfalfa seeds are not sold in the local market. Furthermore, existing farmers in Djibouti do not generally grow these fodder crops. Besides, these crops require more seeds than vegetables. Therefore, they are considered to be difficult to get the seeds in Djibouti.

Table 4.3.9 Seed Procurement Difficulty

Crops	Difficulty*
Tomato	+-
Hot pepper	+-
Okra	+-
Onion	+-
Eggplant	+-
Niebe	+
Melon	+-
Watermelon	+-
Sorghum	+
Sudan glass	+-
Alfalfa	-
Crotalaria	+-
Moringa	+
Leusanea	+

* +: Easy to procure、+-: Slightly difficult to procure、-: Difficult to procure

3) Market Price

A market price survey was conducted at Djibouti city, Dikhil region and Ali Sabieh region. The evaluation of crops regarding the market price is conducted based on the result of Djibouti market (September 2013 to April 2014).

Table 4.3.10 Result of Market Price Survey in Djibouti City

	2013 (DJF/kg)				2014 (DJF/kg)				Major Producing Area	Evaluation
	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr		
Tomato	266	200	150	150	150	100	100	175	Ethiopia, Djibouti	+-
Hot pepper	250	200	150	200	300	200	200	200	Ethiopia	-
Onion	200	150	166	150	150	150	166	200	Ethiopia	-
Okra	383	ND*	ND	250	266	300	250	200	Ethiopia	+-
Eggplant	200	200	200	200	250	200	216	150	Ethiopia	+
Melon	283	300	300	300	300	300	250	275	Djibouti	+
Watermelon	200	100	100	100	100	100	100	140	Somalia	+-

*ND: No Data

Most crops sold in Djibouti market are imported from Ethiopia. In case of tomato, the market price tends to decrease from January to March, which is a harvest season for winter crops in Djibouti.

However, crops such as tomato and onion are generally consumed at a daily base in Djibouti, meaning that demand of these crops is considerably high. Thus, the market value of these crops is considered to be high in Djibouti. Although the market prices of hot pepper and okra are stable throughout the year, the market value is not high in consideration of the prices of 1kg of the crops since the weight of these crops is relatively light. The major production area of melon sold in the market is in Djibouti, and the market price is higher than other crops. In contrast, the majority of watermelon sold in the market is imported from Somalia and the price is low throughout the year. However, watermelon is not often sold in Dikhil and Ali Sabieh markets although it is not mentioned in the table above. Therefore, the market value of the watermelon in the regional markets would be higher than that in Djibouti market.

4) Suitable Crops for Each Farming Group

Based on the results of 1) to 3) mentioned above, the suitable crops for each irrigation farming model are decided as follows.

Table 4.3.11 Suitable Crops for Each Farming Group

Crops	Cultivation	Seed Procurement	Market Price	SW-H	SW-B	SW-S	SW-A	P-H	P-B	P-A
Tomato	Easy	+-	+-	++	++	++	++	++	++	++
Hot pepper	Slightly Easy	+-	-	++	++	+	+-	++	++	+
Okra	Slightly Easy	+-	-	++	++	+	+-	++	++	+
Onion	Slightly Easy	+-	+-	++	++	++	++	++	++	++
Eggplant	Slightly Difficult	+-	+	-	+-	+	++	-	+-	+
Niebe	Easy	+	ND	++	++	-	-	++	++	-
Melon	Difficult	+-	+	-	+-	+	++	-	+-	+
Watermelon	Slightly Easy	+-	+-	+	+	-	-	+	+	-
Sorghum	Easy	+	ND	++	++	++	++	++	++	++
Sudan glass	Easy	+-	ND	+-	+-	+	++	-	-	-
Alfalfa	Easy	-	ND	-	-	+	++	-	-	-
Crotalaria	Easy	+-	ND	+-	+-	+	++	+-	+-	+
Moringa	Easy	+	ND	++	++	++	++	-	-	-
Leusanea	Easy	+	ND	++	++	++	++	-	-	-

* ++: Highly recommended, +: Recommended with high priority, +-: Recommended with low priority, -:Not recommended, ND: No data

The farmers' groups such as Home-garden farmers' group (SW-H, P-H) and Beginner farmers' group (SW-B, P-B) are recommended to choose the crops in terms of lower difficulty of cultivation and seed procurement. For example, the crops requiring proper insects and diseases control techniques such as melon are not recommended for these farmers' groups. However, watermelon cultivation with combination of sales in regional markets is recommended for them.

On the other hand, the farmers' groups such as Self-sustained farmers' group (SW-S, P-S) and Advanced farmers' group (SW-A, P-A) are recommended to cultivate crops with high market value such as eggplant and melon.

In case of fodder crop cultivation, the rank of recommendation is mainly depending on the difficulty of the seed procurement. In particular, only Self-sustained farmers' groups and Advanced farmers' groups are recommended to cultivate alfalfa due to its difficulty of seed procurement in Djibouti. In

case of P-H, P-B and P-S that water sources are ponds, perennial crops are not recommended due to the lack of water in the summer season.

4.3.3 Survey and Consideration of Change of Awareness of Participants

In April 2014, 11 households of the pilot project in the 3 sites, 3 in Kourtimalei, 4 in Hambokto and 4 in Afka Arraba, were interviewed to collect their impressions and opinions regarding implementation of the pilot project. The results suggest below.

(1) Changes Experienced in the Pilot Project

(a) Income: Most households experienced a small or medium increase in income. The increase is caused by selling part of the agricultural products harvested in their farms and consuming part of them. The consumption of their own products is also contributing the income increase since the consumption has helped them to save their money for buying them at the markets.

(a) Farming: Most respondents were nomads and knew only livestock raising. In addition, they didn't have any clear notion in agriculture before the pilot project. However, all respondents learned many things in cultivation such as manure making and application, insects and diseases control, etc. in the pilot project and have gained a positive attitude toward agriculture.

(b) Lifestyle: Their lifestyle has changed for the better due to selling and consuming the products harvested in their farms. Some have expressed that their children are better and healthier than before by consuming the products such as melon and vegetables in their farms. They can save a considerable amount of time and money, not having to buy their vegetables at markets located far away but to get them directly in the farms.

(2) Awareness toward Agriculture

They want to continue crop cultivation since they recognized the profits through the pilot project that they can get from crop cultivation (income and food). Some of them also recognized that one has to work hard initially (land preparation, manure making, tilling, etc.,) to get good results afterwards. Therefore, it is cleared that they are willing to continue the cultivation even the work is hard.

(3) Priority Level of Crops

Crops for food (vegetables) have higher priority than fodder crops since vegetables can be consumed for health of the family or sold for income. Onion and tomato are mostly rated higher among the food crops. Crops that are listed at the lower priority are fodder crops such as Sudan grass, sorghum and maize for livestock. Since their own lives have higher priority than livestock, the priority of fodder crops is low. Some food crops such as maize, okra and green pepper are listed low in some cases since these crops could not bring them more income than other vegetables. Therefore, it is cleared that both aspects of food and income are important for them to select crops.

(4) Awareness toward Cooperative

All respondents expect agricultural cooperatives to solve problems related to farming or to get support from official institutions such as the MAEPE-RH. They have recognized that they have to depend on their own to solve their problems after termination of the pilot project.

(5) Expectation or Dream in Improving Life

All respondents are expecting improvement of life by providing food to the families through farming and by starting a new business. Many people wish to extend their farms to produce more and get more money. For example, the participants in Kourtimalei started a small scale restaurant and a shop near the main road.

4.4 Lesson Learned from Implementation of the Pilot Project

4.4.1 Planning of Water Resource

(1) Shallow Well

1) Shallow wells taking shallow groundwater can be year-round water sources for irrigation use.

The water resources for irrigation in the pilot farms in Hambokto and Afka Arraba are shallow groundwater taken through shallow wells excavated in rock foundations along wadi streams. Although the water table in the wells seasonally fluctuates at both sites, year-round water supply through the wells is confirmed and farming can be conducted in all seasons. It is confirmed that a shallow well taking shallow groundwater can be a year-round water source for irrigation use.

2) The catchment of a shallow well site targeting shallow groundwater in rock foundation should be more than 10km^2 for a water source of irrigation.

It was confirmed by continuous measurements that the water table of shallow groundwater in rock foundation increases in 1 or 2 days after rain. This implies that the shallow groundwater in the wells is affected by rains falling in nearby sites. Hence, some certain size of the catchment is necessary for a shallow well to cover the required water volume. The case of Hambokto catchment can be an indicator, which has a size of about 10km^2. This observation in Hambokto gives the indication that the adequate size of a catchment in a well site targeting shallow groundwater should be over 10km^2.

3) One shallow well may cover about 1ha of irrigation farmland.

The pilot farm in Hambokto covers about 1ha of farmland where one shallow well supplies irrigation water. Full year's irrigation is performed there. However, the groundwater level decreased to a level just enough to supply necessary amount of the irrigation water, when it was no rain for a long period. The case of Hambokto suggests that the possible size of farmland that one shallow well irrigates is about 1ha.

4) Excavation of well can be done by local people.

Shallow wells for the pilot farms were dug by local man power. From the viewpoint of sustainable irrigation agriculture development, a shallow well is a water source that can be developed by using local techniques and local man power.

5) Maximum depth of shallow wells is about 10m in order to keep safety and easy progress of the construction work.

Shallow wells, No.1 and No.2, in Afka Arraba pilot farm are about 10m deep. From the observation of the civil works considering safety and effectiveness of labor work, 10m is almost the maximum depth for the construction of a shallow well.

6) Careful field survey is required to select a location of a shallow well for use of shallow groundwater.

Two shallow wells, which have about 150m distance between them, were obliged to dig for use of the shallow groundwater at Afka Arraba. One well locates in hard rock foundation and another one locates in a fault zone of rock foundation. Because of the conditions of the rock foundation, digging hard rock required several times of works and time. In addition, Signs to show existence of water were observed in shallow depth when the fault zone was dug. Water amount of the well in the fault zone seemed abundant. This implies that selection of well-digging sites is one of important point. In order to develop shallow groundwater by shallow wells, careful field survey is necessary to find

sites which have possibility of existence of fault zones.

7) Introduction of lending system for rock breakers is recommendable for excavation work of shallow wells.

To maintain effective progress of the civil work, a rock breaker apparatus, which was obtainable in Djibouti, was utilized in the pilot project. It was confirmed that the use of this apparatus contributed to the easy and safe work and it was very effective for the rock excavation. As its use requires some cost for fuel besides that for the apparatus, an individual farmer cannot easily cover such expenses. Accordingly, a proper lending system for the rock breaker supported by the government is proposed to assist farmers' groups.

8) Countermeasures against floods are inevitable.

Shallow wells along wadis sometimes suffer from flood damage. Many abandoned wells are observed everywhere. It is firmly recognized that countermeasures including protection works are inevitable for shallow wells constructed nearby wadi streams.

(2) Pond

1) Excavation pocket in a pond is very useful to maintain water storage.

Although Kourtimalei pond holds a large water surface after heavy rain, evaporation shortly reduces the water level of the pond. To reduce evaporation loss from water surface, excavation in the pond was conducted in the pilot project. It was confirmed that this excavation could contribute to maintaining pond water for longer period and it leads to effective use of the impounded water.

2) Water loss through the pond foundation is not negligible.

In Kourtimalei site, water-level sensors were installed to continuously measure changes of water level. And also evaporation was simply measured at the site. As a result, it was suggested that the water loss through the bottom of the pond reached about 20mm/day. In the excavation works in the pilot project, bolder sediment layers were unexpectedly penetrated. Although this excavation might have caused the water losses through the foundation, it is implied that the water losses through the pond foundations is not negligible.

3) A pond requires certain size of catchment area.

Ever year, there are heavy rains and floods in the study area. The ponds at Kourtimalei and Doudoub Bolole stock the floodwater. Catchment areas of both ponds are 30-40km^2, respectively. These cases suggest that a catchment area of a pond should be desirably larger than 30km^2.

4) The water use should be started immediately after the impoundment of the pond.

The Kourtimalei pond cannot keep water all year around. Seasonal heavy rains in August supplies mass water up to the full-water level. Then the water volume decreases gradually and vanishes in the dry season. This cycle is repeated every year. This is to say that irrigation cannot be performed during the whole year and cropping in only one season is possible. Therefore, cultivation should be commenced as soon as possible after impoundment of the pond.

4.4.2 Irrigation Plan

1) Agricultural development can be realized if the access to water source is ensured.

The pilot project had revealed that it is possible to convert stony arid land to irrigated farmland if water source facilities such as shallow wells and ponds are established.

2) Effective use of the heavy construction machines belonging to the MAEPE-RH is essential in conducting reclamation of new agricultural land.

In most cases, land preparation work consisting of removing stones and land leveling is initially required for reclamation of new agricultural land. If heavy construction machines including bulldozers, loaders and graders could be used effectively, land preparation work for stony arid land of one (1) ha would be completed at low cost within about two (2) weeks.

3) Pipeline networks have an advantage in term of water saving.

Pipeline networks were established from water sources to each plot in all pilot farms. It is helpful to reduce conveyance water loss which is caused by seepage and evaporation in the irrigation canals. Pipeline networks certainly lead to water saving compared to earth lining canals.

4) Solar systems for irrigation are useful.

The climate of Djibouti is characterized as long sunshine hour with rich solar radiation. In consideration of such climate feature, a solar system was installed as power source for an irrigation water pump in Afka Arraba pilot farm. Solar systems have following advantages, free operation cost, and easy pump operation with automatic operation systems.

5) Following findings on construction work and materials relating to the establishment of irrigation facilities should be taken into consideration for formulating agricultural development projects.

Construction work of irrigation facilities includes several simple works such as excavation and stone masonry; therefore, local people can participate in the construction work as workers, taking advantage of the scheme “Cash for Work”. The stones readily-accessible at the sites can be utilized as construction material of the well protections, fences and warehouses.

6) Following findings on water management at farm level should be taken into consideration for formulating agricultural development project.

Irregularity along the furrow resulted in uneven growth of crops, showing that better growth in the concave portion due to sufficient irrigated water amount, and poor growth in the convex portion due to less irrigated water amount. To benefit from furrow irrigation technique, it is essential to finish the furrows on the level. In the case that it is difficult to get leveling of farmland and /or furrows, small size hose is useful as a watering tool in terms of handling and water saving.

7) On-line type drip tube is much recommendable than in-line type drip tube as a promising drip irrigation material in Djibouti.

Two types of drip irrigation tubes, on-line type and in-line type, have been introduced in Djibouti. Based on the result of experimental operation conducted at the study team plot of pilot farms, it was proved that the on-line type drip tube worked well even under low water pressure namely gravity pressure of the water tank. In addition, this type drip tube has another advantage of easy maintenance against clogging. Accordingly, on-line type is recognized as a promising material for drip irrigation systems to disseminate in Djibouti.

4.4.3 Farming and Cultivation Plan

1) Manure should be always available during the cultivation period since application of the manure made of livestock dung is very effective for the crop cultivation.

Generally, the soil fertility is rather low in Djibouti, meaning that the fertilizer application is essential for the crop cultivation. However, obtaining commercial chemical fertilizers is quite difficult in

Djibouti. Therefore, application of the manure made of livestock dung is essential instead of the chemical fertilizer application. The manure should be always available during cultivation period in order to apply it when it is necessary. The total quantity of manure annually collected by one household is estimated at 300-400kg approximately, which can cover about only 0.2ha cropping area in only one cropping season. Therefore, it should be noted that it requires additional cost for collecting manure to cultivate more than that.

2) Spot manure application is more effective than broadcast application.

It is necessary to increase efficiency of manure application since the obtainable quantity of the manure is limited in Djibouti. Effectiveness of the manure applying around crops, where the crops can absorb the nutrient more, is higher than that of broadcast application in furrows. Quantity of the basal manure for vegetables should be around 200g/plant. Besides, additional manure should be applied to the soil as necessary.

3) Cultivation of insects and diseases resistant crops is effective under the farming conditions in Djibouti.

To take proper measures on insects and diseases control is quite difficult in Djibouti due to lack of agricultural materials such as pesticides and healthy seeds. At present, cultivation of insects and diseases resistant crops such as tomato and onion is the most effective measure as insects and diseases control, except for advanced farmers who can take necessary measures for that by themselves. In addition, growing healthy seedlings by avoiding strong sunshine with palm tree's leaves and by protecting seedlings with a mosquito net is indispensable to enhance their insects and diseases resistance capacity. Furthermore, basic insects and diseases control techniques such as crop rotation should be well applied.

4) Moringa grows quickly and is useful for windbreak and fodder.

Moringa grows up to 2m height in a year if it is watered enough. In addition, the moringa is useful plant since it can be used not only for windbreak, greening and fodder but also for food. The moringa is extended to around the pilot farms by demonstration in the pilot farms.

5) It is necessary to use locally available materials since the procurement of high-quality seeds, equipment and materials is difficult in Djibouti.

In case of Djibouti, supply system of agricultural materials is not well developed and good quality seeds, equipment and materials in markets are limited. However, locally available materials in Djibouti such as sorghum seeds and handmade tools could be regarded as alternatives. It is necessary to use these materials as much as possible.

6) Repetition of cultivation experience with technical guidance is necessary for the participants to learn and understand appropriate cultivation techniques.

It is not easy for the participants who used to be nomads to understand cultivation techniques and the necessity. Appropriate cultivation techniques can be understood and acquired through the repetition of cultivation experience under technical assistance by agricultural trainers.

7) Surplus agricultural products can be sold in nearby markets in Djibouti

Crops such as tomato and onion can be sold in nearby markets since these crops are relatively easy to produce in quantities. Although much quantity of crops produced in Ethiopia is sold in the markets in Djibouti, there are still plenty of demands since a shortage of the products often happens.

8) Agricultural technical guidance and extension in cooperation with advanced farmers is effective.

Local advanced farmers can effectively guide the former nomads since the advanced farmers have good agricultural techniques which are suitable for Djiboutian characteristic conditions. And they can guide the agricultural techniques in their local language. Therefore, it is an effective method that participation of the local advanced farmers in extension of the agricultural techniques.

9) Advanced farm visit / mutual farm visit are effective to motivate the participants to improve their farming skills.

The participants can imagine a desirable life style based on the agricultural activities through the observation of advanced farms. In case of the mutual farm visit, the participants can mutually recognize their own good points and issues to be improved through the observation of each farm. These training methods seem to be effective to motivate the participants to improve their farming skills.

10) The participation of women in agricultural activities is effective

The daily work of male participants is not only agriculture and livestock raising, but also part time jobs for cash income. Therefore, it is difficult for men to engage in agricultural activities full time. On the other hand, women usually settle and can get involved in agricultural activities in their spare time. Therefore, the participation of women in agricultural activities is effective for the extension of agriculture. Moreover, it is recommended for sustainability of agricultural cooperatives that women take a main role in establishment and management of a cooperative.

4.4.4 Socio-economic Plan

1) Food for Work (FFW) is effective in motivating people to participate in farming at the initial stage.

Nomads who don't have experience in farming don't have knowledge of it, and it is difficult for them to have a correct image of it. It is difficult for such nomads to expect good changes in their life through farming, and some of them are skeptical to participate in the activities. FFW at the initial stage, however, motivates them to participate in farming, and it is effective.

2) The pilot farm becomes a community centre.

Not only farming but also praying and drawing water are done in the pilot farms. As a result, the pilot farms have become places of gathering for the participants and residents living near-by. In addition, some participants moved their residences near the pilot farms. Therefore, people can gather around the farms that may become community centers in some cases.

3) A small scale business is started near the pilot farm

Since people gather around the farms, this creates an opportunity to start a small scale business such as petty trades and restaurants. Therefore, establishment of farms and extension of farming get people to gather around the farms, and indirect effects such as income generation activities can be expected.

4) Priority of food crops is high for the participants.

The participants recognize that getting food for the family is the most important thing. Therefore, cultivating vegetables that they can consume and sell is valuable for the participants and has a higher priority than fodder crops.

5) Men and women can share the farming activities.

The farming activities can be carried out by both men and women, who can take different tasks in the farming activities. Generally, men take heavier works such as land preparation, manure making and seeding. Women take lighter works such as watering and harvesting although they need to go to the farm frequently. In addition, women take an important role in selling since it is a custom that women sell commodities at markets.

6) Organizing agricultural cooperative needs assistance.

On procedures to establish a agricultural cooperative, nomads whose literacy rate is low cannot prepare and apply documents related. Therefore, external assistance on the application procedures is necessary to establish agricultural cooperatives.

4.4.5 Support System of the Administration

1) The number of staffs in MAEPE-RH is limited, which leads to the difficult situation in terms of project management.

In the implementation of the pilot project, a few staffs of the MAEPE-RH worked together with the study team to manage the pilot project. However, the number of the staffs is few and it is not sufficient for the project management. Thus, to promote the project proposed in the M/P, it is essential to increase the number of the staffs of the MAEPE-RH for the proper project management.

2) For proper agricultural extension in regional areas, it is essential to increase the number of staffs in regional Sub-Directorates and to improve their capacity.

The number of staffs for agricultural extension is only one in each Sub-Directorate. The budget is also limited in the Sub-Directorates, which causing lack of fuel of their vehicle for extension activities. Moreover, the staffs working for the agricultural extension does not have enough skills regarding crop cultivation and extension methods. Thus, it is required to improve their skills as an agricultural extension staff.

Chapter 5 FORMULATION OF THE MASTER PLAN

5.1 Framework of the Master Plan

Djibouti is located in arid area and the agriculture production is limited. Even so, nomadic life has been applied continuously from ancient times under the severe condition that water and pasture resources are limited. However, extensive drought hit the region of the Horn of Africa from 2010 to 2012. Nomads living there lost most of their livestock, which has created great number of refugees. To cope with the crisis, WFP (World Food Program) and other donors have deployed the activities of emergency food supply. Meanwhile, it is also pointed out that strengthening of the resilience against drought in middle and long terms is necessary because the drought is recognized to be a chronic phenomenon in this region. In this context, the Government of Djibouti established a policy to improve livelihood of nomads in rural areas by disseminating agricultural activities which will help to strengthen the resilience of nomads against drought. To realize this, it is an urgent issue to formulate the M/P on sustainable irrigated agriculture development in southern Djibouti.

However, there are several constraints to be solved for development and establishment of sustainable irrigated agriculture. The main subjects considered in the M/P are as follows; establishment of a sustainable water resource development, establishment of an irrigation farming model applicable to the natural and regional conditions, improvement of the distribution system of agricultural materials, enhancement of agricultural cooperative activities, enhancement of an extension system of agricultural techniques, and capacity development of the government in implementing the project. Therefore, the main objective of the M/P is to show the roadmap to solve the constraints against development and establishment of sustainable irrigated agriculture.

First, sustainable water resources development for irrigation is considered as the starting point of the M/P. Various approaches are available in developing water resources. For example, large scale water resource development is not suitable to be adopted in the M/P since the construction cost of full-scale dams or deep wells is high, and nomads are scattered over the rural areas. Instead, sub-surface water under the wadis, shallow groundwater, and surface water during floods are regarded as suitable water sources for agricultural development in the M/P. These water resources have not been used effectively or have been wasted so far. Furthermore, it is possible for local people to develop these sub-surface water and shallow groundwater by themselves. In addition, the pilot project successfully verified that the said water sources are certainly available and can be utilized further in the study area.

As described before, the target group of this irrigated agriculture development project is nomad living in rural areas of the three southern regions of Djibouti, where the estimated population is 140,000. In fact, there are several constraints in agricultural development, such as meteorological disadvantage, severe farmland condition, luck of supply system of agricultural materials, insufficient activities of agricultural cooperatives, and less knowledge and experience of the beneficiaries on crop cultivation and farming. Accordingly, another point of the M/P is to establish a sustainable irrigation farming model by breaking through constraints mentioned above. The cultivation plan to be adopted at the pilot farms was formulated considering the current cropping pattern and marketability. It is an agro-pastoral system creating virtuous cycles of agriculture and pastoralism. This M/P aims at developing and establishing a sustainable agro-pastoral system based on irrigated agriculture in southern Djibouti. Judging from the lessons learned from the projects implemented by donors and the outcomes achieved by the pilot project, it was recognized that the provision of instruction and training of irrigation and farming techniques to nomads are essential at the beginning stage.

Meanwhile, this irrigated agriculture development project will be implemented under the supervision of the MAEPE-RH. However, the capacity of the MAEPE-RH is not sufficient in terms of organizational system and project implementation ability. Besides, expansion of the support for the farming activities of local farmers is necessary. Thus, capacity development of the MAEPE-RH and empowerment of farming support system is considered as an essential point of the M/P.

In Djibouti, irrigated agriculture development projects have been implemented so far with support of various international agencies and foreign countries. This M/P is highly expected to be utilized as a roadmap to ensure these projects to be implemented in coherent and effective manner.

5.2 Sustainable Use of the Water Resources

5.2.1 Targeted Water Resources

The water resources used in the M/P are sub-surface water, shallow groundwater and surface water. The facilities for these water resources are shallow wells, ponds and sub-surface dams. Water resources, its characteristics and water taking facilities are briefed in the table below.

Table 5.2.1 Water Resources and Facility

Water resources	Location and water quality	Facility
Sub-surface water	Water in wadis and in terrace deposit. There is an issue of salt in the vicinity of lakes of wadi ending streams.	Shallow well
Shallow groundwater	Seepage water from deep rock through cracks and fracture zone. Including seepage water from surrounding hills. Low seasonal volume change and clean water. However identification of water points is not easy.	Shallow well
Surface water	Impounded surface water at rains. Sometimes muddy but water quality problem is scarce.	Pond and sub-surface dam

5.2.2 Methods of Water Sources Development

(1) Shallow Wells for Shallow Groundwater

In the study area, there are sites using shallow groundwater for agriculture. They include the sites of Hambokto and Afka Arraba. An advanced farmer also developed one shallow well along a wadi in the watershed of Aroru in Dikhil and obtains perennial clean groundwater for agriculture.

The common condition of all these sites is that they belong to the same geological era of early Miocene Delha Basalt, which is a somewhat older geological era in southern Djibouti volcanic zone. Basalt holds normally many open cracks during the process of cooling after eruption. However, the cracks of older Basalt may be filled with calcareous components in the long term geological aquifers. On the contrary, other formations may develop with pervious fissures created by fresh movements of the faults. And a fault itself sometimes becomes impervious curtain in rock so that it may form a specified water passage direction along fissure zone, which provide a chance to take groundwater. Delha Basalt spreads on the southern hill range along the national route No-1.

(2) Shallow Wells for Sub-surface Water

In the mid and downstream stretches of a wadi watershed, the wadi deposit becomes thicker and volume of sub-surface water also increases. In other words, the larger the watershed is, the more sub-surface water is in the wadi deposit. It may be possible to use the water all the year round. The distribution of shallow wells and situation of the usage were studied in the watershed of Idle Djidi wadi in Ali Sabieh region. From the results relating to the distribution of farmlands and size of watershed here, one can roughly conclude that a watershed with size of less than 30 to 40 km^2 cannot provide all year round sustainable water, increasing the number of wells that dries up. Therefore, watershed with size of more than 40km^2 is an indicator to develop a shallow well of sub-surface water.

Farming in Gobbad wadi in Dikhil region, where sub-surface water is abundant, is very active. The number of cooperative members is the highest in Djibouti. On the other hand, however, the flood volume in Gobaad wadi is very high due to the presence of a big watershed. This has damaged many agriculture facilities here before. The flood happened in 2011 gave serious damages and more than 100 farmers stopped farming. Although one part of the farmers rehabilitated the shallow wells by their

own effort and recovered the agriculture, most of them could not return to agriculture. The rehabilitation of the wells has a direct effect on the return of farmers to agriculture again. There is a high demand of wells rehabilitation here, and the M/P focuses on this rehabilitation matter. The same cases can be identified in other sites, where medium to large wadi are running.

(3) Ponds

Impounding rainfall water by a pond is one prospecting new method for the MAEPE-RH. Until recent, surface water was mostly untouched and free in vain, however its use as a water resource is very attractive.

Ponds are made in the moderate or flat plain by excavation. The excavated soil material is used for embankment. The height of the embankment may be 5-10m. Spillway structure, a common appurtenant facility for dams or ponds, is not installed since the overflow can go out on natural rock foundations. The construction can be made cheaper, using only heavy equipment for the earth work. Elevations of impounded water are normally level of or lower than elevations of farmlands. Therefore, pumps are necessary for the water supply.

Three ponds are built for water supply in the study area. Their size of watershed for each pond is over $30km^2$, which is an indicator for pond planning.

At downstream of Petit Bara Desert, near PK58 (km) of the national route No-1, there is a pond constructed at the French era. The embankment of pond is 5m high, 5-7m wide at top crest and about 740m long. The volume of water impounded is one Mm^3. A recent flood has eroded the embankment of central portion of the pond and made it impossible to impound water at all. Both of the MAEPE-RH and local people expect to rehabilitate the pond. Therefore, it is included in rehabilitation sites in the M/P. As the damaged portion of embankment is about 55m long, it can be rehabilitated for about one month, using heavy equipment.

(4) Sub-surface Dams

Sub-surface dams can store wadi water in void of sediment foundation beneath the surface by constructing impervious walls reaching to the rock foundation. As the sub-surface dam does not submerge the ground, land acquisition for a pond is not necessary and many sub-surface dams are constructed in islands of Japan. Sub-surface dams have an advantage of yielding little evaporation since the stored water is underground. Using sub-surface dams in dry areas is done for that reason.

In Djibouti, a sub-surface dam is applicable to develop water resources. At the sites where a pocket exists in the sediment mass, and the length of the valley is short, a sub-surface dam can be applied. The sites of Boule wadi in Arta region and Arouo wadi in Dikhil region have the potential.

For a case of less than 10m deep of sediments, a sub-surface dam is applicable by ordinal simple civil work. The sediments are excavated to the rock foundation, and an impervious wall is installed on the foundation. The space between the wall and excavation slopes is refilled with excavated materials to keep wall stability. The impervious wall is made of silt and clay materials or cemented mass bolder. If a sediment depth is over 10m deep, the construction work is difficult. Therefore, geological survey for sub-surface dam is important before deciding implementation of civil work.

(5) Micro Recharge Dams

A micro recharge dam is a small dam, 4-5m high, with cemented bolder in the wadi foundation. These dams were constructed upstream of Hambokto and downstream of Midgarre of Darrah wadi in Ali Sabieh region to recharge groundwater.

The basement of recharge dam is placed at the depth of 2-3m in the sediment. Since the rest of

sediment foundation left as it is, the recharge dam can stop water flow partially. The dam body over ground surface is about 2-3m high and it can store flood water, making a small pond. The water in a pond infiltrates into ground and contributes to recharging groundwater downstream. As the impound space upstream of dam is small, a pond may be filled-up with flood sediment within a few years. The space, however, can store water for recharge. Though real volume of water recharged by the dam is difficult to estimate, the micro recharge dam in Hambokto, which was constructed in 2013, have effect on the wells at 100-200m downstream from the recharge dam. The wells had more abundant groundwater in 2014 than former years.

A recharge dam is not a typical facility commonly used to directly store water for use. It is an intermediate method for wells to obtain sustainable water. A recharge dam is applicable to places, such as well sites, where wells have been abandoned due to the reduced amount of natural groundwater. The applicable sites for the recharge dam is not selected in the M/P, despite that its necessity is admitted.

5.2.3 Potential Volume of Water and Possible Irrigation Area

From viewpoint of using sustainable water resources, it is necessary to decide possible irrigation area based on potential water volume in each watershed due to maintain the water resources.

(1) Possible Irrigation Area with Shallow Wells

For the case that water source is a shallow well, two variations are taken into account, namely a well for taking shallow groundwater and that for taking sub-surface water.

1) Shallow Wells for Taking Shallow Groundwater

The shallow groundwater in rock foundation is mainly based on the hydraulic structure that rainfalls penetrate into the nearby foundation of wells and it supplies water. This implies that size of the catchment area have an effect on volume of the water resource.

In the pilot project site of Hambokto and Afka Arraba, shallow wells are prepared in the rock foundation. The sizes of catchment areas and irrigation farmlands are shown in the table below.

Pilot Site	Catchment Area (Ac)	Irrigation Farm Land Area (Ai)	Ai at Ac = 10km^2 level
Hambokto	18.2km^2	3ha	1.7ha/10km^2
Afka Arraba	50.9km^2	12ha	2.4ha/10km^2
Mean			2.0ha/10km^2

Based on the above table, an indicator for a shallow well taking shallow groundwater is that Ac=10km^2 can irrigate Ai=2ha.

2) Shallow Wells for Taking Sub-surface Water

In As Ela in Dikhil region, many shallow wells are excavated in the terrace along Gobaad wadi. The sub-surface water is taken through the shallow wells for agriculture. Relation between the catchment area and the total irrigation area is shown in the table below.

Site	Catchment Area (Ac)	Irrigation Farm Land Area (Ai)	Ai at Ac=10km^2 level
As Ela	428.0km^2	343ha	8.0ha

As a general indicator for the sub-surface water is that Ac=10km^2 can irrigate Ai=8.0ha.

On the other hand, the field survey in Idle Djidi watershed in Ali Sabieh region suggested that a basin being smaller than about 100km^2 could not constantly supply sufficient amount of water for irrigation. Considering above suggestion and more margin for sure water supply, 50% of above Ai is applied as the indicator of irrigable area if a catchment area is smaller than 150km^2, namely Ac=10km^2 can irrigate Ai=4.0ha.

For the case in Gaggade watershed in Dikhil region, surface water in the watershed flows into blocked flat low place and evaporates to the air every year. By these characteristics, water retained on/beneath low place has salt concentration causing limitation of land use for agriculture. Accordingly, it is proposed that possible irrigation area in Gaggade should be under-estimated as 50% of above indicator, namely Ac=10km^2 can irrigate Ai=2.0ha.

(2) Possible Irrigation Area with Ponds

The water source of Kourtimalei pilot farm is a pond, which has 40km^2 of catchment area. Water balance for agricultural use about Kourtimalei site is simulated. The result of irrigable area by the water balance simulation is as the table below. The results are analyzed on the data from July on 2000 to May on 2007 (for 7 years duration).

Table 5.2.2 Results of Water Balance Simulation for Kourtimalei Site

Month Year	Scale of Possible Irrigation Farm Land (ha)	Cultivation Period
July,2000 - May,2001	4.4	1st of September→10th of March
July, 2001 - May, 2002	2.5	1st of August→10th of February
July, 2002 - May, 2003	9.0	1st of October→10th of April
July, 2003 - May,2004	0.5	1st of September→10th of March
July, 2004 - May, 2005	2.4	1st of October→10th of April
July, 2005 - May, 2006	0	1st of November→10th of March
July, 2006 - May, 2007	26.6	1st of November→10th of March

Iwai Method of probability calculation to evaluate possible irrigation area is conducted here on the result of 7 years simulation of water balance. Outcome of probability calculation is shown in the table below. In the outcome of 2-years probability, namely, every two (2) years, shows the probability that Kourtimalei pond can cover the size of (Ai=) 2.5ha of possible irrigation area. This case, Ac=40km^2 can irrigate Ai=2.5ha, is an indicator for possible farmland with water resource of pond.

Probability (1/years)	Possible irrigation area (ha)
1/2 years	2.5ha
1/5 years	0.6ha
1/10 years	0.2ha

(3) Possible Irrigation Area with Sub-surface Dams

At sub-surface dam site, water stored in void of sediment foundation beneath the surface is used as well as recharged shallow water in rock foundation and sub-surface water in terrace of the wadi.

Stock volume of submerged water (V) can be influenced by thickness of wadi deposit and gradient of wadi stream etc. In this report, assumed items of wadi deposit are 500m of valley width (B), 10m of depth (D), 1/100=0.01 of gradient (I) and 10% of porosity of deposit mass (P). Then about 300,000m^3 is a rough stock volume of water impounded by a sub-surface dam. (V=B × D × (D/I) × 2/3 × P=500 × 10 × (10/0.01) × 2/3 × P=333,333≒300,000m^3)

Water demand for irrigation is estimated as 28,000m^3/ha for one cultivation season. On the base that every cultivation season requires above volume of water stored by a sub-surface dam, possible irrigation area (Ai) is calculated as Ai=300,000m^3/28,000m^3/ha≒10ha.

Additionally, shallow groundwater in rock foundation and sub-surface water in terrace of wadi can be used for irrigation through shallow wells.

Accordingly, indicator for possible irrigation area (Ai) with a sub-surface dam is as follows;

From a sub-surface dam: Ai=10ha and

From shallow wells in rock foundation and in terrace of wadi: Ac=10km^2→Ai=2+(4~8)=6~10ha

(4) Summary of Possible Irrigation Area of Each Water Source

Table 5.2.3 Types of Water Sources and Possible Irrigation Area

Water Source	Catchment Area Ac and Possible Irrigation Area Ai
Shallow well (A) (rock foundation)	Ac=10km^2→Ai=2ha
Shallow well (B) (wadi terrace)	Case of Ac＞150km^2; Ac=10km^2→Ai=8ha Case of Ac＜150km^2;Ac=10km^2→Ai=4ha Case Gaggade basin ; Ac=10km^2→Ai=2ha
Pond	Ac=40km^2→Ai=2.5ha
Sub-surface dam	By direct effect of a sub-surface dam Ai=10ha and Ac=10km^2→Ai=6~10ha

Note: Ac is catchment area, Ai is possible irrigation area.

5.3 Sustainable Irrigation Farming Models

5.3.1 Establishment of Irrigation Farming Models

(1) Prospective Irrigation Farming Models

In terms of farming scale and agricultural techniques level, the current farming styles in Djibouti are classified into four farmers' groups: Home-garden farmers' group, Beginners farmers' group, Self-sustained farmers' group, and Advanced farmers' group as shown in the figure below.

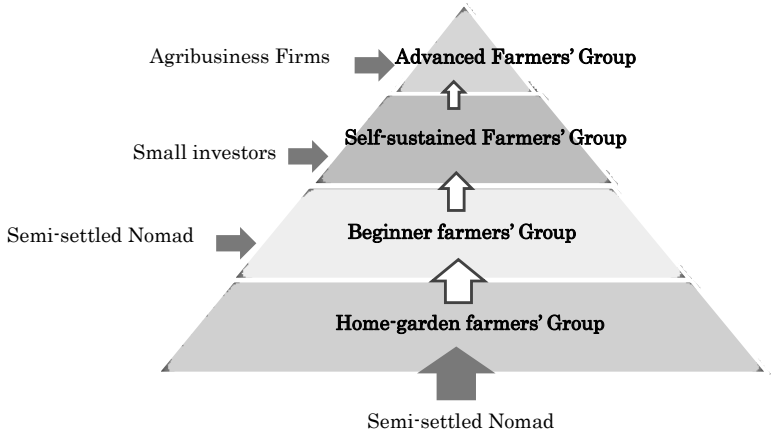


Figure 5.3.1 Farmers' Group in Djibouti

Outline of each farmers' group is described as follows.

1) Home-garden Farmers' Group

This is an elementary farming style that the semi-settled nomads cultivate on a very small scale for example the area of 200 to 300 m^2 with the water source developed by themselves or provided by donors. It is referred to as "Home-garden farmers' group". Since they do not have sufficient funds to purchase an engine pump for irrigation, they irrigate by human power or by using a treadle pump. The products are mainly for self-consumption. However, they can get cash income by selling them when they have surplus products.

2) Beginners Farmers' Group

This is another farmers' group started farming in the wake of getting water source and irrigation facilities with financial assist of donors. It is referred to as "Beginners farmers' group". Those who are semi-settled nomads who have none experience of crop cultivation, or the farmers who are conducting home-garden farming come into this group. This type of farming needs an engine pump instead of the treadle pump to irrigate because irrigated area is bigger than that of home-garden farming. Thus, the farmers need more income from agricultural output to cover the fuel cost.

3) Self-sustained Farmers' Group

Self-sustained farmers' group is defined as an upper level of the Beginners farmers' group. Small investors such as governmental officers and private citizens, who have sufficient fund for initial investment, come into this group. They have their own farmland of approximately one ha, and can cover the running cost of agricultural inputs including seeds, fertilizer, and fuel for the engine pump. In addition, they can cover replacement cost of the irrigation facilities and investment cost for further development.

4) Advanced Farmers' Group

Advanced farmers' group is defined as the highest level among the farmers' groups. They cultivate cash crops such as melon, tomato and onion at their farmland of more than two ha, and have a selling market network as well. Private investors and/or business enterprises that have sufficient funds for managing agri-business come into this group.

In combination with four farmers' groups and two types of water source (shallow well and pond), prospective irrigation farming models for the irrigated agriculture development project is categorized as **Table 5.3.1**. Meanwhile, it is difficult to portray the Advanced farmers' group using ponds as water source since it is impossible to secure irrigation water throughout the year. Accordingly, the prospective irrigation farming models in southern Djibouti are in total seven, namely four irrigation farming models with shallow well and three irrigation farming models with pond.

Table 5.3.1 Prospective Irrigation Farming Models in Irrigated Agriculture Development Project

Water source / Facility		Farmers' Group			
		Home-garden Farmers' Group	Beginner Farmers' Group	Self-sustained Farmers' Group	Advanced Farmers' Group
Groundwater	Shallow Well	**SW-H**	**SW-B**	**SW-S**	**SW-A**
Surface water	Pond	**P-H**	**P-B**	**P-S**	-

(2) Cropping Pattern by Irrigation Farming Model

Five cropping patterns as shown in **Figure 5.3.2** are proposed by merging seven (7) irrigation farming models stated above.

(a) There are some differences between irrigation farming models of SW-H and SW-B in terms of farming scale and irrigation equipment. However, both farming models are managed by the beginners from the viewpoint of farming techniques. So that, same cropping pattern aiming at mainly self-consumption is applied to both irrigation farming models of SW-H and SW-B.

(b) As for the irrigation farming model of SW-S, cropping pattern having higher proportion of vegetable cultivation is applied to ensure sustainability by selling the vegetables at the local market.

(c) As for the irrigation farming model of SW-A, cropping pattern having much higher proportion of vegetable cultivation is applied to raise profitability furthermore.

(d) Same cropping pattern aiming at mainly self-consumption is applied to the irrigation farming models of P-H and P-B under the condition that irrigation water is available only during the winter season.

(e) As for the irrigation farming model of P-S, cropping pattern having higher proportion of vegetable cultivation is applied to ensure both self-consumption and sustainable development of farming. Cultivation period is limited to the winter season as well as P-H and P-B.

(3) Crop Water Requirement by Irrigation Farming Model

Crop water requirement of the five cropping patterns is estimated in accordance with following irrigation dimensions.

Evapo-transpiration (ETo) is calculated with FAO Penman-Monteith equation by using meteorological data in Djibouti City.

Table 5.3.2 Evapo-tarnspiration (ETo)

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
ETo (mm/day)	5.0	5.3	5.4	5.9	6.6	8.3	10.4	10.1	7.7	6.6	5.7	4.7

Crop coefficient (Kc)

Crop type	Kc by Crop Growing Stages		
	Kc initial	Kc middle	Kc end
Vegetable	0.6	1.15	0.8
Fodder	0.4	0.95	0.9
Perennial fodder	0.7	0.65	0.7
Tree crop	0.9	0.9	0.9

Irrigation efficiency Ei=60%

As a result, crop water requirement per one ha is summarized by cropping patterns as follows.

Table 5.3.3 Crop Water Requirement by Cropping Patterns

Irrigation Farming Model	**Irrigation Water Amount (m^3/ha)**												
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	**Total**
SW-H SW-B	2,431	2,131	947	1,306	1,914	2,694	3,363	2,279	1,726	2,163	2,492	2,288	**25,733**
SW-S	2,417	2,124	1,144	1,627	2,277	3,151	3,914	2,697	1,951	2,297	2,518	2,277	**28,393**
SW-A	2,465	2,137	1,142	1,627	2,277	3,151	3,914	2,697	1,996	2,363	2,575	2,324	**28,667**
P-H P-B	2,517	2,082	198	0	0	0	0	0	1,033	1,826	2,468	2,369	**12,494**
P-S	2,614	2,107	194	0	0	0	0	0	1,123	1,958	2,582	2,463	**13,041**

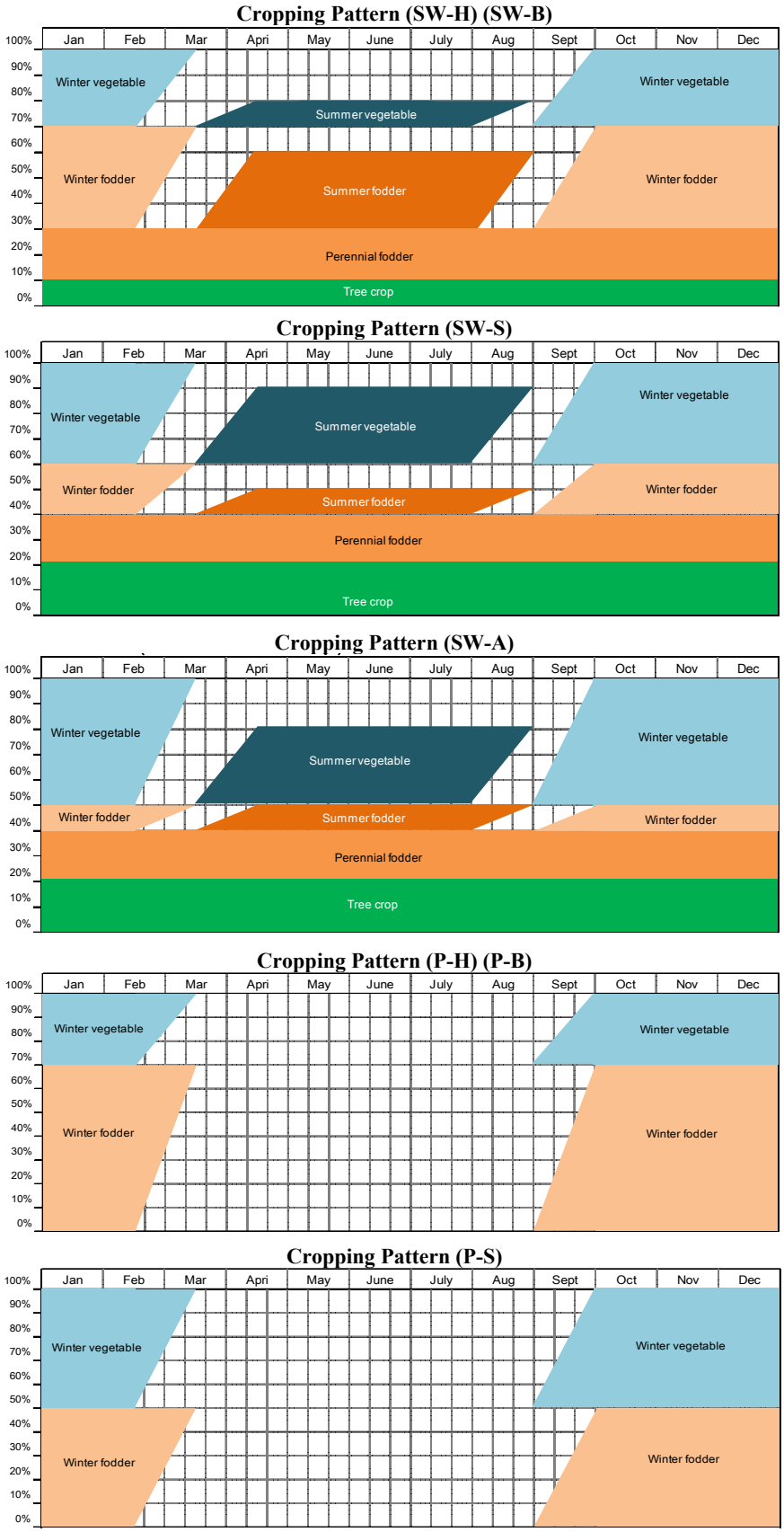


Figure 5.3.2 Cropping Patterns by Irrigation Farming Model

5.3.2 Economical (Benefit) Evaluation of Irrigation Farming Models

(1) Conditions to Considerate Benefit of Irrigation Farming Models

Annual income and cost of the seven irrigation farming models mentioned above are calculated. The assumed conditions of each model are mentioned below. The all irrigation farming models are multiple farming including both of farming and animal husbandry and not only vegetables but also fodder crops are cultivated that soil improvement can be expected. The production and sale indexes used for the calculation are shown in the **Table 5.3.4**.

1) Shallow Well (Home-garden Farmers' Group): SW-H

Scale:	0.025ha
Initial cost:	Establishment costs of the water source and farm are not included since they are established by assistance of donors or the government. Costs of a treadle pump and tools are included since they are bought by the farmer.
Maintenance cost:	Sedimentation cost of the shallow well is included. Repair cost of the irrigation system is not included since the irrigation facility is the only treadle pump.
Fuel cost:	Fuel cost is not needed because of the treadle pump.
Crop cultivation:	Many crops are cultivated for self-consumption with elementary cultivation techniques. Farm inputs are very little and the yields are low. Although percentage of cultivation area of the fodder crops is high, required quantity of the fodder cannot be covered by the production because of small scale. Although crops are cultivated twice in a year (summer and winter), scale of the summer cropping is smaller because of the quantity of irrigation water and working conditions. The products for self-consumption are also calculated as income. Marketing cost is not included since almost all of the products are consumed at home.
Livestock:	Number of the livestock is 20 goats (almost same as present number). The goats are raised by pasturage like present situation and all of the fodder harvested is fed to the goats as additional feed. The fodder harvested covers about half of consumption of the baby goats. The production quantities of live goats and milk are calculated as income.

2) Shallow Well (Beginner Farmers' Group): SW-B

Scale:	0.25ha
Initial cost:	Establishment costs of the water source, farm and irrigation system are not included since they are established by assistance of donors or the government.
Maintenance cost:	Sedimentation cost of the shallow well and repair cost of the irrigation system are included.
Fuel cost:	Fuel cost for the engine pump is included.
Crop cultivation:	Many crops are cultivated mainly for self-consumption with elementary cultivation techniques. Farm inputs are very little and the yields are low. Percentage of cultivation area of the fodder crops is high. Although crops are cultivated twice in a year (summer and winter), scale of the summer cropping is smaller because of the quantity of irrigation water and working conditions. The products for self-consumption are also calculated as income. Marketing cost is not included since the products are consumed at home or sold to neighbors.
Livestock:	Number of the livestock is 25 goats. The goats are raised by pasturage like present situation and all of the fodder harvested is fed to the goats as additional feed. The quantity of the fodder harvested covers about half of consumption of the all goats. The production quantities of live goats and milk are calculated as income. The breeding rate is improved a little because of ensuring water

source and feeding the fodder harvested.

3) Shallow Well (Self-sustained Farmers' Group): SW-S

Scale:	1ha
Initial cost:	Establishment costs of the water source, farm, irrigation system, etc. are included (Added as the depreciation).
Maintenance cost:	Sedimentation cost of the shallow well and repair cost of the irrigation system are included.
Fuel cost:	Fuel cost of the engine pump is included.
Crop cultivation:	Several vegetables are cultivated mainly for sale in relatively larger cultivation area. Since objective of the cultivation is shifted to sale, the yields increase with increase of the farm inputs. Percentage of cultivation area of the fodder crops is slightly lower. Although crops are cultivated twice in a year (summer and winter), scale of the summer cropping is smaller because of the quantity of irrigation water and working conditions. All of the products are calculated as income. Transportation cost is included to sell the products at local markets.
Livestock:	Number of the livestock is 30 goats. Although the quantity of the fodder harvested can cover all consumption of the goats, various kinds of fodder are fed to the goats by pasturage around the residence. The production quantities of live goats and milk are calculated as income. Production of the milk increase a little since the nutrient situation of the goats is improved by feeding the fodder harvested.

4) Shallow Well (Advanced Farmers' Group): SW-A

Scale:	2ha
Initial cost:	Establishment costs of the water source, farm, irrigation system, etc. are included (Added as the depreciation). The cost for 2ha is calculated from the cost per hectare.
Maintenance cost:	Sedimentation cost of the shallow well and repair cost of the irrigation system are included.
Fuel cost:	Fuel cost of the engine pump is included.
Labor cost:	Two workers are employed.
Crop cultivation:	Several vegetables are cultivated for sale in large cultivation area. The yields and quality are improved through improvement of cultivation techniques and increase of farm inputs. The labor is used for the vegetable cultivation more than the fodder cultivation and the livestock raising. Percentage of cultivation area of the fodder crops is lower. Although crops are cultivated twice in a year (summer and winter), scale of the summer cropping is smaller because of the quantity of irrigation water and working conditions. All of the products are calculated as income. Transportation cost is included to sell the products at local markets and Djibouti markets.
Livestock:	Number of the livestock is 40 goats. All of the fodder harvested is fed to the livestock. Since the cultivation area is large, the quantity of fodder harvested can cover all of consumption of the all goats. The production quantities of live goats and milk are calculated as income. Production of the milk increase since the nutrient situation of the goats is improved by feeding the fodder harvested.

5) Pond (Home-garden Farmers' Group): P-H

Scale:	0.025ha
Initial cost:	Establishment costs of the pond and farm are not included since they are established by assistance of donors or the government. Costs of a treadle pump and tools are included since they are bought by the farmer.

Maintenance cost:	Maintenance cost of the pond is not included since it is done by assistance. Repair cost of the irrigation system is not included since the irrigation facility is the only treadle pump.
Fuel cost:	Fuel cost is not needed because of the treadle pump.
Crop cultivation:	Many crops are cultivated for self-consumption with elementary cultivation techniques. Farm inputs are very little and the yields are low. Percentage of cultivation area of the fodder crops is high. Crops are cultivated only in winter cropping season in which the irrigation water is available. Trees and perennial crops are not cultivated since the irrigation water is not available in summer. Products for self-consumption are also calculated as income. Marketing cost is not included since almost all of the products are consumed at home.
Livestock:	Number of the livestock is 20 goats (almost same as present number). The goats are raised by pasturage like present situation and all of the fodder harvested is fed to the goats as additional feed. The production quantities of live goats and milk are calculated as income.

6) Pond (Beginner Farmers' Group): P-B

Scale:	0.25ha
Initial cost:	Establishment costs of the pond, farm, irrigation system, etc. are not included since they are established by assistance of donors or the government.
Maintenance cost:	Maintenance cost of the pond is not included since it is done by assistance. Repair cost of the irrigation system is included.
Fuel cost:	Fuel cost of the engine pump is included.
Crop cultivation:	Many crops are cultivated mainly for self-consumption with elementary cultivation techniques. Farm inputs are very little and the yields are low. Percentage of cultivation area of the fodder crops is high. Crops are cultivated only in winter cropping season in which the irrigation water is available. Trees and perennial crops are not cultivated since the irrigation water is not available in summer. The products for self-consumption are also calculated as income. Marketing cost is not included since the products are consumed at home or sold to neighbors.
Livestock:	Number of the livestock is 25 goats. The goats are raised by pasturage like present situation and all of the fodder harvested is fed to the goats as additional feed. The quantity of fodder harvested covers about 80% of consumption of the baby goats. The production quantities of live goats and milk are calculated as income.

7) Pond (Self-sustained Farmers' Group): P-S

Scale:	1ha
Initial cost:	Establishment cost of the pond is not included since it is established by assistance of donors or the government. Establishment cost of the farm, irrigation system, etc. are included (Added as the depreciation).
Maintenance cost:	Maintenance cost of the pond is not included since it is done by assistance. Repair cost of the irrigation system is included.
Fuel cost:	Fuel cost of the engine pump is included.
Crop cultivation:	Several vegetables are cultivated mainly for sale in relatively larger cultivation area. Since objective of the cultivation is shifted to sale, the yields increase with increase of the farm inputs. Percentage of cultivation area of the fodder crops is slightly low. Crops are cultivated only in winter cropping season in which the irrigation water is available. Trees and perennial crops are not cultivated since the irrigation water is not available in summer. All of the products are calculated as income. Transportation cost is included to sell the products at local markets.

Livestock: Number of the livestock is 30 goats. The goats are raised by pasturage and all of the fodder harvested is fed to the goats as additional feed. The quantity of the fodder harvested covers about half of consumption of the all goats. Production of the milk increase since the nutrient situation of the goats is improved by feeding all of the fodder harvested. The production quantities of live goats and milk are calculated as income.

Table 5.3.4 Production and Sale Indexes of Irrigation Farming Models

			SW-H	P-H	SW-B	P-B	SW-S	P-S	SW-A
Winter vegetable	Tomato	Cultivation area (ha)	0.0015		0.0150		0.0600		0.2000
		Yield (kg/ha)	20,000				25,000		30,000
		Unit price (DJF/kg)	100						
	Onion	Cultivation area (ha)	0.0015		0.0150		0.0600		0.2000
		Yield (kg/ha)	20,000				25,000		30,000
		Unit price (DJF/kg)	100						130
	Green Pepper	Cultivation area (ha)	0.0015		0.0150		0.0800		0.2000
		Yield (kg/ha)	3,000				7,000		10,000
		Unit price (DJF/kg)	150						
	Eggplant	Cultivation area (ha)	-	-	-	-	0.0800	0.1000	0.2000
		Yield (kg/ha)	-	-	-	-	7,000		15,000
		Unit price (DJF/kg)	-	-	-	-	125		150
	Okra	Cultivation area (ha)	0.0015		0.0150		0.0400	0.1000	-
		Yield (kg/ha)	8,000				10,000		-
		Unit price (DJF/kg)	150						-
	Niebe	Cultivation area (ha)	0.0015	-	0.0050		-	-	-
		Yield (kg/ha)	1,000	-	1,000		-	-	-
		Unit price (DJF/kg)	100	-	100		-	-	-
	Melon	Cultivation area (ha)	-	-	-	-	0.0800	0.1000	0.2000
		Yield (kg/ha)	-	-	-	-	12,000		15,000
		Unit price (DJF/kg)	-	-	-	-	130		150
	Watermelon	Cultivation area (ha)	-	0.0015	0.0100		-	-	-
		Yield (kg/ha)	-	10,000	10,000		-	-	-
		Unit price (DJF/kg)	-	100	100		-	-	-
Winter fodder	Sorghum	Cultivation area (ha)	0.0050	0.0100	0.0500	0.1000	0.1000	0.2600	0.1200
		Yield (kg/ha)	27,000				60,000		70,000
	Crotalaria	Cultivation area (ha)	0.0050	0.0075	0.0500	0.0750	0.1000	0.2400	0.0800
		Yield (kg/ha)	7,000				10,000		15,000
Summer vegetable	Melon	Cultivation area (ha)	-	-	-	-	0.1600	-	0.6000
		Yield (kg/ha)	-	-	-	-	12,000	-	15,000
		Unit price (DJF/kg)	-	-	-	-	130	-	150
	Watermelon	Cultivation area (ha)	0.0025	-	0.0250	-	0.1400	-	-
		Yield (kg/ha)	10,000	-	10,000	-	15,000	-	-
		Unit price (DJF/kg)	100	-	100	-	100	-	-
Summer fodder	Sorghum	Cultivation area (ha)	0.0040	-	0.0400	-	0.0600	-	0.1200
		Yield (kg/ha)	27,000	-	27,000	-	60,000	-	70,000
	Crotalaria	Cultivation area (ha)	0.0035	-	0.0350	-	0.0400	-	0.0800
		Yield (kg/ha)	7,000	-	7,000	-	10,000	-	15,000
Perennial fodder	Alfalfa	Cultivation area (ha)	0.0025	-	0.0250	-	0.1000	-	0.2000
		Yield (kg/ha)	33,000	-	33,000	-	35,000	-	50,000
	Sudan grass	Cultivation area (ha)	0.0025	-	0.0250	-	0.1000	-	0.2000
		Yield (kg/ha)	45,000	-	45,000	-	50,000	-	70,000
Tree	Moringa	Cultivation area (ha)	0.0025	-	0.0150	-	0.0750	-	0.1500
		Yield (kg/tree)	11	-	11	-	11	-	11
	Leucaena	Cultivation area (ha)	-	-	0.0100	-	0.0750	-	0.1500
		Yield (kg/tree)	-	-	10	-	10	-	10
	Date palm	Cultivation area (ha)	-	-	-	-	0.0540	-	0.1000
		Yield (kg/tree)	-	-	-	-	15	-	30
		Unit price (DJF/kg)	-	-	-	-	200	-	200
Livestock	Goat meat	No. of head (head)	6	5	13	10	15	13	23
		Unit price (DJF/head)	10,000				15,000		
	Goat milk	Milk quantity (ℓ/head/year)	30				50		70
		Unit price (DJF/ℓ)	200						

(2) Results of Benefit Consideration relating to Irrigation Farming Models

1) Shallow Well (Home-garden Farmers' Group): SW-H

Percentages of livestock in both of the total income and total cost are high. The income from crop cultivation is low since the cultivation area is small and the production is low. Although the amounts of both the total income and total cost are low, the income is higher than the cost. The expected annual benefit is 88,116DJF. (**Fig.5.3.3**)

2) Shallow Well (Beginner Farmers' Group): SW-B

As same as the Home-garden farmers' group, percentages of livestock in both of the total income and total cost are high. However, the income from vegetable cultivation increases a little through the expansion of cultivation scale. The fuel cost for engine pump occurs, and the percentage in total cost is high. The total income is higher than the total cost, and the expected annual benefit is 208,050DJF. (**Fig.5.3.5**)

3) Shallow Well (Self-sustained Farmers' Group): SW-S

The income from crop cultivation is higher than that from livestock. Although the annual total income increases to 1,723,400DJF, the total cost also increases to 1,225,099DJF since the initial cost, fuel cost for engine pump, farm inputs cost, etc. increase. The expected annual benefit is 498,301DJF. (**Fig.5.3.7**)

4) Shallow Well (Advanced Farmers' Group): SW-A

The income increases since the production and quality of products are improved through scale up of the cultivation, improvement of cultivation techniques and increase of farm inputs. On the other hand, costs such as initial cost, fuel cost, farm input cost, labor cost also increase. However, the benefit in this model is the highest among the irrigation farming models. The expected annual benefit is 1,731,867DJF. (**Fig.5.3.9**)

5) Pond (Home-garden Farmers' Group): P-H

Percentages of livestock in both of the total income and total cost are high. The income from crop cultivation is low since the crops are cultivated only in winter cropping season with elementary cultivation techniques in small cultivation area. However, the total income is higher than the total cost, and the expected annual benefit is 66,110DJF. (**Fig.5.3.4**)

6) Pond (Beginner Farmers' Group): P-B

Percentages of livestock in both of the total income and total cost are high. The income from crop cultivation is not much since the crops are cultivated only in winter cropping season with elementary cultivation techniques. However, the income increase since the cultivation area is expanded. Although the fuel cost is required, it can be covered by selling the surplus agricultural products and livestock products. The expected annual benefit is 167,900DJF. (**Fig.5.3.6**)

7) Pond (Self-sustained Farmers' Group): P-S

The income from crop cultivation increases through expansion of the cropping scale and improvement of the cultivation techniques. The income from crop cultivation is lower than that in SW-S since the crops are cultivated only in winter cropping season. However, the costs such as the initial cost for water source, maintenance cost and fuel cost are also low. The expected annual benefit is 490,106DJF. (**Fig.5.3.8**)

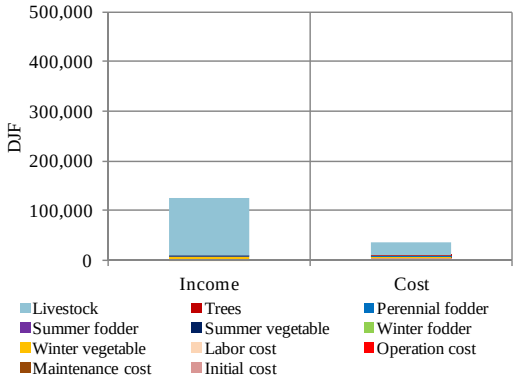


Figure 5.3.3 Annual Income and Cost of SW-H

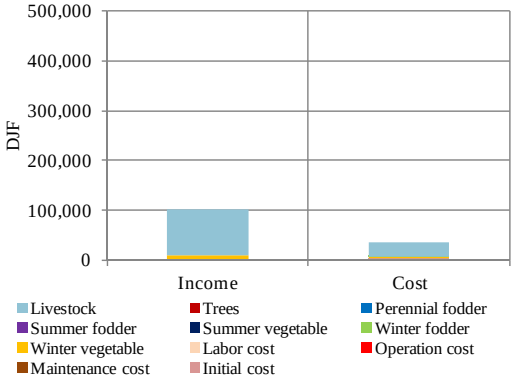


Figure 5.3.4 Annual Income and Cost of P-H

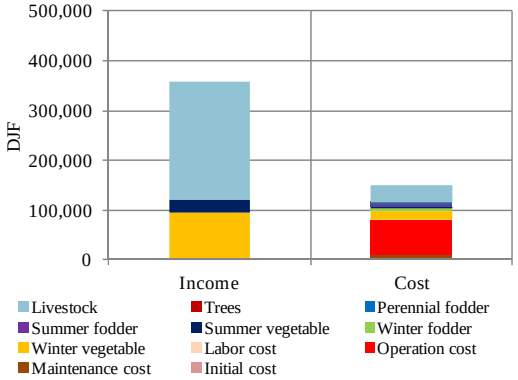


Figure 5.3.5 Annual Income and Cost of SW-B

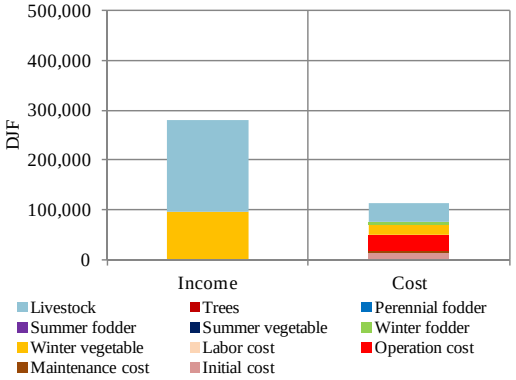


Figure 5.3.6 Annual Income and Cost of P-B

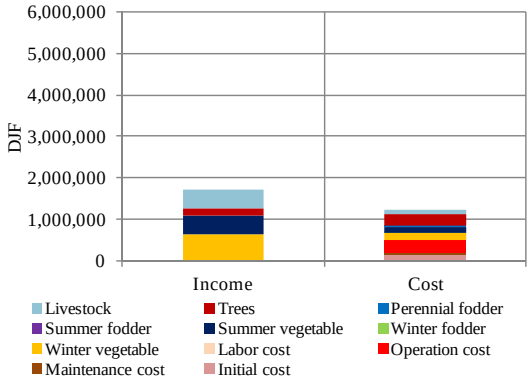


Figure 5.3.7 Annual Income and Cost of SW-S

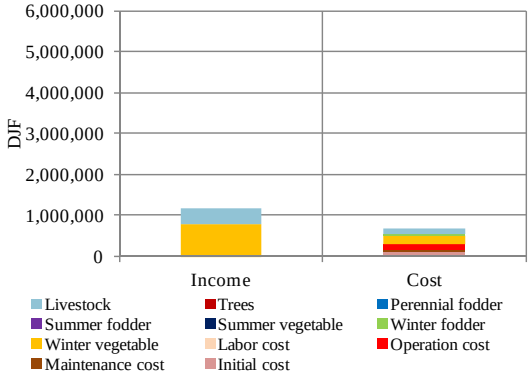


Figure 5.3.8 Annual Income and Cost of P-S

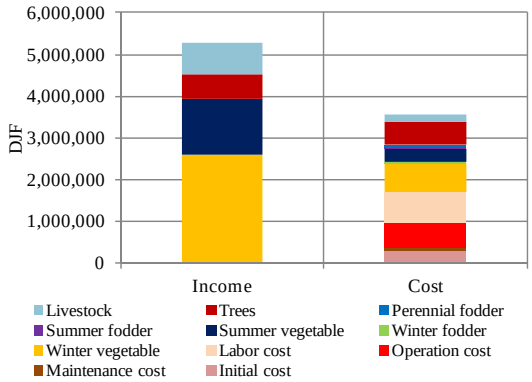


Figure 5.3.9 Annual Income and Cost of SW-A

5.4 Sustainable Irrigated Agriculture Development Plan in Southern Djibouti

Based on the results of verification study on sustainable water use and irrigation farming models, basic concept on the sustainable irrigated agriculture development plan in southern Djibouti is formulated as follows.

It is a fundamental condition for irrigated agriculture to ensure that the water source can be used sustainably for irrigation. Two approaches of water source development are proposed in this development plan: one is new water source development; and the other is restoration through rehabilitation of the existing water source facilities. In formulating the irrigated agriculture development plan, the project sites are categorized according to the types of water sources: shallow well site where the water source is shallow groundwater or sub-surface water of the wadi; pond site where the water source is pond; and sub-surface dam site where the water source is underground stored water. It is essential that the utilization plan of the water resources must be prepared not to lose the balance of available water. Thus, an appropriate irrigable area shall be estimated according to the catchment area at each project site in consideration of the water resource potential from the viewpoint of water resources conservation.

Furthermore, the target group of the M/P is nomads; therefore, the irrigation farming models to be disseminated must be formulated on the premises of multiple farming consisted of pastoralism and agriculture. The entry-level irrigation farming models (Home-garden farmers' group or Beginner farmers' group) are specified at each project site in accordance with the farming scale and the farming technical level. In order to develop and establish the specified farming model at each project site, the M/P includes not only the development of water source facilities but also the development of the irrigation facilities and farmlands for new settlement sites, or the development of the irrigation facilities for the rehabilitation sites.

However, only hard components (development of agricultural infrastructures) are not sufficient to achieve the establishment of the proposed irrigation farming models. Thus, this M/P includes soft components such as the improvement of the supply system of agricultural materials, the empowerment of agricultural cooperatives, and the development of the support and training system for the extension services on farming techniques. The implementation of both components leads to the realization of sustainable agricultural production, which ensures to the beneficiaries the possibility to self-consume their products and to increase income by selling them. This will eventually improve food security of nomads, ensure stable supply of livestock feed, and finally help improve their livelihood and income. However, since the target groups is Home-garden farmers' group and Beginner farmers' group, it is assumed that they self-consume or sell their products in the regional market which is close to the farmlands. Therefore, the support for the marketing of agricultural products is not included in this plan.

Meanwhile, such irrigated agriculture development is managed by the MAEPE-RH which is in charge of agriculture and livestock. However, the organizational structure and the capacity of the MAEPE-RH and the support system for the farmers are not sufficient in terms of the implementation of the development plan. Thus, to implement the project successfully, the capacity development of the MAEPE-RH is included in the M/P.

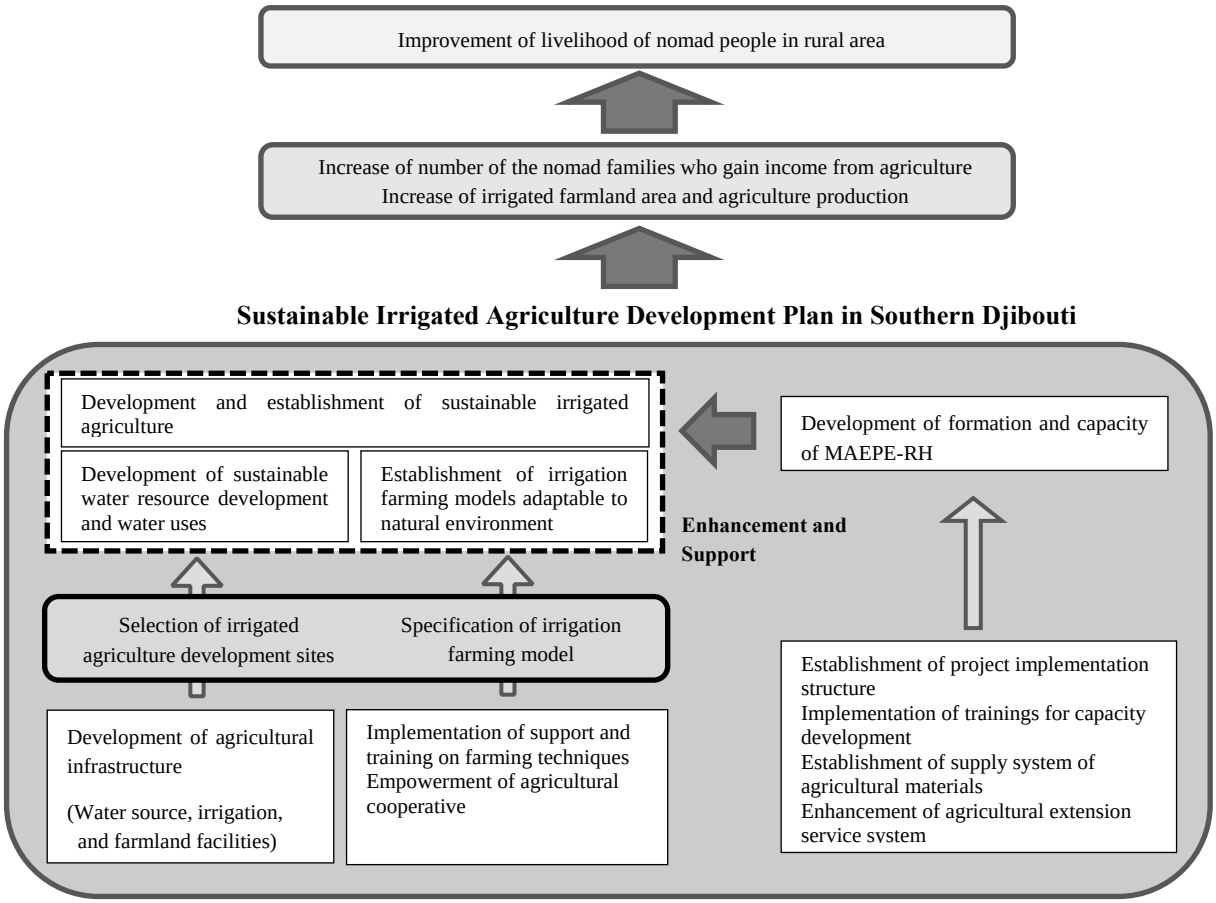


Figure 5.4.1 Outline of Sustainable Irrigated Agriculture Development Plan in Southern Djibouti

5.4.1 Expansion of Sustainable Water Resources Development and Water Uses

In regard to the water resources development for the sustainable irrigated agriculture development plan in southern Djibouti, the conservation of these resources is a fundamental issue as they exist in specified forms and locations in the arid area. To avoid the depletion of these water resources, and also to ensure their permanent use for irrigation, the M/P has a basic strategy ensuring that water uptake must be kept within the available supplies of shallow groundwater. Therefore, the irrigable area of each project site is determined by type of water source in accordance with the scale of the catchment area by water resources.

- For the sites where water source is a shallow well for shallow groundwater
  Irrigable area is estimated 2ha by 10km^2 of catchment area each.
- For the sites where water source is a shallow well for sub-surface water
  In the case that catchment area is more than 150km^2, irrigable area is estimated 8ha by 10km^2 of catchment area each.
  In the case that catchment area is less than 150km^2, irrigable area is estimated 4ha by 10km^2 of catchment area each.
  In the case of Gaggade basin, irrigable area is estimated 2ha by 10km^2 of catchment area each in consideration of negative effect of salt accumulation.
- For the sites where water source is a pond
  Irrigable area is estimated 2.5ha by 40km^2 of catchment area each.
- For the sites where water source is a sub-surface dam
  Irrigable area is estimated 10ha and adding 6 to 10ha by 10km^2 of catchment area each.

Besides, a basic strategy of the water uses for irrigation is defined as follows in the M/P based on investigation results in the Study and verification results of the pilot project.

- In the cases that water sources are shallow groundwater or sub-surface water, irrigation water can be taken and supplied throughout the year under the condition that irrigated area is limited to around 1 to 2ha for one shallow well. Thus, full year's irrigation can be applied to the sites.
- In the case that the water source is a pond, the irrigation throughout the year is difficult to be applied because the period of available water in the pond is limited due to meteorological conditions, especially frequency of the heavy rainfall in southern Djibouti. Thus, irrigation is available in winter season exclusively.

Meanwhile, in consideration of efficient use of water resources and sustainable operation and maintenance of the facilities, the irrigation system applied in the M/P includes the following points verified through the pilot project.

- A pipeline network is applied from the water source to the farm instead of the traditional earth lining canal in order to reduce conveyance water loss.
- A solar pump is applied to the irrigation system, which draws water from a shallow well managed by Beginner farmers' group in consideration of long term economic advantage relating to the free operation cost.
- Considering that further expansion of drip irrigation is contemplated as a water saving method in Djibouti, drip irrigation is applied to the irrigation system for Beginner farmers' group using shallow groundwater as a water source because water quality of this water source is fairly good (less soil contamination).
- Farmland managed by Home garden farmers' group is small. Thus, a treadle pump and small size tube are applied as the irrigation method.

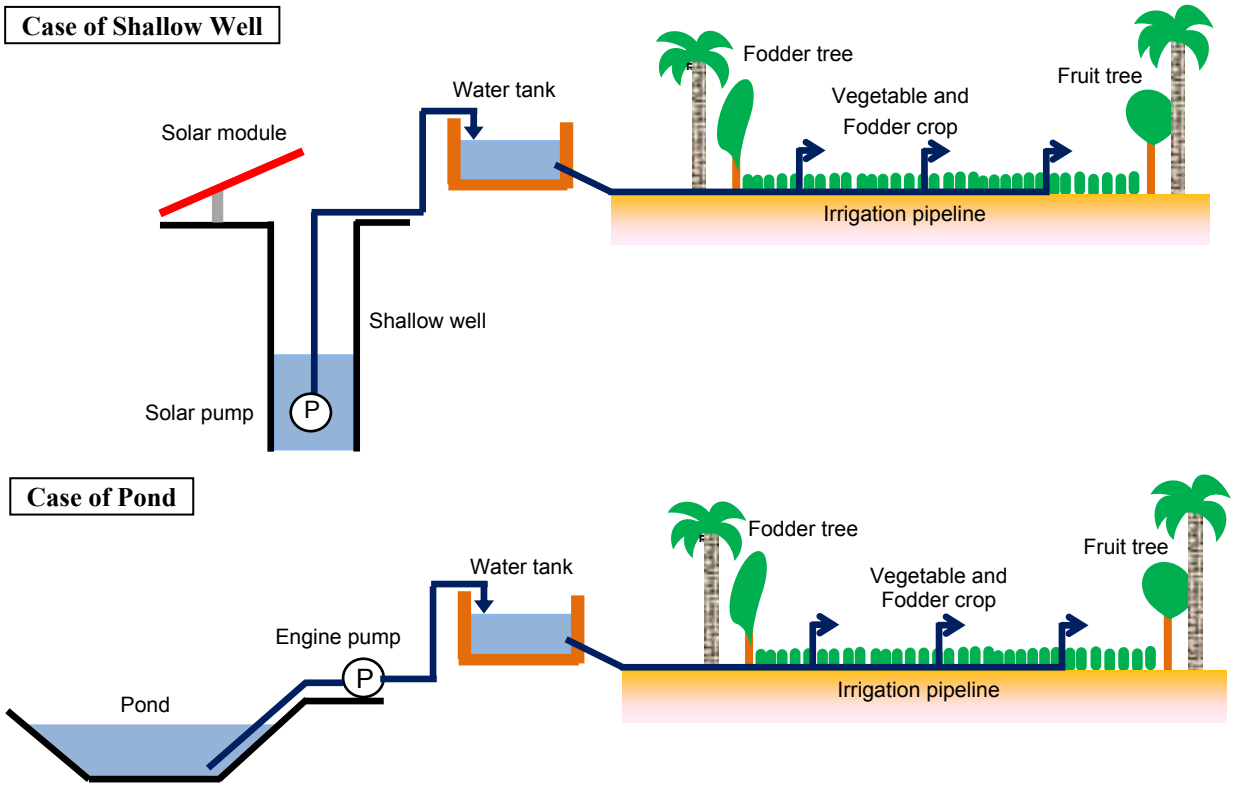


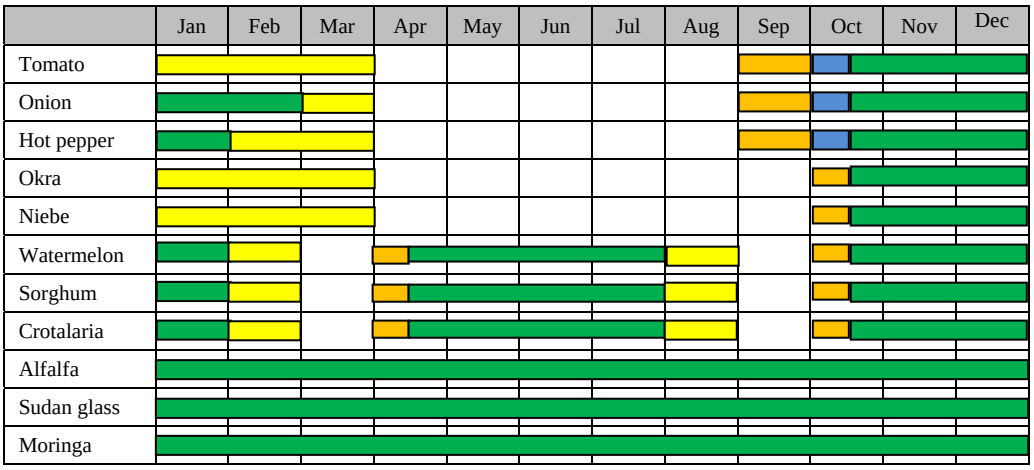
Figure 5.4.2 Image of Irrigation System (Beginner Farmers' Group)

5.4.2 Establishment of Sustainable Farming Systems

(1) Irrigation Farming Systems to be Adopted and Extended

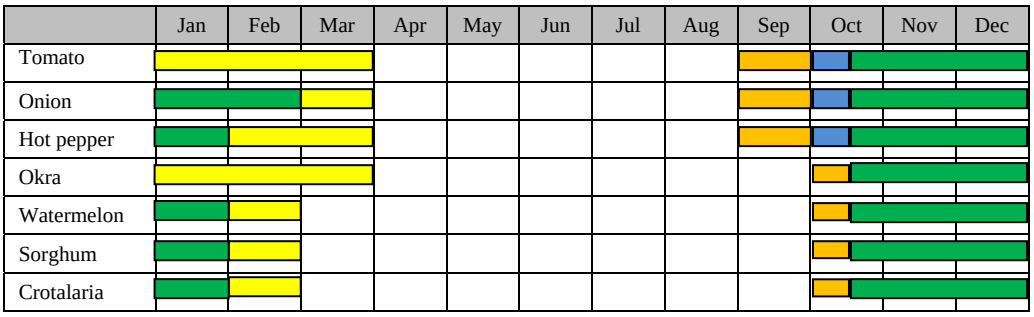
The target group of this M/P is nomads / small farmers. Thus, the irrigation farming models to be extended is 1) Home garden farmers' group (SW-H, P-H) using shallow wells or ponds, and 2) Beginner farmers' group (SW-B, P-B) using shallow wells or ponds. The proposed farming systems are shown in the table below and these models are expected to be extended in southern Djibouti.

Table 5.4.1 Irrigation Farming Systems to be Adopted and Extended



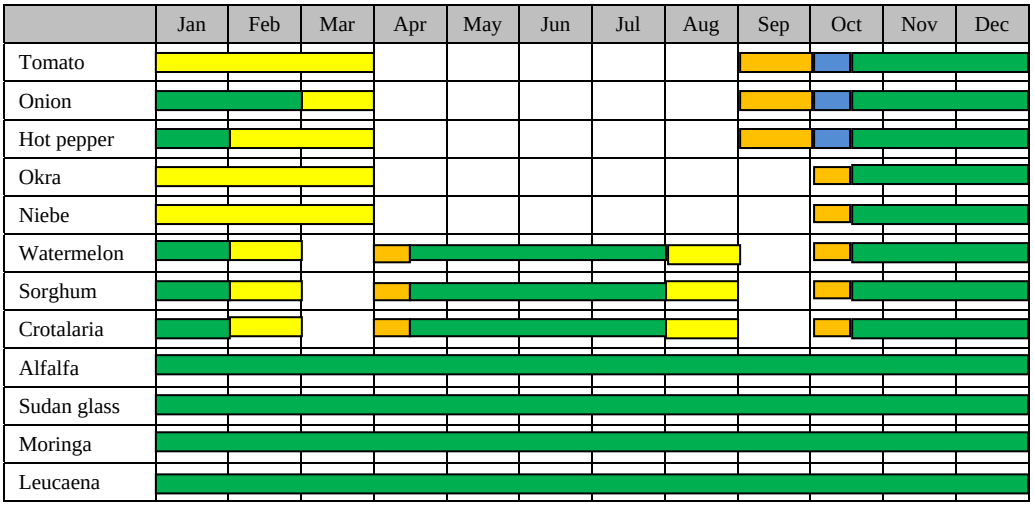
SW-H
Shallow well – Home-garden farmers' Group

Farmland: 0.025 ha
Livestock: Goat 20heads
Income: 88,116 DJF/year
Characteristic: 2 times cropping (summer and winter cropping) in a year. Irrigation by the standstill pump. The harvested forage in this model could meet the half of annual consumption amount of their kid goat.



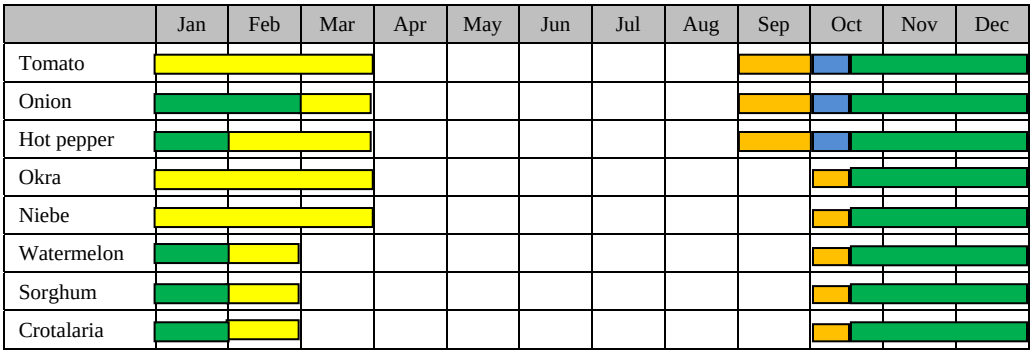
P-H
Pond– Home-garden farmers' Group

Farmland: 0.025 ha
Livestock: Goat 20 heads
Income: 66,110 DJF/year
Characteristic: Winter cropping only due to the limited irrigation water. Irrigation by the standstill pump. The harvested forage is fed to their livestock.



SW-B
Shallow well – Beginner farmers' group

Farmland: 0.25 ha
Livestock: Goat 25heads
Income: 208,050 DJF/year
Characteristic: 2 times cropping (summer and winter cropping) in a year. Irrigation by the engine pump. The harvested forage in this model could meet the half of annual consumption amount of their owned goat.



P-B
Pond– Beginner farmers' group

Farmland: 0.25 ha
Livestock: Goat 25heads
Income: 167,900 DJF/year
Characteristic: Winter cropping only due to the limited irrigation water. Irrigation by the Engine pump. The harvested forage in this model could meet the 80% of annual consumption amount of their kid goat.

Legend: Seeding | Transplanting | Cultivation | Harvesting

(2) Countermeasures for Establishment of the Irrigation Farming Models

The following countermeasures are applied to establish the irrigation farming models in the project sites.

1) Supply of Agricultural Materials

The minimum and necessary agricultural materials are supplied to the beneficiaries for the startup of farming in the project sites.

2) Trainings and Extension of Agricultural Techniques

On-farm instruction provided by the farming instructors and study tours to the advanced farms are implemented for the extension of agricultural techniques to the beneficiaries,

i) On-farm Instruction Conducted by the Farming Instructors

Basic farming skills are instructed to the beneficiaries by the farming instructors.

ii) Study Tours to Advanced Farms

Study tours to advanced farms are planned and conducted by the staffs of the Sub-Directorates. The purpose of this tour is for the beneficiaries to learn the knowledge and methods of land reclamation, advanced farming skills and agricultural cooperatives.

3) Support for Agricultural Cooperatives

i) Study Tours to Existing Agricultural Cooperatives

The beneficiaries receive the opportunities to visit existing agricultural cooperatives and deepen their knowledge regarding agricultural cooperatives.

ii) Leader Trainings for Agricultural Cooperatives

The staffs of the Sub-Directorates conduct the planning and implementation of the leader trainings to develop the leaders for agricultural cooperatives. The selected candidates of the leaders in each project site take a discourse training to learn about agricultural cooperatives.

iii) Support for Official Registration of Agricultural Cooperatives

The staffs of the Sub-Directorates support the beneficiaries for the application procedure regarding official registration of agricultural cooperative.

5.4.3 Empowerment and Capacity Development of the MAEPE-RH's Organization and the Supporting System for Farmers

(1) Empowerment of the MAEPE-RH's Organization

The MAEPE-RH controls the following five Directorates, namely Directorate of Agriculture and Forestry, Animal Husbandry and Veterinary Services, Water, Grand Works and Fishery under the control of a secretary general. Except for temporary employees such as drivers, assistants, etc., the permanent staffs of the ministry are 91 people as shown in the table below.

Table 5.4.2 Number of Permanent Staffs of the MAEPE-RH

Post	Officer	Engineer (university graduate)	Senior technician	Technician	Junior technician	Total
Executive secretary	1	4	1			6
General secretary	1	1				2
Technical advisor			2		1	3
Directorate of General Administration Service	1	1				2
Directorate of Water	3	6	3	7		19
Directorate of Grand Works		1		1		2
Directorate of Agriculture and Forestry	6	8	5	5	7	31
Directorate of Animal Husbandry and Veterinary Services	5	1	5	2	5	18
Directorate of Fishery	2	2	2		2	8
Total	19	24	18	15	15	91

Source: MAEPE-RH reinforcement plan, 2009

The national level administration for the primary industry sector is run by this limited number of staffs. In particular, the Directorate of Grand Works, which was established in 2009, has only two permanent staffs to handle the construction works of ponds and recharge dams in whole country, indicating that this directorate especially needs the reinforcement of human resource. Besides, the number of staffs in each five branch office (Sub-Directorate) is only one to two persons, which is apparently insufficient for the administration activities.

Based on the experience of collaborative works with the MAEPE-RH in the pilot project, it is suggested that the Directorate of Agriculture and Forestry, Grand Works, Water, the Sub-Directorates and a project promotion office under the control of a secretary general are related to this project. Although the Directorate of Water mostly concerns deep well construction, this Directorate will be more related to this project, since it has the division in charge of a solar power generation system. The effort to establish the coordination system of these related Directorates is essential to promote this M/P as the highest priority project of the MAEPE-RH. Therefore, it is proposed to establish a “project promotion office for sustainable irrigated agriculture development project in southern Djibouti (tentative)” (M/P promotion office) placed at a higher level than other Directorates as shown in the figure below. The chief director of this M/P promotion office should be the one possessing higher employment rank than the chief of each Directorate since this project should be recognized as a national priority project. According to the past examples, the implementation of this project may need financial assist from international organizations or donors of foreign countries. It is essential to assign a vice-director in the M/P promotion office to support the chief director since frequent meetings for discussion, reporting etc. with the donors and other related administrative agencies are required of this office.

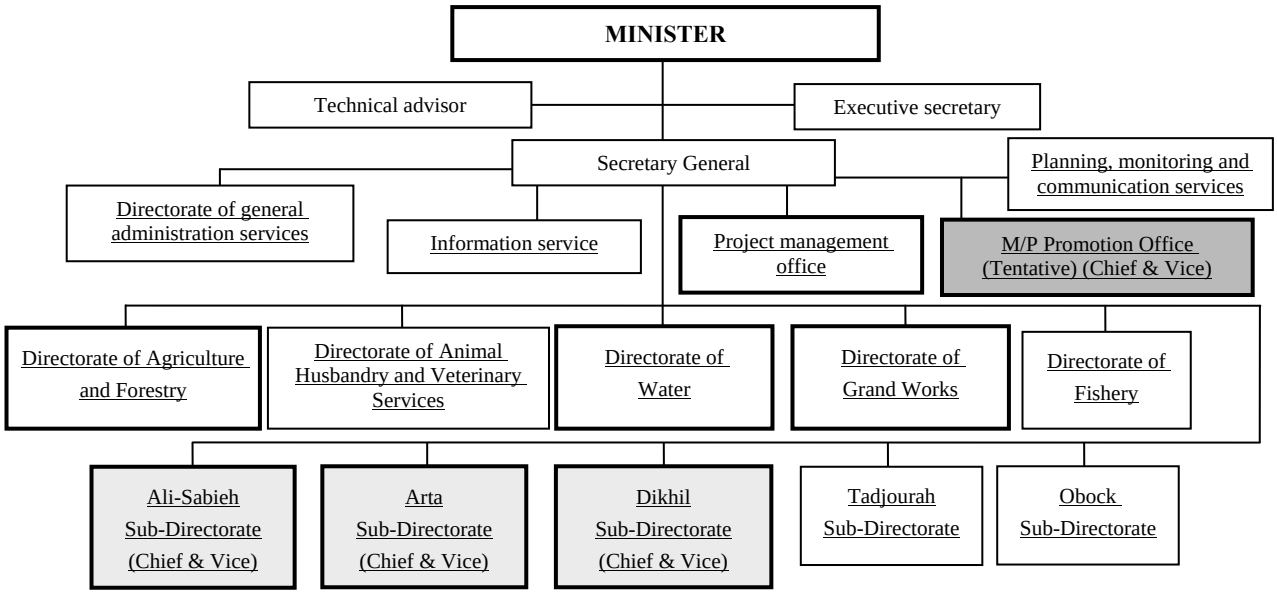


Figure 5.4.3 Position of the M/P Promotion Office

On the other hand, the assignment of staffs in the Sub-Directorates is also necessary to implement the project. At present, the number of staffs in each Sub-Directorate is only one person, although they are in charge of agricultural extension in the entire regions. It is obvious that the budget and human resource of the Sub-Directorates are insufficient, indicating that it is necessary to improve the capacity of the Sub-Directorates in terms of its budget and human resource. As there may be many occasions to meet local farmers for the extension of agricultural techniques, the newly assigned staffs in the Sub-Directorates are recommended to be engineers who belong to the Directorate of Agriculture and Forestry or are newly employed.

Besides, the most of beneficiaries of this project are nomads who have little agricultural experience, meaning that on-farm instruction on farming skills is indispensable. Therefore, the farming instructors should be assigned for the on-farm instruction to the beneficiaries in the project sites under the supervision of the staffs of the Sub-Directorates.

(2) Capacity Development of MAEPE-RH

Although the MAEPE-RH has implemented small-scale agricultural projects based on the assist of donors, successful cases are not many due to the lack of appropriate project management and the support on farming techniques for the beneficiaries after the completion of facility construction. Based on the verification of the past results and the pilot project in this Study, it is concluded that a comprehensive capacity development in terms of the project implementation is indispensable for the staffs of the MAEPE-RH.

One approach of capacity development for the staffs of the MAEPE-RH is to improve their skills as related to administration, farming and cultivation, and civil engineering works through the actual project implementation as On-the-Job-Training. Another approach is to implement trainings for the related contents of project implementation. The M/P promotion office plans the training regarding the skills and knowledge of project administration and management for the technical staffs of the Directorate of Agriculture and Forestry, Grand Works, Water and the Sub-Directorates.

Furthermore, it is necessary to improve the agricultural extension skills of farming instructors assigned in the project sites. The trainings for the farming instructors are planned by the M/P promotion office, and implemented by the technical staffs of the Directorate of Agriculture and Forestry.

(3) Establishment of a Supply System for the Agricultural Materials

The capability of the management system for agricultural materials in the Directorate of Agriculture and Forestry is enhanced for the establishment of a proper supply system for agricultural materials to farmers. Besides, the establishment of the supply system for the agricultural materials in the private sector is promoted through the introduction of a subsidization scheme.

(4) Support for the Agricultural Cooperatives

To promote organizing farmers, the M/P promotion office and the Directorate of Agriculture and Forestry introduce a policy giving priority to the registered cooperatives. For example, the registered agricultural cooperatives can be preferentially selected as the destination of agricultural materials granted by donors or the various farming support provided by the Government of Djibouti.

5.5 Project Site Selection for the Sustainable Irrigated Agriculture Development in Southern Djibouti

5.5.1 Selection of the Project Candidate Sites

Based on existing data and field survey, project candidate sites for the sustainable irrigated agriculture development in southern Djibouti is selected as shown in the table and figure below.

Type of Development	Water Source Facility	Water Resources	Group	Location
New development	Shallow well (A)	Shallow groundwater	I-1	Delha Basalt zone
	Shallow well (B)	Sub-surface water (wadi)	I-2	Wadi, catchment is larger than 100km^2
	Pond	Surface water	I-3	Flat plain, catchment is larger than 30km^2
	Sub-surface dam	Surface water	I-4	Wadi bed, catchment is larger than 30km^2
Rehabilitation	Shallow well (B)	Sub-surface water (wadi)	II-1	Large scale wadi such as Gobaad wadi
	Pond	Surface water	II-2	Petit Bara downstream side

Table 5.5.1 Project Candidate Sites

Type of Development	Water Source Facility	Water Resources	Number	Site		Region	Position		Remarks
				No.	Name of Site		N	E	
New development	Shallow well (A)	Shallow groundwater	I-1	1	Bondara	Dikhil	11-01.0	42-20.2	shallow well existing
				2	Chinnile	Dikhil	11-02.5	42-22.4	w-mark
				3	Afka-Arraba	Dikhil	11-04.5	42-24.8	
				5	Mouloude Ouein tributary up-st.	Dikhil	11-06.5	42-31.7	
				6	Arouo down-st.	Dikhil	11-07.5	42-32.9	
				7	Gablalou	Dikhil	11-08.7	42-35.0	w-mark
				8	Aour Adussa	Ali Sabieh	11-10.1	42-37.2	
				9	Hambokto	Ali Sabieh	11-12.0	42-40.5	w-mark
				10	Garaslei	Arta	11-18.1	42-43.2	
				11	Boelei	Ali Sabieh	11-17.0	42-43.8	
				12	Kalaloho	Arta	11-29.0	42-50.5	
				13	Boulle biyale	Arta	11-28.5	42-58.4	
				14	Gachan	Ali Sabieh	11-27.1	42-59.1	w-mark
				15	Darka Doun Yar	Ali Sabieh	11-07.6	42-41.8	
	Shallow well (B)	Sub-surface water (wadi retaining water)	I-2	1	Bakkirre	Dikhil	10-56.4	41-57.8	w-mark nearby
				2	Agobarre	Dikhil	11-02.5	42-03.1	w-mark
				4	Kerora	Dikhil	11-46.1	42-07.3	
				5	Boukboukto	Dikhil	11-39.3	42-12.3	w-mark
				6	Sek Sabir	Dikhil	11-15.8	42-13.6	
				8	Gaggade	Dikhil	11-27.4	42-18.8	
				10	Dika	Dikhil	11-30.9	42-22.3	
				11	Dhourreh	Ali Sabieh	11-15.9	42-50.9	
				12	Guistir	Ali Sabieh	11-00.4	42-57.6	
				14	Hidka Beyya Adde	Ali Sabieh	11-14.2	43-02.2	
				15	Midgarra	Ali Sabieh	11-09.9	42-58.6	
				16	Dihda Ouead	Arta	11-31.2	43-05.0	
				17	Ambouli down-st.	Arta	11-31.6	43-07.5	
				19	Damerdjog	Arta	11-29.5	43-11.2	
				20	Goum-Bourta	Arta	11-29.1	43-13.4	
	Pond	Surface water	I-3	1	Agan south	Dikhil	11-32.2	41-54.1	
				2	Dahhoto	Dikhil	11-37.6	41-57.8	w-mark
				3	Gara Abbouri	Dikhil	11-29.0	41-58.5	
				4	Dawwano	Dikhil	11-26.8	42-02.2	
				5	Yoboki	Dikhil	11-28.5	42-05.0	
				6	Soulaitou	Dikhil	11-45.5	42-09.4	
				7	Guidoli	Dikhil	11-24.2	42-19.0	w-mark
				8	Dika	Dikhil	11-32.9	42-21.1	w-mark nearby
				9	Koussour	Arta	11-30.8	42-24.6	
				10	Safarie Golla	Dikhil	11-14.8	42-32.5	Grand Bara
				11	Gabla Oalan	Arta	11-17.0	42-35.4	Grand Bara
				13	Elka Hadad	Dikhil	11-15.6	42-40.4	
				15	Didjan Der tributary	Arta	11-21.1	42-43.0	
	Sub-surface dam	Surface water	I-4	1	Boulle middle-st.	Arta	11-30.6	43-01.0	
				2	Mouloude Ouein tributary middle-str	Dikhil	11-07.7	42-29.1	
Rehabilitation	Shallow well (B)	Sub-surface water (wadi retaining water)	II-1	1	Kouta Bouyya	Dikhil	11-00.9	41-58.2	
				2	Gobaad As-Ela	Dikhil	11-00.0	42-06.0	
				3	Dikihl west	Dikhil	11-05.7	42-18.6	
				4	Douda	Arta	11-31.6	43.09.3	
	Pond	Surface water	II-2	1	Didjan Der	Arta	11-22.7	42-44.7	PK58

Note; w-mark in the column of remarks means that a site has an existence of water mark in the Djibouti public map of 1/200,000 scale.

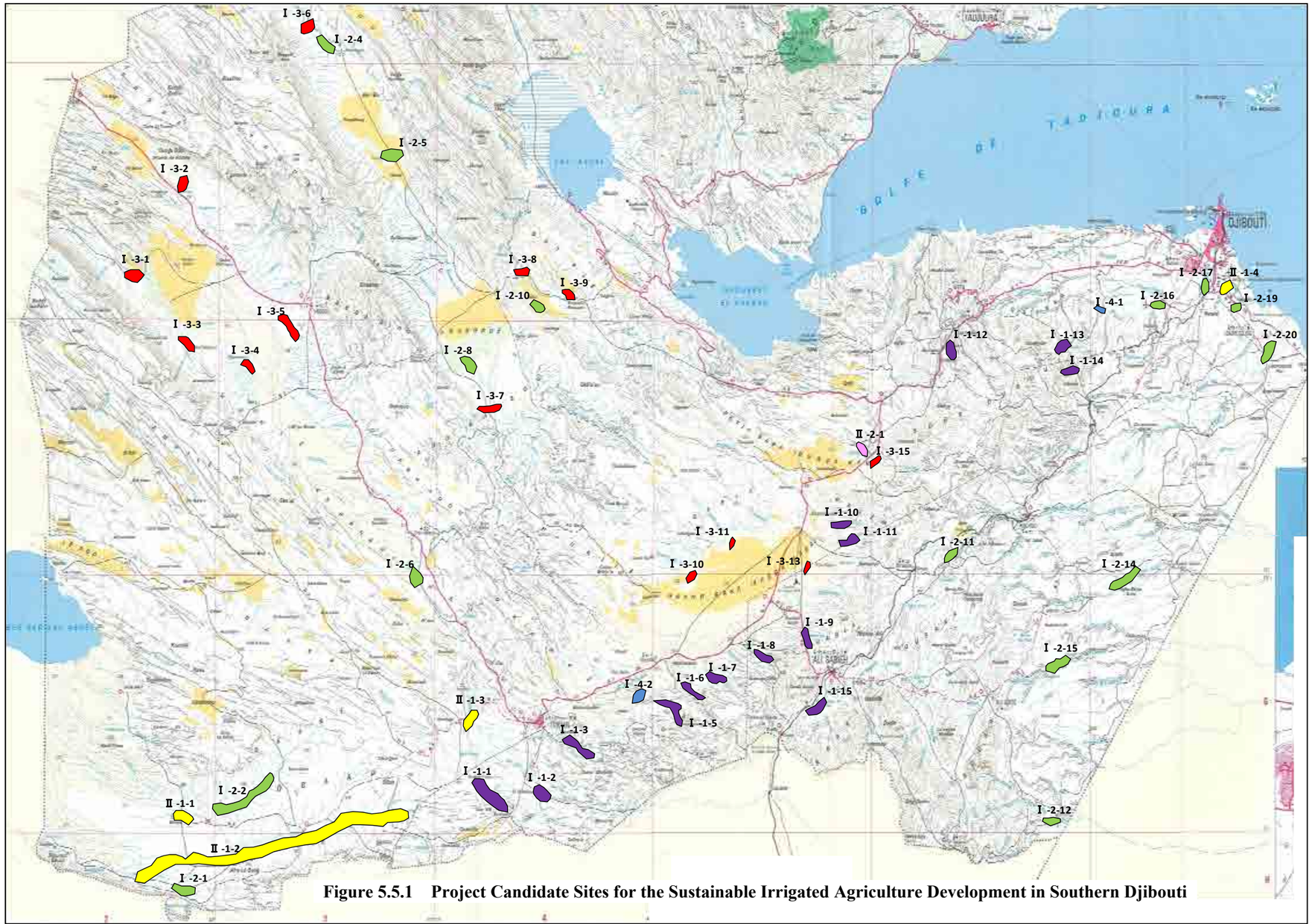


Figure 5.5.1 Project Candidate Sites for the Sustainable Irrigated Agriculture Development in Southern Djibouti

Type of Development	Water Source Facility	Water Resources	Color
New development	Shallow well (A)	Shallow groundwater	**I-1**
	Shallow well (B)	Sub-surface water (wadi retaining water)	**I-2**
	Pond	Surface water	**I-3**
	Sub-surface dam	Surface water	**I-4**

Type of Development	Water Source Facility	Water Resources	Color
Rehabilitation	Shallow well (B)	Sub-surface water (wadi retaining water)	**II-1**
	Pond	Surface water	**II-2**

0 15 30 45 60 km

5.5.2 Priority of the Selected Sites

The number of project candidate sites for the M/P is 49 sites. The priority of the project candidate sites should be evaluated based on the availability of water resources, water quality, socio-economic aspects, etc.

Specific items for the evaluation are ①availability of water sources, ②demand by local authorities, ③accessibility of the site, ④farmland conditions, ⑤existence of villages or populations and ⑥ water quality. This evaluation gives higher points (5 points) to the criteria of ①availability of water sources and ②demand by local authorities than the points of other criteria (3 points). In addition, the sites selected for rehabilitation get higher points in terms of criteria ②demand by local authorities.

Allotment and criteria for evaluation of each item are shown in the table below.

Table 5.5.2 Criteria for Evaluation of the Priority of Project Candidate Sites

Items	Point	Criteria for Evaluation
① Availability of water source	5	Very stable
	4	Stable
	3	Stable, but the development cost will be high.
	2	Stable, but the reliability is lucking
	1	Requiring detailed hydro-geological investigations
② Demand by local authorities	5	High demand / Easy to construct or rehabilitate
	4	High demand but construction or rehabilitation requires the high cost.
	3	Demand by community
	2	Demand by a small number of residents
	1	No specific demand
③ Accessibility	3	Good accessibility
	2	A portion of the access roads need rehabilitation
	1	New access roads are necessary
④ Farm land conditions	3	Soft soil and/or farmland is already existing
	2	Soft soil
	1	Hard soil with many small rocks
⑤ Existence of villages	3	In or near village
	2	Not far from village
	1	No village nor residents
⑥ Water quality	3	Good quality water
	2	Water salinity is a bit high
	1	Water salinity is high

Each project candidate site is evaluated based on the criteria for evaluation, and points are added up. Groups with highest points are classified to rank-A (namely high prospective). The second and third groups are classified to rank-B (good) and rank-C (possible), respectively. The lowest priority group is classified to rank-D (low prospective). The each priority rank and the total evaluation points are designed as shown in the table below.

Table 5.5.3 Priority Rank, Priority Level and Evaluation Points

Priority Rank	Priority Level	Evaluation Point
A	High prospective	19 - 15
B	Good	14 - 12
C	Possible	11 - 9
D	Low prospective	8 - 6

As a result, the numbers of sites in each rank are 16 sites in rank-A, 10 sites in rank-B, 17 sites in

rank-C and 6 sites in rank-D.

Table 5.5.4 Number of Project Candidate Sites in Each Priority Rank

Priority Rank	Priority Level	Evaluation Point	Number of Project Candidate Site
A	Highly prospective	19 - 15	16
B	Good	14 - 12	10
C	Possible	11 - 9	17
D	Low prospective	8 - 6	6
Total			49

Table 5.5.5 Evaluation of the Project Candidate Sites

Type of Development	Water Source Facility	Water Resources	Number	Name of Site	Point							Rank
					①	②	③	④	⑤	⑥	Total	
New development	Shallow well (A)	Shallow groundwater	I-1-1	Bondara	4	3	3	1	3	2	16	**A**
			I-1-2	Chinnile	4	3	3	1	3	2	16	**A**
			I-1-3	Afka-Arraba	4	3	3	1	3	3	17	**A**
			I-1-5	Mouloude Ouein tributary up-st.	4	3	3	1	3	2	16	**A**
			I-1-6	Arouo down-st.	4	3	3	1	2	2	15	**A**
			I-1-7	Gablalou	4	2	3	1	2	2	14	**B**
			I-1-8	Aour Adussa	2	1	1	1	1	2	8	**D**
			I-1-9	Hambokto	4	3	3	1	3	2	16	**A**
			I-1-10	Garaslei	1	1	1	1	1	2	7	**D**
			I-1-11	Boelei	1	1	2	1	1	2	8	**D**
			I-1-12	Kalaloho	1	2	3	1	2	2	11	**C**
			I-1-13	Boulle biyale	4	3	2	1	2	2	14	**B**
			I-1-14	Gachan	2	1	2	1	1	2	9	**C**
			I-1-15	Darka Doun Yar	4	5	3	1	2	3	18	**A**
	Shallow well (B)	Sub-surface water	I-2-1	Bakkirre	3	2	1	2	1	2	11	**C**
			I-2-2	Agobarre	3	2	1	2	2	2	12	**B**
			I-2-4	Kerora	2	1	2	2	2	2	11	**C**
			I-2-5	Boukboukto	2	1	2	2	1	1	9	**C**
			I-2-6	Sek Sabir	3	3	2	2	3	2	15	**A**
			I-2-8	Gaggade	2	2	1	2	3	1	11	**C**
			I-2-10	Dika	2	2	2	2	1	2	11	**C**
			I-2-11	Dhourreh	3	3	3	1	2	2	14	**B**
			I-2-12	Guistir	2	1	1	1	1	2	8	**D**
			I-2-14	Hidka Beyya Adde	4	3	1	2	2	2	14	**B**
			I-2-15	Midgarra	4	5	2	2	2	1	16	**A**
			I-2-16	Dihda Ouead	2	1	1	1	1	2	8	**D**
			I-2-17	Ambouli down-st.	2	2	1	2	2	2	11	**C**
			I-2-19	Damerdjog	2	2	2	2	2	1	11	**C**
			I-2-20	Goum-Bourta	3	1	2	2	2	1	11	**C**
	Pond	Surface water	I-3-1	Agan south	3	2	1	2	2	2	12	**B**
			I-3-2	Dahhoto	2	1	1	2	1	1	8	**D**
			I-3-3	Gara Abbouri	3	1	1	2	1	3	11	**C**
			I-3-4	Dawwano	2	1	2	2	1	3	11	**C**
			I-3-5	Yoboki	3	2	2	2	2	3	14	**B**
			I-3-6	Soulaitou	2	2	1	1	2	3	11	**C**
			I-3-7	Guidoli	2	1	2	2	2	2	11	**C**
			I-3-8	Dika	3	1	1	2	1	3	11	**C**
			I-3-9	Koussour	2	3	2	1	1	3	12	**B**
			I-3-10	Safarie Golla	2	2	1	2	1	3	11	**C**
			I-3-11	Gabla Oalan	2	2	1	2	1	3	11	**C**
			I-3-13	Elka Hadad	3	3	3	2	1	3	15	**A**
			I-3-15	Didjan Der tributary	3	3	3	2	1	3	15	**A**
	Sub-surface dam	Surface water	I-4-1	Boulle middle-st.	2	3	3	1	2	2	13	**B**
			I-4-2	Mouloude Ouein tributary middle-str	3	3	2	1	2	2	13	**B**
Rehabilitation	Shallow well (B)	Sub-surface water	II-1-1	Kouta Bouyya	5	4	2	3	3	2	19	**A**
			II-1-2	Gobaad As-Ela	5	5	3	3	3	3	22	**A**
			II-1-3	Chekheiti	5	4	2	1	1	3	16	**A**
			II-1-4	Douda	4	5	3	2	3	1	18	**A**
	Pond	Surface water	II-2-1	Didjan Der	3	4	2	1	2	3	15	**A**

5.6 Project Plan for the Sustainable Irrigated Agriculture Development in Southern Djibouti

5.6.1 Project Plan

(1) Objectives of the Project

To improve livelihood and to reduce poverty of nomads in southern Djibouti, the project aims at developing and establishing sustainable irrigated agriculture based on the irrigation farming models, which are well applied to the site conditions, by developing new water sources or rehabilitating existing water sources. In addition, the project includes capacity development of the MAEPE-RH which has a responsibility in providing administrative support to achieve the project goals.

(2) Target Areas of the Project

Three regions in southern Djibouti (Arta, Ali Sabieh, and Dikhil region)

(3) Target Groups of the Project

Semi-settled nomads and small farmers living in the rural areas of the target regions and the staffs of the Government of Djibouti

(4) Project Period

The project implementation in the project sites continues for 20 years. The first 5 years (short term) is for the development of sites evaluated as rank-A, while the second 5 years (middle term) is for the rank-B. Another 10 years (long term) is for the rank-C and D. However, the development period of each project site is three years. It is possible to develop each project site separately.

(5) Management Organizations and their Roles for the Project Preparation and Implementation

The administration of this project is managed by the MAEPE-RH, which means that the MAEPE-RH also takes a responsibility on the preparation activities to launch the project. Thus, the MAEPE-RH plays important roles in the preparation process of the project to address and promote the activities of the inside and outside of the ministry.

For the certain launching of the project, first, the MAEPE-RH should establish a preparation office of this project as an internal organization under the authority of the Minister of agriculture. This preparation office is managed only by the staffs of the ministry proper, and continues their activities until launching of the project.

The MAEPE-RH secures the activity budget and selects the chief director and staffs for the preparation office. The preparation office conducts the publicity and public relations activities (preparation of written request, consultation) to get assist from donors in order to launch this M/P in cooperation with related governmental organizations. In this process, the preparation office should consider to conduct only the enablement portion of the M/P, although the achievement of full M/P should be uppermost. Besides, in accordance with the donors' interest towards this project, the MAEPE-RH proceeds to adding up the portion of project budget defrayed by Djibouti side in coordination with related governmental organizations

Subsequently, when launching of the project is decided, the preparation office is upgraded to the '*Project promotion office for sustainable irrigated agriculture development project in southern Djibouti (tentative)'* (M/P promotion office). Besides, the Sub-Directorates are also reinforced in terms of the human resources to establish the certain project implementation structure. Thereafter, the M/P promotion office conducts project implementation and management in accordance with the project implementation schedule.

The M/P promotion office should also carry out the project evaluation at each end of the project implementation term to share the results and lessons and to feed back them to the following project implementation in cooperation with the related governmental organizations, donors and experts.

The figure below describes the roles of preparation office and the M/P promotion office for this project in accordance with the project flow.

Establishment of the Preparation Office Project Preparation Activities	Preparation Period	・To assign staffs (only from the ministry proper) and secure budget for the preparation office. ・To conduct publicity and public relations activities towards donors to get support for the project implementation. ・To add up the portion of project budget defrayed by Djibouti side.
Upgrade to the M/P Promotion office	At the Time of Decision of Launching the Project	
Project Management by the M/P promotion Office	Initial Year of the Project Implementation	・To assign staffs in the M/P promotion office (Sub-Directorates) ・To formulate the project implementation plan. ・To continue requests for donors' assist. ・To conduct the trainings of the staffs of the MAEPE-RH for capacity development of project implementation and management. ・To prepare the supply system of agricultural materials in the MAEPE-RH. ・To clarify the support for organizing farmers.
	From the Second Year of the Project Implementation	・To continue the request of donors' assist. ・To supervise the construction works for the facilities in the project sites. ・To supervise the support activities regarding farming techniques and organizing agricultural cooperatives for the beneficiaries in each project site. ・To supervise the trainings of faming instructors for their capacity development. ・To establish and operate a subsidization scheme for the preparation of supply system of agricultural materials ・To conduct the interim and final project evaluation.

(6) Irrigation Farming Models to be Applied in the Project

Since the target groups are semi-settled nomads and small farmers who have little experience in farming, lower level of the irrigation farming models are applied in the plan; SW-H (Shallow Well, Home-garden farmers' group), SW-B (Shallow Well, Beginner farmers' group), P-H (Pond, Home-garden farmers' group), and P-B (Pond, Beginner farmers' group). The farming area of Home-garden farmers' group (SW-H, P-H) is assumed to be 0.025 ha per family, while that of Beginner farmers' group (SW-B, P-B) is 0.25 ha per family.

(7) Project Implementation Sites and Farmland Area to be Developed

The entire project candidate sites, namely A, B, C, and D in the priority rank, are included into the target sites for the project implementation. The farmland area to be developed within this project is basically the same as the estimated possible irrigation area, which is calculated based on the types of water source facilities and catchment area of each project site. Besides, the available human resources at each site are taken into the consideration, in particular the number of households which are expected to continue farming into the future. In the cases that the water sources are shallow wells at the rehabilitation sites, the farmland area to be rehabilitated supposes that half of the farmers who stopped farming before restart it in an average cultivation area of a household in each site.

Table 5.6.1 Summary of the Project Implementation Sites

Priority Rank	Number of Sites	Farmland Area (ha)	Number of Beneficiary (households)
Rank-A	16	408	1,893
Rank-B	10	175	2,320
Rank-C	17	191	5,516
Rank-D	6	55	2,200
Total	49	829	11,929

Table 5.6.3 shows the evaluation rank, assumed irrigation farming model, catchment area, farmland area, and number of beneficiaries of each site. It is possible to implement this project partially by extracting the project implementation sites as necessary.

(8) Contents of the Project

The contents of this project consist of the following two components.

Component 1: Development and establishment of sustainable irrigated agriculture for the beneficiaries in the project implementation sites

Component 2: Capacity development of the staffs and empowerment of farming support system of the MAEPE-RH

The table below shows the objectives, countermeasures and activities of each component.

Component	Objective	Countermeasure	Activity
1.Development and establishment of the sustainable irrigated agriculture	To establish the sustainable irrigated agriculture in the project sites by preparation of the irrigation facilities, supply of agricultural materials and technical support.	1.1 Construction of facilities and land preparation in the project sites	1.1.1 Construction of water sources & irrigation facilities and land preparation
		1.2 Supply of agricultural materials	1.2.1 Supply of seeds and farming tools to the beneficiaries
		1.3 Implementation of the trainings of farming techniques for the beneficiaries	1.3.1 On-farm instruction in the project sites 1.3.2 Implementation of study tours to advanced farms for the beneficiaries
		1.4 Support for organizing farmers	1.4.1 Implementation of study tours to existing agricultural cooperatives for the beneficiaries 1.4.2 Implementation of leader trainings 1.4.3 Support for application of official registration of agricultural cooperatives
2. Capacity development of the staffs and empowerment of farming support system of the MAEPE-RH	To enhance the farming support for the beneficiaries of this project, existing agricultural cooperatives and farmers by developing the capacity of the MAEPE-RH for project implementation	2.1 Capacity development of the staffs in the MAEPE-RH for project implementation	2.1.1 Implementation of trainings in terms of project implementation and management for the staffs of the MAEPE-RH
		2.2 Capacity development of the farming instructors	2.2.1 Implementation of trainings in terms of technical instruction for the farming instructors
		2.3 Preparation of the supply system of agricultural materials	2.3.1 Preparation of supply system of agricultural materials in the Directorate of Agriculture and Forestry 2.3.2 Establishment and operation of a subsidization scheme for the preparation of supply system of agricultural materials
		2.4 Clarification of the support for organizing farmers	2.4.1 Clarification and official announcement of the support policy for agricultural cooperatives

Component1: Development and Establishment of the Sustainable Irrigated Agriculture

Component 1 consists of hard aspect and soft aspect. The hard aspect is defined as the infrastructure development for sustainable irrigated agriculture, which includes the construction of water sources, irrigation facilities and land preparation. Meanwhile, the soft aspect is defined as the dissemination and establishment of sustainable irrigated agriculture, which includes support and training activities for the beneficiaries. In regard to the hard aspect, 1.1) Construction of facilities and land preparation are implemented in the project sites. And in regard to the soft aspect, in order to prepare the condition of sustainable farming activities for the beneficiaries, 1.2) Supply of agricultural materials, 1.3) Implementation of the trainings regarding farming techniques for the beneficiaries, 1.4) Support for organizing farmers are implemented.

The hard aspect (design study, construction) for one year and the soft aspect (farming support and trainings) for two years are conducted as one package in each project site.

1.1) In the construction of facilities and land preparation in the project sites, necessary construction works are implemented depending on the water source type of the site and whether it is a new development site or a rehabilitation site.

1.2) The supply of agricultural materials is conducted just after the completion of facilities construction in each project site. The necessary materials such as seeds and farming tools are supplied to the beneficiaries for promoting cultivation in the project sites.

1.3) The farming trainings for the beneficiaries start just after the completion of facilities construction and continue for 2 years. The contents of trainings are the continuous On-farm training by the farming instructors assigned in each project site under the supervision of the MAEPE-RH and the study tours to advanced farms (conducted once at 2nd year) for the beneficiaries to learn elementally farming skills and enhance their motivation towards farming activities.

1.4) The support for organizing farmers is conducted at the 3rd year. The support includes study tours to existing agricultural cooperatives, trainings for leaders selected in each project site and support for application of official registration of agricultural cooperatives.

The important point of countermeasures in the soft aspect is the continuous On-farm instruction in farming skills to the beneficiaries for 2 years. This activity would determine the result of establishment of sustainable irrigated agriculture in the project sites. Thus, this activity should be particularly focused for the project implementation. After the end of the farming support for 2 years, monitoring, technical support and advices towards the beneficiaries are continued by the staffs of the Sub-Directorates under the agricultural extension system of the MAEPE-RH, which is enhanced through this project.

Table 5.6.2 Schedule of the Activities in Each Project Site

Activity	1st year	2nd year	3rd year
1.1.1 Construction of water sources & irrigation facilities and land preparation	■		
1.2.1 Supply of seeds and farming tools to the beneficiaries		▲	
1.3.1 On-farm instruction in the project sites		■	■
1.3.2 Implementation of study tours to advanced farms for the beneficiaries		▲	
1.4.1 Implementation of study tours to existing agricultural cooperatives for the beneficiaries			▲
1.4.2 Implementation of leader trainings			▲
1.4.3 Support for application of official registration of agricultural cooperatives.			■

【Countermeasure 1.1】Construction of Facilities and Land Preparation in the Project Sites

Activity 1.1.1 Construction of water source and irrigation facilities and land preparation (Timing of implementation: 1st year)

[Development of Water Source Facilities]

- Shallow wells are built following a ratio of one well per 1.5 ha of farmland.
- Ponds are designed to be built as dam body having the dike 5m in height and 5m in width at the top. Silty-clay soil which is available around the dam site are mainly utilized as the material in filling the dike, and heavy construction machines are utilized for the dike construction as well.
- Sub-surface dams are designed as follows. An impermeable wall made of stone masonry and concrete is built at the excavated potion crossing the wadi in order to store groundwater inside the foundation ground under the wadi.

[Field Improvement]

- Field improvement is planned to be carried out in the new development sites. In particular, for the sites having plenty of stones and irregularity, heavy construction machines are effectively used to make the cultivable farmland.
- For the rehabilitation sites, the field improvement is not included because previous farmland can be recovered without any difficulties.

[Establishment of Irrigation Facilities]

Pump

- As for the Home-garden farmers' group, a treadle pump is proposed to be used.
- As for the Beginner farmers' group with a pond, an engine pump is proposed to be used because it is difficult to install a solar pump due to pond's structure.
- As for the Beginner farmers' group with a shallow well, a solar pump is proposed to be used.

Irrigation facilities

- As for the Home-garden farmers' group, a small-bore tube is planned to be used.
- As for the Beginner farmers' group, an irrigation network consisting of water tank, pipeline, and hydrants is planned to be established.

Irrigation method

- As for the Beginner farmers' group with a shallow well (A), drip irrigation is proposed to be applied because water quality of shallow well (A) is considered good for drip irrigation.
- As for other cases, surface irrigation is proposed to be applied.

The contents of the construction of irrigation facilities mentioned above are summarized in the following table.

Type of Development	Water Source Facility	Irrigation Farming Model	Intake Pump			Irrigation Facility		Irrigation Method	
			Foot Pump	Engine Pump	Solar Pump	Irrigation Network	Tube	Surface Irrigation	Drip Irrigation
New development	Shallow well (A)	SW-H	○				○	○	
		SW-B			○	○			○
	Shallow well (B)	SW-H	○				○	○	
		SW-B			○	○		○	
	Pond	P-H	○				○	○	
		P-B		○		○		○	
	Sub-surface dam	SW-B			○	○		○	
Rehabilitation	Shallow well (B)	SW-B			○	○		○	
	Pond	P-B		○				○	

Contents		Rank-A	Rank-B	Rank-C	Rank-D	Total
Solar Power Generation System	Irrigated Area (ha)	365	123	56	-	544
	*No. of Pump	244	82	38	-	364
Drip Irrigation	Irrigated Area (ha)	85	-	7		92

A well is constructed in each 1.5ha of the irrigated farmland in the project sites. A solar pump is installed in each well in the project sites where the solar power generation system is introduced.

"The technical manual for establishing irrigated farmland" should be used as reference in constructing the facilities.

【Countermeasure 1.2】Supply of Agricultural Materials

Activity 1.2.1 Supply of seeds and farming tools to the beneficiaries (Timing of implementation: 2nd year)

- The beneficiaries of the project are selected after the completion of the facility construction. In selecting the beneficiaries, the local custom should be paid attention. Moreover, the opinion of village chief should also be respected for the selection of the beneficiaries.
- The agricultural materials shown in the table below are supplied to the beneficiaries. The seeds of annual crops are supplied multiple times, if necessary.

Water Source	Crop Seed	Farming Tool
Shallow well (Winter＋Summer Cultivation)	Tomato, Hot pepper, Onion, Okra, Watermelon, Cowpea, Sorghum, Sudan Glass, Alfalfa, Moringa, Leucaena	Picks, Hoe, Shovel, Scoop, Wheelbarrow, Sandbag (to collect livestock dung), Mosquito net (for nursery), Watering can、Bucket
Pond (Only Winter Cultivation)	Tomato, Hot pepper, Onion, Okra, Watermelon, Cowpea, Crotalaria	

【Countermeasure 1.3】Implementation of the Trainings of Farming Techniques to the Beneficiaries

Activity 1.3.1 On-farm instruction in the project sites (Timing of implementation: 2nd - 3rd year)

- The farming instructors are assigned following a ratio of one person per 50 ha of the project sites. These persons go around the farmlands in the project sites and provide the farming instruction to the beneficiaries directly. The assignment period of the farming instructors is two years starting

from the beginning of farming activities in each project site.

- During the two years, totally four times of cultivation (twice in winter and another twice in summer) are conducted in the sites having shallow wells as water sources, while in the sites with ponds, totally twice of cultivation (winter cultivation only) are conducted. The on-farm instruction is conducted when those cultivation are implemented.
- The "Manual for the Vegetable & Pasture Cultivation in Djibouti" which is prepared in this Study should be referred for the farming instruction to the beneficiaries.
- The table below shows the contents of faming instruction to the beneficiaries.

Activity	Contents of the Instruction
Land consolidation	Removing stones/ Making ridges/ Leveling of ridges
Irrigation	Establishment of the water channels/Adjustment of irrigation interval
Cultivation management	Making manure/Fertilization technique/Insects & diseases control/Establishment of nursery/Seeding /Harvesting

Activity 1.3.2 Implementation of study tours to advanced farms for the beneficiaries (Timing of implementation: 2nd year)

- The objective of this study tour is for the beneficiaries to learn the advanced farming skills and enhance their motivation towards agriculture.
- The one day study tour to the advanced farms is conducted for the beneficiaries of the Beginner farmers' group.
- The farmlands of advanced farmers in southern Djibouti are selected for the destination of this study tour. The study tour is conducted once in the 2nd year.
- At the study tour, the staffs of the Sub-Directorates in the MAEPE-RH or the advanced famers explain to the beneficiaries in terms of the faming situation, cultivation techniques and the sequence of events from the timing of farmland establishment to the current state.
- The table below shows the contents of the study tour.

Contents
Melon cultivation, Date cultivation, Other fruits tree cultivation Method for making high-quality manure, Fertilization technique Pest and disease control technique (Method to use commercial pesticide, Method to make organic pesticide)

【Countermeasure 1.4】Support for Organizing Farmers

Activity 1.4.1 Implementation of study tours to existing agricultural cooperatives for the beneficiaries (Timing of implementation: 3rd year)

- The objective of this study tour is for the beneficiaries to deepen their understanding of the agricultural cooperatives.
- The one day study tour to existing agricultural cooperatives is conducted for the beneficiaries. The agricultural cooperatives conducting cooperative activities continuously in southern Djibouti are selected for the destination of this study tour. The study tour is conducted once in the 3rd year.
- The table below shows the contents of the study tour.

Contents
Regulations of the agricultural cooperative, Organization structure of agricultural cooperative, Roles of managerial position, Method to collect and manage cooperative fees, Examples of Activities of agricultural cooperative

Activity 1.4.2 Implementation of leader trainings (Timing of implementation: 3rd year)

- The objective of this training is for selected leaders of the beneficiaries to learn the basic knowledge regarding activities, regulations and procedures for the official registration of the agricultural cooperatives.
- The one day leader training is conducted for the selected leaders of the beneficiaries.
- The training mainly consists of classroom lectures in Djibouti city, which is conducted once in the 3rd year.
- The staffs of the MAEPE-RH take charge of the lecturers of this training. In the lectures, the low literacy rate of the beneficiaries should be noted. Thus, it is recommended to explain the lecture contents with showing the pictures or oral explanation, and take more time for the question and answer session than the lectures themselves.
- The table below shows the contents of the leader training.

Contents
Roles of the leader in agricultural cooperative, Organization structure of agricultural cooperative, Roles of each managerial position, Method to collect and manage the cooperative fees, Examples of activities of agricultural cooperatives

Activity 1.4.3 Support for application of official registration of agricultural cooperatives (Timing of implementation: 3rd year)

- The beneficiaries in each project site are asked whether they have the intension to establish a agricultural cooperative and to register it officially. If they have, the staffs of the MAEPE-RH and farming instructors support the beneficiaries in terms of the following procedure for the official registration of the agricultural cooperatives.
- The persons wishing to participate are gathered to make a draft list of the cooperative member.
- Based on the statutes and regulations of existing agricultural cooperatives, the drafts of those documents are prepared through the discussion with the leaders.
- The General Assembly for establishment of the agricultural cooperative is held in the presence of the persons wishing to participate in the cooperative. In the meeting, the drafts of statute and regulation are explained to all members in order to get the agreement from them. Besides, the managerial persons of cooperative are elected. Afterwards, the list of managerial person and cooperative members are made.
- After the meeting, documents such as the statute, the regulation, the minutes of the general assembly and the request for the registration are prepared and submitted to the regional office.
- After the submission of those documents, the registration certificate is delivered to the cooperative.

Contents
Formulation of cooperative regulations, Setting of cooperative fee, Support for the election of managerial persons, Support on the official registration procedure for the agricultural cooperative

Component 2: Capacity Development of the Staffs and Empowerment of Farming Support System of the MAEPE-RH

Component 2 focuses on the capacity development for the staffs of the MAEPE-RH in terms of project implementation and management and the empowerment of the support system for the beneficiaries in the project sites, existing farmers and agricultural cooperatives. As the countermeasures of these issues, the following four points are indicated, which are 2.1) Capacity development of the staffs of the

MAEPE-RH for project implementation, 2.2) Capacity development of the farming instructors, 2.3) Preparation of the supply system of agricultural materials, 2.4) Clarification of the support for organizing farmers.

2.1) Trainings regarding the project implementation and management are conducted for the staffs of the M/P promotion office, the Directorate of Water, Agriculture and Forestry, Grand Works and the Sub-Directorates.

2.2) Technical trainings are conducted regarding the methods of on-farm instruction on the agricultural skills for the faming instructors who take charge of the farming support for the beneficiaries in the project sites.

2.3) Supply system capability for the agricultural materials is enhanced to manage and distribute those materials properly. Besides, the supply system for easier procurement of agricultural materials is also established for farmers.

2.4) Policy to promote organizing farmers is clarified as enhancement of its support.

【Countermeasure 2.1】Capacity Development of the Staffs in the MAEPE-RH for Project Implementation

Activity 2.1.1 Implementation of trainings in terms of project implementation and management for the staffs of the MAEPE-RH

- Trainings described in the table below are carried out for the staffs of the M/P promotion office, the Directorate of Water, Agriculture and Forestry, Grand Works and the Sub-Directorates for around two weeks in total.
- The M/P promotion office manages the trainings and provides the lectures of the contents.
- Candidate Lecturers are the staffs of the MAEPE-RH, advanced farmers, foreign experts, etc. The M/P promotion office coordinates the lecturers.
- Third Country Training Program (North-Africa, Mideast, etc.) is included in the trainings in the subjects relating to facilities and agricultural techniques.
- Monthly meetings are to be held in the M/P promotion office to share and discuss the monitoring results of activities and progress of the project. This activity also contributes to the capacity development for the staffs as an On-the-Job-Training.

Training Subject	Contents
Project Implementation	Project management, Monitoring, Project evaluation
Facility	Design, Construction supervision, Operation and maintenance
Agriculture technique	Irrigation plan, Irrigation manner, Crop cultivation
Training	Training planning, Training management

【Countermeasure 2.2】Capacity Development of the Farming Instructors

Activity 2.2.1 Implementation of trainings in terms of technical instruction for farming instructors

- Practical trainings described in the table below are conducted for the farming instructors assigned in the project sites.
- Directorate of Agriculture and Forestry in the MAEPE-RH plans and conducts this training with reference of “Manual for the Vegetable & Pasture Cultivation in Djibouti” prepared in this Study. Besides, this technical training is conducted in cooperation with the vocational training school (agriculture, animal husbandry, fishery) controlled by the Ministry of Education.

Activity	Contents of the Training
Land consolidation	Removing stones/ Making ridges/ Leveling of ridges
Irrigation	Establishment of the water channels/Adjustment of irrigation interval
Cultivation management	Making manure/Fertilization technique/Insects & diseases control/Establishment of nursery/Seeding /Harvesting

【Countermeasure 2.3】Preparation of the Supply System of Agricultural Materials

Activity 2.3.1 Preparation of supply system of agricultural materials in the Directorate of Agriculture and Forestry

- The Directorate of Agriculture and Forestry in the MAEPE-RH takes charge of the management and distribution of agricultural materials provided by donors for local farmers. First, it is necessary to check the stock status, and to prepare an inventory of the received materials. Besides, the list of registered agricultural cooperatives is also prepared for reference to the deciding destinations of these materials.
- The Directorate of Agriculture and Forestry in the MAEPE-RH clearly regulates the management method of agricultural materials (making the inventory, recording distributed materials/destinations/quantities and assigning storekeepers) in order to enhance the system capability for proper material management.
- A database of the quantity and kinds of demanded materials is prepared based on the list of agricultural cooperatives and requests from the cooperatives.
- Based on the inventory and the database mentioned above, the Directorate of Agriculture and Forestry in the MAEPE-RH makes the distribution plan (destination, kinds of material, quantity) of the agricultural materials.
- The Directorate of Agriculture and Forestry in the MAEPE-RH distributes the agricultural materials to the agricultural cooperatives in cooperation with the staffs of the Sub-Directorates.
- After the distribution of the materials, the staffs of the Sub-Directorates monitor the use situation of those materials and feedback the monitoring results to the Directorate of Agriculture and Forestry.

Activity 2.3.2 Establishment and operation of a subsidization scheme for the preparation of supply system of agricultural materials

- In addition to the supply system of the agricultural materials by the Directorate of Agriculture and Forestry in the MAEPE-RH, A subsidization scheme for opening and managing shops dealing in agricultural materials is established to promote the easier procurement of those materials by local farmers. Operation of this scheme starts from the end of the implementation in the project sites of rank-A and continues for 10 years.
- The NGOs or agricultural cooperatives or private suppliers that are willing to open shops dealing in agricultural materials in the Arta, Ali Sabieh and Dikhil regions are invited and selected. The selected organizations receive subsidies from the government for the rent, utility cost and the portion of labor cost. These organizations can receive subsidies for five years per shop. After the end of the subsidy from the government, these organizations receive support such as tax exemption, if necessary.

【Countermeasure 2.4】Clarification of the Support for Organizing Farmers

Activity 2.4.1 Clarification and official announcement of the support policy for agricultural cooperatives

- The staffs of the Sub-Directorates give support for the application of official registration of the

agricultural cooperatives.

- The M/P promotion office and the Directorate of Agriculture and Forestry clarifies the support policy, giving priority to registered cooperatives in terms of providing the agricultural materials given by the donors or the farming support from the Government of Djibouti.
- The publicity activities are enhanced to disseminate the support policy for agricultural cooperatives. For example, the publicity documents are published and are put up on notice boards in each region. Besides, mass media such as radio or television are utilized for the publicity of the support policy.

Table 5.6.3 List of Project Implementation Sites

Type of Development	Water Source Facility	Water Resources	Site Number	Site Name	Evaluation Rank	Irrigation Farming Model	Catchment Area (km^2)	Farmland Area to be Developed (ha)	Number of Beneficiary (households)
New development	Shallow well (A)	Shallow groundwater	I-1-1	Bondara	A	SW-B	84.0	17	68
			I-1-2	Chinnile	A	SW-B	118.8	24	96
			I-1-3	Afka-Arraba	A	SW-B	50.9	10	40
			I-1-5	Mouloude Ouein tributary up-st.	A	SW-B	64.1	13	52
			I-1-6	Arouo down-st.	A	SW-B	20.9	4	16
			I-1-7	Gablalou	B	SW-H	18.0	4	160
			I-1-8	Aour adussa	D	SW-H	19.5	4	160
			I-1-9	Hambokto	A	SW-B	18.2	4	16
			I-1-10	Garaslei	D	SW-H	8.4	2	80
			I-1-11	Boelei	D	SW-H	12.3	2	80
			I-1-12	Kalaloho	C	SW-B	36.9	7	28
			I-1-13	Boulle biyale	B	SW-H	16.7	3	120
			I-1-14	Gachan	C	SW-H	21.7	4	160
			I-1-15	Darka Doun Yar	A	SW-B	66.9	13	52
	Shallow well (B)	Sub-surface water (wadi retaining water)	I-2-1	Bakkirre	C	SW-H	43.4	17	680
			I-2-2	Agobarre	B	SW-B	201.2	16	64
			I-2-4	Kerora	C	SW-H	83.6	33	1,320
			I-2-5	Boukboukto	C	SW-H	48.1	19	760
			I-2-6	Sek Sabir	A	SW-B	50.2	20	80
			I-2-8	Gaggade	C	SW-H	445.4	15	600
			I-2-10	Dika	C	SW-H	192.7	15	600
			I-2-12	Guistir	D	SW-H	155.5	12	480
			I-2-11	Dhourreh	B	SW-B	106.9	43	172
			I-2-14	Hidka Beyya Adde	B	SW-H	332.9	26	1,040
			I-2-15	Midgarra	A	SW-H	78.2	31	1,240
			I-2-16	Dihda Quead	D	SW-H	69.7	28	1,120
			I-2-17	Ambouli down-st.	C	SW-B	-	10	40
			I-2-19	Damerdjog	C	SW-B	44.6	18	72
			I-2-20	Goum-Bourta	C	SW-B	266.8	21	84
	Pond	Surface water	I-3-1	Agan south	B	P-H	90.2	6	240
			I-3-2	Dahhoto	D	P-H	114.4	7	280
			I-3-3	Gara Abbouri	C	P-H	56.0	4	160
			I-3-4	Dawwano	C	P-H	37.2	2	80
			I-3-5	Yoboki	B	P-B	113.2	7	28
			I-3-6	Soulaitou	C	P-H	67.4	4	160
			I-3-7	Guidoli	C	P-H	153.0	10	400
			I-3-8	Dika	C	P-H	106.6	7	280
			I-3-9	Koussour	B	P-H	95.2	6	240
			I-3-10	Safarie Golla	C	P-H	37.7	2	80
			I-3-11	Gabla Oalan	C	P-B	44.4	3	12
			I-3-13	Elka Hadad	A	P-B	64.6	3	12
			I-3-15	Didjan Der tributary	A	P-B	37.0	2	8
	Sub-surface dam	Surface water	I-4-1	Boulle middle-st.	B	SW-B	46.0	38	152
			I-4-2	Mouloude Ouein tributary middle-str	B	SW-B	27.4	26	104
Rehabilitation	Shallow well (B)	Sub-surface water	II-1-1	Kouta Bouyya	A	SW-B	255.7	5	7
			II-1-2	Gobaad As-Ela	A	SW-B	428.0	224	132
			II-1-3	Chekheiti	A	SW-B	245.1	4	6
			II-1-4	Douda	A	SW-B	67.0	27	40
	Pond	Surface water	II-2-1	Didjan Der	A	P-B	116.0	7	28
Total								829	11,929

5.6.2 Project Implementation Structure

For the implementation of this project, the preparation office is upgraded to the M/P promotion office after the decision of project launching described in 5.6.1 (5) 'Management Organizations and their Roles for the Project Preparation and Implementation'. Thereafter, the M/P promotion office carries out the management of this project. In addition, the regional Sub-Directorates under the MAEPE-RH are involved into the project office in order to coordinate with local authorities, and monitor the progress of the project at the sites that are widely spread out in the rural areas of southern Djibouti. Taking these points into consideration, the project implementation structure is proposed as shown in the table below. Due to the insufficient number of staffs, the MAEPE-RH may not be able to assign the staffs in the Sub-Directorates. In this case, a priority of arrangement can be placed in the Sub-Directorate of Dikhil which has the largest area among the three Sub-Directorates. Since Ali Sabieh and Arta regions are adjacent each other and the total area of both regions is still smaller than that of Dikhil region, temporary unification of those regions for the M/P promotion service is also proposed.

The staffs of the M/P promotion office are in charge of implementation and management of the project with technical support from the concerned directorates under the MAEPE-RH. Monthly meeting of the project office is expected to be held to share the information on successful experiences and challenges found through the monitoring of the project implementation. The capacity of the staff could be developed through sharing information, discussion about the solution of the challenges, mutual training among the staffs, and advices from other directorates. Meanwhile, the project implementation is reviewed based on the results of the consultation in the monthly meetings.

Table 5.6.4 Project Implementation Structure (Draft)

Organization		Number of Members	Work Contents	Concerned Agency
MAEPE-RH Project promotion office for sustainable irrigated agriculture development project in southern Djibouti		2 persons (Director, Assistant)	Allocation and execution of the project budget, management of the project implementation, coordination with donors and the concerned agencies, and etc.	Ministry of Environment, Ministry of Education, Ministry of Interior
Regional Sub-Directorates under the MAEPE-RH	Arta	2persons (Regional director, Assistant)	Confirmation of the implementation contents at each project site. Coordination and consultation with local authorities and concerned personnel. Monitoring of the project implementation of each project site. Selection of the participants. Training of farming techniques and maintenance of the facilities, and etc.	Regional Government
	Ali Sabieh	2persons (Regional director, Assistant)		
	Dikhil	2persons (Regional director, Assistant)		

In addition, the farming instructors taking charge of the farming instruction to the beneficiaries are to be assign at a ratio of one person per 50 ha of farmland in the project sites. The human resources for the farming instructors could be the farmers working in advanced farmers' farmlands or young engineers working in the MAEPE-RH. The activity cost of farming instructors are added up in the project cost.

5.6.3 Implementation Schedule of the Project

The activities establishing the project implementation structure are carried out in the 1st year, while the development activities in the project sites are implemented from the 2nd to 20th year in accordance with the priority of the project sites. The 16 project sites of rank-A, 10 project sites of rank-B, 17 project sites of rank-C, and 6 project sites of rank-D are implemented every five years, respectively. The interim evaluation is conducted at the end of the short and middle term development of the project sites to check the results and lessons learned as reference to the next development term. Besides, the final project evaluation is carried out at the end of the project.

The table below describes the process plans of each project activities.

Table 5.6.5 Process Plan of the Project

Project Activity		Preparation	Project Implementation			Project Evaluation
		1 year	Short term (5years)	Middle term (5years)	Long term (10years)	1 year
Preparation		Establishment of the project implementation structure	-	-	-	-
1.1.1 - 1.4.3	Development and establishment of the sustainable irrigated agriculture	-	Rank A 16sites	Rank B 10sites	Rank C, D 23sites	-
			Hard aspects (design study, construction) for 1 year and soft aspects (farming support and training) for 2 years are conducted as one package in each project site.			
2.1.1	Implementation of trainings in terms of project implementation and management for the staffs of the MAEPE-RH	Implementation of trainings for the capacity development of staffs in the MAEPE-RH	-	-	-	-
2.2.1	Implementation of trainings in terms of technical instruction for farming instructors	-	Trainings for farming instructors are conducted at the first 3 years of each development term.			-
2.3.1	Preparation of supply system of agricultural materials in the Directorate of Agriculture and Forestry	Establishment of the supply system of agricultural materials	-	-	-	-
2.3.2	Establishment and operation of a subsidization scheme for the preparation of supply system of agricultural materials	-	The subsidization scheme is prepared for the establishment of the supply system of agricultural materials. Shops dealing in the agricultural materials are opened and managed by the NGOs and/or agricultural cooperatives, etc. under the subsidization scheme.			
2.4.1	Clarification and official announcement of the support policy for agricultural cooperatives	Clarification of support policy for agricultural cooperatives	Organizing farmers is promoted through the enhancement of publicity of the support policy regarding agricultural cooperatives.			-
Project Evaluation		-	Interim evaluation is conducted at the end of short and middle term development of the project site to check the results and lesson learned as reference for the next development term.			Final evaluation of the entire project

Overall schedule of the project implementation is shown in the chart below.

Table 5.6.6 Overall Schedule of the Project Implementation

	1st Year	2nd Year	3rd Year	4th Year	5th Year	6th Year	7th Year	8th Year	9th Year	10th Year	11th Year	12th Year	13th Year	14th Year	15th Year	16th Year	17th Year	18th Year	19th Year	20th Year	21st Year	22nd Year
Sustainable Irrigated Agriculture Development Project in Southern Djibouti																						
Preparation Period																						
Establishment of Project Implementation Structure	■																					
Component1: Development and Establishment of the Sustainable Irrigated Agriculture																						
Countermeasure 1.1～1.4：Short Term Implementation (A rank)		■	■	■	■	■																
Countermeasure 1.1～1.4：Middle Term Implementation (B rank)							■	■	■	■	■											
Countermeasure 1.1～1.4：Long Term Implementation (C,D rank)												■	■	■	■	■	■	■	■	■	■	
Component 2: Capacity Development of the Staffs and Empowerment of Farming Support System of the MAEPE-RH																						
【Countermeasure 2.1】Capacity Development of the Staffs in the MAEPE-RH for Project Implementation																						
Activity 2.1.1 Implementation of trainings in terms of project implementation and management for the staffs of the MAEPE-RH	■																					
【Countermeasure 2.2】Capacity Development of the Farming Instructors																						
Activity 2.2.1 Implementation of trainings in terms of technical instruction for farming instructors		■	■	■			■	■	■			■	■	■			■	■	■			
【Countermeasure 2.3】Preparation of the Supply System of Agricultural Materials																						
Activity 2.3.1 Preparation of supply system of agricultural materials in the Directorate of Agriculture and Forestry	■																					
Activity 2.3.2 Establishment and operation of a subsidization scheme for the preparation of supply system of agricultural materials		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■						
【Countermeasure 2.4】Clarification of the Support for Organizing Farmers																						
Activity 2.4.1 Clarification and official announcement of the support policy for agricultural cooperative	■																					
Project Evaluation						■					■											■
Irrigated farmland to be developed (Cumulative total value)																					829ha	
800ha																774ha						
700ha																						
600ha											583ha											
500ha																						
400ha						408ha																
300ha																						
200ha																						
100ha																						
0																						
Irrigated Farmland by Shallow Well (Perennial Farming) ha		79	158	238	317	396	427	458	490	521	552	584	616	647	679	711	721	730	740	749	759	
Irrigated Farmland by Pond (Winter Season Farming) ha		2	5	7	10	12	16	20	23	27	31	37	44	50	57	63	64	66	67	69	70	
Total Irrigated Farmland ha		82	163	245	326	408	443	478	513	548	583	621	659	698	736	774	785	796	807	818	829	
No. of Beneficiaries (Households) (Cumulative total value)		379	757	1,136	1,514	1,893	2,357	2,821	3,285	3,749	4,213	5,316	6,419	7,523	8,626	9,729	10,169	10,609	11,049	11,489	11,929	

5.6.4 Project Cost Estimation

(1) Conditions of Project Cost Estimation

Component 1: Development and Establishment of the Sustainable Irrigated Agriculture

1) Project Management Cost

- 5% of the construction cost is allocated to consultant fee for investigation and design, and construction supervision.
- 3% of the total cost of construction cost, farming support cost, and training cost is allocated to the project management cost for '*Project promotion office for sustainable irrigated agriculture development project in southern Djibouti (tentative)*'.
- Project cost is estimated on the basis of 2014.

2) Construction Cost

- In regard to earth work, heavy construction machines belong to the Directorate of Grand Works of the MAEPE-RH are exclusively used.
- Construction cost of the shallow well is assumed based on the experience of the pilot project. Shallow well (A): 1,600,000DJF/site, Shallow well (B): 600,000DJF/site
- Construction cost of the pond is calculated by multiplying length (m) of the dike by construction unit cost 54,620DJF/m.
- Construction cost of the sub-surface dam is calculated by multiplying length (m) of the cut-off wall by construction unit cost 450,130DJF/m.
- Land preparation cost is estimated by two cases of stony land and ordinary land.
- Construction cost of the irrigation network including water tank, pipeline, and hydrants, and appurtenant work including warehouse, fence, and gate are assumed 3,100,000DJF/ha in total.
- Construction cost of solar pump system is assumed 3,100,000DJF/ha based on the experience of the pilot project.
- Construction cost of drip irrigation is assumed 500,000DJF/ha.
- Construction period is planned according to the project area of each site as follows.

Area of the project site	Construction period
－10ha	3 months
10ha－100ha	6 months
100ha－	9 months

- Site management cost of one contractor is assumed 1,000,000DJF/month. Since one contractor can manage two construction sites, site management cost is calculated to be 500,000DJF/month/site.
- 17% of VAT is added on the construction cost.

3) Supporting Cost for Farming

- Cultivation plans in the project sites are assumed as shown in the table below. Necessary materials for farming practice such as seeds are included into the project cost. Seeds and/or nursery of fodder trees are provided once.

Site	Crop cultivation during farming support	
Pond site	-	Two times in winter season
Other site	Two times in summer season	Two times in winter season

- Cost for the farming tools is included into the project cost.

4) Training Cost

- On-farm training is planned to be conducted during the farming support period; 6 months/year (for winter cultivation) at the pond site and 12 months/year (for summer and winter cultivation) at other sites. Number of the farming instructors is allocated depending on the farmland area of the project sites as shown in the table below.

Area of the project site	Allocated number of farming instructor
－50ha	1 person
50ha－100ha	2 persons
100ha－150ha	3 persons
150ha－200ha	4 persons
200ha－250ha	5 persons
250ha－	6 persons

- Study tour is also organized once a year, namely twice in total at the sites for Beginner farmers' group (SW-B, P-B) at the rate of 20% of the beneficiaries.

Component 2: Capacity Development of the Staffs and Empowerment of Farming Support System of the MAEPE-RH

1) Training Cost for the Staffs of the MAEPE-RH for the Project Implementation and Management

- Training cost of project implementation and management for the staffs of the MAEPE-RH is calculated as shown in the table below.

Contents	Item	Quantity	Total (DJF)
Lecture	Lecture Fee, Travel Expense	14 days	560,000
Third Country Training Program	Travel Expense, Daily Allowance, Accommodation Fee	17 persons × 1 time	9,180,000
Monthly Meeting	Travel Expense	1 time/month, 22 years	11,880,000
Total			21,620,000

2) Training Cost for the Capacity Development of Farming Instructors

- Training cost for the capacity development of farming instructors is calculated as shown in the table below.

Item	Unit Price	Quantity	Total (DJF)
Lecture Fee	10,000 DJF/day	36 person·day	360,000
Daily Allowance, Accommodation Fee	10,000 DJF/day	658 person·day	6,580,000
Travel Expense	2,000 DJF/day	658 person·day	1,316,000
Room Charge for the Training Facilities	50,000 DJF/day	36 days	1,800,000
Textbook	5,000 DJF/person	94 persons	470,000
Total			10,526,000

3) Subsidization Scheme for Establishing Supply System of Agricultural Materials

Central government provides financial support to NGOs and/or agricultural cooperatives, private firms which are able to open shops in provincial cities. The operation cost including rent, utility cost and labor cost of the shop are partially covered by the subsidy. To design this subsidization scheme, it requires the preparation term for five years. The actual application of this scheme starts just after the end of short term development of the project site of rank A and continues for 10 years.

The cost for the establishment of subsidization system is calculated as shown in the table below. The targets of this system limits to two shops in each region. Besides, the each shop receives the subsidy support for only five years.

Item	Unit Price	Quantity	Total (DJF)
Rent of the shop	50,000 DJF/month	12 months × 5 years × 2 shops × 3 regions	18,000,000
Utility cost	20,000 DJF/month	12 months × 5 years × 2 shops × 3 regions	7,200,000
Labor cost	30,000 DJF/month	2 persons × 12 months × 5 years × 2 shops × 3regions	21,600,000
Total			46,800,000

(2) Project Cost

Project cost is calculated by the project site on the condition mentioned above. (Refer to Appendix11 Project Cost Estimation) Entire project cost is summarized as shown in the table below by the implementation terms: short term, middle term, and long term.

Finally, total project cost of *'Sustainable irrigated agriculture development project in southern Djibouti'* is estimated **6,916,969,000 DJF** as of 2014.

Table 5.6.7 Breakdown of the Project Cost (Unit: DJF)

Components	Items	Short term	Middle term	Long term		Total
		A rank (16 sites)	B rank (10 sites)	C rank (17 sites)	D rank (6 sites)	49 sites
Development and establishment of the sustainable irrigated agriculture	Construction cost	3,049,382,000	1,361,936,000	1,326,775,000	185,126,000	5,923,219,000
	Supporting cost for farming	137,075,000	73,117,000	106,764,000	36,554,000	353,510,000
	Training cost	31,920,000	14,160,000	20,640,000	7,920,000	74,640,000
	Project management cost	249,004,000	111,564,000	109,947,000	16,139,000	486,654,000
	Sub-total	3,467,381,000	1,560,777,000	1,564,126,000	245,739,000	6,838,023,000
Capacity development of the staffs and empowerment of farming support system of the MAEPE-RH	Training cost for the project implementation and management	7,060,000	4,410,000	7,500,000	2,650,000	21,620,000
	Training cost for the capacity development of the farming instructors	4,191,000	1,873,000	3,123,000	1,339,000	10,526,000
	Operation cost of the subsidization scheme for the preparation of supply system	0	23,400,000	23,400,000	0	46,800,000
	Sub-total	11,251,000	29,683,000	34,023,000	3,989,000	78,946,000
Total		3,478,632,000	1,590,460,000	1,598,149,000	249,728,000	6,916,969,000

5.6.5 Project Effects on Vegetables and Fodder Production

(1) Project Effects on Vegetables Production

Fruit vegetables such as tomato and okra and leaf vegetables such as onion are designed to be cultivated in the farmlands developed in this project. The vegetables production is expected to increase through the implementation of the project. The project effect on the self-sufficiency rate of vegetables is evaluated as follows.

According to the vegetable production trend reported in the PDDSP, the domestic vegetable production is estimated 2,651ton in 2007. This accounts for 5.6% of domestic vegetable consumption (46,928ton) in 2007 based on the data released by FAO. Assuming that domestic vegetable consumption is same as that in 2007 during the entire period of this project, self-sufficiency rate of vegetables in 2035 is expected to reach 13.4%, which is about 2.4 times as much as that in 2007.

Table 5.6.8 Project Effect on the Self Sufficiency Rate of Vegetables

Year	2007	-2020	-2025	-2035
Increased vegetable production through the project (ton)	-	1,816	2,581	3,644
Expected domestic vegetable production (ton)	2,651*	4,467	5,232	6,295
Self-sufficiency rate of vegetables (%)**	5.6	9.5	11.1	13.4

* PDDSP
** Self-sufficiency rate of vegetables is computed by dividing domestic vegetable production by domestic vegetable consumption (46,928t).

(2) Project Effects on Fodder Production

In regard to fodder, the expected production is estimated from the present period to the end of the project. According to the data of PDDSP, fodder production was only 216ton in 2007. With the implementation of this project, annual fodder production is expected to increase to 9,084ton by 2020, 12,848ton by 2025, and 18,019ton by the end of the project. As previously mentioned, it is confirmed that 50% of annual fodder consumption by livestock could be covered by fodder production of this project, especially in the case of the Beginner farmers' group, irrigating their farmlands with shallow wells. The increase of fodder production due to the project implementation helps enhance the resilience against drought.

Table 5.6.9 Project Effect on Fodder Production

	2007	-2020	-2025	-2035
Increased fodder production through the project (ton)	-	9,084	12,848	18,019
Expected fodder production (ton)	216*	9,300	13,064	18,235

* PDDSP

Chapter 6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

(1) The study area, southern part of Djibouti, is located in an arid region. The annual precipitation is less than 150mm, and the mean temperature is around 30°C. Although various scale of wadis make river channels, water is not running there except for temporal effluent water running just after rains. Vegetation in ground surface is very few. In other words, dark brownish and dry bare ground is mainly seen in the study area. However, once we excavate the ground, we could have chance to get water although the water emerging depth in underground depends on the location. The groundwater could be obtained at shallow layers of ground in the wadis and its surrounding areas. The three (3) shallow wells were constructed in the pilot project. In Hambokto, the wells were not completed at the first and second positions since we could not find spring water there although the well was successfully constructed at the third position. In Afka Arraba, the first and second position for the well construction was completed after the introduction of a rock breaker. After that, all wells completed can supply irrigation water throughout the year. Moreover, results of using surface water stored in the pond were shown. Although it depends on the climate, so far, the pond can supply enough irrigation water for winter cropping in the pilot farm. According to these results mentioned above, it is verified that even in Djibouti, there was a potential to get water for the agriculture, although it was not easy.

Farm condition is also very severe. Since in general, surface ground of terrace plains around wadis, which has high potential of water resources, is formed by gigantic stones, gravels, sand and slight amount of clay, it is necessary to reform the lands as farmlands. However, those lands could be farmlands after honest works such as removing gigantic stones and gravels from the ground surface. It is possible to harvest vegetables and pastures in each pilot farm without utilizing chemical fertilizer, but organic fertilizer made of livestock dung. According to the results mentioned above, it is verified that the farming has a potential to be more extended in southern Djibouti despite the severe environmental conditions.

(2) The pilot project participants are former nomads. Thus, this was the first time for them to engage in farming activities. However, they have learned elementary farming techniques, and produced crops through the pilot project activities for two (2) years that includes the provision of continuous on-farm training by the study team. In case of Hambokto, several experienced persons also joined the pilot project. They could improve their farming skills through the training conducted in pilot farm. Eventually, they could produce more crops than other beginner participants. In each site, while male participants take charge of the heavy works such as plowing and ridge making, female participants mainly work in irrigation, weeding and harvesting. Farming is a family activity. Especially, the female showed positive attitude towards the farming activities. By the last year of this Study, two agricultural cooperatives were established in two (2) pilot project sites. They started collecting cooperative fees to buy fuel for the engine pumps, which is a first step for a sustainable agriculture. However, the farming activities in Kourtimalei were not well managed since their leader was not honest and the participants were not serious in carrying out cooperative activities.

(3) The farmers in Djibouti are classified into several farmers' groups depending on farmers' skill and funding ability. Taking into account the income and expenditure for farmers, it is proved that each farmers' group could benefit from farming activities if they could get support from the government for the initial investment. Moreover, if farming skills are improved further and farmland is expanded, farmers can make enough profit to enable them to develop their own irrigation facilities by themselves. In fact, several participants have already started selling their harvested crops in nearby markets. In addition, because of the profit made, some have opened small business shops to sell daily commodities and food near the pilot farm. Therefore, one can conclude that even if it is a small scale farming, it can stimulate the nomad people and the local society, which is proving the

validity of this project.

(4) In the Study, the sixty (60) candidate sites for agricultural development in southern Djibouti were selected based on map information. Thereafter, the study team surveyed the candidate sites to grasp those characteristics. Several criteria, including water resources availability and accessibility, were selected to evaluate each project candidate site. Eventually, the study team selected 49 potential sites for the agriculture development in southern Djibouti. Moreover, the study team calculated the size of the farmland that could be developed based on the scale of catchment area and type of water resource. As a result, approximately 800ha of farmland is planned to be developed in the M/P. By implementing the M/P, the self-sufficiency rate of vegetables would increase from 5.6 % (2007) to 13.4% (2035). Besides, the amount of forage production would also increase from 206 t (2007) to 18,019 t (2035).

6.2 Recommendations

(1) Forty nine (49) potential sites in southern Djibouti were selected for the agricultural development project in combination with the water resource development, although those selected sites are all under the severe climatic condition. The beneficiaries are poor local residents who have none or little farming experience. Since the M/P is formulated to improve their livelihood and stimulate the local society, its implementation is urgently expected. However, this project of the M/P will be managed by the MAEPE-RH which does not have enough budget. Therefore, the M/P is formulated in consideration with the order of priority for project sites. These sites were fairly evaluated based on several criteria such as the demand from local residents, accessibility and reliability of the project. Thus, starting the implementation from the high priority sites would be appropriate.

(2) It is impossible for poor nomads or small farmers to pay initial costs for developing water sources, irrigation facilities and farmlands. Thus, public support is expected for preparation of the necessary facilities for farming. These facilities can be established through the existing techniques typically utilized in Djibouti. After its completion, approximately 12,000 households in southern Djibouti, where the population is 218,000, can benefit from it. Since this project has also high potential to develop sustainable agriculture, it is recommended that the MAEPE-RH implements it with the highest priority in the ministry.

(3) When implementing the project, only establishing the facilities is not enough. In previous projects assisted by donors, the technical support for the farming activities was not well taken in account. Therefore, there are many cases where the on-farm technical support for farming activities was not enough after provision of the facilities and equipment. On-farm instruction is essential to enable farmers to acquire necessary farming techniques, especially when the targets are nomads who have none experience of the faming.

(4) Using pumps to intake water is necessary for agricultural production in Djibouti. Fuel is used as pump energy in Djibouti at present, while fuel procurement requires much time and money, which is a heavy burden for local farmers. However, solar power generation system has been recently established in several farms. This system has the advantage of being economically efficient considering service life, though it requires high initial cost. Thus, the further extension of the solar power generation system to the agricultural sector is recommended. However, it is not easy for the local farmers or cooperatives to operate and maintain the system. Thus, support and instruction for the operation and the maintenance of the solar power generation systems should be provided by the MAEPE-RH. For this purpose, trainings for concerned staffs of the MAEPE-RH and securing equipment and budget are required.

(5) The drip irrigation system is a promising irrigation method for water saving in Djibouti. The dissolved solids in the irrigation water sticks in the thin drip tube. Based on verification in the pilot project, drip irrigation systems with on-line types are recommended because of easy maintenance

and operation under low water pressure. Although the drip tubes are not expensive, the extension of the drip irrigation system depends highly on the domestic procurement of drip materials.

(6) The total number of projected sites is 49 while each size is small. It is obvious that the MAEPE-RH will not be able to manage securely the project proposed in the M/P based on its actual organization. It is indispensable to establish an M/P promotion office under the direct control of the secretary general and add several staffs in charge of this project to the M/P promotion office and Sub-Directorates in the regions. For this purpose, it is strongly recommended to increase the number of staffs. Also, it is an important that this project contributes in developing capacities of the MAEPE-RH staffs.

ATTACHMENT

SCOPE OF WORK

THE MASTER PLAN STUDY PROJECT

FOR

SUSTAINABLE IRRIGATION AND FARMING IN SOUTHERN DJIBOUTI

AGREED UPON BETWEEN

THE GOVERNMENT OF THE REPUBLIC OF DJIBOUTI

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

Djibouti, 18th August, 2011

Mr. Niwa Noriaki
Deputy Director General,
Rural Development Department,
Japan International Cooperation Agency
(JICA)

Mr. Idriss Abdou Ali
Secretary General,
Ministry of Agriculture, Fisheries Livestock, and Marine Resources,
Republic of Djibouti

Witnessed by Mr. Ali Hassan
Secretary General, PI
Ministry of Foreign Affairs and International Cooperation ,
Republic of Djibouti

I. INTRODUCTION

In response to the official request of the Government of the Republic of Djibouti (hereinafter referred to as "GoD"), the Government of Japan decided to conduct the Master Plan Study Project for Sustainable Irrigation and Farming in Southern Djibouti (hereinafter referred to as "the Study ") in accordance with the Agreement on Technical Cooperation between the Government of Japan and the Government of Djibouti, signed in Djibouti on 14th November, 2005 (hereinafter referred to as "the Agreement").

Accordingly, Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, will jointly undertake the Study with the authorities concerned of the Government of Djibouti represented by the Ministry of Agriculture, Fisheries Livestock, and Marine Resources (hereinafter referred to as "MAEM").

The present document sets forth the Scope of Work with regard to the Study.

II. OBJECTIVES OF THE STUDY

The objectives of the Study are:

1. To formulate a Master Plan through examining sustainable system of irrigation and farming, after the verification by the Pilot Project, and

2. To let counterpart personnel learn relevant skills and technology through formulating the Master Plan.

III. STUDY AREA

The Study will cover Dikhil, Ali-Sabieh, Arta.

IV. SCOPE OF THE STUDY

In order to achieve the objectives mentioned above, Master Plan Study shall address the major issues and development strategy for sustainable system of irrigation and farming in Southern Djibouti.
This Study shall cover the followings:

1: Basic data and their analysis
2: Implementation of the Pilot Projects
3: Finalizing of the Master Plan

1: Basic Survey for Master Plan

(1) Data collection and situation analysis
1) Review of the existing data, information and reports on irrigation and agriculture including the social and economic aspects, the relevant institutions and organizations in the study area.

2) Baseline survey for data collection on the following aspects in the above-mentioned Study Area:
a. Topography and geological condition
b. Meteorological data
c. Water source
d. Farming system, land ownership and agricultural production
e. Household economies of farmers
f. Farmers organizations and extension services
g. Post-harvest and processing system
h. Marketing of agricultural product
i. Agricultural finance
j. Others

(2) Conceptualization of draft Master Plan
1) Formulation of strategies in line with the above potentials and constraints identified
2) Formulation of short-term and mid/long-term action plans

(3) Selection and planning of Pilot Projects
1) Selection of Pilot Projects according to the criteria prepared through the Study
2) Design of Pilot Projects

2: Implementation of Pilot Projects
(1) Preparation of Pilot Projects (required materials and facilities)
(2) Implementation of Pilot Projects with capacity development of organizations concerned
(3) Monitoring and evaluation of Pilot Projects

3: Finalization of the Master Plan
Finalization of the draft Master Plan

V. SCHEDULE OF THE STUDY

The Study will be carried out in accordance with the tentative schedule. The schedule is tentative and subject to be modified when both parties agree upon any necessity that may arise during the course of the Study.

VI. REPORTS

JICA shall prepare and submit following reports in French and English to the Government of Djibouti.

1. Inception Report:
Fifteen (15) copies will be submitted at the commencement of the first work period in Djibouti. This report will contain the schedule and methodology of the Study.

2. Progress Report (1):
Fifteen (15) copies will be submitted at the midst of the first work period in Djibouti.

3. Progress Report (2):

Fifteen (15) copies will be submitted at the end of the first work period in Djibouti. This report will contain draft Master Plan and plan of Pilot Projects

4. Interim Report:
Fifteen (15) copies will be submitted at the commencement of the second work period in Djibouti. The report will summarize the progress of Pilot Projects.

5. Progress Report (3):
Fifteen (15) copies will be submitted at the midst of the second work period in Djibouti. The report will summarize the preliminary evaluation and findings of Pilot Projects.

6. Draft Final Report:
Twenty (20) copies will be submitted at the completion of the second period in Djibouti. The Government of Djibouti shall submit its comments within one (1) month after the receipt of the Draft Final Report.

7. Final Report:
Twenty-five (25) copies will be submitted within one (1) month after the receipt of the comments on the Draft Final Report.

Ⅶ. STEERING COMITTEE

For the smooth and effective Study, a steering committee consisting of the following members will be established. The Chairperson may invite representatives from other relevant organizations, whenever necessary.

1) Djiboutian Side
- Secretary General, MAEM (Chairperson)
- Director of Agriculture and Forest, MAEM
- Director of Water Department or Director of Major Works, Ministry of Natural Resource Energy
- Director of Dikhil, Ali-Sabieh and Arta Subdivision, MAEM
- Head of Program Monitoring and Communication
- Coordinator of PROMES-GDT

2) Japanese Side
- JICA study team leader
- Chief Representative of JICA Djibouti Office

3) Observers
- Representative of Embassy of Japan

Ⅷ. UNDERTAKINGS OF THE GOVERNMENT OF DJIBOUTI

1. In accordance with the provisions of the Agreement, the Government of Djibouti shall accord privileges, exemptions and benefits to the Japanese study team (hereinafter referred to as "the Team") as follows:

   (1) To facilitate smooth implementation of the Project, the Government of Djibouti shall take the following necessary measures;

a. To provide necessary facilities to the Team for remittance as well as utilization of the funds introduced into Djibouti from Japan in connection with the implementation of the Study.
b. To bear claims, if any arise, against the members of the Team resulting from, occurring in the course of, or otherwise connected with, the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Team.

(2) MAEM shall, at its own expense, provide the Team with the following in cooperation with other agencies concerned:
a. Security-related information on as well as measures to ensure the safety of the Team,
b. Information on as well as support in obtaining medical service,
c. Available data and information related to the Study,
d. Counterpart personnel,
e. Suitable office spaces with necessary equipment and furniture, and
f. Credentials or identification cards.

2. MAEM shall act as the counterpart agency to the Team and also as the coordinating body in relation with other governmental and non-governmental organizations concerned for the smooth implementation of the Study.

3. MAEM shall assign a necessary number of counterpart personnel in accordance with areas of the Team members and submit the list of counterpart personnel at the beginning of the Study.

IX. UNDERTAKINGS OF JICA

For the implementation of the Study, JICA will take the following measures:
1. To dispatch, at its own expenses, the Team to Djibouti; and
2. To pursue technology and skills transfer to the Djiboutian counterpart personnel through the Study
3. To accept the Djiboutian counterparts for training in Japan on specific relevant subjects.

X. CONSULTATION

MAEM and JICA shall consult with each other in respect of any matter that may arise from or in connection with the Study.

ANNEX 1. Process of the Study

	Year 1	Year 2	Year 3
1. Basic survey			
2.Implementation of the Pilot Projects			
(1) Site Selection			
(2) Construction			
(3) Farming			
(4) Monitoring & Evaluation			
3.Finalizing Master Plan			

ANNEX2. The Outline of the Pilot Projects

The number of total sites; three sites, according to the further study

1. Concept

The Pilot Project will establish a sustainable farming model on the base of the settlement of nomads. The water resource for irrigation can be shallow wells, existing water reservoirs.

2. Contents

(1) Installment of a shallow well around Wadi

(2) Rehabilitation of the reservoir and construction of the intake

(3) Development of farmland (about 2ha)

(4) Building livestock barns and storages for products

(5) Capacity development of farmers' organization

(6) Establishment of sustainable farming model

ANNEX 3. Possible sites

* Pilot project sites will be proposed as follows.

Site	Water resources	Farming Conditions	Settlement Conditions
(1) Afka Arraba	-Shallow well -Deep well mainly for households (by JICA Rural Water Supply Project)	-Soil; suitable but covered with rocks -Private farmers -Access; good (15 minutes by car to Dikhil) -Size; about 2 ha can be reclaimed	-Access; good (15 minutes by car to Dikhil) -About 3 new settlement observed -Deep well for households (by JICA Rural Water Supply Project)
(2) Hamboucta	-Reservoir (by MALF/WR) -Deep well mainly for households (by JICA Rural Water Supply Project) -Deep well and Reservoir (by MALF/WR around Doudoub Bolale)	-Soil; not bad (sandy) -Private farmers who have just started farming	-Deep well for households (by JICA Rural Water Supply Project) -New School established -Access; about 5 km from Ali Sabieh
(3) Kourtimalei	-Reservoir (by MALF/WR) -Shallow well besides the reservoir mainly for households (- Watershed Agriculture)	-Existing farmland (2 ha) improved by MALF/WR, which requires agricultural technical assistance - Enough space to expand -Possibility of applying Watershed Agriculture Method	-8 nomads under selection by MALF/WR -Access; not good (far from towns)

ANNEXE 4. LISTE DES PRINCIPALES DISPOSITIONS A PRENDRE

Disposition	Prise par	
	Partie Djiboutienne	Partie Japonaise
Bureau du Projet		
Local du bureau	○	
Meubles du bureau	○	
Climatiseur	○	
Equipements du bureau (PC, Photocopieuse, etc.)		○
Connexion d'internet	○	
Ligne téléphonique (pour les experts japonais)	○	
Frais mensuel de communication téléphonique (pour les experts japonais)		○
Autres	Ils doivent être discutés et acceptés par les deux parties	
Dépenses pour les activités du projet		
Outil et équipement pour l'expérimentation		○
Dépense pour la maintenance et les pieces de rechange des équipements	○	○
Dépenses pour les consommables comme les équipement et outils pour l'expérimentation		○
Autres	Ils doivent être discutés et acceptés par les deux parties	
Véhicule(s)		
Frais de location de voiture(s)		○
Véhicule(s)		○
Immatriculation	○	
Chauffer(s)	○	
Carburant		○
Autres	Ils doivent être discutés et acceptés par les deux parties	
Indemnité de Voyage d'Affaires au Djibouti		
Personnel djiboutien	○	
Experts japonais		○
Comité de Coordination Conjointe, séminaire, atelier, conférence, réception tenue au Djibouti		
Lieu(à l'exception des places appurtenant au gouvernement)		○
Prospectus, manuel, brochures, photocopie		○
Dépenses pour les reunions quotidiennes (tenues entre les chercheurs)	○	
Autres	Ils doivent être discutés et acceptés par les deux parties	

MINUTES OF MEETING ON THE INCEPTION REPORT
FOR
THE MASTER PLAN STUDY FOR SUSTAINABLE IRRIGATION AND FARMING
IN SOUTHERN DJIBOUTI

DJIBOUTI, FEBRUARY 23, 2012

Mr. Idriss Abdou Ali
Director General of the Ministry of Agriculture,
Fisheries, Livestock and Marine Resources
(MAPE)

Mr. Michimasa MENJO
Team Leader, JICA Study Team

Mr. Katunari HARADA
Representative, JICA Djibouti Office

The Study Team for the Master Plan Study for Sustainable Irrigation and Farming in Southern Djibouti (hereinafter referred to as the Study Team) organized by Japan International Cooperation Agency (JICA), headed by Mr. Michimasa MENJO as Team Leader, and the Steering Committee headed by Mr. Ahmed Mohamed Awaleh, Minister of the Ministry of Agriculture, Fisheries, Livestock and Marine Resources (MAEM), held a meeting and discussed on the Inception Report explained by the Study Team.

The list of participants is attached in Annex.

1. Submission of the Inception Report

The Steering Committee received 15 copies in French and 15 copies in English of the Inception Report submitted by the Study Team on February 23, 2012.

2. Meeting

A meeting was held between the Study Team and the Steering Committee at the Conference room of the MAEM in Djibouti on February 23, 2012 to discuss on the Inception Report.

3. Presentation

The Study Team explained to the steering committee the Inception Report that contains the objectives, approaches and methodologies of the Master Plan and activities of Pilot Projects in the Study for the Southern three (3) Provinces Dikhil (Afka-Arraba site), Ali-Sabieh (Hambokta site) and Atra (Koutimalei site) of Djibouti.

4. Discussion

Based on the discussion, the Steering Committee and the Study Team confirmed their agreement on the contents of the Inception Report. Meanwhile, the following matters were discussed between both the parties.

(a) Djibouti side explained some types of farming system to be referred as a good model case for the agricultural development plan, that include modernized drip-irrigation system, sun-shield cultivation method and also traditional but saving-water irrigation ideas to economize agricultural products. The Study Team responded to make visit of presented agriculture sites to refer for the Project

(b) The Study Team also explained basic concept that the proposed irrigation farming system is low cost and not big but good benefit with resource of shallow water and surface water.

(c) Djibouti side insisted strongly that pump energy for taking irrigation water from well or reservoir should be applied by solar generation, not by diesel generator which is recognised here in Djibouti to be difficult for maintenance and especially fuel supply. The Study team responded that comparison work for solar energy and diesel pump is one of our study subjects. However, a request of solar system for pumping will be transmitted to main office of JICA.

5. Confirmation

The Study team confirmed the attendance of officials from Ministry of Energy and Water-resources and Study and Research Centre in Djibouti (CERD) as cooperation organization for the project. Both organizations accepted participation of discussions and field activities if demanded by Study team.

LIST OF ATTENDANTS

Djibouti Side

Ministry of Agriculture, Fishery and Livestock

SEM. Ahmed Mohamed Awaleh	Minister
Mr.Idris Abdou Ali	General Secretary
Mr.Ahmed Mohamed Ali	Director of Agriculture
Mr.Mohamed Bahouch	Chief Technician
Mr.Ibrahima Naiga	Consultant of SDSA
Mr. Warsama Osman	Staff
Mr. Abdi Etni Bosoreh	Staff
Mr. Tabarek Dowario	Chief of BPSC
Mr. Ali Del Wais	Director of Administration
Mr. Imuhim Ehmi Neg	Technical Advisor
Mr. Baragoita Saudik	Coodinator of UGP

Ministry of Energy and Water-resources

Mr. Aouled Djeme Ahmed	Director of GDS TRX

Study and Research Centre in Djibouti

Mr. Abdourahman Daher	Director

Japanese Side

JICA Djibouti Office

Mr. Katunari HARADA	Representative, JICA Djibouti Office
Mrs. Yasue MIYANAKA	JICA Djibouti Office

Study Team

Mr. Michimasa MENJO	Leader/Water-resource development
Mr. Ikutarou ITO	Sub-team leader /Farm management and cultivation
Mr. Tomoki HOTTA	Irrigation plan
Mr. Massamba GUEYE	Socioeconomic survey and analysis
Mr. Takashi KOTEGAWA	Coordinator/ Assistant of farm management and cultivation

MINUTES OF MEETING ON THE INTERIM REPORT

FOR

THE MASTER PLAN STUDY FOR SUSTAINABLE IRRIGATION AND FARMING IN SOUTHERN DJIBOUTI

DJIBOUTI, AUGUST 29, 2013

Mr. Aouled Djama Ahmed	Mr. Michimasa MENJO
Director of Major Works, MAEPE-RH	Team Leader, JICA Study Team

The Study Team for the Master Plan Study for Sustainable Irrigation and Farming in Southern Djibouti (hereinafter referred to as the Study Team) organized by Japan International Cooperation Agency (JICA), headed by Mr. Michimasa MENJO as Team Leader, and the Steering Committee headed by Mr. Aouled Djama Ahamed, Director of Grand Works in the Ministry of Agriculture, Water, Fisheries, Livestock and Marine Resources (MAEPE-RH), held a meeting and discussed on the Interim Report.

The list of participants is attached in Annex.

1. Submission of the Interim Report

The Steering Committee received 15 copies in French and 15 copies in English of the Interim Report submitted by the Study Team on August 29, 2013.

2. Meeting

The meeting was held between the Study Team and the Steering Committee at the conference room of the MAEPE-RH in Djibouti on August 29, 2013 to discuss the Interim Report.

3. Presentation

The leader of the Study Team presented the contents of the Interim Report which contains the progress of the pilot project activities, cost and benefit evaluation of prospective farming models, selection of candidate sites for the sustainable agriculture development project, and implementation schedule of the project. The Study Team also explained present condition of water resource for each pilot project site, where abundant water is available more than last season.

4. Discussion

Based on the presentation of the Interim Report, the Steering Committee and the Study Team discussed the following subjects.

(a) Djibouti side have questioned if there are possible cases in the candidate sites where gravity irrigation is applicable. The Study Team has answered that there is scarce site applicable for gravity irrigation and every site will require pumping system to obtain irrigation water.
Djibouti side has commented that consequently a solar system pumping is important when considering long term operation of farming without the expenditure for power generation.
The Study Team responded that a final report will describe the importance and necessity of solar system pumping for sustainable farming with an analysis on merit and demerit for both solar system and fuel pumping type.

(b) The Study Team mentioned an issue about the pilot project participant's working stance relating to WFP support, namely some pilot project participants joined the farming activities aiming to make a good chance of getting "Food for Work". Djibouti side has responded that actually there are some undesirable cases about "Food for Work" support for poor farmers, and so that proper procedure and time limit of "Food for Work" support will be considered.

(c) JICA attendant has advised that some kinds of water user's association for the pilot project would be recommended to establish in order to maintain sustainable farming activities at the pilot project sites.

(d) Djibouti side has commented that drip irrigation is preferable irrigation method in this country. The Study Team has replied that drip irrigation system will be applied in the plots of Study Team at Hanbokuto and Afka Arraba pilot farms for demonstration purpose.

LIST OF ATTENDANTS

Djibouti Side

Ministry of Agriculture, Water, Fisheries, Livestock and Marine Resources

Mr. Aouled Djama Ahmed	Director of Major Works
Mr. Legroun Abdelrair	Adviser of Minister
Mr. Ahmed Mohamed Ali	Director of Agriculture
Mr. Tabarek Mohamed	Chief of BPSC
Mr. Ali Mohamed Ali	Rural Development Director in Obock
Mr. Ahmed Abdoul Galil	Engineer of Direction of Hydraulic Rural
Mr. Abdoul Kader Hamadou	Coordinator of South Region

Japanese Side

Japan Embassy

Mr. Tatsuo UNUMA	3rd Secretary, Economic Affairs/Economic Cooperation

JICA Djibouti Office

Ms. Yasue MIYANAKA	JICA Djibouti Office/Project Formulation Adviser

Study Team

Mr. Michimasa MENJO	Leader/Water-resource Development
Mr. Ikutaro ITO	Sub-team Leader /Farm Management and Cultivation
Mr. Tomoki HOTTA	Irrigation Plan

MINUTES OF MEETING ON THE PROGRESS REPORT (3)

FOR

THE MASTER PLAN STUDY FOR SUSTAINABLE IRRIGATION AND FARMING IN SOUTHERN DJIBOUTI

DJIBOUTI, JUNE 18, 2014

Mr. Aouled DJAMA AHMED

Director of GDS TRX (Grand Works), Ministry of Agriculture Fisheries, Livestock and Marine Resources (MAEPE-RH)

Mr. Michimasa MENJO

Team Leader, JICA Study Team

Mr. Katsunari HARADA

Representative, JICA Djibouti Office

The Study Team for the Master Plan Study for Sustainable Irrigation and Farming in Southern Djibouti (hereinafter referred to as the Study Team) organized by Japan International Cooperation Agency (JICA), headed by Mr. Michimasa MENJO as Team Leader, and the Steering Committee headed by Mr. Aouled DJAMA AHMED as Director of GDS TRS (Grand Works), Ministry of Agriculture, Fisheries, Livestock and Marine Resources (MAEPE-RH), held a meeting and discussed on the Progress Report (3) explained by the Study Team.

The list of participants is attached in Annex.

1. Submission of the Progress Report (3)

The Steering Committee received 15 copies in French and 15 copies in English of the Progress Report (3) submitted by the Study Team on June 18, 2014.

2. Meeting

A meeting was held between the Study Team and the Steering Committee at the conference room of the MAEPE-RH in Djibouti on June 18, 2014 to discuss on the Progress Report (3).

3. Presentation

The leader of Study Team presented the progress of the JICA Project. Contents of the progress are focused on the summary of results/issues of the pilot project and the field survey. And explanation was also done for the selection of tentative potential sites for future. All potential sites are classified several groups by the type of water resource development, and ranking of priority for each site is evaluated.

4. Discussion

Based on the presentation of the progress report, the Steering Committee and the Study Team exchange some comments for the project.

(a) Djibouti attendants express the necessity and effectiveness of solar pumping system. JICA Team replied that consideration of the solar system would be mentioned in the final report.

(b) Djibouti attendants express that drip-irrigation is on going in the north of Djibouti (Tadjoura) and farmers there have been getting good experience and result. JICA team replied that at next visit to Djibouti the team member would visit drip-irrigation site and discuss about adaptability of drip irrigation system for future project.

LIST OF ATTENDANTS

Djibouti Side

Ministry of Agriculture, Fisheries, Livestock and Marine Resources

Mr. Aouled Djama Ahmed	Director of GDS TRX
Mr. Legroun Abdelkrim	Minister Adviser
Mr. Tabareck Mohamed	Head of Program and Monitoring
Mr. Salifou Mahamadou	DATE
Mr. Alessandro Aubry	DATE
Mr. Ali Ahmed Bourhan	Engineer Agronomy
Mr. Abdallah Bourhan	Joint Director of Tadjoura
Mr. Omar Ali Kharieh	Engineer

Japanese Side

JICA Djibouti Office

Mr. Katsunari HARADA	Representative, JICA Djibouti Office

Study Team

Mr. Michimasa MENJO	Leader/Water-Resource Development
Mr.Takashi KOTEGAWA	Coordinator/Assistant of Farm Management & Cultivation

MINUTES OF MEETING ON THE DRAFT FINAL REPORT

FOR

THE MASTER PLAN STUDY FOR SUSTAINABLE IRRIGATION AND FARMING

IN SOUTHERN DJIBOUTI

DJIBOUTI, OCTOBER 21, 2014

Mr. Ahmed Mohamed Ali

Director, Direction of Agriculture and Forest,
Ministry of Agriculture, Water, Fisheries,
Livestock and Marine Resources (MAEPE-RH)

Mr. Michimasa MENJO

Team Leader, JICA Study Team

The Study Team for the Master Plan Study for Sustainable Irrigation and Farming in Southern Djibouti (hereinafter referred to as the Study Team) organized by Japan International Cooperation Agency (JICA), headed by Mr. Michimasa MENJO as Team Leader, and the Steering Committee headed by Mr. Ahmed Mohamed Ali as Director of Direction of Agriculture and Forest, Ministry of Agriculture, Water, Fisheries, Livestock and Marine Resources (MAEPE-RH), held a meeting and discussed on the Draft Final Report explained by the Study Team.

The list of participants is attached in Annex.

1. Submission of the Draft Final Report

The Steering Committee received 20 copies in French and 20 copies in English of the Draft Final Report submitted by the Study Team on October 16, 2014.

2. Meeting

A meeting was held between the Study Team and the Steering Committee at the conference room of the MAEPE-RH in Djibouti on October 21, 2014 to discuss on the Draft Final Report.

3. Presentation

The leader of the Study Team presented the result of the pilot projects and the Master Plan for the JICA Project. The presentation focused mainly on the summary of the Master Plan formulation which stands on three (3) pillars as the development of sustainable water, the establishment of sustainable irrigation agriculture and the capacity building of concerned organization and farmers. Regarding the development of water resource, detailed explanation on the selection for potential sites for water resources was conducted. To establish sustainable irrigation agriculture it is emphasized that mindful and constant training for beginners in farming is required based on the actual experience in the pilot farms. It is also pointed out that the number of staff in MAEPE-RH is insufficient to smoothly promote future project.

4. Discussion

After the presentation of the report, the Steering Committee and the Study Team express and exchange comments for the project.

(a) The chairman and other Djibouti attendants said that very good results were achieved in the pilot farms as many beginners in farming conducted continuous agriculture with satisfactory outputs, which is a rare case, comparing with other conducted agricultural projects assisted by international agencies.

(b) Attendants from concerned international organizations such as, FAO, IGAD, highly appreciated and commented that sites selection for water resource is very interesting and will be utilized in their future work as the selection work is based on confirmed standard and

actual field reconnaissance.

(c) In the potential sites for water resources, a sub-surface dam is planned for two (2) sites. Djibouti side commented that a sub-surface dam may interfere with the flow of groundwater in wadi foundation and affect it downstream, therefore reducing the water supply.

(d) The Study Team responded that the possibility of water reduction may be slight, but the downstream side of the proposed sub-surface dam is a desert zone or not useful zone for agriculture and others causing only slight impact to be anticipated. The Study Team also added that in case there still remain some issues about water supply at the downstream side, corrective measures on the dam structure will be taken so as to admit wadi bottom-flow downward from the reservoir.

(e) The Study Team advised and proposed about MAEPE-RH organization that in order to implement the future project of Mater Plan designated office (service or direction) should be created and the number of staff should be increased.

(f) Djibouti side responded that the advice of the Study Team is appropriate and that an ad hoc committee in the Ministry will be established soon in order to prepare settling service sector or unite specialized for the Master Plan Project prior to the commencement of the project.

LIST OF ATTENDANTS

Djibouti Side

Ministry of Agriculture, Water, Fisheries, Livestock and Marine Resources

Mr. Ahmed Mohamed Ali	Director, Direction of Agriculture and Forest/MAEPE-RH
Mr. Aouled Djama Ahmed	Director, Direction of Big works/MAEPE
Mr. Tabareck Mohamed	Head of Program and Monitoring/MAEPE-RH
Mr. Ali Ahmed Bourhan	Engineer Agronomy/MAEPE-RH
Mr. Ismael Elmi Habaneh	Technical Adviser/MAEPE-RH
Mr. Mouktar Mohamoud Houssein	Hydro-geologist, Direction of Water/MAEPE-RH
Mr. Abdoulkader Ibrahim	Member, Unit of project implementation/MAEPE-RH
Mr. Sanogo Mori	Member, Unit of project implementation /IFAD
Mr. Alessandro Aubry	Consultant of IGAD
Mr. Leone M. Lombi	FAO
Mr. Houssein Rirache	Director, Department of environment/MHUE

Japanese Side

Japan Embassy

Mr. Hidekazu NAGASAWA	Adviser (Conseiller)
Mr. Tatsro UNUMA	3rd Secretary

JICA Djibouti Office

Mr. Koichi SASADATE	Representative, JICA Djibouti Office
Mr. Yuchi MORIMOTO	Project Formulation Adviser

Study Team

Mr. Michimasa MENJO	Leader/Water-Resource Development
Mr. Ikutaro ITO	Sub-leader/Farm Management & Cultivation

APPENDIX

Appendix 1: Results of Market Survey on Agricultural Products

Unit: DJF/kg

Market	Products	2012	2013				2014						
		Mar.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.
Djibouti	Tomato	120	266	200	150	150	150	100	100	175	140	167	183
	Hot Pepper	250	250	200	150	200	300	200	200	200	183	200	193
	Onion	120	200	150	166	150	150	150	166	200	140	167	150
	Eggplant	200	200	200	200	200	250	200	216	150	250	190	200
	Potato	120	-	100	100	100	100	100	100	130	100	100	100
	Okra	200	383	-	-	250	300	300	250	200	-	267	217
	Melon	300	283	300	300	300	300	300	250	275	300	300	300
	Water Melon	120	200	100	100	100	100	100	100	140	150	200	150
	Table Beet	100	100	80	100	100	100	100	-	107	93	100	100
	Dates	300	400	-	-	-	100	-	-	400	-	-	-
	Mango	150	250	-	150	150	150	150	150	210	233	233	200
	Guava	200	183	150	-	150	150	150	-	250	-	200	200
Ali Sabihe	Tomato	125	-	250	200	200	200	120	120	150	150	150	200
	Hot Pepper	200	-	200	250	200	200	150	150	267	200	200	200
	Onion	150	-	150	150	150	150	200	166	250	150	150	200
	Eggplant	150	-	-	-	-	-	-	-	-	-	-	-
	Potato	200	-	100	100	100	100	-	100	133	140	100	120
	Okra		-	-	-	-	-	-	-	-	-	-	-
	Melon	200	-	-	-	-	-	-	-	-	-	-	-
	Water Melon	100	-	-	-	-	-	-	-	-	-	-	-
	Table Beet	150	-	-	-	-	150	-	-	100	100	-	100
	Dates	400	-	-	-	-	-	-	-	-	-	-	-
	Mango	200	-	-	-	-	-	-	-	-	150	150	150
	Guava		-	-	200	200	200	-	-	200	-	200	-
Dikhil	Tomato	100	300	250	200	150	150	120	120	150	200	200	217
	Hot Pepper	130	300	250	175	200	150	200	200	200	200	200	200
	Onion	115	200	216	190	200	200	250	300	150	150	150	150
	Eggplant	150	-	-	-	-	-	-	-	100	-	-	-
	Potato	150	-	106	100	100	100	100	100	100	100	100	100
	Okra		-	-	-	-	-	-	-	-	-	-	-
	Melon	150	-	-	-	-	-	-	-	-	-	-	-
	Water Melon	110	-	-	-	-	-	-	-	-	-	-	-
	Table Beet	100	-	116	100	-	100	-	-	100	100	-	100
	Dates	400	-	-	-	-	-	-	-	-	-	-	-
	Mango	150	-	-	-	-	-	-	-	125	150	150	150
	Guava	150	-	150	200	-	-	-	-	-	-	-	-

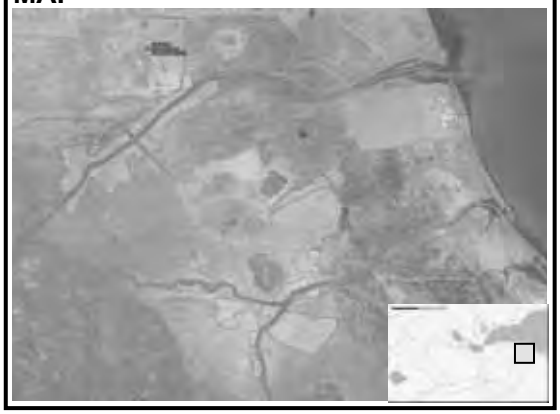
Source: March 2012 is a result of the baseline survey. Others were surveyed by the Study Team.

Appendix 2: Data Sheets of Existing Irrigated Agricultural Lands in Southern Djibouti

■ BASIC INFORMATION

Name of area	Douda
Population	No data
No. of farmer's household	63
Total area of farmland	86.8 ha
Average area of household's farmland	0.72 ha
Year of starting agriculture	1982
Name of Cooperative	Agricultural Cooperative of small and big Douda
No. of Cooperative member	63
Fee of Cooperative	1,000 DJF/month (2013)
Contents of Activity	Preparing good quality seed. Fixing pump. etc

MAP



■ FARMING SITUATION

Crop Cultivation																		
◎ : Abundant ○ : Moderate △ : Few	Vegetables								Fruit		Glass		Fruits Tree					
	Tomato	Onion	Pepper	Eggplant	Okra	Beat	Carrot	Cabbage	Melon	Watermelon	Sorghum	Other Glass	Mango	Guava	Papaya	Lemon	Orange	Date
Winter (Oct. – Mar.)	◎	○	◎	◎	○						◎	◎	△	△		△	△	△
Summer (Apr. – Sep.)									◎	○	◎	◎	△	△		△	△	△

Water Taking Facility		Agricultural technique	
Water taking Facility	Engine Pump	Type of Fertilizer	Manure, Urea
Energy Source	Gasoline	Cost of fertilizer	No Data
Consumption	2-10L/day	Pesticide	2 type of insecticide
Cost	600-3000 DJF/day	Cost of insecticide	2500-3000 DJF/L
Water Source		**Market Situation**	
Water Source	Shallow well	Market name	Djibouti (Liyad Market)
Level of water	6-13m	Transportation	Public bus
Quality of water	pH: 8.05, EC: 870 μS/cm (after raining)	Transportation cost	10 DJF/kg

Current Situation of Main Crop Cultivation													
Main Crop	1	2	3	4	5	6	7	8	9	10	11	12	Selling Price (Min. - Max./kg)
Tomato	★	★											40-100 DJF
Pepper	★	★	★										100-200 DJF
Melon	○			★					○			★	150-150 DJF
Okra	○	○	○	○	○	○	○	○	○	○	○	○	200-400 DJF
○ : Seeding ★Harvest Term													

■ OTHERS

Remarks
The well water in this site has high salt concentration. Thus, the vegetable cultivation is considerably difficult here in Douda area. The salt concentration is even higher especially in the farm located near the sea side.

■ PICTURES

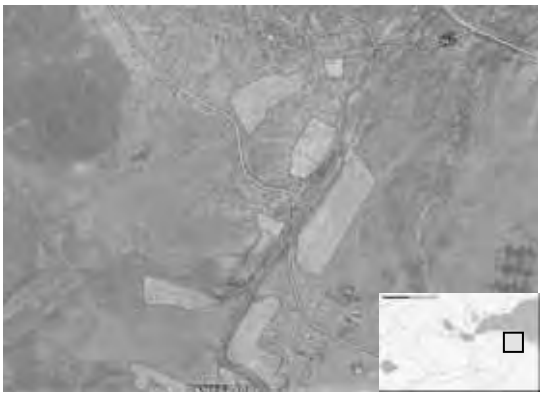
Glass cultivation

Glass cultivation

■ BASIC INFORMATION

Name of area	Damerdjog
Population	No data
No. of farmer's household	60
Total area of farmland	55.1 ha
Average area of household's farmland	0.92 ha
Year of starting agriculture	2006
Name of Cooperative	Agricultural cooperative of Damerdjog
No. of Cooperative member	60
Fee of Cooperative	No collection
Contents of Activity	Not active

MAP



■ FARMING SITUATION

Crop Cultivation																		
◎ : Abundant ○ : Moderate △ : Few	Vegetables								Fruit		Glass		Fruits Tree					
	Tomato	Onion	Pepper	Eggplant	Okra	Beat	Carrot	Cabbage	Melon	Watermelon	Sorghum	Other Glass	Mango	Guava	Papaya	Lemon	Orange	Date
Winter (Oct. – Mar.)	◎	○	◎	◎	○						◎	◎			△			△
Summer (Apr. – Sep.)									◎	○	◎	◎			△			△

Water Taking Facility		Agricultural technique	
Water taking Facility	Public Water	Type of Fertilizer	Manure
Energy Source	Electricity	Cost of fertilizer	Free
Consumption		Pesticide	Organic pesticide
Cost	No data	Cost of insecticide	Free
Water Source		**Market Situation**	
Water Source	Public water, shallow well	Market name	Djibouti (Liyad Market)
Level of water	No data	Transportation	Commission to dealer
Quality of water	No data	Transportation cost	Commission fee (Price is unknown.)

Current Situation of Main Crop Cultivation													
Main Crop	1	2	3	4	5	6	7	8	9	10	11	12	Selling Price (Min. - Max./kg)
Tomato		★	★	★						○			100 DJF
Pepper		★	★	★						○			100-200 DJF
Melon		★	★	★						○			100-150 DJF
Okra		★	★	★						○			100-150 DJF
○ : Seeding ★Harvest Term													

■ OTHERS

Remarks
There are 60 households possessing the farm land in this area. But in fact, most of households have stopped farming activities because of the lack of non-salty water for irrigation. Some farmers take water from public water supply, which is applicable as irrigation water.

■ PICTURES

Glass cultivation

Glass cultivation

■ BASIC INFORMATION

Name of area	Atar
Population	No data
No. of farmer's household	60
Total area of farmland	81.5 ha
Average area of household's farmland	1.35 ha
Year of starting agriculture	1973
Name of Cooperative	Agricultural cooperative of Atar
No. of Cooperative member	60
Fee of Cooperative	500 DJF / month
Contents of Activity	Repairing engine pump

MAP

■ FARMING SITUATION

Crop Cultivation

◎ : Abundant ○ : Moderate △ : Few	Vegetables								Fruit		Glass		Fruits Tree					
	Tomato	Onion	Pepper	Eggplant	Okra	Beat	Carrot	Cabbage	Melon	Watermelon	Sorghum	Other Glass	Mango	Guava	Papaya	Lemon	Orange	Date
Winter (Oct. – Mar.)	◎	○	◎	◎	○								△	△		△		
Summer (Apr. – Sep.)					○				◎				△	△		△		

Water Taking Facility		Agricultural technique	
Water taking Facility	Engine pump	Type of Fertilizer	Manure
Energy Source	Diesel & Gasoline	Cost of fertilizer	100 DJF /50 kg
Consumption	5-10L/day	Pesticide	Insecticide (from Somalia)
Cost	1500 DJF/ day	Cost of insecticide	3000-5000 DJF/L
Water Source		**Market Situation**	
Water Source	Shallow well	Market name	Djibouti (Liyad Market)
Level of water	5-8 m	Transportation	Public bus & truck
Quality of water	pH: 7.7, EC: 2940 μS/cm	Transportation cost	10 DJF / kg

Current Situation of Main Crop Cultivation

Main Crop	1	2	3	4	5	6	7	8	9	10	11	12	Selling Price (Min. – Max./kg)
Tomato	★	★	★							○			60 DJF
Eggplant	★	★	★	★	★					○			100 DJF
Mango			★	★									200 DJF
Guava			★	★									150 DJF

○ : Seeding ★Harvest Term

■ OTHERS

Remarks
Each household has several shallow wells. If the water of well located in downstream side gets salty, then the farmer stop using the well and start using another well located in upstream side. Several farms along the wadi had been destroyed by the flood. Most of the farms located near the sea side have already been abandoned due to the high water salinity.

■ PICTURES

Broken well

Farmland after flooding

■ BASIC INFORMATION

Name of area	Atar
Population	No data
No. of farmer's household	32
Total area of farmland	12.3 ha
Average area of household's farmland	0.4 ha
Year of starting agriculture	1982
Name of Cooperative	Farmer Cooperative perimeter of Atar
No. of Cooperative member	32
Fee of Cooperative	No collection
Contents of Activity	Not in active

■ FARMING SITUATION

Crop Cultivation

◎ : Abundant
○ : Moderate
△ : Few

	Vegetables								Fruit		Glass		Fruits Tree					
	Tomato	Onion	Pepper	Eggplant	Okra	Beat	Carrot	Cabbage	Melon	Watermelon	Sorghum	Other Glass	Mango	Guava	Papaya	Lemon	Orange	Date
Winter (Oct. – Mar.)	◎		◎	◎	○								◎	◎	△	△		
Summer (Apr. – Sep.)													◎	◎	△	△		

Water Taking Facility		Agricultural technique	
Water taking Facility	Engine pump	Type of Fertilizer	Manure, Soil from wadi
Energy Source	Electricity	Cost of fertilizer	Free
Consumption		Pesticide	No use
Cost		Cost of insecticide	
Water Source		**Market Situation**	
Water Source	Deep well	Market name	Djibouti (Liyad Market)
Level of water	No data	Transportation	Trucks of dealers
Quality of water	pH: 8.2 EC: 1780 μS/cm	Transportation cost	Commission fee (Price is unknown.)

Current Situation of Main Crop Cultivation

Main Crop	1	2	3	4	5	6	7	8	9	10	11	12	Selling Price (Min. - Max./kg)
Mango			★	★									200 DJF
Lemon			★	★									100 DJF
Guava			★	★									200 DJF

○ : Seeding ★Harvest Term

■ OTHERS

Remarks

The frequency of irrigate water in the farm is 1 time / 8 days. Previously, the farming can make a good profit, but since the water availability has been limited, the yield of the crops had declined drastically and now, most of farmers can't make any profit from the farm.

■ PICTURES

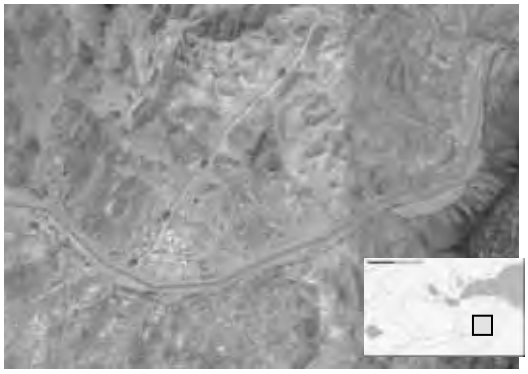
Farmland

Eggplant cultivation

■ BASIC INFORMATION

Name of area	Ali Adde
Population	No data
No. of farmer's household	20
Total area of farmland	10.0 ha
Average area of household's farmland	0.5 ha
Year of starting agriculture	1977
Name of Cooperative	Agricultural cooperative of Ali Adde
No. of Cooperative member	20
Fee of Cooperative	300 DJF/month
Contents of Activity	To employ worker for excavating well

MAP



■ FARMING SITUATION

Crop Cultivation																		
	Vegetables								Fruit		Glass		Fruits Tree					
◎ : Abundant ○ : Moderate △ : Few	Tomato	Onion	Pepper	Eggplant	Okra	Beat	Carrot	Cabbage	Melon	Watermelon	Sorghum	Other Glass	Mango	Guava	Papaya	Lemon	Orange	Date
Winter (Oct. – Mar.)	○	○	○			△							○	○	△			
Summer (Apr. – Sep.)									○	○			○	○	△			

Water Taking Facility		Agricultural technique	
Water taking Facility	Engine Pump	Type of Fertilizer	Manure
Energy Source	Gasoline	Cost of fertilizer	Free
Consumption	4L/day	Pesticide	No use
Cost	400 DJF/L	Cost of insecticide	
Water Source		**Market Situation**	
Water Source	Shallow well	Market name	Ali Adde
Level of water	7-8m	Transportation	On foot
Quality of water	pH: 8.36 EC: 4300 μS/cm	Transportation cost	

Current Situation of Main Crop Cultivation													
Main Crop	1	2	3	4	5	6	7	8	9	10	11	12	Selling Price (Min. - Max./kg)
Tomato	★	★							○	○			100-150 DJF
Pepper	★	★							○	○			100-160 DJF
Guava			★	★	★								100-150 DJF
Mango				★	★								150 DJF
○ : Seeding ★Harvest Term													

■ OTHERS

Remarks
Most of the crops harvested in this area are consumed in Ali Adde. The refugees settled here can afford to buy the crops produced in this area, if those crops are cheap enough.

■ PICTURES

Guava cultivation

Pepper cultivation

■ BASIC INFORMATION

Name of area	Assamo
Population	No data
No. of farmer's household	53
Total area of farmland	36 ha
Average area of household's farmland	0.68 ha
Year of starting agriculture	1994
Name of Cooperative	Peasant Asso. of Assamo
No. of Cooperative member	53
Fee of Cooperative	500 DJF/month
Contents of Activity	To provide agricultural materials

MAP

■ FARMING SITUATION

Crop Cultivation																		
◎ : Abundant ○ : Moderate △ : Few	Vegetables								Fruit		Glass		Fruits Tree					
	Tomato	Onion	Pepper	Eggplant	Okra	Beat	Carrot	Cabbage	Melon	Watermelon	Sorghum	Other Glass	Mango	Guava	Papaya	Lemon	Orange	Date
Winter (Oct. – Mar.)	○	○											◎	◎		△		
Summer (Apr. – Sep.)									○	○			◎	◎		△		

Water Taking Facility		Agricultural technique	
Water taking Facility	Engine Pump	Type of Fertilizer	Manure
Energy Source	Gasoline	Cost of fertilizer	Free
Consumption	5L/day	Pesticide	No use
Cost	ND	Cost of insecticide	
Water Source		**Market Situation**	
Water Source	Shallow well	Market name	Djibouti (Liyad Market)
Level of water	12m	Transportation	Trucks of dealers
Quality of water	pH: 7.83 EC: 1700 μS/cm	Transportation cost	Commission fee (Price is unknown.)

Current Situation of Main Crop Cultivation													
Main Crop	1	2	3	4	5	6	7	8	9	10	11	12	Selling Price (Min. - Max./kg)
Tomato	★	★							○	○			100 DJF
Onion	★	★							○	○			150 DJF
Guava			★	★	★								100-250 DJF
Mango				★	★	★							150 DJF
○ : Seeding ★Harvest Term													

■ OTHERS

Remarks
The mango and guava cultivation is dominant in this farming area. The president of the agricultural cooperative in this site has a truck for the transporting crops. The members of the cooperative can transport and sell their crops as well by using the president's truck.

■ PICTURES

Guava cultivation

Guava harvesting

■ BASIC INFORMATION

Name of area	Dhourreh
Population	No Data
No. of farmer's household	20
Total area of farmland	38.4 ha
Average area of household's farmland	1.92 ha
Year of starting agriculture	1990
Name of Cooperative	Agricultural Cooperative of Dhourreh
No. of Cooperative member	20
Fee of Cooperative	No collection
Contents of Activity	Not in active

MAP

■ FARMING SITUATION

Crop Cultivation																		
◎ : Abundant ○ : Moderate △ : Few	Vegetables								Fruit		Glass		Fruits Tree					
	Tomato	Onion	Pepper	Eggplant	Okra	Beat	Carrot	Cabbage	Melon	Watermelon	Sorghum	Other Glass	Mango	Guava	Papaya	Lemon	Orange	Date
Winter (Oct. – Mar.)	○	○	○					△					○	△	△			
Summer (Apr. – Sep.)									○				○	△	△			

Water Taking Facility		Agricultural technique	
Water taking Facility	Engine Pump	Type of Fertilizer	Manure,2.5t/week
Energy Source	Gasoline	Cost of fertilizer	No data
Consumption	1.5L/day	Pesticide	No use
Cost	400DJF/L	Cost of insecticide	
Water Source		**Market Situation**	
Water Source	Shallow well	Market name	Djibouti
Level of water	8m	Transportation	Truck (personal)
Quality of water	pH: 8.07 EC: 1800 μS/cm	Transportation cost	No Data

Current Situation of Main Crop Cultivation

Main Crop	1	2	3	4	5	6	7	8	9	10	11	12	Selling Price (Min. - Max./kg)
Tomato		★	★							○			100-200 DJF
Pepper		★	★							○			150-200 DJF
Guava		★	★	★									150-200 DJF
Mango		★	★	★									150-200 DJF

○ : Seeding ★Harvest Term

■ OTHERS

Remarks
Mr. Kenedi who has engaged in farming in this area since 2002 is the president of the cooperative in this area. Since he owns a truck for transporting crops, several adjacent farmers have also chances to sell their crops to the Djibouti market by paying transportation cost to Mr. Kenedi.

■ PICTURES

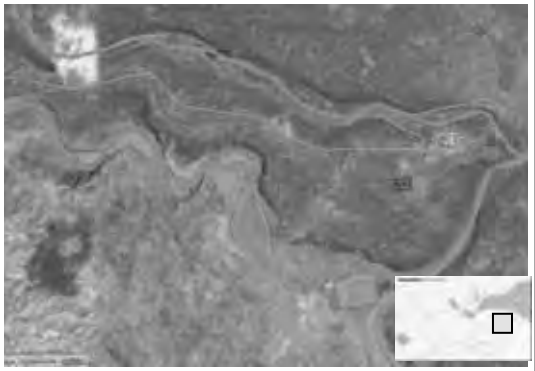
Papaya cultivation

Mango & cabbage cultivation

■ BASIC INFORMATION

Name of area	Holhol
Population	No data
No. of farmer's household	40
Total area of farmland	17 ha
Average area of household's farmland	0.43 ha
Year of starting agriculture	2006
Name of Cooperative	Agricultural Cooperative of Holhol
No. of Cooperative member	40
Fee of Cooperative	No collection
Contents of Activity	Not active

MAP



■ FARMING SITUATION

Crop Cultivation																		
◎ : Abundant ○ : Moderate △ : Few	Vegetables								Fruit		Glass		Fruits Tree					
	Tomato	Onion	Pepper	Eggplant	Okra	Beat	Carrot	Cabbage	Melon	Watermelon	Sorghum	Other Glass	Mango	Guava	Papaya	Lemon	Orange	Date
Winter (Oct. – Mar.)	○	○	○										△	△	△			
Summer (Apr. – Sep.)									○	○			△	△	△			

Water Taking Facility		Agricultural technique	
Water taking Facility	Engine Pump	Type of Fertilizer	Manure
Energy Source	Gasoline	Cost of fertilizer	Free
Consumption	ND	Pesticide	No use
Cost	400DJF /L	Cost of insecticide	
Water Source		**Market Situation**	
Water Source	Shallow well	Market name	Ali Adde, Holhol
Level of water	7-9m	Transportation	On foot
Quality of water	pH: 8.12 EC: 2370 µS/cm	Transportation cost	

Current Situation of Main Crop Cultivation													
Main Crop	1	2	3	4	5	6	7	8	9	10	11	12	Selling Price (Min. - Max./kg)
Tomato	★	★							○	○			100-200 DJF
Pepper	★	★							○	○			100-200 DJF
Guava			★	★	★								100-150 DJF
Mango				★	★								100-150 DJF
○ : Seeding ★Harvest Term													

■ OTHERS

Remarks
The cooperative has been established recently. But the actual cooperative activities have not been conducted yet.

■ PICTURES

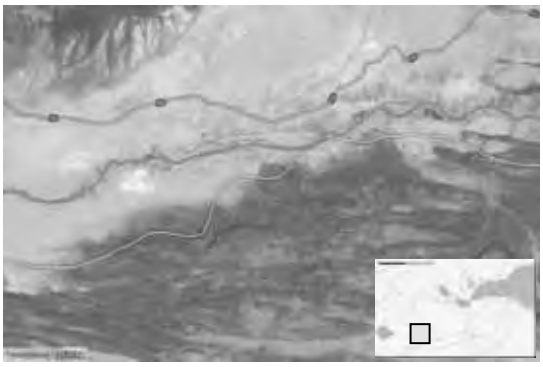
Guava cultivation

Farmland

■ BASIC INFORMATION

Name of area	As Ela
Population	No data
No. of farmer's household	200
Total area of farmland	343 ha
Average area of household's farmland	1.7 ha
Year of starting agriculture	1976
Name of Cooperative	Agro-Pastoral Cooperative of Gobaad and Dikhil
No. of Cooperative member	200
Fee of Cooperative	12,000 DJF/month
Contents of Activity	To help the construction of shallow well

MAP



■ FARMING SITUATION

Crop Cultivation																		
◎ : Abundant ○ : Moderate △ : Few	Vegetables								Fruit		Glass		Fruits Tree					
	Tomato	Onion	Pepper	Eggplant	Okra	Beat	Carrot	Cabbage	Melon	Watermelon	Sorghum	Other Glass	Mango	Guava	Papaya	Lemon	Orange	Date
Winter (Oct. – Mar.)	◎	◎	◎								◎							△
Summer (Apr. – Sep.)									◎	△	◎							△

Water Taking Facility		Agricultural technique	
Water taking Facility	Engine Pump	Type of Fertilizer	Manure
Energy Source	Gasoline	Cost of fertilizer	Free
Consumption	No data	Pesticide	No use
Cost	380DJF/L	Cost of insecticide	
Water Source		**Market Situation**	
Water Source	Shallow well	Market name	As Ela, Dikhil, Djibouti
Level of water	7-8m	Transportation	Public Truck
Quality of water	pH: 8.16 EC: 951 μS/cm	Transportation cost	500 DJF/50kg/Djibouti/Melon 200 DJF/20kg/Djibouti/Tomato 200 DJF/50kg/Djibouti/Pepper

Current Situation of Main Crop Cultivation													
Main Crop	1	2	3	4	5	6	7	8	9	10	11	12	Selling Price (Min. - Max./kg)
Tomato		★	★							○			100 DJF
Pepper		★	★							○			150-200 DJF
Onion		★	★							○			150 DJF
Melon		○			★								200 DJF
Date				★	★								150 DJF
○ : Seeding ★Harvest Term													

■ OTHERS

Remarks
More than half of the farmland is not in cultivation since the flood in 2010 destroyed the farmland including shallow well and irrigation facilities such as engine pump.

■ PICTURES

Melon cultivation

Well

■ BASIC INFORMATION

Name of area	Hanle
Population	No data
No. of farmer's household	68
Total area of farmland	120 ha
Average area of household's farmland	1.7ha
Year of starting agriculture	No data
Name of Cooperative	Agro-Pastoral Cooperative of Hanle
No. of Cooperative member	68
Fee of Cooperative	No collection
Contents of Activity	Not in Active

MAP

■ FARMING SITUATION

Crop Cultivation																		
◎ : Abundant ○ : Moderate △ : Few	Vegetables								Fruit		Glass		Fruits Tree					
	Tomato	Onion	Pepper	Eggplant	Okra	Beat	Carrot	Cabbage	Melon	Watermelon	Sorghum	Other Glass	Mango	Guava	Papaya	Lemon	Orange	Date
Winter (Oct. – Mar.)	◎	◎	◎			△	△	△										△
Summer (Apr. – Sep.)									◎	○								△

Water Taking Facility		Agricultural technique	
Water taking Facility	Engine Pump	Type of Fertilizer	Manure
Energy Source	Gasoline	Cost of fertilizer	Free
Consumption	ND	Pesticide	No use
Cost	380 DJF/L	Cost of insecticide	
Water Source		**Market Situation**	
Water Source	Shallow well	Market name	Djibouti, Dikhil
Level of water	3-5m	Transportation	Public truck
Quality of water	pH: 8.36 EC: 328 μS/cm	Transportation cost	No data

Current Situation of Main Crop Cultivation

Main Crop	1	2	3	4	5	6	7	8	9	10	11	12	Selling Price (Min. - Max./kg)
Tomato	★	★							○	○			100-150 DJF
Pepper	★	★							○	○			100-160 DJF
Onion		★	★						○	○			100 DJF
Melon			○			★							200 DJF
Watermelon			○			★							100 DJF

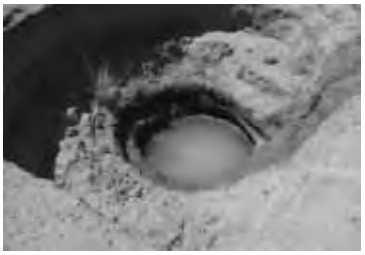
○ : Seeding ★Harvest Term

■ OTHERS

Remarks
A lot of farmers have lost their engine pumps because of the heavy flood in 2010. Most of the crops harvested in this area are transported to Dikhil and Djibouti market.

■ PICTURES

Onion cultivation



Shallow well

■ BASIC INFORMATION

Name of area	Mouloud
Population	No data
No. of farmer's household	28
Total area of farmland	14.0 ha
Average area of household's farmland	0.5 ha
Year of starting agriculture	1979
Name of Cooperative	Agro-Pastoral Cooperative of Mouloud
No. of Cooperative member	28
Fee of Cooperative	51,000 DJF/month
Contents of Activity	To provide agricultural materials

MAP

■ FARMING SITUATION

Crop Cultivation																		
◎ : Abundant ○ : Moderate △ : Few	Vegetables								Fruit		Glass		Fruits Tree					
	Tomato	Onion	Pepper	Eggplant	Okra	Beat	Carrot	Cabbage	Melon	Watermelon	Sorghum	Other Glass	Mango	Guava	Papaya	Lemon	Orange	Date
Winter (Oct. – Mar.)	○	○	○								◎	○						△
Summer (Apr. – Sep.)									○	○	◎	○						△

Water Taking Facility		Agricultural technique	
Water taking Facility	Engine Pump	Type of Fertilizer	Manure,
Energy Source	Electricity	Cost of fertilizer	Free
Consumption		Pesticide	No use
Cost		Cost of insecticide	
Water Source		**Market Situation**	
Water Source	Deep well	Market name	Ali Sabieh, Dikhil, Djibouti
Level of water	No data	Transportation	By truck
Quality of water	pH:8.24, EC:2800 μS/cm	Transportation cost	No data

Current Situation of Main Crop Cultivation

Main Crop	1	2	3	4	5	6	7	8	9	10	11	12	Selling Price (Min. - Max./kg)
Tomato	★	★							○	○			50-60 DJF
Pepper	★	★							○	○			250 DJF
Onion		★	★										70-150 DJF
Sorghum	○	○	○	○	○	○	○	○	○	○	○	○	No sale
Melon			○			★							200 DJF

○ : Seeding ★Harvest Term

■ OTHERS

Remarks
The deep well used to be able to supply enough water for the cultivation of the fruits trees such as Guava, Mango and Orange. But recently, the water supplying capacity of the deep well has subsided considerably. The residents can irrigate their farm only 1 time per 5 days.

■ PICTURES

Date cultivation

Tomato cultivation

Appendix 3: Outline of Agricultural Cooperatives (1/2)

Category	Name of cooperative	Coopérative Agropastorale de Dikhil	Association pour le Dévelopment agropastorale de Hanle	Coopérative Agro-élevage de Gobaad	Coopérative Agricole de Mouloud
General Information	Address(Province/District/Village)	Dikhil / Dikhil	Dikhil / Yoboki	Dikhil /As Eyla,	Dikhil / Mouloud
	Farm land area	45 ha	140 ha	60 ha	12 ha
	Number of cooperative members	40 persons	90 persons	365 persons	28 persons
	Percentage of cooperative members for total farmers	100 %	45 %	70 %	100 %
	Percentage of cooperative members who are cultivating at present	80 %	100 %	51 %	100 %
	Average area of farm land of the members	1.1 ha	1.6 ha	0.2ha	0.8ha
Institutional Information	Number of managing staff	8 persons	7 persons	9 persons	5 persons
	Number of agricultural engineers / technicians	3 persons	0	0	0
	Membership fee	12,000 DJF/year	6,000 DJF/year	12,000 DJF/year	10,000 DJF/year
	Income of the cooperative in 2011	715,000 DJF/year	1,370,000 DJF/year	-	220,000 DJF/year
		Member free	Member free Sales	Member free	Member free
	Expenditure of the cooperative in 2011	325,000 DJF/year	570,000 DJF/year	-	100,000 DJF/year
		Pump repair Purchase of materials Transportation	Pump repair Purchase of Agricultural inputs Purchase of materials	Pump repair Purchase of materials Fuel	Well repair Purchase of Agricultural inputs
	Official support to the cooperative	370,000 DJF/year	100,000 DJF/year	-	-
		Agricultural materials Pump	Agricultural materials	-	Agricultural materials Rehabilitation of farm land Pesticide
Activities	Major activities of the cooperative	Collection and selling of products Supply of agricultural input Technical service Credit business	Collection and selling of products Supply of agricultural input Technical service Others	Collection and selling of products Supply of agricultural input Technical service	Supply of agricultural input Technical service

Appendix 3: Outline of Agricultural Cooperatives (2/2)

Category	Name of cooperative	Groupement Paysans Agricoles d'Assamo	Association Agro-pastorale d'Ali-Addé	Association de Périmètre Paysan d'Atar	Association pour la Promotion d'Agriculture d'Atar
General Information	Address(Province/District/Village)	Djibouti / Balbala,/ Cité Barwako	Ali-Sabieh / Ali-Addé	Arta / Damerdjog	Arta / Damerdjog
	Farm land area	10 ha	18 ha	35 ha	80 ha
	Number of cooperative members	51 persons	20 persons	32 persons	60 persons
	Percentage of cooperative members for total farmers	100 %	100 %	100 %	100 %
	Percentage of cooperative members who are cultivating at present	100%	100 %	100 %	60 %
	Average area of farm land of the members	0.2 ha	0.9 ha	1.1 ha	1.1 ha
Institutional Information	Number of managing staff	7 persons	6 persons	6 persons	6 persons
	Number of agricultural engineers / technicians	3 persons	1 person	0	0
	Membership fee	15,300 DJF/year	3,600 DJF/year	10,000 DJF/year	5,000 DJF/year
	Income of the cooperative in 2011	1,406,000 DJF/year Member fee Rental fee	72,000 DJF/year Member fee	160,000 DJF/year Member fee	160,000 DJF/year Member fee
	Expenditure of the cooperative in 2011	1,000,000 DJF/year Pump repair Purchase of materials	30,000 DJF/year Purchase of Agricultural inputs Transportation	160,000 DJF/year Well repair	40,000 DJF/year Transportation Activities
	Official support to the cooperative	100,000 DJF/year Pump Seed	360,000 DJF/year Agricultural materials	1,000,000 DJF/year Agricultural materials Seed	5,000,000 DJF/year Agricultural materials Fertilizer Construction of office
Activities	Major activities of the cooperative	Supply of agricultural input Technical service Others	Collection and selling of products Supply of agricultural input Technical service	Collection and selling of products Supply of agricultural input Technical service	Supply of agricultural input Technical service

Appendix 4: Outline of Projects Implemented by International Aid Organizations

UNDP

Project name	**Agro-Pastoral Pilot Farms Development Project (PACCRAS)**
Objective	To diversify and promote climate resilient agro-pastoral practices in rural Djibouti
Project sites	Qoor Qalooc (Rakubyeel Moutains), Dhourreh and Beyaa Adey (Ali-sabieh)
Beneficiaries	79 Households
Project cost	1,000,000 US$
Donors	JAPAN
Implementing Agency	UNDP
Key partners	Ministry of Agriculture, Livestock, Fisheries, Water and Marine Resources (MAEPE-RH)
Implementation	March 2012-February 2013
Activities implemented	Construction of 3 Agro-pastoral farms covering a surface area of 22 ha for the 3 sites Mobilization of surface and shallow groundwater through: • 6 wells constructed (3 in Beyaa Ade and 3 in Dhourreh) • 1 infiltration gallery in Beyaa Ade and 2 subsurface dams (one in Beyaa Ade and one in Dhourreh) • 1 flood protection dyke constructed in Qoor Qalooc • 3 water management committees established Poultry planned to be introduced for 13 households in the 3 sites
Expected Results	This project will build the resilience of rural population by developing small scale agro-pastoral farms for poor households in the three heavily affected rural areas of the Ali-Sabieh region, implementing a set of climate change adapted activities to collect groundwater and store surface runoff water during the rainy season. Plantations and main field works will be ensured by the technical teams of the Ministry of Agriculture, in close collaboration with the mobilized agro-pastoralists. Besides date palms, the gardens will also include (i) fruit and other high value (e.g. henna, jujube, etc.) trees; (ii) forages and vegetables; and (iii) agro-forestry with multipurpose local varieties, enclosing each 0.25 ha plot to contribute to the creation of microclimate to offer wind protection and provide multiple potential benefits for drought and water scarcity alleviation. Vegetables production and some fruits like the melon will provide rapidly cash revenues for families.

Source: UNDP, 2014

UNDP

Project name	**Developing Agro-Pastoral Shade Gardens as an Adaptation Strategy for Poor Rural Communities**
Objective	To diversify and promote climate resilient agro-pastoral practices in rural Djibouti
Project sites	Plains of Petit Bara (Arta region) and Grand Bara (Ali-sabieh)
Beneficiaries	228 Households
Project cost	4,658,556 US$
Donors	GEF (USA)
Implementing Agency	UNDP
Key partners	Ministry of Habitat, Urbanism and Environment, Ministry of Agriculture, Fisheries and Animal Husbandry, Djiboutian Centre for Studies and Research – CERD, State Secretariat to the Prime Minister in charge of National Solidarity, and Djiboutian Agency for Social Development - ADDS
Implementation	Start of Project/Programme Implementation (05/2011); Mid-term Review (06/2014); Project/ Programme Closing (06/2016); Terminal Evaluation (08/2016)
Activities implemented	To install small hydrological infrastructures such as earth dams, water ponds, percolation tanks and injection bore wells in different locations of Petit Bara and Grand Bara with the aim of increasing water retention and penetration into soil, developing new large pastureland areas, providing new water points to livestock while supporting agricultural intensification and fodder production in shade-gardens for subsequent seasonal storage.
	(i) To structure involved agro-pastoralists into well-established cooperatives and/or associations, with a physical location (concretely represented by the shade gardens) in Petit Bara and Grand Bara; (ii) To closely work with the microfinance institution in place in order to define a loan offer adapted to agro-pastoralists needs and specific context; (iii) To train and follow-up involved populations so that they learn how to use microfinance and what it can bring them
Expected Results	1.Community-based surface water harvesting infrastructures, such as earth dams, water injection wells established that mobilize water and improve ground water recharge are introduced and tested in support of shade-garden pilot schemes 2.A set of 8 pilot community-managed agro-pastoral shade garden plots (10 ha each) that include date palms, fruit trees, multi-purpose fence trees, vegetable and forage, climate resilient local and regional varieties henna, dates, jujube, mango, etc...) are developed and tested ; 3.An adaptation-oriented micro-finance scheme that supports shade garden based agro-pastoral enterprises in the Grand and Petit Bara plains, is developed through partnership with CPEC (supported by AfDB), and generate a total value of $300,000 during project duration (5 years);

Source: UNDP, 2014

FAO

Project name	**Emergency Assistance in Pastoral Areas of Djibouti**
Objective	To contribute to restoring agricultural and livestock production of drought-affected communities, as well as increasing the efficiency of response to food security emergencies by national institutions and the Government.
Project sites	All regions of Djibouti
Beneficiaries	6,364 households
Project cost	1,910,467 USD
Donors	JAPAN
Implementing Agency	FAO
Key Partners	Ministry of Agriculture's Departments of Water and Agriculture, Ministry of Education, regional and local authorities, local communities
Implementation	7/3/2012 – 31/10/2013
Activities implemented	• 900 kg of assorted vegetable seeds and 480 kg of fodder seeds procured and distributed to 400 pastoral and agro pastoral households, along with training, to establish small-scale vegetable and fodder production. • 800 micro-irrigation tools were distributed – two per household. • 300 of the most vulnerable families benefited from an 11-day cash-for-work scheme to quickly improve their food security. • Two training programmes on Agro pastoral Field Schools (APFS) organized for APFS facilitators (38 in first session, 34 in second). • Inputs provided to enable facilitators to set up groups in their communities. • Two dams of 20,000 m^3 each constructed in remote areas of Arta and Dikhil regions, along transhumance routes.
Results	• Vegetable and fodder gardens helped improve the livelihoods of vulnerable households, diversifying their livelihoods and providing them with a source of income. • 16 APFS groups are operational, benefiting 2,436 people. • 50,000 head of livestock have improved access to water. • Livestock mortality rates have reportedly declined slightly.

Source: FAO, 2014

WFP

SUMMARY OF PROPOSED PROJECTS SUPPORTED BY THE PROGRAM 3 A "FOOD ASSISTANCE ACTIVITIES"

Period: October 2012-April 2013

I -SUPPORT FOR AGRICULTURAL PRODUCTION

Region	Number of participants	Typology	Descriptions of Food Assistance Activities	Tonnage in Mt	Partnership	Implementation schedule
Tadjourah	680	11 agricultural cooperatives and 17 community gardens	•Vegetable production / fruit and forage	327.3	WFP/PREF & RC /MAEPE-RH	OCTOBER 2012-APRIL 2013
Dikhil	383	9 Agricultural Cooperatives	•Vegetable production / fruit and forage	184.3		
Arta	367	4 Agricultural perimeters , 7 Agricultural Cooperatives and 2 new gardens	•Vegetable production / fruit and forage	176.6		
Ali-Sabieh	255	11 cooperatives and one community garden	•Vegetable production / fruit and forage	122.7		
Total	**1685**			**810.91**		

II -SUPPORT FOR HYDRAULIC STRUCTURES

A. COMPONENT MOBILISATION OF SURFACE WATER: PROGRAM PROMES GDT

Region	Number of participants	Typology	Descriptions of Food Assistance Activities	Tonnage in Mt	Partnership	Implementation schedule
Development of hydraulic structures						
Tadjourah	240	100 m^3 tank on catchment area, pond rehabilitaion, 10000m^3 pond,	4 tanks of 100 m^3, 5 ponds rehabilitated, 5ponds of 10000m^3 developed,	57.37	WFP/IFAD/MAEPE-RH	JANUARY 2013 - DECEMBER 2013
Dikhil	60	100 m^3 tank, ponds rehabilitation , 10000m^3 pond development, rehabilitation of 10000m^3 pond	3 tanks 100 m^3, 2 ponds of 10000m^3, 1 rehabilitation of 10000m^3 pond	9.63	WFP/IFAD/MAEPE-RH	
Arta	80	100 m^3 tank, pond rehabilitation , 10000m^3 pond development,	2 tanks 100 m^3, 1 pond rehabilitated, 1 10000m^3 pond developed,	8.25	WFP/IFAD/MAEPE-RH	
Sous Total	**380**			**75.25**	**PAM/FIDA/MAEPE-RH**	

B. COMPONENT MOBILISATION OF SURFACE WATER: PROGRAM PRODERMO

Region	Number of participants	Typology	Descriptions of Food Assistance Activities	Tonnage in Mt	Partnership	Implementation schedule
Development of hydraulic structures						
Obock	230	tanks of 100 m^3, pond rehabilitation, tanks of 10000m^3,	3 tanks of 100 m^3, 2 ponds rehabilitated, 2 deep wells and 3 traditionnal wells,	23.03	WFP/WB/MAEPE-RH	JANUARY 2013 - DECEMBER 2013
Dikhil	190	tank of 100 m^3, pond rehabilitation, ponds of 10000m^3,	5 tanks of 100 m^3, 2 ponds rehabilitated , 2 deep wells and 3 traditionnal wells,	35.51	WFP/WB/MAEPE-RH	
Sous Total	**420**			**58.54**	**PAM/FIDA/MAEPE-RH**	

C. COMPONENT MOBILISATION OF SURFACE WATER: PROGRAM AfDB

Region	Number of participants	Typology	Descriptions of Food Assistance Activities	Tonnage in Mt	Partnership	Implementation schedule
Development of hydraulic structures						
Ali-Sabieh	120	Tank of 100 m^3,	3 Tanks of 100 m^3,	8.25	WFP/AfDB/MAEPE-RH	JANUARY 2013 - DECEMBER 2013
Obock	40	Tank of 100 m^3,	4 Tanks of 100 m^3,	11	WFP/AfDB/MAEPE-RH	
Sous Total	**160**			**19.25**		
Total	**960**			**153.04**		

Source: WFP, 2014

Appendix 5: Participants of Pilot Activity and Board Members of Agricultural Cooperatives

List of Participants of Pilot Activity

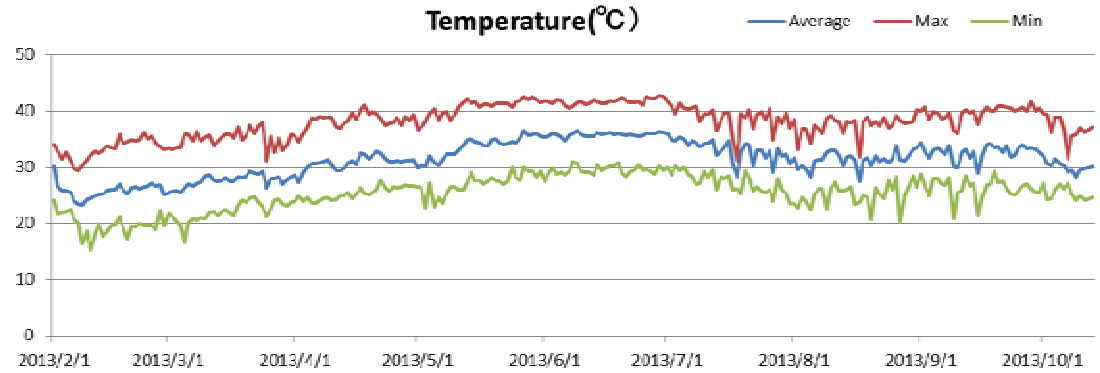
Position	Kourtimalei	Hambokto	Afka Arraba
Leader	Daher Hanad Assoweh	Mohamed IBRAHIM	Elmi Waberi
Sub-Leader	Djama Guedi Robleh	Awaleh Abdilahi AWLED	Abdi Diraneh
Sub-Leader	Ibrahim Darar Waberi	Hassan Abdi IGUEH	Kadir Ahmed Moussa
	Mohamed Seid Waiss	Moktar Ahmed HOUSSEIN	Idris Djama
	Mohamed Ismael Farah	Omar Dilaleh DARAR	Moussa Djama
	Mahamoud Hassan Gouled	Bobeh Awled BOBEH	Mohamed Abdillahi
	Mahamoud Omar Adaweh	Mouloud FARAH	Ismael Hassan
	Abdillahi Darar Assoweh	Ali Abdillahi MIGUIL	Hassan Dirieh
	Abdu Elmi Obieh	Houssein Aden AWLED	Saleiman Djama
	Abdillahi Souleh Assoweh	Kowrah Housein BAREH	Mohamed Hassan
	Farham Ahmed Darar	Souleiman Ibrahim DIDEH	Safiya Barkaleh
	Abdallah Gouled Dirir	Mariam Ali BOULALEH	Ali Robleh
	Farah Guechi Ninerumeh	Said Ali BOWLALEH	Omar Houssen
	Ali Atteiyer Nambie	Kadir Abdi IGUEH	Ali Housein
	Abdillahi Waberi Robleh	Omar Abdi FARAH	Wilo Youssouf

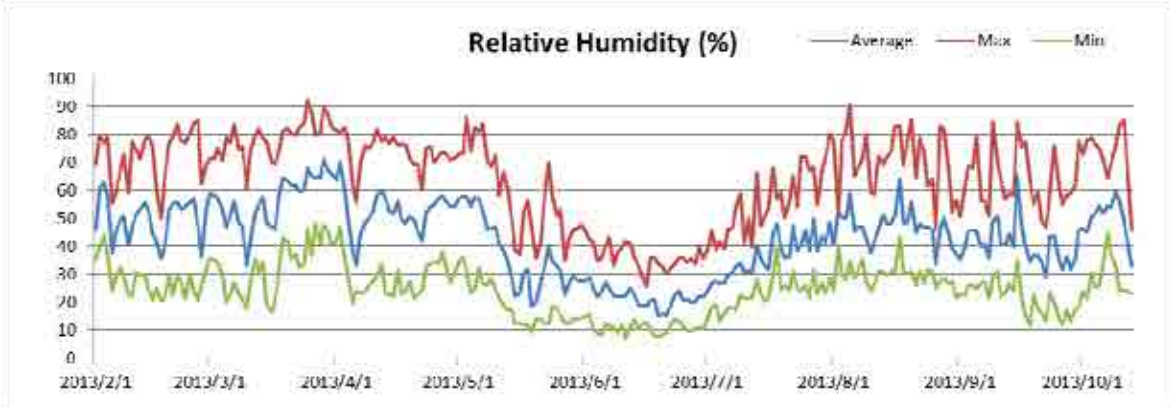
List of Board Members of Agricultural Cooperatives

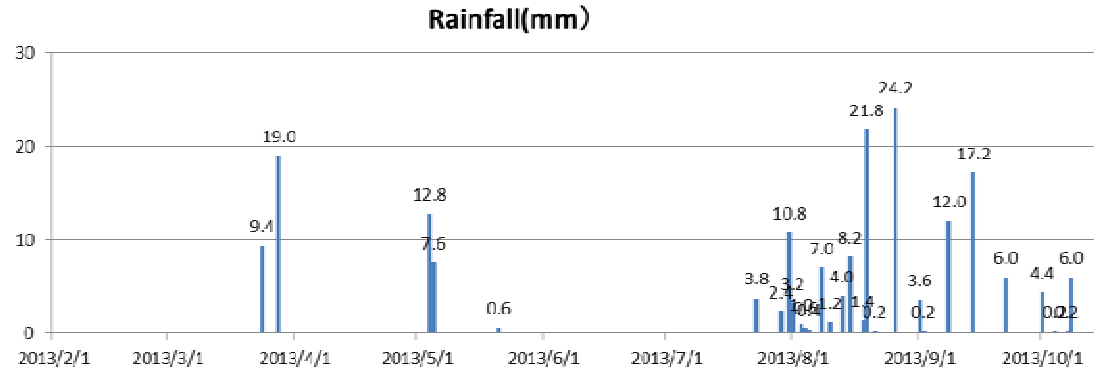
	Hambokto	Afka Arraba
Name of Farmer's Cooperative	Association des Femmes Agropastorales d'Hambocta (AFAH)	Association des Agropastorales d'Afka-Arraba (AAA)
President	Habiba Miguil GUEREH	Elmi Waberi
Vice-president	Saada Mohamoud IGUEH	Ismael Hassan
Secretary	Fatouma Gaeleh ATTEYEH	Mohamed Abdillahi
General treasure	Marian Ali DABAR	Abdi Diraneh
Audit	Fatouma Ali DIRIEH	Ali Robleh

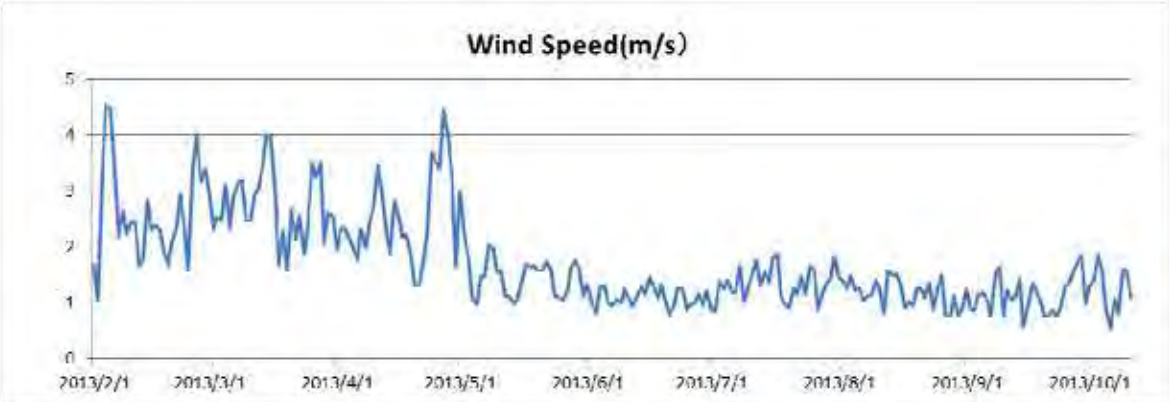
Appendix 6: Meteorological and Water Level Observation Results of the Pilot Project

Meteorological Observation Result (Afka Arraba site) 01/02/2013 – 12/10/2013

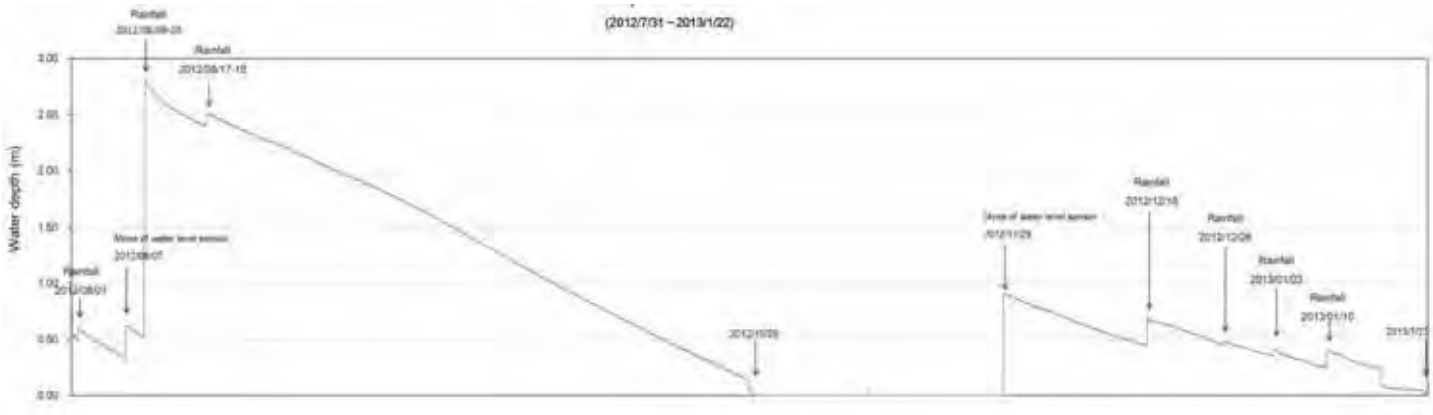




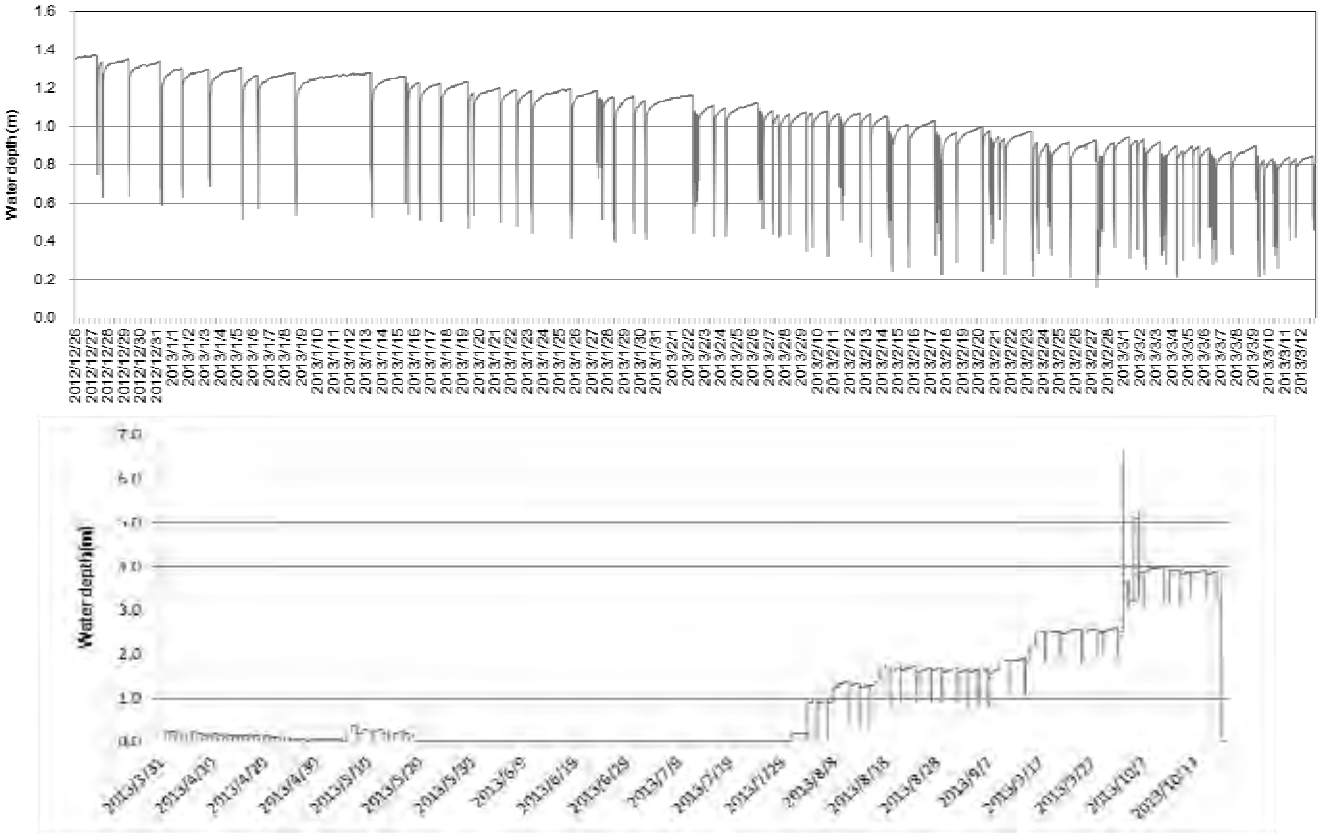




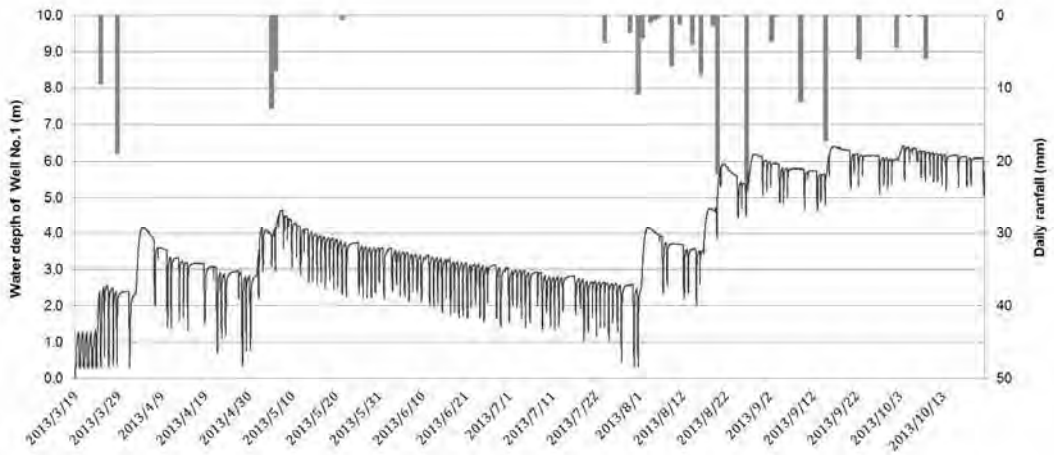
Rainfall and Water Level of Kourtimalei Pond



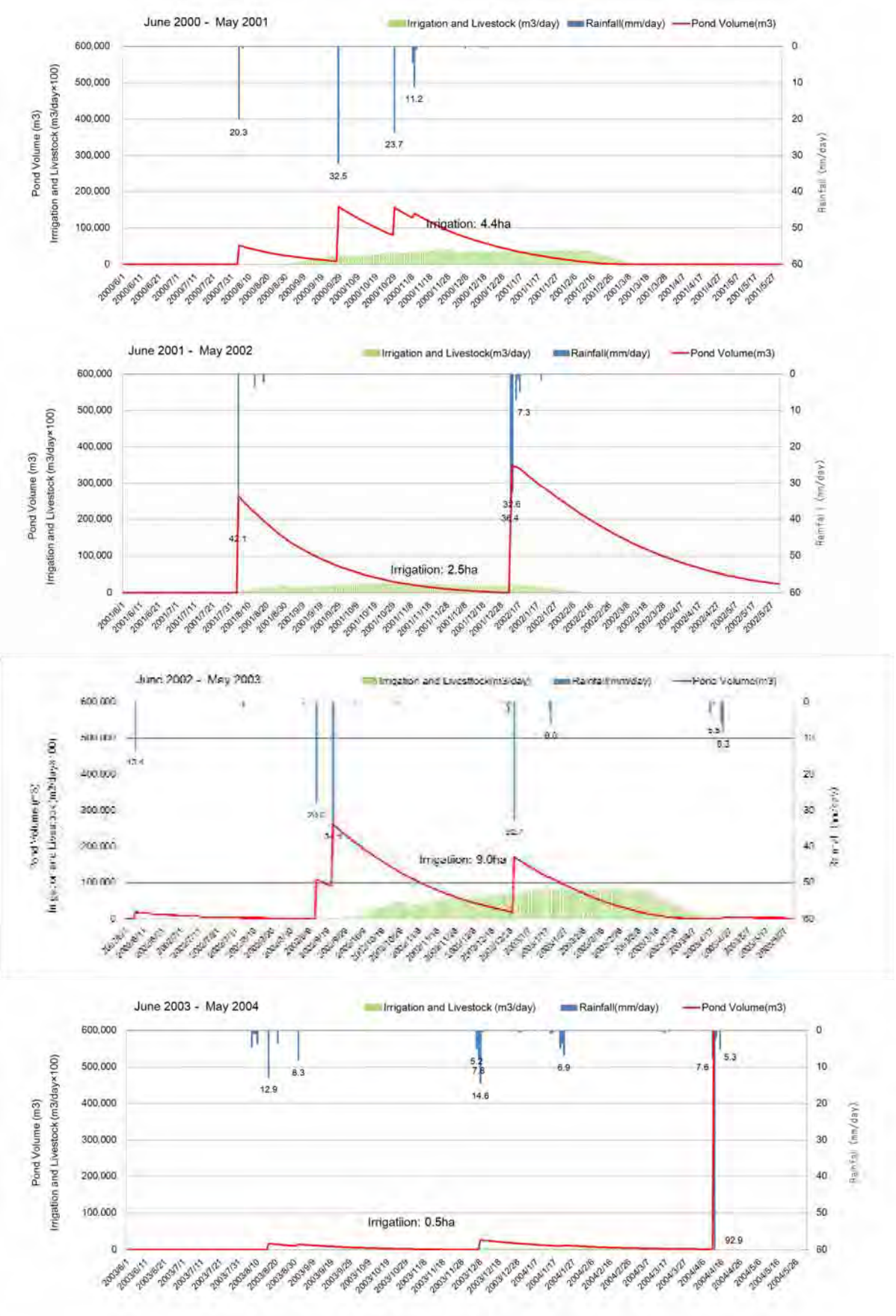
Water Level of Hambokto Shallow Well

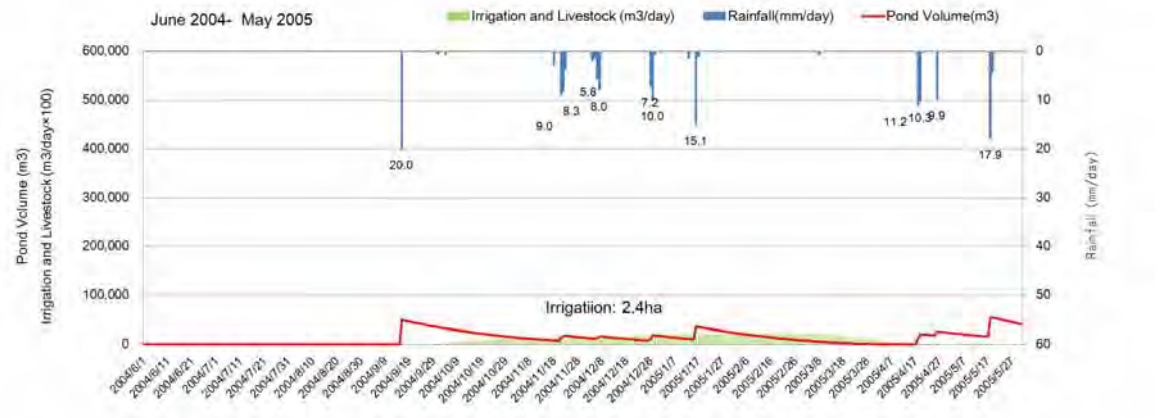


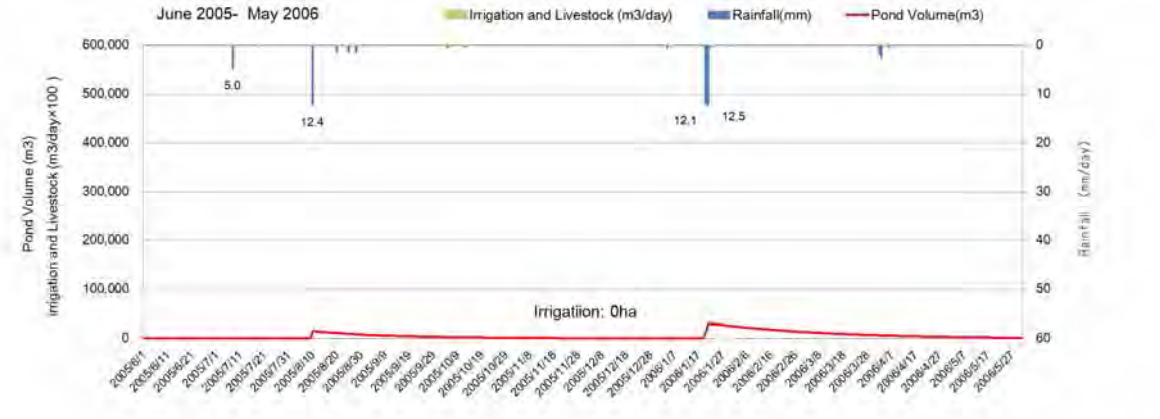
Rainfall and Water Level of Afka Arraba Shallow Well

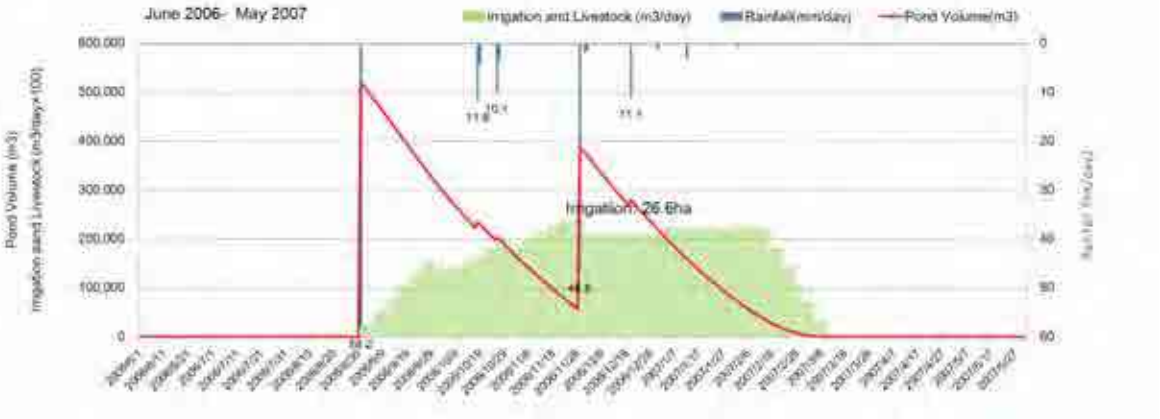


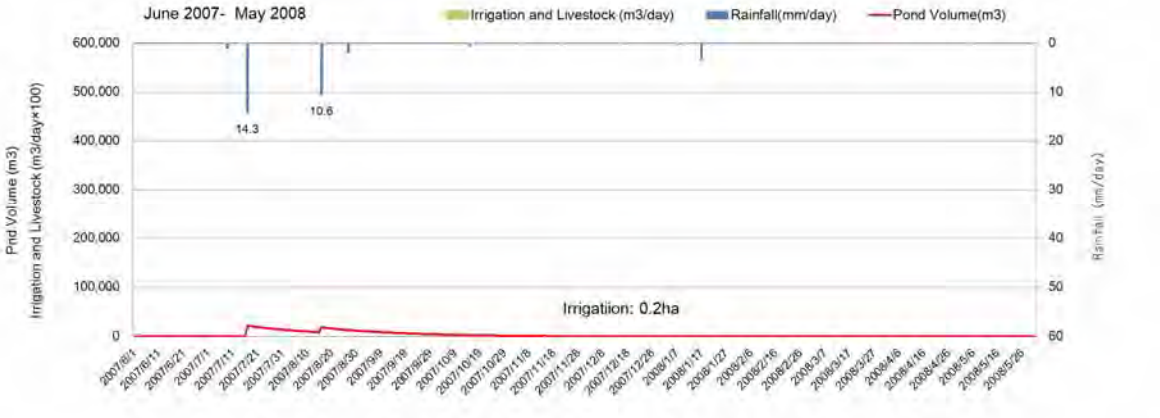
Appendix 7: Water Balance Simulation Result of the Pond

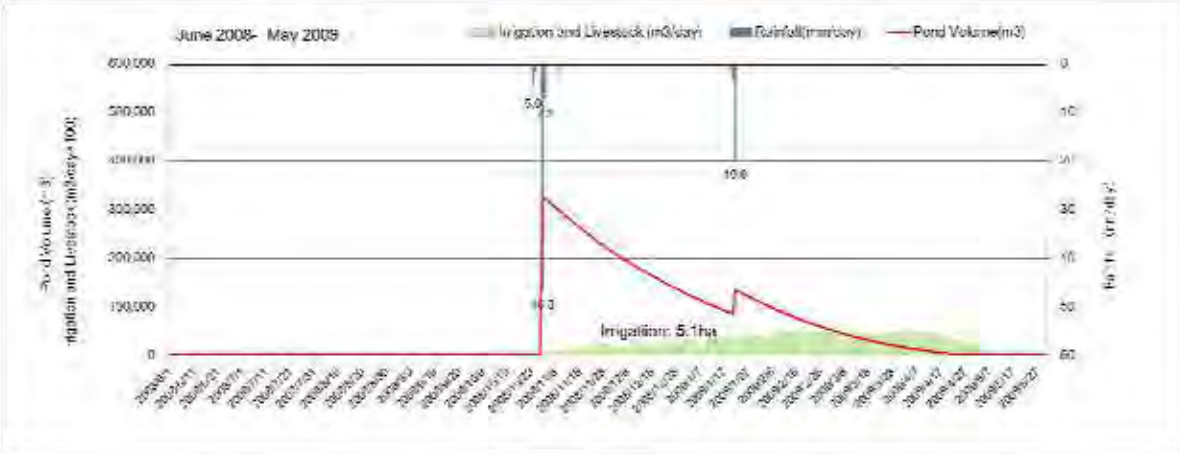


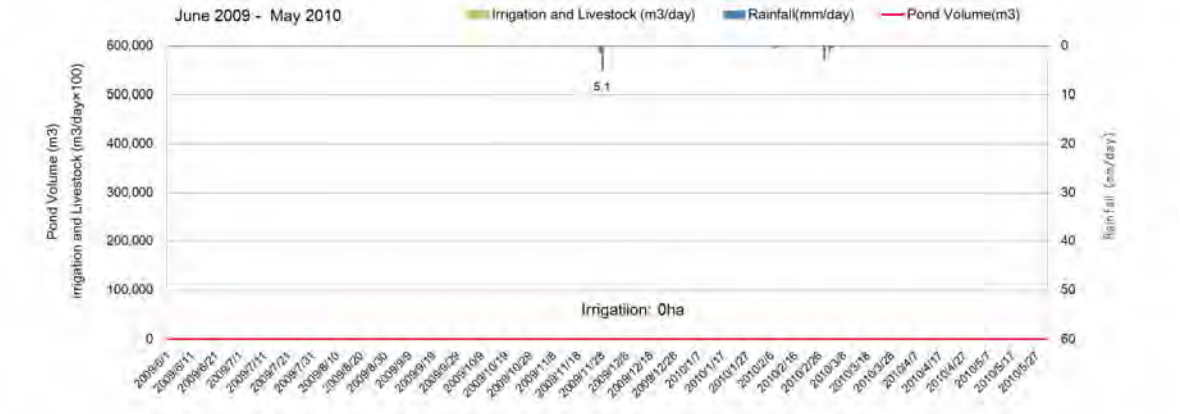

June 2004- May 2005
Irrigation and Livestock (m3/day)
Rainfall(mm/day)
Pond Volume(m3)
Pond Volume (m3)
Irrigation and Livestock (m3/day×100)
Rainfall (mm/day)
Irrigatiion: 2.4ha

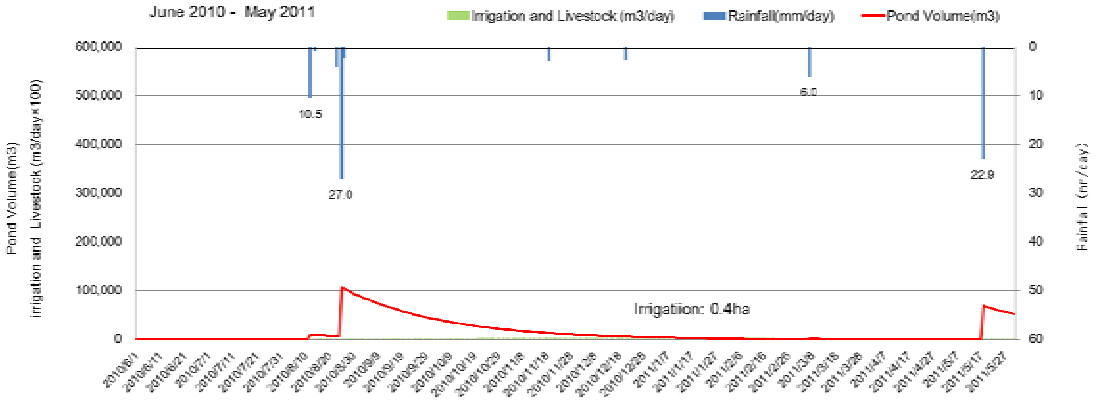

June 2005- May 2006
Irrigation and Livestock (m3/day)
Rainfall(mm)
Pond Volume(m3)
Pond Volume (m3)
Irrigation and Livestock (m3/day×100)
Rainfall (mm/day)
Irrigatiion: 0ha


June 2006- May 2007
Irrigation and Livestock (m3/day)
Rainfall(mm/day)
Pond Volume(m3)
Irrigation: 26.6ha


June 2007- May 2008
Irrigation and Livestock (m3/day)
Rainfall(mm/day)
Pond Volume(m3)
Pnd Volume (m3)
Irrigation and Livestock (m3/day×100)
Rainfall (mm/day)
Irrigatiion: 0.2ha

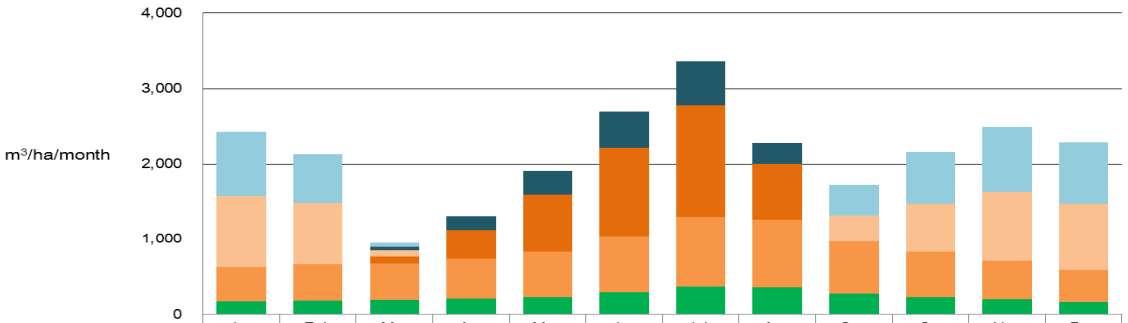

June 2008- May 2009
Irrigation and Livestock (m3/day)
Rainfall(mm/day)
Pond Volume(m3)
Irrigation: 5.1ha


June 2009 - May 2010
Irrigation and Livestock (m3/day)
Rainfall(mm/day)
Pond Volume(m3)
Pond Volume (m3)
Irrigation and Livestock (m3/day*100)
Rainfall (mm/day)
5.1
Irrigation: 0ha


June 2010 - May 2011
Irrigation and Livestock (m3/day)
Rainfall(mm/day)
Pond Volume(m3)
Pond Volume(m3)
Irrigation and Livestock (m3/day*100)
Rainfall (mm/day)
10.5
27.0
6.0
22.9
Irrigation: 0.4ha

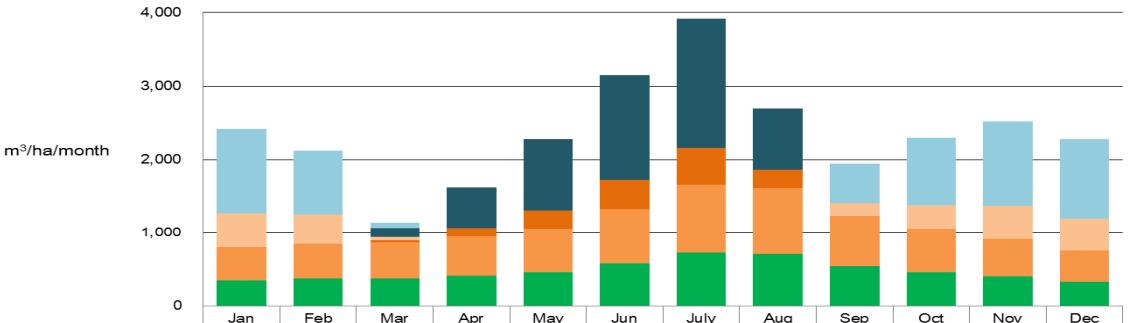
Appendix 8: Crop Water Requirement by Cropping Pattern

Cropping Pattern (SW-H, SW-B)
Crop Water Requirement=25,733m^3/year/ha



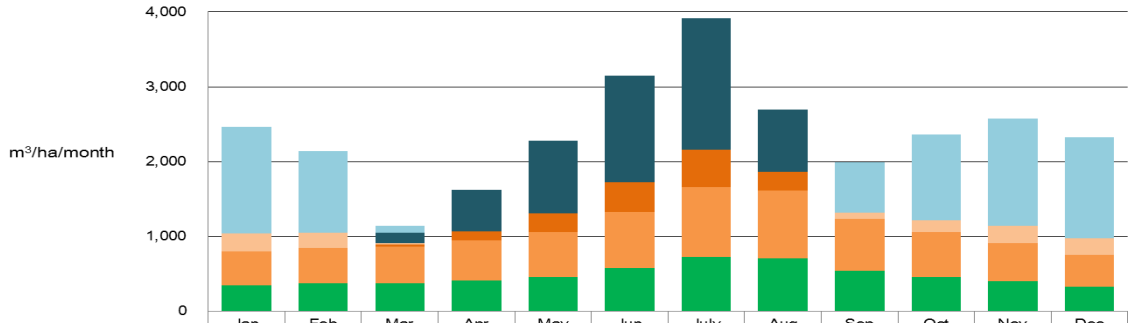
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Winter vegetable	857	651	56	0	0	0	0	0	404	686	860	809
Summer vegetable	0	0	45	185	322	476	586	278	0	0	0	0
Winter fodder	949	818	81	0	0	0	0	0	359	651	919	891
Summer fodder	0	0	90	384	767	1,180	1,477	738	0	0	0	0
Perennial fodder	450	477	486	531	594	747	936	909	693	594	513	423
Tree crops	175	186	189	207	231	291	364	354	270	231	200	165

Cropping Pattern (SW-S)
Crop Water Requirement=28,393m^3/year/ha



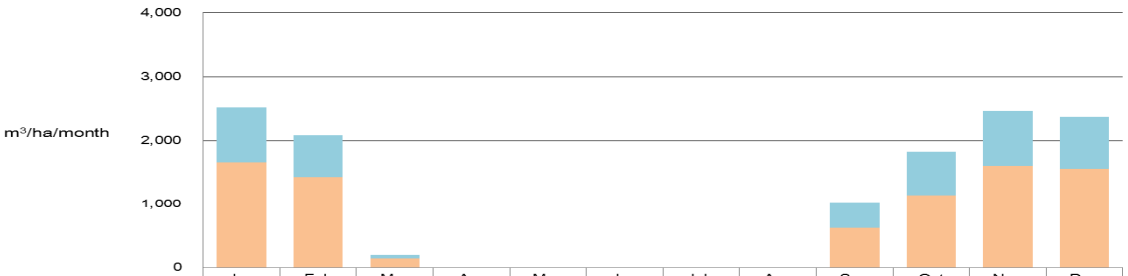
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Winter vegetable	1,142	867	74	0	0	0	0	0	539	915	1,147	1,079
Summer vegetable	0	0	135	556	965	1,429	1,758	835	0	0	0	0
Winter fodder	474	409	41	0	0	0	0	0	180	326	459	446
Summer fodder	0	0	30	128	256	393	492	246	0	0	0	0
Perennial fodder	450	477	486	531	594	747	936	909	693	594	513	423
Tree crops	350	371	378	413	462	581	728	707	539	462	399	329

Cropping pattern (SW-A)
Crop Water Requirement=28,667m^3/year/ha



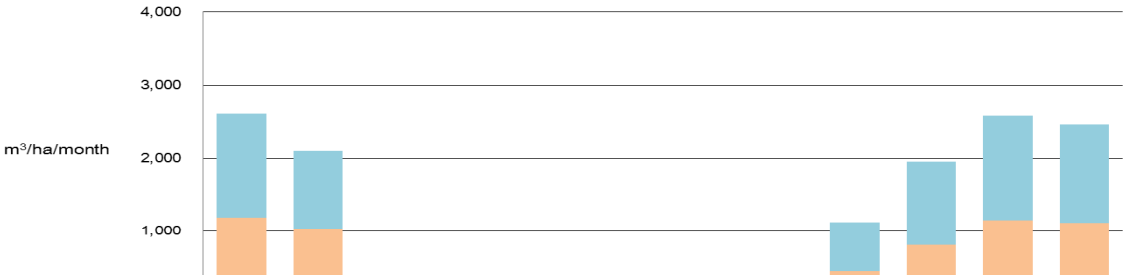
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Winter vegetable	1,428	1,084	93	0	0	0	0	0	674	1,144	1,434	1,349
Summer vegetable	0	0	135	556	965	1,429	1,758	835	0	0	0	0
Winter fodder	237	204	20	0	0	0	0	0	90	163	230	223
Summer fodder	0	0	30	128	256	393	492	246	0	0	0	0
Perennial fodder	450	477	486	531	594	747	936	909	693	594	513	423
Tree crops	350	371	378	413	462	581	728	707	539	462	399	329

Cropping Pattern (P-H, P-B)
Crop Water Requirement=12,494m^3/year/ha



	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Winter vegetable	857	651	56	0	0	0	0	0	404	686	860	809
Summer vegetable	0	0	0	0	0	0	0	0	0	0	0	0
Winter fodder	1,661	1,431	142	0	0	0	0	0	629	1,140	1,608	1,560
Summer fodder	0	0	0	0	0	0	0	0	0	0	0	0
Perennial fodder	0	0	0	0	0	0	0	0	0	0	0	0
Tree crops	0	0	0	0	0	0	0	0	0	0	0	0

Cropping Pattern (P-S)
Crop Water Requirement=13,041m^3/year/ha



	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Winter vegetable	1,428	1,084	93	0	0	0	0	0	674	1,144	1,434	1,349
Summer vegetable	0	0	0	0	0	0	0	0	0	0	0	0
Winter fodder	1,186	1,022	102	0	0	0	0	0	449	814	1,149	1,114
Summer fodder	0	0	0	0	0	0	0	0	0	0	0	0
Perennial fodder	0	0	0	0	0	0	0	0	0	0	0	0
Tree crops	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 9: Cost and Benefit Data of Irrigation Farming Models

Irrigation Farming Model

Water source: Shallow well Farmer's group: Home-garden

Assumptions

Cultivation area = 0.025 ha
Goat total = 20 heads

- The farm and shallow well are established by assistance.
- Amount for home consumption is included in the income.
- The fodder is used by own livestock.

Items		Amount		Unit income	Income	Unit cost	Cost
Initial cost						**Sub total**	**5,200 DJF/year**
1	Tools	1 set				1,200 DJF/set/year	1,200 DJF/year
2	Treadle pump	1 set				4,000 DJF/set/year	4,000 DJF/year
Maintenance cost						**Sub total**	**375 DJF/year**
1	Shallow well					15,000 DJF/ha/year	375 DJF/year
Operation cost						**Sub total**	**0 DJF/year**
Labor cost						**Sub total**	**0 DJF/year**
Winter vegetable	**Total**	**0.0075 ha**	30%	**Sub total**	**8,625 DJF**	**Sub total**	**1,623 DJF**
1	Tomato	0.0015 ha	6%	2,000,000 DJF/ha	3,000 DJF	250,000 DJF/ha	375 DJF
2	Onion	0.0015 ha	6%	2,000,000 DJF/ha	3,000 DJF	400,000 DJF/ha	600 DJF
3	Green pepper	0.0015 ha	6%	450,000 DJF/ha	675 DJF	120,000 DJF/ha	180 DJF
4	Okra	0.0015 ha	6%	1,200,000 DJF/ha	1,800 DJF	300,000 DJF/ha	450 DJF
5	Niebe	0.0015 ha	6%	100,000 DJF/ha	150 DJF	12,000 DJF/ha	18 DJF
Winter fodder	**Total**	**0.0100 ha**	40%	**Sub total**	**0 DJF**	**Sub total**	**520 DJF**
1	Sorghum	0.0050 ha	20%	0 DJF/ha	0 DJF	4,000 DJF/ha	20 DJF
2	Crotalaria	0.0050 ha	20%	0 DJF/ha	0 DJF	100,000 DJF/ha	500 DJF
Summer vegetable	**Total**	**0.0025 ha**	10%	**Sub total**	**2,500 DJF**	**Sub total**	**450 DJF**
1	Watermelon	0.0025 ha	10%	1,000,000 DJF/ha	2,500 DJF	180,000 DJF/ha	450 DJF
Summer fodder	**Total**	**0.0075 ha**	30%	**Sub total**	**0 DJF**	**Sub total**	**366 DJF**
1	Sorghum	0.0040 ha	16%	0 DJF/ha	0 DJF	4,000 DJF/ha	16 DJF
2	Crotalaria	0.0035 ha	14%	0 DJF/ha	0 DJF	100,000 DJF/ha	350 DJF
Perennial fodder	**Total**	**0.0050 ha**	20%	**Sub total**	**0 DJF**	**Sub total**	**425 DJF**
1	Alfalfa	0.0025 ha	10%	0 DJF/ha	0 DJF	120,000 DJF/ha	300 DJF
2	Sudan grass	0.0025 ha	10%	0 DJF/ha	0 DJF	50,000 DJF/ha	125 DJF
Trees	**Total**	**100 trees**		**Sub total**	**0 DJF**	**Sub total**	**50 DJF**
		0.0025 ha	10%				
1	Moringa	100 trees		0 DJF/tree	0 DJF	0.5 DJF/tree	50 DJF
Livestock	**Total**	**20 heads**		**Sub total**	**114,000 DJF**	**Sub total**	**28,000 DJF**
1	Goat (total)	20 heads		DJF/head	0 DJF	1,400 DJF/head	28,000 DJF
2	Goat meat	6 heads	70%	10,000 DJF/head	60,000 DJF		
3	Goat milk	9 heads	45%	6,000 DJF/head	54,000 DJF		

Cropping area in winter	0.0250 ha	100%	**Annual income**	**125,125 DJF**	**Annual cost** **37,009 DJF**
Cropping area in summer	0.0175 ha	70%	**Annual profit**	**88,116 DJF**	

Irrigation Farming Model

Water source: Shallow well Farmer's group: Beginner

Assumptions

Cultivation area = 0.25 ha
Goat total = 25 heads

- The farm and shallow well are established by assistance.
- Amount for home consumption is included in the income.
- The products are sold to neighbors.
- The fodder is used by own livestock.

Items		Amount		Unit income	Income	Unit cost	Cost
Initial cost						**Sub total**	**1,200 DJF/year**
1	Tools	1 set				1,200 DJF/set/year	1,200 DJF/year
Maintenance cost						**Sub total**	**8,750 DJF/year**
1	Shallow well					15,000 DJF/ha/year	3,750 DJF/year
2	Irrigation system					20,000 DJF/ha/year	5,000 DJF/year
Operation cost						**Sub total**	**69,230 DJF/year**
1	Diesel	322 Liter				215 DJF/Liter	69,230 DJF/year
Labor cost						**Sub total**	**0 DJF/year**
Winter vegetable	**Total**	**0.075 ha**	30%	**Sub total**	**95,250 DJF**	**Sub total**	**17,910 DJF**
1	Tomato	0.015 ha	6%	2,000,000 DJF/ha	30,000 DJF	250,000 DJF/ha	3,750 DJF
2	Onion	0.015 ha	6%	2,000,000 DJF/ha	30,000 DJF	400,000 DJF/ha	6,000 DJF
3	Green pepper	0.015 ha	6%	450,000 DJF/ha	6,750 DJF	120,000 DJF/ha	1,800 DJF
4	Okra	0.015 ha	6%	1,200,000 DJF/ha	18,000 DJF	300,000 DJF/ha	4,500 DJF
5	Niebe	0.005 ha	2%	100,000 DJF/ha	500 DJF	12,000 DJF/ha	60 DJF
6	Watermelon	0.010 ha	4%	1,000,000 DJF/ha	10,000 DJF	180,000 DJF/ha	1,800 DJF
Winter fodder	**Total**	**0.100 ha**	40%	**Sub total**	**0 DJF**	**Sub total**	**5,200 DJF**
1	Sorghum	0.050 ha	20%	0 DJF/ha	0 DJF	4,000 DJF/ha	200 DJF
2	Crotalaria	0.050 ha	20%	0 DJF/ha	0 DJF	100,000 DJF/ha	5,000 DJF
Summer vegetable	**Total**	**0.025 ha**	10%	**Sub total**	**25,000 DJF**	**Sub total**	**4,500 DJF**
1	Watermelon	0.025 ha	10%	1,000,000 DJF/ha	25,000 DJF	180,000 DJF/ha	4,500 DJF
Summer fodder	**Total**	**0.075 ha**	30%	**Sub total**	**0 DJF**	**Sub total**	**3,660 DJF**
1	Sorghum	0.040 ha	16%	0 DJF/ha	0 DJF	4,000 DJF/ha	160 DJF
2	Crotalaria	0.035 ha	14%	0 DJF/ha	0 DJF	100,000 DJF/ha	3,500 DJF
Perennial fodder	**Total**	**0.050 ha**	20%	**Sub total**	**0 DJF**	**Sub total**	**4,250 DJF**
1	Alfalfa	0.025 ha	10%	0 DJF/ha	0 DJF	120,000 DJF/ha	3,000 DJF
2	Sudan grass	0.025 ha	10%	0 DJF/ha	0 DJF	50,000 DJF/ha	1,250 DJF
Trees	**Total**	**1,000 trees**		**Sub total**	**0 DJF**	**Sub total**	**500 DJF**
		0.025 ha	10%				
1	Moringa	600 trees		0 DJF/tree	0 DJF	0.5 DJF/tree	300 DJF
2	Leusaena	400 trees		0 DJF/tree	0 DJF	0.5 DJF/tree	200 DJF
Livestock	**Total**	**25 heads**		**Sub total**	**238,000 DJF**	**Sub total**	**35,000 DJF**
1	Goat (total)	25 heads		DJF/head	0 DJF	1,400 DJF/head	35,000 DJF
2	Goat meat	13 heads	70%	10,000 DJF/head	130,000 DJF		
3	Goat milk	18 heads	72%	6,000 DJF/head	108,000 DJF		

Cropping area in winter	0.250 ha	100%	**Annual income**	**358,250 DJF**	**Annual cost** **150,200 DJF**
Cropping area in summer	0.175 ha	70%	**Annual profit**	**208,050 DJF**	

Irrigation Farming Model

Water source: Shallow well Farmer's group: Self-sustained

Assumptions

Cultivation area = 1 ha
Goat total = 30 heads

- Amount for home consumption is included in the income.
- The products are sold in the local markets.
- The fodder is used by own livestock.

Items		Amount		Unit income	Income	Unit cost	Cost
Initial cost						**Sub total**	**147,829 DJF/year**
1	Land preparation					9,110 DJF/ha/year	9,110 DJF/year
2	Shallow well					9,460 DJF/ha/year	9,460 DJF/year
3	Irrigation system					62,367 DJF/ha/year	62,367 DJF/year
4	Other facilities					51,267 DJF/ha/year	51,267 DJF/year
5	Others					14,425 DJF/ha/year	14,425 DJF/year
6	Tools	1 set				1,200 DJF/set/year	1,200 DJF/year
Maintenance cost						**Sub total**	**35,000 DJF/year**
1	Shallow well					15,000 DJF/ha/year	15,000 DJF/year
2	Irrigation system					20,000 DJF/ha/year	20,000 DJF/year
Operation cost						**Sub total**	**305,300 DJF/year**
1	Diesel	1,420 Liter				215 DJF/Liter	305,300 DJF/year
Labor cost						**Sub total**	**0 DJF/year**
Winter vegetable	**Total**	**0.400 ha**	40%	**Sub total**	**638,800 DJF**	**Sub total**	**182,603 DJF**
1	Tomato	0.060 ha	6%	2,500,000 DJF/ha	150,000 DJF	655,075 DJF/ha	39,305 DJF
2	Onion	0.060 ha	6%	2,500,000 DJF/ha	150,000 DJF	805,075 DJF/ha	48,305 DJF
3	Green pepper	0.080 ha	8%	1,050,000 DJF/ha	84,000 DJF	255,075 DJF/ha	20,406 DJF
4	Eggplant	0.080 ha	8%	875,000 DJF/ha	70,000 DJF	260,075 DJF/ha	20,806 DJF
5	Okra	0.040 ha	4%	1,500,000 DJF/ha	60,000 DJF	480,075 DJF/ha	19,203 DJF
6	Melon	0.080 ha	8%	1,560,000 DJF/ha	124,800 DJF	432,225 DJF/ha	34,578 DJF
Winter fodder	**Total**	**0.200 ha**	20%	**Sub total**	**0 DJF**	**Sub total**	**13,775 DJF**
1	Sorghum	0.100 ha	10%	0 DJF/ha	0 DJF	26,500 DJF/ha	2,650 DJF
2	Crotalaria	0.100 ha	10%	0 DJF/ha	0 DJF	111,250 DJF/ha	11,125 DJF
Summer vegetable	**Total**	**0.300 ha**	30%	**Sub total**	**459,600 DJF**	**Sub total**	**132,177 DJF**
1	Melon	0.160 ha	16%	1,560,000 DJF/ha	249,600 DJF	432,225 DJF/ha	69,156 DJF
2	Watermelon	0.140 ha	14%	1,500,000 DJF/ha	210,000 DJF	450,150 DJF/ha	63,021 DJF
Summer fodder	**Total**	**0.100 ha**	10%	**Sub total**	**0 DJF**	**Sub total**	**6,040 DJF**
1	Sorghum	0.060 ha	6%	0 DJF/ha	0 DJF	26,500 DJF/ha	1,590 DJF
2	Crotalaria	0.040 ha	4%	0 DJF/ha	0 DJF	111,250 DJF/ha	4,450 DJF
Perennial fodder	**Total**	**0.200 ha**	20%	**Sub total**	**0 DJF**	**Sub total**	**20,375 DJF**
1	Alfalfa	0.100 ha	10%	0 DJF/ha	0 DJF	131,250 DJF/ha	13,125 DJF
2	Sudan grass	0.100 ha	10%	0 DJF/ha	0 DJF	72,500 DJF/ha	7,250 DJF
Trees	**Total**	**2,060 trees**		**Sub total**	**180,000 DJF**	**Sub total**	**265,000 DJF**
		0.200 ha	20%				
1	Date palm	60 trees		3,000 DJF/tree	180,000 DJF	650 DJF/tree	39,000 DJF
2	Moringa	1,000 trees		0 DJF/tree	0 DJF	113 DJF/tree	113,000 DJF
3	Leusaena	1,000 trees		0 DJF/tree	0 DJF	113 DJF/tree	113,000 DJF
Livestock	**Total**	**30 heads**		**Sub total**	**445,000 DJF**	**Sub total**	**117,000 DJF**
1	Goat (total)	30 heads		DJF/head	0 DJF	3,400 DJF/head	102,000 DJF
2	Goat meat	15 heads	70%	15,000 DJF/head	225,000 DJF	1,000 DJF/head	15,000 DJF
3	Goat milk	22 heads	72%	10,000 DJF/head	220,000 DJF		

Cropping area in winter	1.000 ha	100%	**Annual income**	**1,723,400 DJF**	**Annual cost** **1,225,099 DJF**
Cropping area in summer	0.800 ha	80%	**Annual profit**	**498,301 DJF**	

Irrigation Farming Model

Water source: Shallow well Farmer's group: Advanced

Assumptions

Cultivation area = 2 ha
Goat total = 40 heads

- Amount for home consumption is included in the income.
- The products are sold in the local and Djibouti markets.
- The fodder is used by own livestock.

Items		Amount		Unit income	Income	Unit cost	Cost
Initial cost						**Sub total**	**295,658 DJF/year**
1	Land preparation					9,110 DJF/ha/year	18,220 DJF/year
2	Shallow well					9,460 DJF/ha/year	18,920 DJF/year
3	Irrigation system					62,367 DJF/ha/year	124,734 DJF/year
4	Other facilities					51,267 DJF/ha/year	102,534 DJF/year
5	Others					14,425 DJF/ha/year	28,850 DJF/year
6	Tools	2 set				1,200 DJF/set/year	2,400 DJF/year
Maintenance cost						**Sub total**	**70,000 DJF/year**
1	Shallow well					15,000 DJF/ha/year	30,000 DJF/year
2	Irrigation system					20,000 DJF/ha/year	40,000 DJF/year
Operation cost						**Sub total**	**616,405 DJF/year**
1	Diesel	2,867 Liter				215 DJF/Liter	616,405 DJF/year
Labor cost						**Sub total**	**720,000 DJF/year**
1	Farm worker	2 person/year				360,000 DJF/person/year	720,000 DJF/year
Winter vegetable	**Total**	**1.000 ha**	50%	**Sub total**	**2,580,000 DJF**	**Sub total**	**667,175 DJF**
1	Tomato	0.200 ha	10%	3,000,000 DJF/ha	600,000 DJF	867,100 DJF/ha	173,420 DJF
2	Onion	0.200 ha	10%	3,900,000 DJF/ha	780,000 DJF	999,100 DJF/ha	199,820 DJF
3	Green pepper	0.200 ha	10%	1,500,000 DJF/ha	300,000 DJF	415,500 DJF/ha	83,100 DJF
4	Eggplant	0.200 ha	10%	2,250,000 DJF/ha	450,000 DJF	499,100 DJF/ha	99,820 DJF
5	Melon	0.200 ha	10%	2,250,000 DJF/ha	450,000 DJF	555,075 DJF/ha	111,015 DJF
Winter fodder	**Total**	**0.200 ha**	10%	**Sub total**	**0 DJF**	**Sub total**	**38,300 DJF**
1	Sorghum	0.120 ha	6%	0 DJF/ha	0 DJF	245,000 DJF/ha	29,400 DJF
2	Crotalaria	0.080 ha	4%	0 DJF/ha	0 DJF	111,250 DJF/ha	8,900 DJF
Summer vegetable	**Total**	**0.600 ha**	30%	**Sub total**	**1,350,000 DJF**	**Sub total**	**333,045 DJF**
1	Melon	0.600 ha	30%	2,250,000 DJF/ha	1,350,000 DJF	555,075 DJF/ha	333,045 DJF
Summer fodder	**Total**	**0.200 ha**	10%	**Sub total**	**0 DJF**	**Sub total**	**38,300 DJF**
1	Sorghum	0.120 ha	6%	0 DJF/ha	0 DJF	245,000 DJF/ha	29,400 DJF
2	Crotalaria	0.080 ha	4%	0 DJF/ha	0 DJF	111,250 DJF/ha	8,900 DJF
Perennial fodder	**Total**	**0.400 ha**	20%	**Sub total**	**0 DJF**	**Sub total**	**55,250 DJF**
1	Alfalfa	0.200 ha	10%	0 DJF/ha	0 DJF	131,250 DJF/ha	26,250 DJF
2	Sudan grass	0.200 ha	10%	0 DJF/ha	0 DJF	145,000 DJF/ha	29,000 DJF
Trees	**Total**	**4,100 trees**		**Sub total**	**600,000 DJF**	**Sub total**	**556,000 DJF**
		0.400 ha	20%				
1	Date palm	100 trees		6,000 DJF/tree	600,000 DJF	1,040 DJF/tree	104,000 DJF
2	Moringa	2,000 trees		0 DJF/tree	0 DJF	113 DJF/tree	226,000 DJF
3	Leusaena	2,000 trees		0 DJF/tree	0 DJF	113 DJF/tree	226,000 DJF
Livestock	**Total**	**40 heads**		**Sub total**	**751,000 DJF**	**Sub total**	**159,000 DJF**
1	Goat (total)	40 heads		DJF/head	0 DJF	3,400 DJF/head	136,000 DJF
2	Goat meat	23 heads	80%	15,000 DJF/head	345,000 DJF	1,000 DJF/head	23,000 DJF
3	Goat milk	29 heads	72%	14,000 DJF/head	406,000 DJF		

Cropping area in winter	2.000 ha	100%	**Annual income**	**5,281,000 DJF**	**Annual cost** **3,549,133 DJF**
Cropping area in summer	1.600 ha	80%	**Annual profit**	**1,731,867 DJF**	

Irrigation Farming Model

Water source: Pond Farmer's group: Home-garden

Assumptions

Cultivation area = 0.025 ha
Goat total = 20 heads

- The pond is established and maintained by assistance.
- The farm is established by assistance.
- Amount for home consumption is included in the income.
- The fodder is used by own livestock.

Items		Amount		Unit income	Income	Unit cost	Cost
Initial cost						**Sub total**	**5,200 DJF/year**
1	Tools	1 set				1,200 DJF/set/year	1,200 DJF/year
2	Treadle pomp	1 set				4,000 DJF/set/year	4,000 DJF/year
Maintenance cost						**Sub total**	**0 DJF/year**
Operation cost						**Sub total**	**0 DJF/year**
Labor cost						**Sub total**	**0 DJF/year**
Winter vegetable	**Total**	**0.0075 ha**	30%	**Sub total**	**9,975 DJF**	**Sub total**	**1,875 DJF**
1	Tomato	0.0015 ha	6%	2,000,000 DJF/ha	3,000 DJF	250,000 DJF/ha	375 DJF
2	Onion	0.0015 ha	6%	2,000,000 DJF/ha	3,000 DJF	400,000 DJF/ha	600 DJF
3	Green pepper	0.0015 ha	6%	450,000 DJF/ha	675 DJF	120,000 DJF/ha	180 DJF
4	Okra	0.0015 ha	6%	1,200,000 DJF/ha	1,800 DJF	300,000 DJF/ha	450 DJF
5	Watermelon	0.0015 ha	6%	1,000,000 DJF/ha	1,500 DJF	180,000 DJF/ha	270 DJF
Winter fodder	**Total**	**0.0175 ha**	70%	**Sub total**	**0 DJF**	**Sub total**	**790 DJF**
1	Sorghum	0.0100 ha	40%	0 DJF/ha	0 DJF	4,000 DJF/ha	40 DJF
2	Crotalaria	0.0075 ha	30%	0 DJF/ha	0 DJF	100,000 DJF/ha	750 DJF
Summer vegetable	**Total**	**0.0000 ha**	0%	**Sub total**	**0 DJF**	**Sub total**	**0 DJF**
		ha		DJF/ha	0 DJF	DJF/ha	0 DJF
Summer fodder	**Total**	**0.0000 ha**	0%	**Sub total**	**0 DJF**	**Sub total**	**0 DJF**
		ha		DJF/ha	0 DJF	DJF/ha	0 DJF
Perennial fodder	**Total**	**0.0000 ha**	0%	**Sub total**	**0 DJF**	**Sub total**	**0 DJF**
		ha		DJF/ha	0 DJF	DJF/ha	0 DJF
Trees	**Total**	**0.0000 trees**		**Sub total**	**0 DJF**	**Sub total**	**0 DJF**
		0.0000 ha	0%				
		trees		DJF/tree	0 DJF	DJF/tree	0 DJF
Livestock	**Total**	**20 heads**		**Sub total**	**92,000 DJF**	**Sub total**	**28,000 DJF**
1	Goat (total)	20 heads		DJF/head	0 DJF	1,400 DJF/head	28,000 DJF
2	Goat meat	5 heads	70%	10,000 DJF/head	50,000 DJF		
3	Goat milk	7 heads	36%	6,000 DJF/head	42,000 DJF		

Cropping area in winter	0.025 ha	100%	**Annual income**	**101,975 DJF**	**Annual cost** **35,865 DJF**
Cropping area in summer	0.000 ha	0%	**Annual profit**	**66,110 DJF**	

Irrigation Farming Model

Water source: Pond Farmer's group: Beginner

Assumptions

Cultivation area = 0.25 ha
Goat total = 25 heads

- The pond is established and maintained by assistance.
- The farm and irrigation system are established by assistance.
- Amount for home consumption is included in the income.
- The products are sold to neighbors.
- The fodder is used by own livestock.

	Items	Amount		Unit income	Income	Unit cost	Cost
Initial cost						**Sub total**	**12,000 DJF/year**
1	Tools	1 set				12,000 DJF/set/year	12,000 DJF/year
Maintenance cost						**Sub total**	**5,000 DJF/year**
1	Irrigation system					20,000 DJF/ha/year	5,000 DJF/year
Operation cost						**Sub total**	**33,540 DJF/year**
1	Diesel	156 Liter				215 DJF/Liter	33,540 DJF/year
Labor cost						**Sub total**	**0 DJF/year**
Winter vegetable	**Total**	**0.075 ha**	30%	**Sub total**	**95,250 DJF**	**Sub total**	**17,910 DJF**
1	Tomato	0.015 ha	6%	2,000,000 DJF/ha	30,000 DJF	250,000 DJF/ha	3,750 DJF
2	Onion	0.015 ha	6%	2,000,000 DJF/ha	30,000 DJF	400,000 DJF/ha	6,000 DJF
3	Green pepper	0.015 ha	6%	450,000 DJF/ha	6,750 DJF	120,000 DJF/ha	1,800 DJF
4	Okra	0.015 ha	6%	1,200,000 DJF/ha	18,000 DJF	300,000 DJF/ha	4,500 DJF
5	Niebe	0.005 ha	2%	100,000 DJF/ha	500 DJF	12,000 DJF/ha	60 DJF
6	Watermelon	0.010 ha	4%	1,000,000 DJF/ha	10,000 DJF	180,000 DJF/ha	1,800 DJF
Winter fodder	**Total**	**0.175 ha**	70%	**Sub total**	**0 DJF**	**Sub total**	**7,900 DJF**
1	Sorghum	0.100 ha	40%	0 DJF/ha	0 DJF	4,000 DJF/ha	400 DJF
2	Crotalaria	0.075 ha	30%	0 DJF/ha	0 DJF	100,000 DJF/ha	7,500 DJF
Summer vegetable	**Total**	**0.000 ha**	0%	**Sub total**	**0 DJF**	**Sub total**	**0 DJF**
		ha		DJF/ha	0 DJF	DJF/ha	0 DJF
Summer fodder	**Total**	**0.000 ha**	0%	**Sub total**	**0 DJF**	**Sub total**	**0 DJF**
		ha		DJF/ha	0 DJF	DJF/ha	0 DJF
Perennial fodder	**Total**	**0.000 ha**	0%	**Sub total**	**0 DJF**	**Sub total**	**0 DJF**
		ha		DJF/ha	0 DJF	DJF/ha	0 DJF
Trees	**Total**	**0 trees**		**Sub total**	**0 DJF**	**Sub total**	**0 DJF**
		0.000 ha	0%				
		trees		DJF/tree	0 DJF	DJF/tree	0 DJF
Livestock	**Total**	**25 heads**		**Sub total**	**184,000 DJF**	**Sub total**	**35,000 DJF**
1	Goat (total)	25 heads		DJF/head	0 DJF	1,400 DJF/head	35,000 DJF
2	Goat meat	10 heads	70%	10,000 DJF/head	100,000 DJF		
3	Goat milk	14 heads	54%	6,000 DJF/head	84,000 DJF		

Cropping area in winter	0.250 ha	100%	**Annual income**	**279,250 DJF**	**Annual cost** **111,350 DJF**
Cropping area in summer	0.000 ha	0%	**Annual profit**	**167,900 DJF**	

Irrigation Farming Model

Water source: Pond Farmer's group: Self-sustained

Assumptions

Cultivation area = 1 ha
Goat total = 30 heads

- The pond is established and maintained by assistance.
- Amount for home consumption is included in the income.
- The products are sold in the local markets.
- The fodder is used by own livestock.

Items		Amount		Unit income	Income	Unit cost	Cost
Initial cost						**Sub total**	**138,369 DJF/year**
1	Land preparation					9,110 DJF/ha/year	9,110 DJF/year
2	Irrigation system					62,367 DJF/ha/year	62,367 DJF/year
3	Other facilities					51,267 DJF/ha/year	51,267 DJF/year
4	Others					14,425 DJF/ha/year	14,425 DJF/year
5	Tools	1 set				1,200 DJF/set/year	1,200 DJF/year
Maintenance cost						**Sub total**	**20,000 DJF/year**
1	Irrigation system					20,000 DJF/ha/year	20,000 DJF/year
Operation cost						**Sub total**	**140,180 DJF/year**
1	Diesel	652 Liter				215 DJF/Liter	140,180 DJF/year
Labor cost						**Sub total**	**0 DJF/year**
Winter vegetable	**Total**	**0.500 ha**	50%	**Sub total**	**777,500 DJF**	**Sub total**	**225,255 DJF**
1	Tomato	0.060 ha	6%	2,500,000 DJF/ha	150,000 DJF	655,075 DJF/ha	39,305 DJF
2	Onion	0.060 ha	6%	2,500,000 DJF/ha	150,000 DJF	805,075 DJF/ha	48,305 DJF
3	Green pepper	0.080 ha	8%	1,050,000 DJF/ha	84,000 DJF	255,075 DJF/ha	20,406 DJF
4	Eggplant	0.100 ha	10%	875,000 DJF/ha	87,500 DJF	260,075 DJF/ha	26,008 DJF
5	Okra	0.100 ha	10%	1,500,000 DJF/ha	150,000 DJF	480,075 DJF/ha	48,008 DJF
6	Melon	0.100 ha	10%	1,560,000 DJF/ha	156,000 DJF	432,225 DJF/ha	43,223 DJF
Winter fodder	**Total**	**0.500 ha**	50%	**Sub total**	**0 DJF**	**Sub total**	**33,590 DJF**
1	Sorghum	0.260 ha	26%	0 DJF/ha	0 DJF	26,500 DJF/ha	6,890 DJF
2	Crotalaria	0.240 ha	24%	0 DJF/ha	0 DJF	111,250 DJF/ha	26,700 DJF
Summer vegetable	**Total**	**0.000 ha**	0%	**Sub total**	**0 DJF**	**Sub total**	**0 DJF**
		ha		DJF/ha	0 DJF	DJF/ha	0 DJF
Summer fodder	**Total**	**0.000 ha**	0%	**Sub total**	**0 DJF**	**Sub total**	**0 DJF**
		ha		DJF/ha	0 DJF	DJF/ha	0 DJF
Perennial fodder	**Total**	**0.000 ha**	0%	**Sub total**	**0 DJF**	**Sub total**	**0 DJF**
		ha		DJF/ha	0 DJF	DJF/ha	DJF
Trees	**Total**	**0 trees**		**Sub total**	**0 DJF**	**Sub total**	**0 DJF**
		0.000 ha	0%				
		trees		DJF/tree	0 DJF	DJF/tree	DJF
Livestock	**Total**	**30 heads**		**Sub total**	**385,000 DJF**	**Sub total**	**115,000 DJF**
1	Goat (total)	30 heads		DJF/head	0 DJF	3,400 DJF/head	102,000 DJF
2	Goat meat	13 heads	70%	15,000 DJF/head	195,000 DJF	1,000 DJF/head	13,000 DJF
3	Goat milk	19 heads	63%	10,000 DJF/head	190,000 DJF		

Cropping area in winter	1.000 ha	100%	**Annual income**	**1,162,500 DJF**	**Annual cost**	**672,394 DJF**
Cropping area in summer	0.000 ha	0%	**Annual profit**	**490,106 DJF**		

Appendix 10: Outline of the Project Candidate Sites

Outline of project candidate site: I-1-1 (Bondara)

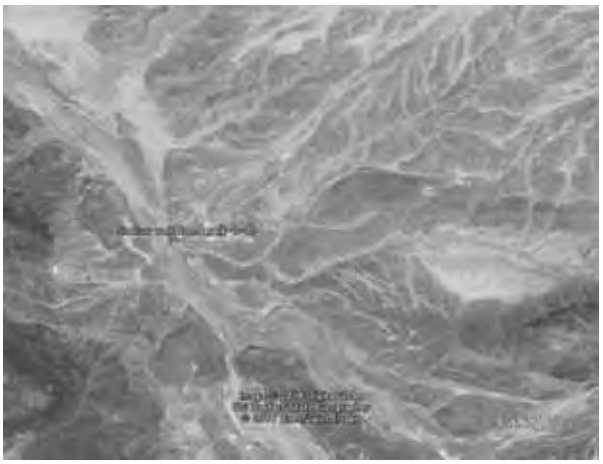
Basic information

Site number	I-1-1
Site name	Bondara
Region	Dikhil
Type of development	New settlement
Type of water source	Shallow groundwater
Water source facility	Shallow well A
Catchment area	84 km^2

Location

Latitude	N: 11-01.0
Longitude	E: 42-20.2

Map



Evaluation

Score	① Availability of water source	4	16
	② Demand by local community	3	
	③ Accessibility	3	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	3	
	⑥ Water quality	2	
Evaluation rank		A	

Overview

The village with around 100 households is located near the border of Ethiopia. There is one shallow well which have been utilized for livestock and human consumption. Since the wadi is expected to have sufficient potential in terms of water-source availability, the shallow well can be also used as irrigation purpose. Inhabitants have never used this shallow well for irrigation due to lack of irrigation facilities such as pump and pipes. Disadvantage of this candidate site is poor accessibility to local market in Dikhil; therefore, target farming model will be home garden farming which is small-scale farming with fodder crops and vegetables for self-consumption.

Site Photos

Residential houses in the village

Shallow well built in the wadi

Upstream of the wadi

Remarks

Outline of project candidate site: I-1-2 (Chinnile)

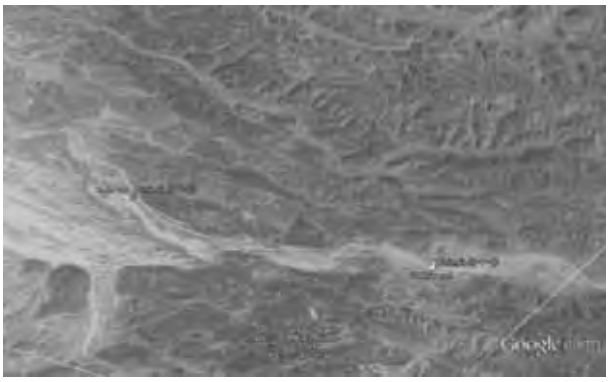
Basic information

Site number	I-1-2
Site name	Chinnile
Region	Dikhil
Type of development	New settlement
Type of water source	Shallow groundwater
Water source facility	Shallow well A
Catchment area	119 km^2

Location

Latitude	N: 11-02.5
Longitude	E: 42-22.4

Map



Evaluation

Score	① Availability of water source	4	16
	② Demand by local community	3	
	③ Accessibility	3	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	3	
	⑥ Water quality	2	
Evaluation rank		A	

Overview

There are some inhabitants using shallow wells at the upstream of the Chinnile Wadi. Despite the availability of flat terraces for farming in particular at the left bank of the wadi, nobody has taken up farming so far. This site is expected to have a potential similar to Afka Arraba in agricultural development if infrastructure such as water-source and irrigation facilities is available. However, this site is less accessible to the local market in Dikhil than Afka Arraba.

Site Photos

Shallow well in use for livestock and human consumption at the upstream of the Chinnile Wadi.

Upstream of the Chinnile Wadi

Downstream of the Chinnile Wadi

MAEPE-RH farmland located at the downstream of the Chinnile Wadi

Remarks

Outline of project candidate site: I-1-3 (Afka-Arraba)

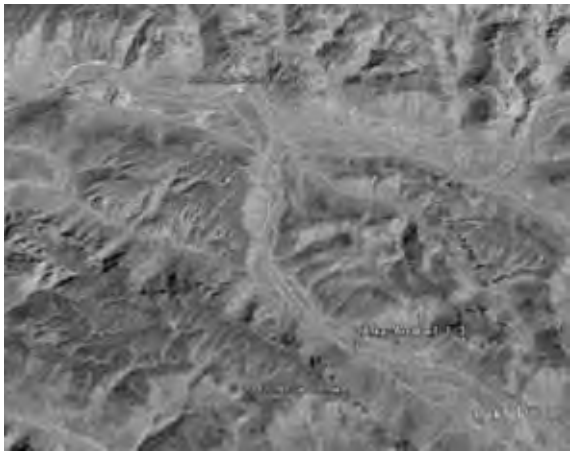
Basic information

Site number	I-1-3
Site name	Afka-Arraba
Region	Dikhil
Type of development	New settlement
Type of water source	Shallow groundwater
Water source facility	Shallow well A
Catchment area	51km^2

Location

Latitude	N: 11-04.5
Longitude	E: 42-24.8

Map



Evaluation

Score	① Availability of water source	4	17
	② Demand by local community	3	
	③ Accessibility	3	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	3	
	⑥ Water quality	3	
Evaluation rank		A	

Overview

This site is located at the upstream of Afka Arraba pilot farm. Despite there are five shallow wells, only two wells are in use at present. Mr. Elmi Waberi, village chef of Afka Arraba lives in this area, and engages in farming on a small scale. To extend his farming further, he needs digging the wells deeper into hard rock layer to extract sufficient water amount for irrigation.

Site Photos

Shallow well built in the wadi

Inside of the shallow well

Overview of the wadi

Overview of the wadi

Remarks

Outline of project candidate site: I-1-5 (Mouloude Quein tributary upstream)

Basic information

Site number	I-1-5
Site name	Mouloude Quein tributary upstream
Region	Dikhil
Type of development	New settlement
Type of water source	Shallow groundwater
Water source facility	Shallow well A
Catchment area	64 km^2

Location

Latitude	N: 11-06.5
Longitude	E: 42-31.7

Map

Evaluation

Score	① Availability of water source	4	16
	② Demand by local community	3	
	③ Accessibility	3	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	3	
	⑥ Water quality	2	
Evaluation rank		A	

Overview

There is a big-size shallow well of 10m in diameter which was built with financial support of ACF (Action against Hunger) and EU. This well has been used for agriculture, livestock and human consumption by around 100 households of Dadaholo. There are two farmlands of 0.5ha each, on which date trees, olive trees and sorghum are cultivated. In addition, another big-size shallow well was built with financial support of ACF downstream. This site is recognized as high potential site in terms of good accessibility and water availability.

Site Photos

Big-size shallow well built with support of ACF and EU.

Farmland near the big-size well

Drip irrigation system has been applied at the farmland.

New big-size shallow well built with support of ACF

Elementary school established two years ago.

Landscape of the wadi

Remarks

Outline of project candidate site: I-1-6 (Arouo downstream)

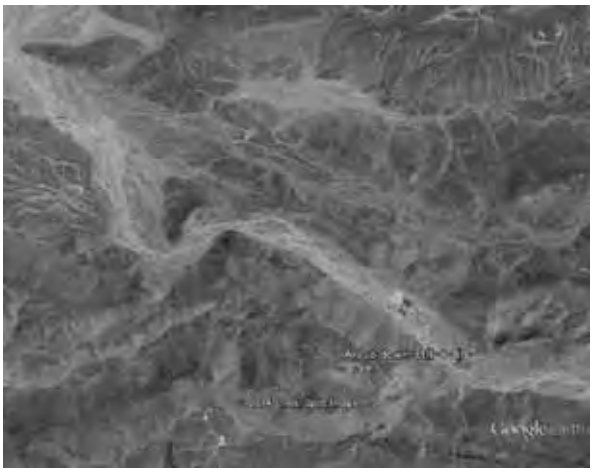
Basic information

Site number	I-1-6
Site name	Arouo downstream
Region	Dikhil
Type of development	New settlement
Type of water source	Shallow groundwater
Water source facility	Shallow well A
Catchment area	21km^2

Location

Latitude	N: 11-07.5
Longitude	E: 42-32.9

Map



Evaluation

Score	① Availability of water source	4	15
	② Demand by local community	3	
	③ Accessibility	3	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	2	
Evaluation rank		A	

Overview

There are four large–scale advanced farmlands irrigated with shallow wells. This site has the potential for expanding farmland by developing water source further more.

Site Photos

Panoramic landscape of the advanced farmland

Onion cultivation

Crop cultivation

Remarks

Outline of project candidate site: I-1-7 (Gablalou)

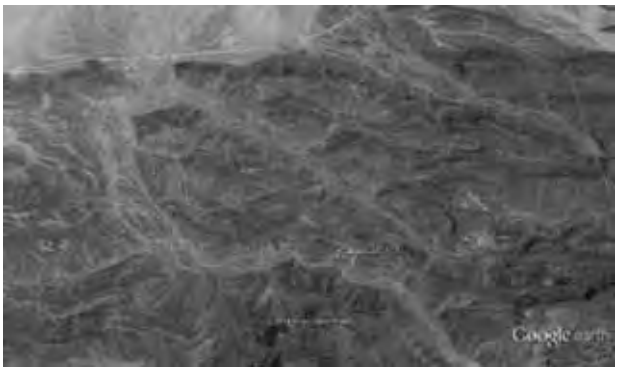
Basic information

Site number	I-1-7
Site name	Gablalou
Region	Dikhil
Type of development	New settlement
Type of water source	Shallow groundwater
Water source facility	Shallow well A
Catchment area	18km^2

Location

Latitude	N: 11-08.7
Longitude	E: 42-35.0

Map



Evaluation

Score	① Availability of water source	4	14
	② Demand by local community	2	
	③ Accessibility	3	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	2	
Evaluation rank		B	

Overview

Six to seven families practice nomadic grazing in the valley of the Gablalou Wadi, which is located about 2km away from National Road No.1. They have received food supply from WFP for the past 10 years. There are three shallow wells: one is abandoned due to flood damage, but water is available in other two wells. Inhabitants use one utilizable well for livestock and human consumption, which was built three years ago at the most downstream stretch of the wadi. They sometimes face water shortage of the well in severe drought year.

Site Photos



Shallow well in use for livestock and human consumption


Landscape of the wadi

Residential houses of nomads

Remarks

Electric Conductivity of the water: EC=1,700μS/cm

Outline of project candidate site: I-1-8 (Aour Adussa)

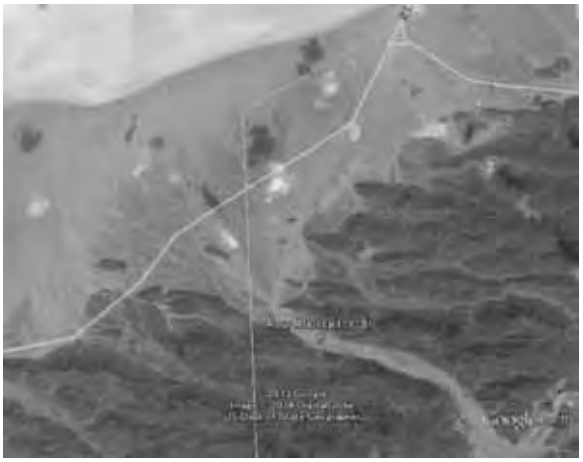
Basic information

Site number	I-1-8
Site name	Aour Adussa
Region	Ali Sabieh
Type of development	New settlement
Type of water source	Shallow groundwater
Water source facility	Shallow well A
Catchment area	20km^2

Location

Latitude	N: 11-10.1
Longitude	E: 42-37.2

Map



Evaluation

Score	① Availability of water source	2	8
	② Demand by local community	1	
	③ Accessibility	1	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	2	
Evaluation rank		D	

Overview

There is no evidence which shows the presence of wells and residences at the site. This site has a possibility of getting water with a shallow well; however, the available water amount might be limited because catchment area of the wadi is small.

Site Photos

Wide landscape of the wadi

Remarks

Outline of project candidate site: I-1-9 (Hambokto)

Basic information

Site number	I-1-9
Site name	Hambokto
Region	Ali Sabieh
Type of development	New settlement
Type of water source	Shallow groundwater
Water source facility	Shallow well A
Catchment area	18km^2

Location

Latitude	N: 11-12.0
Longitude	E: 42-40.5

Map

Evaluation

Score	① Availability of water source	4	16
	② Demand by local community	3	
	③ Accessibility	3	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	3	
	⑥ Water quality	2	
Evaluation rank		A	

Overview

There are lots of shallow wells in use for agriculture, livestock and human consumption. Various sizes of farmlands have been developed at the terraces along the wadi. JICA established a pilot farm of 1ha in 2012 for the purpose of implementing the pilot project of the master plan study. In addition, UNDP built two shallow wells and one small recharge dam in 2013 to enhance effective use of underground water.

Site Photos

Shallow well and the wadi

Developed farmland at the terrace of the wadi

Small recharge dam constructed by UNDP project

Remarks

Outline of project candidate site: I-1-10 (Garaslei)

Basic information		**Location**	
Site number	I-1-10	Latitude	N: 11-18.1
Site name	Garaslei	Longitude	E: 42-43.2
Region	Arta	**Map**	
Type of development	New settlement		
Type of water source	Shallow groundwater		
Water source facility	Shallow well A		
Catchment area	8km^2		

Evaluation

Score	① Availability of water source	1	7
	② Demand by local community	1	
	③ Accessibility	1	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	2	
Evaluation rank		D	

Overview

This site is located behind the existing deep well in the catchment area of Kourtimalei Pond, which was established with financial support of Saudi Arabia. Only one family lives near the deep well site. The site is characterized by sedimentary layers with numbers of big stones. The potential of water-source availability might be low because geological fault and/or crushed zone are not observed in this valley.

Site Photos



Landscape of the valley

Remarks

Outline of project candidate site: I-1-11 (Boelei)

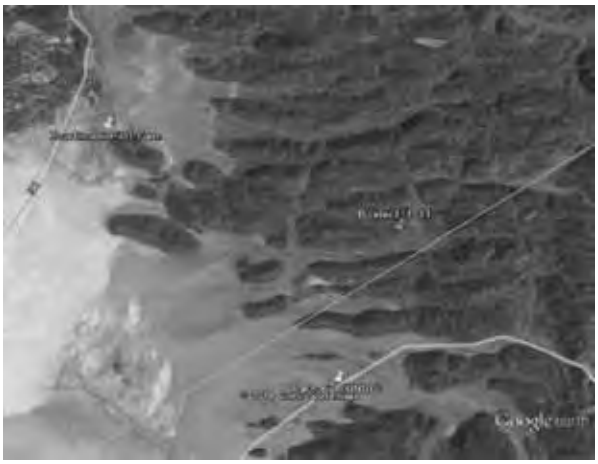
Basic information

Site number	I-1-11
Site name	Boelei
Region	Ali Sabieh
Type of development	New settlement
Type of water source	Shallow groundwater
Water source facility	Shallow well A
Catchment area	12km^2

Location

Latitude	N: 11-17.0
Longitude	E: 42-43.8

Map



Evaluation

Score	① Availability of water source	1	8
	② Demand by local community	1	
	③ Accessibility	2	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	2	
Evaluation rank		D	

Overview

The site is the southern basin neighboring Kourtimalei pond. The access to the site from National Route No.1 is easy when one uses a four-wheel drive car. In the past few years, there have been inhabitants in this area; however, the evidence of a shallow well was not found. Since the trees growing in the valley are always green, this site might have a potential of water source availability.

Site Photos

Landscape of the valley

The slope of the left bank border is constant. This might be resulting from a geological fault.

Trees in the valley are mostly green.

Remarks

Outline of project candidate site: I-1-12 (Kalaloho)

Basic information

Site number	I-1-12
Site name	Kalaloho
Region	Arta
Type of development	New settlement
Type of water source	Shallow groundwater
Water source facility	Shallow well A
Catchment area	37km^2

Location

Latitude	N: 11-29.0
Longitude	E: 42-50.5

Map

Evaluation

Score	① Availability of water source	1	11
	② Demand by local community	2	
	③ Accessibility	3	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	2	
Evaluation rank		C	

Overview

There is one deep well in use at this site. The deep well equipped with solar system was constructed with the financial support of the United States of America. After the solar system broke down, it was replaced by a diesel engine pump.
Seven families practicing cultivation of vegetable and fruit trees are organized as water users association to operate and maintain the diesel engine pump. In terms of ground water availability, this site is considered to have limited potential in developing agriculture by means of the shallow wells.

Site Photos

Upstream of the wadi

Solar system behind is out of order.

Farmland irrigated with deep well

This vegetable nursery is prepared by women.

This mango and lemon fruit garden is also managed by women.

Remarks

The water users association collects monthly water fee from the users, which ranges from 5,000DJF to 1,000DJF according to the scale of the farmland. A monthly 20,000DJF is in total collected: 5,000DJF is paid for fuel, and remaining 15,000DJF is saved for future expense.

Outline of project candidate site: I-1-13 (Boulle biyale)

Basic information	
Site number	I-1-13
Site name	Boulle biyale
Region	Arta
Type of development	New settlement
Type of water source	Shallow groundwater
Water source facility	Shallow well A
Catchment area	17km^2

Location	
Latitude	N: 11-28.5
Longitude	E: 42-58.4

Map

Evaluation

Score	① Availability of water source	4	14
	② Demand by local community	3	
	③ Accessibility	2	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	2	
Evaluation rank		B	

Overview

There are four shallow wells: two wells are unusable due to flood damage, and the other two wells are usable. One of usable wells was built with the financial support of foreign donors, and it is in use for livestock and human consumption.
If additional shallow wells can be constructed, around 10ha of farmland could be developed at this site.

Site Photos

Shallow well in use

This well had been in use in the past years; however, nobody uses it right now after a monkey has fallen to its dearth into the well.

Farmland could be developed at the terrace along the wadi.

Remarks

Electric Conductivity (EC) of the wadi water is 1,020μS/cm.

Outline of project candidate site: I-1-14 (Gachan)

Basic information

Site number	I-1-14
Site name	Gachan
Region	Ali Sabieh
Type of development	New settlement
Type of water source	Shallow groundwater
Water source facility	Shallow well A
Catchment area	22km^2

Location

Latitude	N: 11-27.1
Longitude	E: 42-59.1

Map

Evaluation

Score	① Availability of water source	2	9
	② Demand by local community	1	
	③ Accessibility	2	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	2	
Evaluation rank		C	

Overview

This valley is one of the tributaries of the Boulle Waji. Judging from the site name "Boulle Omane", which means no water, it might be difficult to secure water source here comparing to Boulle Biyale (I-1-14). However, Ministry of Agriculture launched the construction of three small dams along this valley for the purposes of flood control and groundwater recharge. With this project, potential of water source availability is expected to increase significantly upstream and downstream of the small dams' construction site.

Site Photos

Landscape of the Boulle Wadi

Small dam is under construction which is being supervised by Ministry of Agriculture.

Landscape of the upstream of small dam construction site.

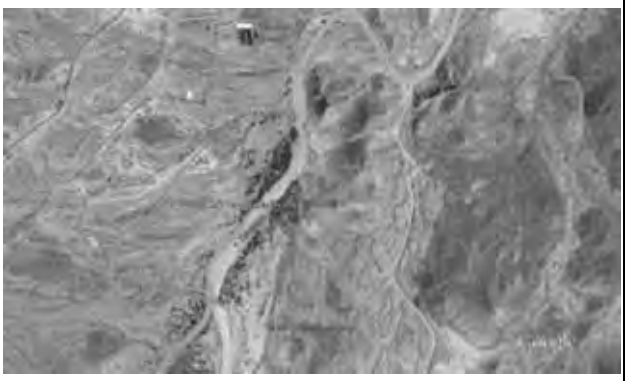
Remarks

Outline of project candidate site: I-1-15 (Darka Dour Yar)

Basic information	
Site number	I-1-15
Site name	Darka Dour Yar
Region	Ali Sabieh
Type of development	New settlement
Type of water source	Shallow groundwater
Water source facility	Shallow well A
Catchment area	67km^2

Location	
Latitude	N: 11-07.6
Longitude	E: 42-41.8

Map



Evaluation

Score	① Availability of water source	4	18
	② Demand by local community	5	
	③ Accessibility	3	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	3	
Evaluation rank		A	

Overview

This site is very close to the provincial capital, Ali Sabieh. In this sense, this site has a big advantage in terms of accessibility to local market in Ali Sabieh. This site is expected to develop as a self-sustain farming model and/or advanced farming model because no nomad people live near the site.

Site Photo

There are lots of shallow wells along the wadi.

Cement plant is located near the site.

Vegetable and fruit tree farming is in practice with existing shallow wells. In most farmland, Ethiopian people are hired as worker.

Remarks

Outline of project candidate site: I-2-1 (Bakkirre)

Basic information

Site number	I-2-1
Site name	Bakkirre
Region	Dikhil
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	43km^2

Location

Latitude	N: 10-56.4
Longitude	E: 41-57.8

Map

Evaluation

Score	① Availability of water source	3	11
	② Demand by local community	2	
	③ Accessibility	1	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	2	
Evaluation rank		C	

Overview

This site is located about 15km west of As Ela town, and is very close to the border of Ethiopia. In addition, access from As Ela to the site is poor. There is one shallow well with a protection wall; however, it is not in use due to flood damage. Meanwhile, traditional shallow wells are available in the site. Five young men can construct a new traditional well within five days. Therefore, there are lots of traditional wells, and these are used by about100 households.

Site Photos

Shallow well damaged by flood

Traditional shallow well is in use.

Trees growing on the side edge of the wadi have fresh green leaves.

Traditional shallow well is in use for human consumption

Traditional shallow well is in use for livestock as well.

Traditional well protected with thorn woods.

Remarks

Water of traditional shallow well is 1,080μS/cm in electric conductivity (EC).

Outline of project candidate site: I-2-2 (Agobarre)

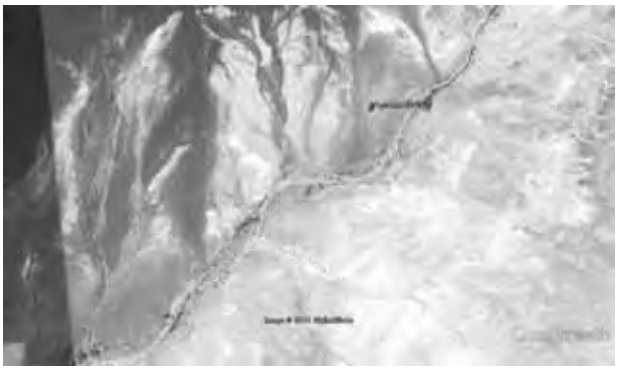
Basic information

Site number	I-2-2
Site name	Agobarre
Region	Dikhil
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	201km^2

Location

Latitude	N: 11-02.5
Longitude	E: 42-03.1

Map



Evaluation

Score	① Availability of water source	3	12
	② Demand by local community	2	
	③ Accessibility	1	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	2	
Evaluation rank		B	

Overview

Only one family practices farming in about 2ha of farmland, which was developed at the right bank terrace of the wadi. Irrigation facilities including shallow well and water tank were set up with financial support from outside in 2009. As for the engine pump, the farmer purchased it on his own through Gobaad agricultural cooperative. Considering that the wadi has large basin area, this site is highly expected to have a potential for water-source development by means of shallow well.

Site Photos

Wide view of the landscape of the wadi

Abandoned shallow well

Farmland of about 2ha

Irrigation water tank

Remarks

Outline of project candidate site: I-2-4 (Kerora)

Basic information	
Site number	I-2-4
Site name	Kerora
Region	Dikhil
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	84km^2

Location	
Latitude	N: 11-46.1
Longitude	E: 42-07.3

Map

Evaluation

Score	① Availability of water source	2	11
	② Demand by local community	1	
	③ Accessibility	2	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	2	
Evaluation rank		C	

Overview

This site is proposed upstream of the wadi which is located beside the beneficiary village, Dabudayya. Water source is sub-surface water with shallow well. Judging from the scale of the wadi, sub-surface water is expected to be abundant. This site is away from the local market and the access to this market is also poor, making it therefore difficult to transport the agricultural products to the market. Considering these conditions, this site is classified into evaluation rank "C".

Site Photos

Upstream side of the wadi

Downstream of the wadi

There are lots of stones at the site.

Remarks

Outline of project candidate site: I-2-5 (Boukboukto)

Basic information	
Site number	I-2-5
Site name	Boukboukto
Region	Dikhil
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	48km^2

Location	
Latitude	N: 11-39.3
Longitude	E: 42-12.3

Map

Evaluation

Score	① Availability of water source	2	9
	② Demand by local community	1	
	③ Accessibility	2	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	1	
Evaluation rank		C	

Overview

This site is located in the central part of Gaggade area. The flat terrain is formed by flood runoff water of the Kerora Wadi, which flows on the northern side of this site. Quality of water taken from the existing traditional shallow well is good for both human consumption and irrigation. Judging from the water quality and soil texture available here, farmlands can be developed in the flat terrain. It is noted that the farmlands should be protected with small dikes, or established in a relatively higher elevation in order to avoid impounding during floods. This site is classified into evaluation rank "C".

Site Photos

		
There are more than 20 residential houses of nomad families at the foot of the mountains.	In time of heavy rainfall, flood flows in the wadi.	Traditional shallow wells have been established here and there, which can be easily made by manpower because soil of the wadi is soft. Water level is less than 1m below the ground surface. Salinity level seems to be not high.

Remarks

Outline of project candidate site: I-2-6 (Sek Sabir)

Basic information

Site number	I-2-6
Site name	Sek Sabir
Region	Dikhil
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	50km^2

Location

Latitude	N: 11-15.8
Longitude	E: 42-13.6

Map

Evaluation

Score	① Availability of water source	3	15
	② Demand by local community	3	
	③ Accessibility	2	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	3	
	⑥ Water quality	2	
Evaluation rank		A	

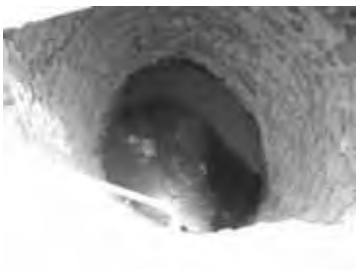
Overview

There is a village where a significant number of nomad families live. In 2012, deep well equipped with solar system was set as drinking and domestic water supply facility under the Japanese grant aid project.
This area is recognized as a potential site of agricultural development because it has several advantages as 1) fairly large basin area, 2) presence of a significant number of inhabitants, and 3) availability of sufficient water amount.

Site Photo

Panoramic landscape of the wadi

Drinking and domestic water supply facility constructed with the support of Japan.



Abandoned shallow well in the wadi

Remarks

Outline of project candidate site: I-2-8 (Gaggade)

Basic information

Site number	I-2-8
Site name	Gaggade
Region	Dikhil
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	445km^2

Location

Latitude	N: 11-27.4
Longitude	E: 42-18.8

Map

Evaluation

Score	① Availability of water source	2	11
	② Demand by local community	2	
	③ Accessibility	1	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	3	
	⑥ Water quality	1	
Evaluation rank		C	

Overview

This site is located downstream of the site I -3-7 (Guidoli). Here, the wadi expands in width, forming the impounding area. High level of salinity is observed at the end of the wadi stream, making therefore the planning of the proposed site upstream of that point. The terrace of the proposed site is about 1 to 2m higher than the bottom of the wadi, on which the proposed farmland will be developed.

Site Photos

The wadi expands in width, forming the impounding area.

Doum palm trees which have resilience against salinity are growing naturally downstream of this site.

Flow path is clearly formed, and the height of the terrace is about 1 to 2m from the bottom of the wadi.

Remarks

Outline of project candidate site: I-2-10 (Dika)

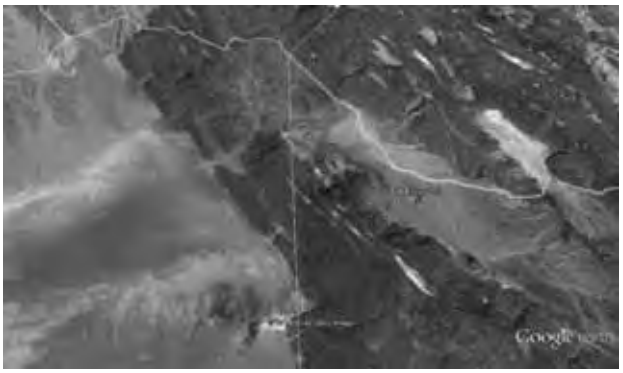
Basic information

Site number	I-2-10
Site name	Dika
Region	Arta
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	193km^2

Location

Latitude	N: 11-30.9
Longitude	E: 42-22.3

Map



Evaluation

Score	① Availability of water source	2	11
	② Demand by local community	2	
	③ Accessibility	2	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	2	
Evaluation rank		C	

Overview

This is the candidate site for irrigation development project by extracting the wadi retaining water through shallow well. Since the catchment area of the wadi is significant large, this site is expected to have a potential of water-source availability. On the other hand, this site has the some disadvantages in terms of accessibility and presence of inhabitants: there is no village with a local market near this site, and the number of inhabitants is limited.

Site Photos

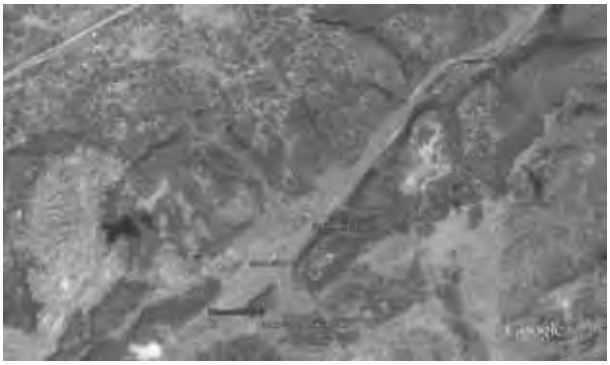
Despite the catchment area of the wadi is large, there is no evidence that shallow wells were built so far.

The cut trees are placed here and there for sale.

Remarks

Outline of project candidate site: I-2-11 (Dhourreh)

Basic information		**Location**	
Site number	I-2-11	Latitude	N: 11-15.9
Site name	Dhourreh	Longitude	E: 42-50.9
Region	Ali Sabieh	**Map**	
Type of development	New settlement		
Type of water source	Sub-surface water		
Water source facility	Shallow well B		
Catchment area	107km^2		



Evaluation

Score	① Availability of water source	3	14
	② Demand by local community	3	
	③ Accessibility	3	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	2	
Evaluation rank		B	

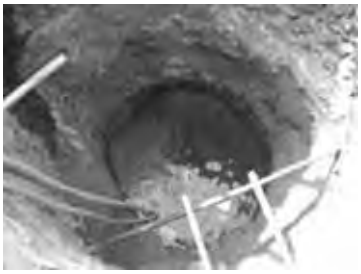
Overview

Farmlands have been developed at the terraces of both banks. Since the catchment area of the wadi is fairly large, this site is expected to have a potential of water-source availability. UNDP implemented an agro-pastoral development project at this site in 2012. A farmland of 12ha was newly developed within UNDP project. It shows that this site has a potential of agricultural development.

Site Photos

Landscape of the wadi

The existing shallow well is in use for agriculture.



Inside of the existing shallow well

Farmland irrigated with the existing shallow well.

This is a signboard of UNDP project which was implemented with the financial support of Japan in 2012.

Remarks

Outline of project candidate site: I-2-12 (Guistir)

Basic information

Site number	I-2-12
Site name	Guistir
Region	Ali Sabieh
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	156km^2

Location

Latitude	N: 11-00.4
Longitude	E: 42-57.6

Map

Evaluation

Score	① Availability of water source	2	8
	② Demand by local community	1	
	③ Accessibility	1	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	2	
Evaluation rank		D	

Overview

This site is located beside Guistir village, which is close to the national border with Ethiopia and Somalia. Judging from that, the basin area of the wadi is large, making the available water amount seemingly sufficient. Nobody has started farming so far, as the inhabitants here have been exclusively relying on nomadic grazing. The site is fairly distant from the local markets of Ali Sabeih, and the road condition to Ali Sabieh is also poor. Accordingly, the target farming model will be home garden farming, which is a small-scale farming with fodder crops and vegetables for self-consumption.

Site Photos

Landscape of the wadi

Number of households fluctuates from 150 to 250 by season.

A primary school was newly constructed at the village.

Several shallow wells and hand pumps have been acquired with the financial support of CIDA (Canadian International Development Agency). However, these facilities are not in use for irrigation.

With the financial support of IFAD, a small dam was constructed to recharge underground water in 2013.

Remarks

Outline of project candidate site: I-2-14 (Hidka Beyya Adde)

Basic information

Site number	I-2-14
Site name	Hidka Beyya Adde
Region	Ali Sabieh
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	333km^2

Location

Latitude	N: 11-14.2
Longitude	E: 43-02.2

Map

Evaluation

Score	① Availability of water source	4	14
	② Demand by local community	3	
	③ Accessibility	1	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	2	
Evaluation rank		B	

Overview

Since the catchment area of the wadi is significant large, this site is expected to have a potential of water-source availability. UNDP project under financial support of Japan developed a farmland of 8ha which was allocated to 32 households. Within this project, four water tanks and two shallow wells were established for the purpose of irrigation. This site has a potential of available water to be taken through shallow wells. The biggest challenge is accessibility to local market. The distance to Ali Sabeih is about 25km, and road condition from Ali Sabieh to this site is bad.

Site Photos

Wide landscape of the wadi

Existing shallow well and intake pump

Farmland of 8ha being allocated to 32 households was developed by UNDP project under financial support of Japan. Within this project, four water tanks and two shallow wells were established for the purpose of irrigation.

Remarks

Water quality: pH=8.2, EC=1,700μs/cm

Outline of project candidate site: I-2-15 (Midgarra)

Basic information

Site number	I-2-15
Site name	Midgarra
Region	Ali Sabieh
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	78km^2

Location

Latitude	N: 11-09.9
Longitude	E: 42-58.6

Map

Evaluation

Score	① Availability of water source	4	16
	② Demand by local community	5	
	③ Accessibility	2	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	1	
Evaluation rank		A	

Overview

The traditional shallow well has been used for livestock and human consumption by more than 200 households. Another shallow well was built by local people themselves in 2006 at about 1km downstream of the traditional well, and protection work was done with the financial support of Kuwait in 2012. Inhabitants practice farming at two sites about 0.5ha each by using this well since 2008. However, water quality is not good even for irrigation, because electric conductivity is quite-high 3,610μS/cm. Meanwhile, the water supply facility was completed under the Japanese grand aid project in 2013. In the future, the population is expected to increase in this site.

Site Photos

Traditional shallow well is built inside the wadi.

Water quality of the traditional shallow well is fairly good, EC=1,204μS/cm.

This shallow well is utilized for irrigation.

These are the farmlands irrigated by the shallow well, where date, guava, mango, orange, pepper, tomato, onion and sorghum are planted.

Water supply facility was constructed with the support of Japan in 2013.

Remarks

Outline of project candidate site: I-2-16 (Dihda Ouead)

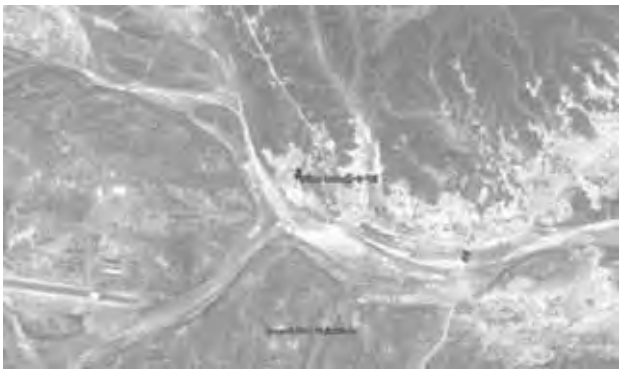
Basic information

Site number	I-2-16
Site name	Dihda Ouead
Region	Arta
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	70km^2

Location

Latitude	N: 11-31.2
Longitude	E: 43-05.0

Map



Evaluation

Score	① Availability of water source	2	8
	② Demand by local community	1	
	③ Accessibility	1	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	2	
Evaluation rank		D	

Overview

Water is retained as sub-surface water in the Dihda Ouead Wadi that is a tributary of the Ambouli Wadi. Thick silty sediment layer is widely observed in the stream bottom of the wadi. In addition, the scale of the flood is supposed to be big at this site. There is one farmland beside the wadi; however, the owner gets irrigation water by using water tanks. Accordingly, people here have never used shallow wells so far. Taking the above presented aspects into consideration, this site has low potential as a candidate site for water-source development. Furthermore, it has less prospect as a candidate site for agricultural development.

Site Photos

Wide landscape of the wadi

Remarks

Outline of project candidate site: I-2-17 (Ambouli downstream)

Basic information

Site number	I-2-17
Site name	Ambouli downstream
Region	Arta
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	-

Location

Latitude	N: 11-31.6
Longitude	E: 43-07.5

Map

Evaluation

Score	① Availability of water source	2	11
	② Demand by local community	2	
	③ Accessibility	1	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	2	
Evaluation rank		C	

Overview

The Ambouli Wadi narrows suddenly at the entrance of the suburbs of Djibouti city. It is therefore well known that the scale of the flooding is so big at this point. Without construction of flood control dam upstream, water-source development by means of shallow wells would be difficult. Meanwhile, accessibility to huge market in Djibouti City is good because this site is located very close to the national capital of Djibouti. Judging in a comprehensive manner, this site has less prospect as a candidate site for agricultural development.

Site Photo

Wide landscape of the basin area

Downstream of the wadi

Irrigation pump is temporarily placed beside the wadi to pump up surface flow water.

Upstream of the wadi

Remarks

Outline of project candidate site: I-2-19 (Damerdjog)

Basic information

Site number	I-2-19
Site name	Damerdjog
Region	Arta
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	45km^2

Location

Latitude	N: 11-29.5
Longitude	E: 43-11.2

Map

Evaluation

Score	① Availability of water source	2	11
	② Demand by local community	2	
	③ Accessibility	2	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	1	
Evaluation rank		C	

Overview

The upstream area of Damerdjog is not included as target area of the master study because the water source is deep well. Meanwhile, the downstream area of Damerdjog is included as target area because the water source is shallow well. Considering that a small village is located near the downstream area, this site is regarded to have needs for agricultural development.

Site Photo

The deep well was recently rehabilitated by ONEAD upstream of Damerdjog. It supplies drinking water to the village free of charge.

At the upstream area of Damerdjog, the farmlands are irrigated by the water supplied from the deep well.

There are three shallow wells at the downstream area of Damerdjog, Farming is not so active near the shallow wells probably due to high level of salt concentration.

Remarks

Outline of project candidate site: I-2-20 (Goum-Bourta)

Basic information

Site number	I-2-20
Site name	Goum-Bourta
Region	Arta
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	267km^2

Location

Latitude	N: 11-29.1
Longitude	E: 43-13.4

Map

Evaluation

Score	① Availability of water source	3	11
	② Demand by local community	1	
	③ Accessibility	2	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	1	
Evaluation rank		C	

Overview

The soil is strongly affected by salt concentration because the site is very close to seaside. There are some evidences that farming had been done in past years; however, there are no shallow wells and farmland in use right now. Dispite the Atar Wadi seems to have a potential of water-source availability, the priority of this site is not high in consideration of the situation mentioned above.

Site Photos

Downstream of the Atar Wadi is small in size.

An abandoned shallow well located beside National Road No.2.

Soil surface of the Atar Wadi is reddish due to salinity concentration.

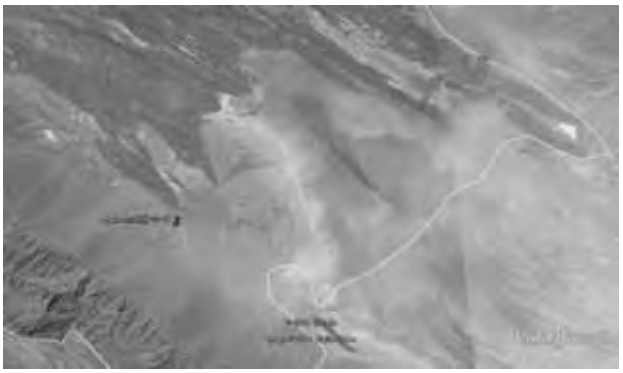
Remarks

Outline of project candidate site: I-3-1 (Agna south)

Basic information	
Site number	I-3-1
Site name	Agna south
Region	Dikhil
Type of development	New settlement
Type of water source	Surface flow water
Water source facility	Reservoir by Barrage
Catchment area	90km^2

Location	
Latitude	N: 11-32.2
Longitude	E: 41-54.1

Map



Evaluation

Score	① Availability of water source	3	12
	② Demand by local community	2	
	③ Accessibility	1	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	2	
Evaluation rank		B	

Overview

This site is located about 13km away from the border of Ethiopia, and about 25km away from the local town, Yoboki. Around 100 households live in this area. The target farming model would be home garden farming, which is a small-scale farming with fodder crops and vegetables for self-consumption.

Site Photos

This is a panoramic landscape of the site. As shown on the photo, an alluvial fan is formed with a gentle slope starting from the right side to the left side. Flood runoff water can be effectively collected and stored by constructing a dike (2 to 3km in length) around the alluvial fan.

A traditional shallow well built in the wadi is in use for human and livestock consumption. Water level is about 1m below the ground surface of the wadi.

Remarks

Outline of project candidate site: I-3-2 (Dahhoto)

Basic information

Site number	I-3-2
Site name	Dahhoto
Region	Dikhil
Type of development	New settlement
Type of water source	Surface flow water
Water source facility	Reservoir by Barrage
Catchment area	114km^2

Location

Latitude	N: 11-37.6
Longitude	E: 41-57.8

Map

Evaluation

Score	① Availability of water source	2	8
	② Demand by local community	1	
	③ Accessibility	1	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	1	
Evaluation rank		D	

Overview

Soil salinity contamination is high around this site; therefore, this candidate site is regarded as having a low potential for agricultural development.

Site Photos

Panoramic landscape of Dahhoto

Salt contamination is observed on the surface of the wadi.

There is a spring inside the grove of dome trees. Spring water is available throughout the year, and salinity level is not so high; therefore spring water is used as drinking water by inhabitants.

Remarks

Outline of project candidate site: I-3-3 (Gara Abbouri)

Basic information	
Site number	I-3-3
Site name	Gara Abbouri
Region	Dikhil
Type of development	New settlement
Type of water source	Surface flow water
Water source facility	Reservoir by Barrage
Catchment area	56km^2

Location	
Latitude	N: 11-29.0
Longitude	E: 41-58.5

Map

Evaluation

Score	① Availability of water source	3	11
	② Demand by local community	1	
	③ Accessibility	1	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	3	
Evaluation rank		C	

Overview

It is possible to store runoff water from the catchment area by making a dike (2 to 3km in length) which encloses the alluvial fan. However, the number of nomad households is limited around this site.

Site Photos

An alluvial fan is formed with runoff water from the valley as shown in the middle of the photo.

The alluvial fan has a number of scattered small wadi streams.

Nomad residences are scattered around this site.

Remarks

Outline of project candidate site: I-3-4 (Dawwano)

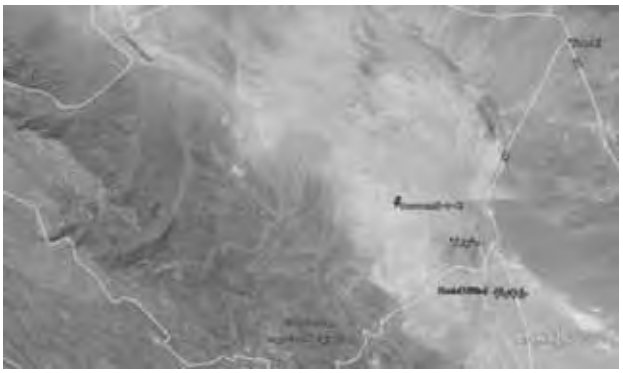
Basic information

Site number	I-3-4
Site name	Dawwano
Region	Dikhil
Type of development	New settlement
Type of water source	Surface flow water
Water source facility	Reservoir by Barrage
Catchment area	37km^2

Location

Latitude	N: 11-26.8
Longitude	E: 42-02.2

Map



Evaluation

Score	① Availability of water source	2	11
	② Demand by local community	1	
	③ Accessibility	2	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	3	
Evaluation rank		C	

Overview

This site is located along the tributary that flows into the main wadi stream in Hanlle Plain. A pond can be made by shutting flood flow with a dike at the tributary of the wadi. However, the number of nomad households is limited around this site.

Site Photos

This is the photo of the wadi; however, the wadi stream is not clearly observed.

Nomad residences are scattered around this site.

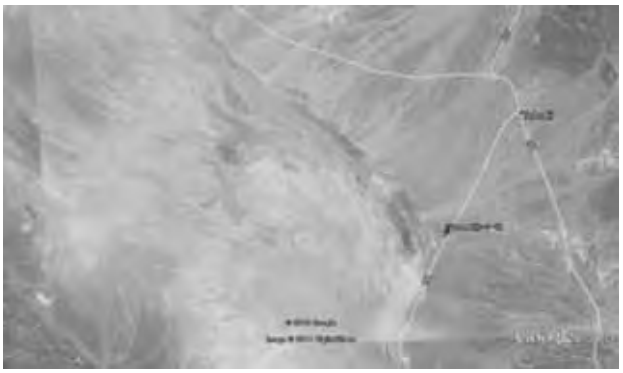
Remarks

Outline of project candidate site: I-3-5 (Yoboki)

Basic information	
Site number	I-3-5
Site name	Yoboki
Region	Dikhil
Type of development	New settlement
Type of water source	Surface flow water
Water source facility	Reservoir by Barrage
Catchment area	113km^2

Location	
Latitude	N: 11-28.5
Longitude	E: 42-05.0

Map



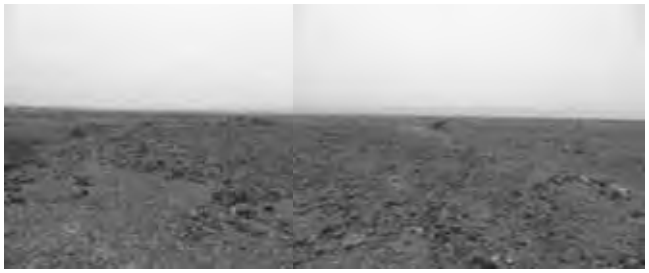
Evaluation

Score	① Availability of water source	3	14
	② Demand by local community	2	
	③ Accessibility	2	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	3	
Evaluation rank		B	

Overview

This area is alluvial fan that was formed by several streams of the wadi crossing National Route No.1. There are lots of candidate sites suitable for new reservoirs or ponds, which would be built with dikes in parallel to National Route No.1 in order to collect runoff surface water during floods. The site is close to Yoboki town; therefore, it is not difficult to access the local market of Yoboki town for selling the agricultural product.

Site Photos



Panoramic landscape of the candidate site for the pond which helps to collect and store runoff water during floods.

The wadi is crossing National Road No.1

Remarks

Outline of project candidate site: I-3-6 (Soulaitou)

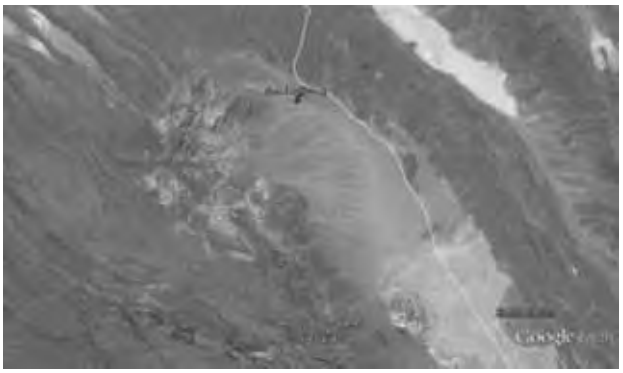
Basic information

Site number	I-3-6
Site name	Soulaitou
Region	Dikhil
Type of development	New settlement
Type of water source	Surface flow water
Water source facility	Reservoir by Barrage
Catchment area	67km^2

Location

Latitude	N: 11-45.5
Longitude	E: 42-09.4

Map



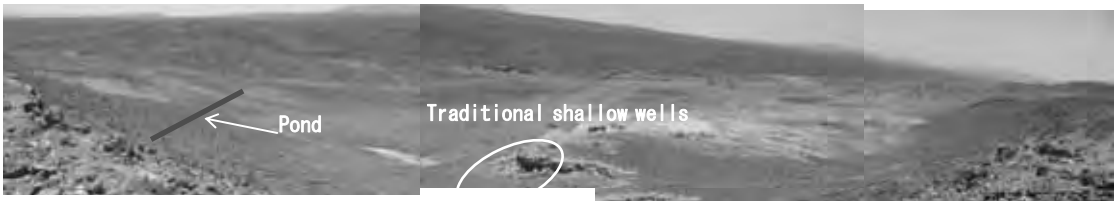
Evaluation

Score	① Availability of water source	2	11
	② Demand by local community	2	
	③ Accessibility	1	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	3	
Evaluation rank		C	

Overview

This site is located about 1km north of the small village, Dabudayya. There are about 10 traditional wells in use for human consumption. Judging from the topographic feature, this site is regarded having an advantage to collect and store wadi water. Thus, shallow well water is available throughout the year. A pond can be proposed upstream of the existing traditional wells. To ensure a sufficient catchment area, it is also proposed to make a connecting open canal that will divert water of the Karora Wadi. Since this site is far away from major local towns, and access to this site is poor, the evaluation rank is classified into "C".

Site Photos



Panoramic landscape of the proposed pond site and existing traditional wells

There are about 200 households in Dabudayya, and a school for the children.

Two sets of solar panels for drinking water supply are established.

This is the photo of a traditional well with stone cover. Water level is about 1m below the ground surface.

Remarks

Outline of project candidate site: I-3-7 (Guidoli)

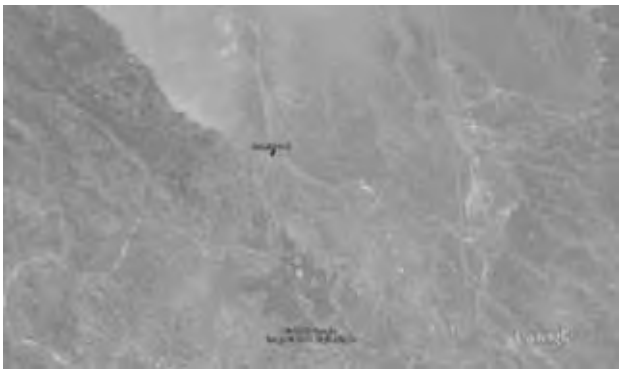
Basic information

Site number	I-3-7
Site name	Guidoli
Region	Dikhil
Type of development	New settlement
Type of water source	Surface flow water
Water source facility	Reservoir by Barrage
Catchment area	153km^2

Location

Latitude	N: 11-24.2
Longitude	E: 42-19.0

Map



Evaluation

Score	① Availability of water source	2	11
	② Demand by local community	1	
	③ Accessibility	2	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	2	
Evaluation rank		C	

Overview

This is the candidate site for the pond planned as water source for the development of southern Gaggade area. The wadi is clearly formed with terraces at the southern edge through converging runoff water flows from the southern basin area. The proposed pond, which is expected to have a capacity of about 1 million m^3, can be made by damming up water flow of the wadi with a dike having 5m in height. Farmlands can be developed at the terraces of the wadi as well. However, the development priority of this site is not high because the number of inhabitants is limited.

Site Photos

Panoramic landscape of the wadi

Upstream of the proposed pond site

Downstream of the proposed pond site

Remarks

Outline of project candidate site: I-3-8 (Dika)

Basic information

Site number	I-3-8
Site name	Dika
Region	Arta
Type of development	New settlement
Type of water source	Surface flow water
Water source facility	Reservoir by Barrage
Catchment area	107km^2

Location

Latitude	N: 11-32.9
Longitude	E: 42-21.1

Map

Evaluation

Score	① Availability of water source	3	11
	② Demand by local community	1	
	③ Accessibility	1	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	3	
Evaluation rank		C	

Overview

Since the catchment area of the wadi is fairly large, this site has a potential of water-source availability. However, this site has some disadvantages in terms of accessibility and presence of inhabitants: there is no village with a local market near this site, and the number of inhabitants is also limited.

Site Photos

Panoramic landscape of the wadi where the reservoir is proposed as a means of water source for irrigation. Salinity contamination level may be high considering that dome trees grow here and there inside the wadi.

The proposed reservoir site is located behind this point.

Remarks

Outline of project candidate site: I-3-9 (Koussour)

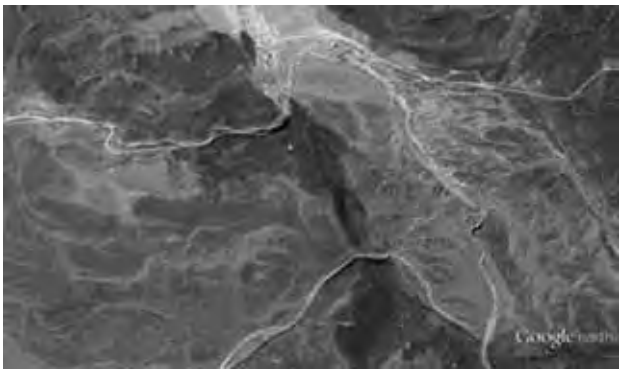
Basic information

Site number	I-3-9
Site name	Koussour
Region	Arta
Type of development	New settlement
Type of water source	Surface flow water
Water source facility	Reservoir by Barrage
Catchment area	95km^2

Location

Latitude	N: 11-30.8
Longitude	E: 42-24.6

Map



Evaluation

Score	① Availability of water source	2	12
	② Demand by local community	3	
	③ Accessibility	2	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	3	
Evaluation rank		B	

Overview

The catchment area of the wadi is fairly-large; therefore, this site is expected to have a potential of water-source availability. Since the deep well was built with the support of Saudi Arabia, numbers of nomad families had settled nearby. Meanwhile, this site has a disadvantage of accessibility to local market because there is no town nearby.

Site Photo

Panoramic landscape of the wadi where the pond is planned as a means of developing a water-source for irrigation. The candidate site of the proposed pond is behind the right side on the panoramic photo above.

A deep well with solar system was built with the support of Saudi Arabia. More or less 100 nomad families living around here have been using the deep well for livestock and human consumption. When an irrigated farm is developed with the reservoir, they could start farming to cultivate vegetable for self-consumption and fodder crops for livestock.

Remarks

Outline of project candidate site: I-3-10 (Safari Golla)

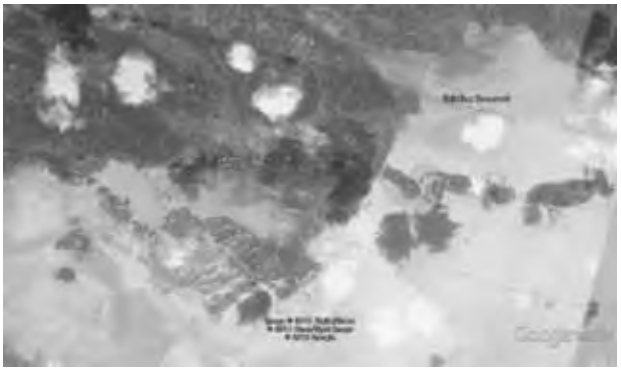
Basic information

Site number	I-3-10
Site name	Safari Golla
Region	Arta
Type of development	New settlement
Type of water source	Surface flow water
Water source facility	Reservoir by Barrage
Catchment area	38km^2

Location

Latitude	N: 11-14.8
Longitude	E: 42-32.5

Map



Evaluation

Score	① Availability of water source	2	11
	② Demand by local community	2	
	③ Accessibility	1	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	3	
Evaluation rank		C	

Overview

The same type of reservoir or pond as the existing one (refer to photos below) would be proposed for this site. Run-off surface water could be certainly collected and stored with this type of reservoir. Meanwhile, there is no inhabitant at all around here. The priority of this site is regarded low in term of agricultural development.

Site Photos

Panoramic landscape of the candidate site

Existing pond built nearby the candidate site

Remarks

Outline of project candidate site: I-3-11 (Gabla Oalan)

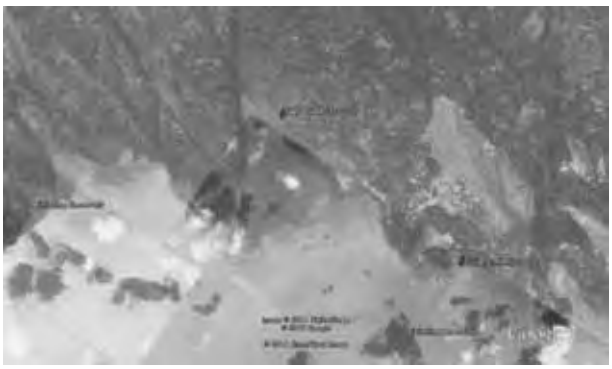
Basic information

Site number	I-3-11
Site name	Gabla Oalan
Region	Arta
Type of development	New settlement
Type of water source	Surface flow water
Water source facility	Reservoir by Barrage
Catchment area	44km^2

Location

Latitude	N: 11-17.7
Longitude	E: 42-35.4

Map



Evaluation

Score	① Availability of water source	2	11
	② Demand by local community	2	
	③ Accessibility	1	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	3	
Evaluation rank		C	

Overview

Approximately, 500 inhabitants live in the vicinity of the deep well which was built with financial support of Saudi Arabia in 2005. There is no farmland around here at present; however, this site could be classified as high priority site for agricultural development. In an interview, an inhabitant told that he has strong interest in JICA pilot project being undertaken in Kourtimalei.

Site Photo

Deep well built with the financial support of Saudi Arabia in 2005.

Project signboard placed at the entrance of the deep well

Inhabitants use the water extracted from the deep well for livestock and human consumption.

Landscape of the Gabla Galla Wadi

Remarks

Outline of project candidate site: I-3-13 (Elka Hadad)

Basic information

Site number	I-3-13
Site name	Elka Hadad
Region	Arta
Type of development	New settlement
Type of water source	Surface flow water
Water source facility	Reservoir by Barrage
Catchment area	65km^2

Location

Latitude	N: 11-15.6
Longitude	E: 42-40.4

Map

Evaluation

Score	① Availability of water source	3	15
	② Demand by local community	3	
	③ Accessibility	3	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	3	
Evaluation rank		A	

Overview

The proposed site for new pond would be selected between Natinal Road No.1 and the high-voltage electrical power lines running in parallel. There is the evidence of a dike built in the past to catch run-off water. At this site, an excavated type of pond would be proposed.

Site Photos

Wide landscape of the candidate site

Remarks

Outline of project candidate site: I-3-15 (Didjan der tributary)

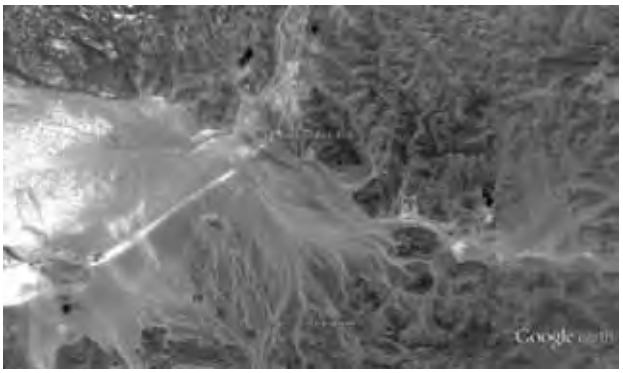
Basic information

Site number	I-3-15
Site name	Didjan der tributary
Region	Arta
Type of development	New settlement
Type of water source	Surface flow water
Water source facility	Reservoir by Barrage
Catchment area	37km^2

Location

Latitude	N: 11-21.1
Longitude	E: 42-43.0

Map



Evaluation

Score	① Availability of water source	3	15
	② Demand by local community	3	
	③ Accessibility	3	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	3	
Evaluation rank		A	

Overview

This site is located in the eastern basin next to Kourtimalei basin. Taking the moderate basin area and the big number of beneficiaries into consideration, this site has same potential as Kourtimalei for agricultural development.

Site Photo

Panoramic landscape of the candidate site

There is a big nomad camp near the candidate site (4 - 5km, eastward); therefore, the number of the beneficiaries is big.

There is the evidence of an abandoned farmland of about 15ha. The farmland was developed by Ministry of Agriculture in the past; however, it was abandoned as shown in the photos above due to lack of water-source.

Remarks

Outline of project candidate site: I-4-1 (Boule middle stream)

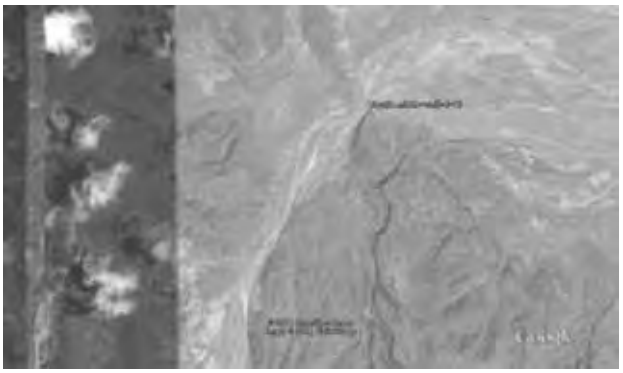
Basic information

Site number	I-4-1
Site name	Boule middle stream
Region	Arta
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Sub-surface dam
Catchment area	46km^2

Location

Latitude	N: 11-30.6
Longitude	E: 43-01.0

Map



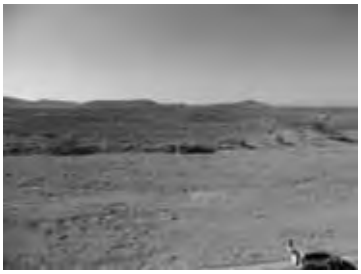
Evaluation

Score	① Availability of water source	2	13
	② Demand by local community	3	
	③ Accessibility	3	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	2	
Evaluation rank		B	

Overview

A sub-surface dam would be proposed at this site to ensure steady water supply for irrigation. With the sub-surface dam, run-off surface water could be effectively stored into the underground sedimentary layers upstream of the dam. The development of farmlands could be proposed at the terraces of both banks of the wadi; in this regard, the left bank is more promising because it has a larger flat area than the right bank.

Site Photos



The wadi is wide and flat upstream of the proposed sub-surface dam site.

This is the candidate sub-surface dam site. The proposed dam axis is estimated at about 50m in width.

Remarks

Outline of project candidate site: I-4-2 (Mouloude ouein tributary middle-stream)

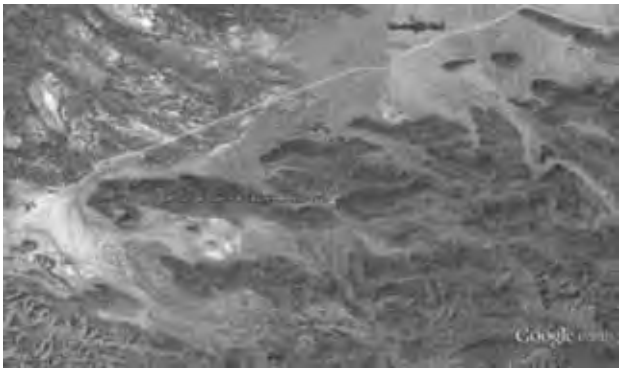
Basic information

Site number	I-4-2
Site name	Mouloude ouein tributary middlestraem
Region	Arta
Type of development	New settlement
Type of water source	Sub-surface water
Water source facility	Sub-surface dam
Catchment area	27km^2

Location

Latitude	N: 11-07.7
Longitude	E: 42-29.1

Map



Evaluation

Score	① Availability of water source	3	13
	② Demand by local community	3	
	③ Accessibility	2	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	2	
Evaluation rank		B	

Overview

There is a narrow point about 100m in width between two hills at the tributary middle stream of the Mouloude Ouein Wadi. A huge plain area stretches out upstream of this point, and a number of trees are also observed along the wadi. In fact, shallow groundwater is certainly retained upstream. If the sub-surface dam is constructed at this point, the retaining of the groundwater will be significantly enhanced upstream of the wadi.

Site Photos

The proposed sub-surface dam site

Remarks

Outline of project candidate site: II-1-1 (Kouta Bouyya)

Basic information

Site number	II-1-1
Site name	Kouta Bouyya
Region	Dikhil
Type of development	Rehabilitation
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	256km^2

Location

Latitude	N: 11-00.9
Longitude	E: 41-58.2

Map

Evaluation

Score	① Availability of water source	5	19
	② Demand by local community	4	
	③ Accessibility	2	
	④ Farmland condition	3	
	⑤ Presence of inhabitants	3	
	⑥ Water quality	2	
Evaluation rank		A	

Overview

There are three usable shallow wells in the wadi; however, only one well is in use for human consumption. Despite farming had been done until 10 years ago, there is no farmland at present. The population of Kouta Bouyya is fairly large, but the place is located away from the local market, As Ela. For this site, a farming model mainly destined for self consumption will be proposed.

Site Photos

Panoramic landscape of the wadi

The water table in the wadi is high after a rainfall.

This well seems to be in use, because a new engine pump is placed at the top of the well.

This shallow well is not in use, but seems to be usable.

This shallow well is not in use as well. However, a water tank connected with this well was constructed in 2012.

Remarks

Outline of project candidate site: II-1-2 (Gobaad As-Ela)

Basic information

Site number	II-1-2
Site name	Gobaad As-Ela
Region	Dikhil
Type of development	Rehabilitation
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	428km^2

Location

Latitude	N: 11-00.0
Longitude	E: 42-06.0

Map

Evaluation

Score	① Availability of water source	5	22
	② Demand by local community	5	
	③ Accessibility	3	
	④ Farmland condition	3	
	⑤ Presence of inhabitants	3	
	⑥ Water quality	3	
Evaluation rank		A	

Overview

Gobaad As Ela is well known as being the biggest agricultural region in Djibouti in the past. However, a great number of shallow wells and broad farmlands were heavily damaged by repeated floods. As a result, most shallow wells are still abandoned due to no financial support from outside. The rehabilitation of the wells could be easily worked out by utilizing heavy construction machines owned by the Ministry of Agriculture. This site is expected to regain prosperity as an advanced agricultural region.

Site Photos

Great numbers of shallow wells were damaged by flooding. Irrigation water use is not available here because the damaged wells are not rehabilitated yet.

This is an abandoned farmland.

This is a shallow well that was recently rehabilitated by the owner himself. He started farming with the rehabilitated well and newly purchased engine pump.

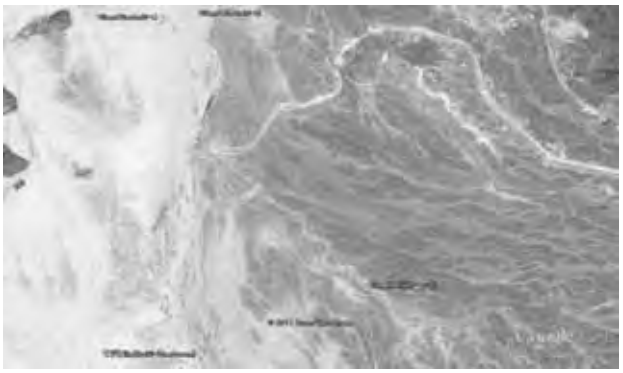
Remarks

Outline of project candidate site: II-1-3 (Chekheiti)

Basic information	
Site number	II-1-3
Site name	Chekheiti
Region	Dikhil
Type of development	Rehabilitation
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	245km^2

Location	
Latitude	N: 11-05.7
Longitude	E: 42-18.6

Map



Evaluation

Score	① Availability of water source	5	16
	② Demand by local community	4	
	③ Accessibility	2	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	1	
	⑥ Water quality	3	
Evaluation rank		A	

Overview

There are some farmlands which were developed in the right bank upstream and downstream of Chekheiti Wadi. Water seems to be sufficient for irrigation, and also access to Dikhil is good. This site is regarded to have a high potential for agricultural development.

Site Photos



Upstream of the Chekheiti Wadi, there are six farmlands irrigated with shallow wells. Farmers own only one engine pump, which they share for irrigation.



Downstream of the Chekheiti Wadi, there are some small farmlands irrigated with five shallow wells. Products are shipped to small markets of the surrounding villages and also to the bigger Dikhil market and/or Djibouti depending on yield amount.

Remarks

Outline of project candidate site: II-1-4 (Douda)

Basic information

Site number	II-1-4
Site name	Douda
Region	Arta
Type of development	Rehabilitation
Type of water source	Sub-surface water
Water source facility	Shallow well B
Catchment area	67km^2

Location

Latitude	N: 11-31.6
Longitude	E: 43-09.3

Map

Evaluation

Score	① Availability of water source	4	18
	② Demand by local community	5	
	③ Accessibility	3	
	④ Farmland condition	2	
	⑤ Presence of inhabitants	3	
	⑥ Water quality	1	
Evaluation rank		A	

Overview

Douda is known as a big agricultural region located in the suburbs of the biggest Djibouti city market. However, a great number of shallow wells were heavily damaged by the repeated floods. This site includes two wadi, big Douda and small Douda. With the rehabilitation work of the damaged shallow wells, Douda is expected to regain prosperity as an agricultural region.

Site Photos



【Big Douda】
Most wells were damaged by floods. At present, about 50 out of 300 wells are in use.



【Small Douda】
A small wadi runs in parallel with a big wadi in the south. There are some farmlands (0.5 to 1.0ha) which are owned by single proprietors; however, only one farmland is well managed by hired workers. This site is regarded to have high needs for expanding irrigated farmlands because there is a village nearby where numbers of inhabitants live.

Remarks

Outline of project candidate site: II-2-1 (Didjan Der)

Basic information

Site number	II-2-1
Site name	Didjan Der
Region	Arta
Type of development	Rehabilitation
Type of water source	Surface flow water
Water source facility	Reservoir by barrage
Catchment area	116km^2

Location

Latitude	N: 11-22.7
Longitude	E: 42-44.7

Map

Evaluation

Score	① Availability of water source	3	15
	② Demand by local community	4	
	③ Accessibility	2	
	④ Farmland condition	1	
	⑤ Presence of inhabitants	2	
	⑥ Water quality	3	
Evaluation rank		A	

Overview

Near PK58, there is a pond whose embankment was partially washed away by floods. The length of the embankment to be rehabilitated is just about 500m; therefore, the rehabilitation will be done easily by utilizing heavy construction machine owned by the Ministry of Agriculture. This site is located opposite to the candidate site I-3-15 (Didjan Der Tributary) by National Road No.1. In terms of presence of inhabitants, this site also has a priority as a rehabilitation project site.

Site Photos

Wide landscape of the pond

Upstream of the embankment washed away

Remarks

Appendix 11: Project Cost Estimations (1/3)

Development type	Water source facility	Water resource	Site number	Site name	Evaluation rank	Irrigation farming model	Development farm land (ha)	Project cost					
								Construction cost DJF	Supporting cost for framing DJF	Training cost DJF	Consultant fee DJF	Project management cost DJF	Total (2014) DJF
New development	Shallow well(A)	Shallow groundwater	I -1-1	Bondara	A	SW-B	17	158,041,000	5,525,000	1,680,000	7,902,000	4,957,000	178,105,000
			I -1-2	Chinnile	A	SW-B	24	222,552,000	7,800,000	1,680,000	11,127,000	6,960,000	250,119,000
			I -1-3	Afka-Arraba	A	SW-B	10	93,646,000	3,250,000	1,680,000	4,682,000	2,957,000	106,215,000
			I -1-5	Mouloude Ouein tributary up-st.	A	SW-B	13	122,782,000	4,225,000	1,680,000	6,139,000	3,860,000	138,686,000
			I -1-6	Arouo down-st.	A	SW-B	4	38,886,000	1,300,000	1,680,000	1,944,000	1,255,000	45,065,000
			I -1-7	Gablalou	B	SW-H	4	10,618,000	2,688,000	1,440,000	530,000	442,000	15,718,000
			I -1-8	Aour adussa	D	SW-H	4	10,618,000	2,688,000	1,440,000	530,000	442,000	15,718,000
			I -1-9	Hambokto	A	SW-B	4	38,886,000	1,300,000	1,680,000	1,944,000	1,255,000	45,065,000
			I -1-10	Garaslei	D	SW-H	2	5,250,000	1,344,000	1,440,000	262,000	241,000	8,537,000
			I -1-11	Boelei	D	SW-H	2	5,250,000	1,344,000	1,440,000	262,000	241,000	8,537,000
			I -1-12	Kalaloho	C	SW-B	7	66,266,000	2,275,000	1,680,000	3,313,000	2,106,000	75,640,000
			I -1-13	Boulle biyale	B	SW-H	3	7,934,000	2,016,000	1,440,000	396,000	341,000	12,127,000
			I -1-14	Gachan	C	SW-H	4	10,618,000	2,688,000	1,440,000	530,000	442,000	15,718,000
			I -1-15	Darka Doun Yar	A	SW-B	13	122,782,000	4,225,000	1,680,000	6,139,000	3,860,000	138,686,000
	Shallow well(B)	Sub-surface water	I -2-1	Bakkirre	C	SW-H	17	14,295,000	11,424,000	1,440,000	714,000	814,000	28,687,000
			I -2-2	Agobarre	B	SW-B	16	117,823,000	5,200,000	1,680,000	5,891,000	3,741,000	134,335,000
			I -2-4	Kerora	C	SW-H	33	24,899,000	22,176,000	1,440,000	1,244,000	1,455,000	51,214,000
			I -2-5	Boukboukto	C	SW-H	19	16,059,000	12,768,000	1,440,000	802,000	908,000	31,977,000
			I -2-6	Sek Sabir	A	SW-B	20	145,875,000	6,500,000	1,680,000	7,293,000	4,621,000	165,969,000
			I -2-8	Gaggade	C	SW-H	15	13,232,000	10,080,000	1,440,000	661,000	742,000	26,155,000
			I -2-10	Dika	C	SW-H	15	13,232,000	10,080,000	1,440,000	661,000	742,000	26,155,000
			I -2-11	Dhourreh	B	SW-B	43	310,333,000	13,975,000	1,920,000	15,516,000	9,786,000	351,530,000
			I -2-12	Gusistir	D	SW-H	12	11,288,000	8,064,000	1,440,000	564,000	623,000	21,979,000
			I -2-14	Hidka Beyya Adde	B	SW-H	26	20,128,000	17,472,000	1,440,000	1,006,000	1,171,000	41,217,000
			I -2-15	Midgarra	A	SW-H	31	23,837,000	20,832,000	1,440,000	1,191,000	1,383,000	48,683,000
			I -2-16	Dihda Ouead	D	SW-H	28	21,893,000	18,816,000	1,440,000	1,094,000	1,264,000	44,507,000
			I -2-17	Ambouli down-st.	C	SW-B	10	73,288,000	3,250,000	1,680,000	3,664,000	2,346,000	84,228,000
			I -2-19	Damerdjog	C	SW-B	18	131,849,000	5,850,000	1,680,000	6,592,000	4,181,000	150,152,000
			I -2-20	Goum-Bourta	C	SW-B	21	153,239,000	6,825,000	1,680,000	7,661,000	4,852,000	174,257,000
	Pond	Surface flow water	I -3-1	Agan south	B	P-H	6	66,741,000	3,684,000	720,000	3,337,000	2,134,000	76,616,000
			I -3-2	Dahhoto	D	P-H	7	130,827,000	4,298,000	720,000	6,541,000	4,075,000	146,461,000
			I -3-3	Gara Abbouri	C	P-H	4	132,813,000	2,456,000	720,000	6,640,000	4,079,000	146,708,000
			I -3-4	Dawwano	C	P-H	2	129,926,000	1,228,000	720,000	6,496,000	3,956,000	142,326,000
			I -3-5	Yoboki	B	P-B	7	162,358,000	3,598,000	960,000	8,117,000	5,007,000	180,040,000
			I -3-6	Soulaitou	C	P-H	4	100,861,000	2,456,000	720,000	5,043,000	3,121,000	112,201,000
			I -3-7	Guidoli	C	P-H	10	105,732,000	6,140,000	720,000	5,286,000	3,377,000	121,255,000
			I -3-8	Dika	C	P-H	7	66,921,000	4,298,000	720,000	3,346,000	2,158,000	77,443,000
			I -3-9	Koussour	B	P-H	6	70,532,000	3,684,000	720,000	3,526,000	2,248,000	80,710,000
			I -3-10	Safarie Golla	C	P-H	2	129,926,000	1,228,000	720,000	6,496,000	3,956,000	142,326,000
			I -3-11	Gabla Oalan	C	P-B	3	143,619,000	1,542,000	960,000	7,180,000	4,383,000	157,684,000
			I -3-13	Elka Hadad	A	P-B	3	109,771,000	1,542,000	960,000	5,488,000	3,368,000	121,129,000
			I -3-15	Didjan Der tributary	A	P-B	2	89,742,000	1,028,000	960,000	4,487,000	2,751,000	98,968,000
	Sub surface dam	Sub-surface water	I -4-1	Boulle middle-st.	B	SW-B	38	350,888,000	12,350,000	1,920,000	17,544,000	10,954,000	393,656,000
			I -4-2	Mouloude Ouein tributary middle-st.	B	SW-B	26	244,581,000	8,450,000	1,920,000	12,229,000	7,648,000	274,828,000
Rehabilitation	Shallow well(B)	Sub-surface water	II-1-1	Kouta Bouyya	A	SW-B	5	36,621,000	1,495,000	1,680,000	1,831,000	1,193,000	42,820,000
			II-1-2	Gobaad As-Ela	A	SW-B	224	1,577,511,000	65,160,000	9,120,000	78,875,000	49,553,000	1,780,219,000
			II-1-3	Chekheiti	A	SW-B	4	30,069,000	1,200,000	1,680,000	1,503,000	988,000	35,440,000
			II-1-4	Douda	A	SW-B	27	193,050,000	8,095,000	1,680,000	9,652,000	6,084,000	218,561,000
	Pond	Surface flow water	II-2-1	Didjan Der	A	P-B	7	45,331,000	3,598,000	960,000	2,266,000	1,496,000	53,651,000
Total							**829**	**5,923,219,000**	**353,510,000**	**74,640,000**	**296,137,000**	**190,517,000**	**6,838,023,000**

Appendix 11: Project Cost Estimations (2/3)

Development type	Water source facility	Water resource	Site number	Site name	Evaluation rank	Irrigation farming model	Development farm land (ha)	Construction cost							
								Sallow well cost DJF	Pond cost DJF	Sub surface dam cost DJF	Land reclamation cost DJF	Irrigation facilities cost DJF	Contractor management cost DJF	Total DJF	Total (+VAT) DJF
New development	Shallow well(A)	Shallow groundwater	I -1-1	Bondara	A	SW-B	17	17,600,000			10,778,000	103,700,000	3,000,000	135,078,000	158,041,000
			I -1-2	Chinnile	A	SW-B	24	25,600,000			15,216,000	146,400,000	3,000,000	190,216,000	222,552,000
			I -1-3	Afka-Arraba	A	SW-B	10	11,200,000			6,340,000	61,000,000	1,500,000	80,040,000	93,646,000
			I -1-5	Mouloude Ouein tributary up-st.	A	SW-B	13	14,400,000			8,242,000	79,300,000	3,000,000	104,942,000	122,782,000
			I -1-6	Arouo down-st.	A	SW-B	4	4,800,000			2,536,000	24,400,000	1,500,000	33,236,000	38,886,000
			I -1-7	Gablalou	B	SW-H	4	4,800,000			2,536,000	240,000	1,500,000	9,076,000	10,618,000
			I -1-8	Aour adussa	D	SW-H	4	4,800,000			2,536,000	240,000	1,500,000	9,076,000	10,618,000
			I -1-9	Hambokto	A	SW-B	4	4,800,000			2,536,000	24,400,000	1,500,000	33,236,000	38,886,000
			I -1-10	Garaslei	D	SW-H	2	1,600,000			1,268,000	120,000	1,500,000	4,488,000	5,250,000
			I -1-11	Boelei	D	SW-H	2	1,600,000			1,268,000	120,000	1,500,000	4,488,000	5,250,000
			I -1-12	Kalaloho	C	SW-B	7	8,000,000			4,438,000	42,700,000	1,500,000	56,638,000	66,266,000
			I -1-13	Boulle biyale	B	SW-H	3	3,200,000			1,902,000	180,000	1,500,000	6,782,000	7,934,000
			I -1-14	Gachan	C	SW-H	4	4,800,000			2,536,000	240,000	1,500,000	9,076,000	10,618,000
			I -1-15	Darka Doun Yar	A	SW-B	13	14,400,000			8,242,000	79,300,000	3,000,000	104,942,000	122,782,000
	Shallow well(B)	Sub-surface water	I -2-1	Bakkirre	C	SW-H	17	6,600,000			1,598,000	1,020,000	3,000,000	12,218,000	14,295,000
			I -2-2	Agobarre	B	SW-B	16	6,600,000			1,504,000	89,600,000	3,000,000	100,704,000	117,823,000
			I -2-4	Kerora	C	SW-H	33	13,200,000			3,102,000	1,980,000	3,000,000	21,282,000	24,899,000
			I -2-5	Boukboukto	C	SW-H	19	7,800,000			1,786,000	1,140,000	3,000,000	13,726,000	16,059,000
			I -2-6	Sek Sabir	A	SW-B	20	7,800,000			1,880,000	112,000,000	3,000,000	124,680,000	145,875,000
			I -2-8	Gaggade	C	SW-H	15	6,000,000			1,410,000	900,000	3,000,000	11,310,000	13,232,000
			I -2-10	Dika	C	SW-H	15	6,000,000			1,410,000	900,000	3,000,000	11,310,000	13,232,000
			I -2-11	Dhourreh	B	SW-B	43	17,400,000			4,042,000	240,800,000	3,000,000	265,242,000	310,333,000
			I -2-12	Gusistir	D	SW-H	12	4,800,000			1,128,000	720,000	3,000,000	9,648,000	11,288,000
			I -2-14	Hidka Beyya Adde	B	SW-H	26	10,200,000			2,444,000	1,560,000	3,000,000	17,204,000	20,128,000
			I -2-15	Midgarra	A	SW-H	31	12,600,000			2,914,000	1,860,000	3,000,000	20,374,000	23,837,000
			I -2-16	Dihda Ouead	D	SW-H	28	11,400,000			2,632,000	1,680,000	3,000,000	18,712,000	21,893,000
			I -2-17	Ambouli down-st.	C	SW-B	10	4,200,000			940,000	56,000,000	1,500,000	62,640,000	73,288,000
			I -2-19	Damerdjog	C	SW-B	18	7,200,000			1,692,000	100,800,000	3,000,000	112,692,000	131,849,000
			I -2-20	Goum-Bourta	C	SW-B	21	8,400,000			1,974,000	117,600,000	3,000,000	130,974,000	153,239,000
	Pond	Surface flow water	I -3-1	Agan south	B	P-H	6		54620000		564,000	360,000	1,500,000	57,044,000	66,741,000
			I -3-2	Dahhoto	D	P-H	7		109,240,000		658,000	420,000	1,500,000	111,818,000	130,827,000
			I -3-3	Gara Abbouri	C	P-H	4		109,240,000		2,536,000	240,000	1,500,000	113,516,000	132,813,000
			I -3-4	Dawwano	C	P-H	2		109,240,000		188,000	120,000	1,500,000	111,048,000	129,926,000
			I -3-5	Yoboki	B	P-B	7		109,240,000		4,438,000	23,590,000	1,500,000	138,768,000	162,358,000
			I -3-6	Soulaitou	C	P-H	4		81,930,000		2,536,000	240,000	1,500,000	86,206,000	100,861,000
			I -3-7	Guidoli	C	P-H	10		81,930,000		6,340,000	600,000	1,500,000	90,370,000	105,732,000
			I -3-8	Dika	C	P-H	7		54,620,000		658,000	420,000	1,500,000	57,198,000	66,921,000
			I -3-9	Koussour	B	P-H	6		54,620,000		3,804,000	360,000	1,500,000	60,284,000	70,532,000
			I -3-10	Safarie Golla	C	P-H	2		109,240,000		188,000	120,000	1,500,000	111,048,000	129,926,000
			I -3-11	Gabla Oalan	C	P-B	3		109,240,000		1,902,000	10,110,000	1,500,000	122,752,000	143,619,000
			I -3-13	Elka Hadad	A	P-B	3		81,930,000		282,000	10,110,000	1,500,000	93,822,000	109,771,000
			I -3-15	Didjan Der tributary	A	P-B	2		68,275,000		188,000	6,740,000	1,500,000	76,703,000	89,742,000
	Sub surface dam	Sub-surface water	I -4-1	Boulle middle-st.	B	SW-B	38	15,000,000		45,013,000	24,092,000	212,800,000	3,000,000	299,905,000	350,888,000
			I -4-2	Mouloude Ouein tributary middle-st.	B	SW-B	26	10,200,000		33759750	16,484,000	145,600,000	3,000,000	209,043,750	244,581,000
Rehabilitation	Shallow well(B)	Sub-surface water	II-1-1	Kouta Bouyya	A	SW-B	5	1,800,000				28,000,000	1,500,000	31,300,000	36,621,000
			II-1-2	Gobaad As-Ela	A	SW-B	224	89,400,000				1,254,400,000	4,500,000	1,348,300,000	1,577,511,000
			II-1-3	Chekheiti	A	SW-B	4	1,800,000				22,400,000	1,500,000	25,700,000	30,069,000
			II-1-4	Douda	A	SW-B	27	10,800,000				151,200,000	3,000,000	165,000,000	193,050,000
	Pond	Surface flow water	II-2-1	Didjan Der	A	P-B	7		13,655,000			23,590,000	1,500,000	38,745,000	45,331,000
Total							**829**	**380,800,000**	**1,147,020,000**	**78,772,750**	**165,688,000**	**3,182,320,000**	**108,000,000**	**5,062,600,750**	**5,923,219,000**

Appendix 11: Project Cost Estimations (3/3)

Development type	Water source facility	Water resource	Site number	Site name	Evaluation rank	Irrigation farming model	Development farm land (ha)	Supporting cost for farming				Training cost		
								Farm equipment	Agriculture inputs		Total	On-farm Training	Site visit Training	Total
									Vegetable, Feed crops	Tree crops				
								DJF	DJF	DJF	DJF	DJF	DJF	DJF
New development	Shallow well(A)	Shallow groundwater	I -1-1	Bondara	A	**SW-B**	17	680,000	4,828,000	17,000	5,525,000	1,440,000	240,000	1,680,000
			I -1-2	Chinnile	A	**SW-B**	24	960,000	6,816,000	24,000	7,800,000	1,440,000	240,000	1,680,000
			I -1-3	Afka-Arraba	A	**SW-B**	10	400,000	2,840,000	10,000	3,250,000	1,440,000	240,000	1,680,000
			I -1-5	Mouloude Ouein tributary up-st.	A	**SW-B**	13	520,000	3,692,000	13,000	4,225,000	1,440,000	240,000	1,680,000
			I -1-6	Arouo down-st.	A	**SW-B**	4	160,000	1,136,000	4,000	1,300,000	1,440,000	240,000	1,680,000
			I -1-7	Gablalou	B	**SW-H**	4	1,600,000	1,080,000	8,000	2,688,000	1,440,000		1,440,000
			I -1-8	Aour adussa.	D	**SW-H**	4	1,600,000	1,080,000	8,000	2,688,000	1,440,000		1,440,000
			I -1-9	Hambokto	A	**SW-B**	4	160,000	1,136,000	4,000	1,300,000	1,440,000	240,000	1,680,000
			I -1-10	Garaslei	D	**SW-H**	2	800,000	540,000	4,000	1,344,000	1,440,000		1,440,000
			I -1-11	Boelei	D	**SW-H**	2	800,000	540,000	4,000	1,344,000	1,440,000		1,440,000
			I -1-12	Kalaloho	C	**SW-B**	7	280,000	1,988,000	7,000	2,275,000	1,440,000	240,000	1,680,000
			I -1-13	Boulle biyale	B	**SW-H**	3	1,200,000	810,000	6,000	2,016,000	1,440,000		1,440,000
			I -1-14	Gachan	C	**SW-H**	4	1,600,000	1,080,000	8,000	2,688,000	1,440,000		1,440,000
			I -1-15	Darka Doun Yar	A	**SW-B**	13	520,000	3,692,000	13,000	4,225,000	1,440,000	240,000	1,680,000
	Shallow well(B)	Sub-surface water	I -2-1	Bakkirre	C	**SW-H**	17	6,800,000	4,590,000	34,000	11,424,000	1,440,000		1,440,000
			I -2-2	Agobarre	B	**SW-B**	16	640,000	4,544,000	16,000	5,200,000	1,440,000	240,000	1,680,000
			I -2-4	Kerora	C	**SW-H**	33	13,200,000	8,910,000	66,000	22,176,000	1,440,000		1,440,000
			I -2-5	Boukboukto	C	**SW-H**	19	7,600,000	5,130,000	38,000	12,768,000	1,440,000		1,440,000
			I -2-6	Sek Sabir	A	**SW-B**	20	800,000	5,680,000	20,000	6,500,000	1,440,000	240,000	1,680,000
			I -2-8	Gaggade	C	**SW-H**	15	6,000,000	4,050,000	30,000	10,080,000	1,440,000		1,440,000
			I -2-10	Dika	C	**SW-H**	15	6,000,000	4,050,000	30,000	10,080,000	1,440,000		1,440,000
			I -2-11	Dhourreh	B	**SW-B**	43	1,720,000	12,212,000	43,000	13,975,000	1,440,000	480,000	1,920,000
			I -2-12	Gusistir	D	**SW-H**	12	4,800,000	3,240,000	24,000	8,064,000	1,440,000		1,440,000
			I -2-14	Hidka Beyya Adde	B	**SW-H**	26	10,400,000	7,020,000	52,000	17,472,000	1,440,000		1,440,000
			I -2-15	Midgarra	A	**SW-H**	31	12,400,000	8,370,000	62,000	20,832,000	1,440,000		1,440,000
			I -2-16	Dihda Ouead	D	**SW-H**	28	11,200,000	7,560,000	56,000	18,816,000	1,440,000		1,440,000
			I -2-17	Ambouli down-st.	C	**SW-B**	10	400,000	2,840,000	10,000	3,250,000	1,440,000	240,000	1,680,000
			I -2-19	Damerdjog	C	**SW-B**	18	720,000	5,112,000	18,000	5,850,000	1,440,000	240,000	1,680,000
			I -2-20	Goum-Bourta	C	**SW-B**	21	840,000	5,964,000	21,000	6,825,000	1,440,000	240,000	1,680,000
	Pond	Surface flow water	I -3-1	Agan south	B	**P-H**	6	2,400,000	1,284,000		3,684,000	720,000		720,000
			I -3-2	Dahhoto	D	**P-H**	7	2,800,000	1,498,000		4,298,000	720,000		720,000
			I -3-3	Gara Abbouri	C	**P-H**	4	1,600,000	856,000		2,456,000	720,000		720,000
			I -3-4	Dawwano	C	**P-H**	2	800,000	428,000		1,228,000	720,000		720,000
			I -3-5	Yoboki	B	**P-B**	7	280,000	3,318,000		3,598,000	720,000	240,000	960,000
			I -3-6	Soulaitou	C	**P-H**	4	1,600,000	856,000		2,456,000	720,000		720,000
			I -3-7	Guidoli	C	**P-H**	10	4,000,000	2,140,000		6,140,000	720,000		720,000
			I -3-8	Dika	C	**P-H**	7	2,800,000	1,498,000		4,298,000	720,000		720,000
			I -3-9	Koussour	B	**P-H**	6	2,400,000	1,284,000		3,684,000	720,000		720,000
			I -3-10	Safarie Golla	C	**P-H**	2	800,000	428,000		1,228,000	720,000		720,000
			I -3-11	Gabla Oalan	C	**P-B**	3	120,000	1,422,000		1,542,000	720,000	240,000	960,000
			I -3-13	Elka Hadad	A	**P-B**	3	120,000	1,422,000		1,542,000	720,000	240,000	960,000
			I -3-15	Didjan Der tributary	A	**P-B**	2	80,000	948,000		1,028,000	720,000	240,000	960,000
	Sub surface dam	Sub-surface water	I -4-1	Boulle middle-st.	B	**SW-B**	38	1,520,000	10,792,000	38,000	12,350,000	1,440,000	480,000	1,920,000
			I -4-2	Mouloude Ouein tributary middle-st.	B	**SW-B**	26	1,040,000	7,384,000	26,000	8,450,000	1,440,000	480,000	1,920,000
Rehabilitation	Shallow well(B)	Sub-surface water	II-1-1	Kouta Bouyya	A	**SW-B**	5	70,000	1,420,000	5,000	1,495,000	1,440,000	240,000	1,680,000
			II-1-2	Gobaad As-Ela	A	**SW-B**	224	1,320,000	63,616,000	224,000	65,160,000	8,640,000	480,000	9,120,000
			II-1-3	Chekheiti	A	**SW-B**	4	60,000	1,136,000	4,000	1,200,000	1,440,000	240,000	1,680,000
			II-1-4	Douda	A	**SW-B**	27	400,000	7,668,000	27,000	8,095,000	1,440,000	240,000	1,680,000
	Pond	Surface flow water	II-2-1	Didjan Der	A	**P-B**	7	280,000	3,318,000		3,598,000	720,000	240,000	960,000
Total							**829**	**119,290,000**	**233,246,000**	**974,000**	**353,510,000**	**67,680,000**	**6,960,000**	**74,640,000**