CHAPTER 4 BACKGROUND AND CONSTRAINTS TO IRRIGATION DEVELOPMENT

4.1 *Natural Conditions*

(1) Land

Zanzibar comprises two main islands of Unguja and Pemba and a few smaller islands. Its total area[1] is about 2,654 km^2 consisting of Unguja 1,666 km^2 and Pemba 988 km^2. Unguja and Pemba islands, which lie about 40 km and 60 km, respectively, off the east-coast of Mainland Tanzania, are located approximately at latitudes 4° 00" and 6° 30"south and longitudes 39°00" and 40°00" east.

(2) Topography

Unguja has a topography forming a series of low flat corridors bounded by a number of parallel ridges running in the north-south direction. Pemba is undulated due to numerous long and narrow valleys formed by perennial small streams originating from springs. The valley bottom is flat and cultivated with paddy. The altitudes of both islands are less than 100 m above mean sea level.

(3) Meteorology

Zanzibar has two distinct monsoon seasons related to the monsoon trade winds: the North Monsoon (Masika season) from late March until June, and the South Monsoon (Vuli season) from late September until December. Rainfall averages 1,550 mm for Unguja and 1,830 mm for Pemba, of which more than 90 % is concentrated in the monsoon seasons. The western side has the higher rainfall. The dry season is also divided into two patterns due to the sea influence. The short dry season occurs between August and September, and the long dry season between December and the end of March. Zanzibar has a mean temperature of 27 °C with small seasonal temperature fluctuations caused by the country's proximity to the equator.

(4) Groundwater

The study on groundwater resources undertaken in 1983 and 1994 shows that there are no large reserves of water which can be mined and, therefore, supplies rely on recharge from rainfall water. This requires the careful water abstraction from groundwater. In Unguja, some potential aquifers in three main hydro-geological zones (eastern limestone/sandstone corridor, western sedimentary corridor and coastal limestone deposits) were found. The annual

[1] *Agriculture: Performance and Strategies for Sustainable Growth*

acceptable yield was estimated at 293 MCM/year. In Pemba, there is less potential for developing the groundwater resources as compared with Unguja, with an annual acceptable yield estimated at only 46 MCM/year.

4.2 Zanzibar Irrigation Development Programme (ZIDP)

4.2.1 Philosophy of ZIDP

In view of the importance of irrigated agriculture, the GOZ formulated an irrigation development plan intending to establish a basic strategy and master plan of future irrigation development in Zanzibar. Under the financial and technical assistance of UNDP and FAO, a final draft of the ZIDP was prepared in 1997 on the basis of Zanzibar's experience in irrigated agriculture over two decades. The ZIDP consists of eleven chapters with the following contents:

Composition and Contents of ZIDP

Chp.	Title of Chapter	Contents of Chapter	Remarks
1	Introduction	The Introduction introduces the project and describes the objectives of irrigation development during 15 years since 1997.	It was also mentioned that successful launch of the NIDP for the Mainland induced the GOZ to prepare the ZIDP.
2	Background	This chapter explained the agriculture situation of those days. The role of irrigation to meet future demand was also mentioned.	Areas required for self-sufficiency in major crops were presented. Inexplicably however, target areas of irrigation were not argued, and figures of the areas required were not mentioned.
3	Changing Policies in Agriculture	Transition of agricultural policy and change of the Ministry of Agriculture were described.	Present structure of the Ministry was clarified in this chapter.
4	Natural Resources	Availability of natural resources of land, soil and water were quantified, and finally, potential irrigable rice lands were estimated at 3,750 ha (Unguja: 2,500 ha, Pemba: 1,250 ha) for planning purposes.	Estimated irrigable area is far below that required for self-sufficiency discussed in Chapter 2, however, no justification and adjustment were taken.
5	Environmental Considerations	Issues in environment related to irrigated agriculture in Zanzibar were overviewed.	Concrete proposal on environmental consideration was not given.
6	Development Planning for Irrigated Agriculture	General aspects in planning for irrigated agriculture were enumerated, but without clear linkages.	Contents of this chapter are very vague since clear development target is not given. In the ZIDP, identification of development target is a further important subject.
7	Institutional Framework for Irrigated Agriculture	Based on the analysis of institutional roles in irrigation development, enrolment of private sector was emphasized in future. Discussion on the subject of "transition to self-sustainability" was also highlighted.	The ZIDP puts particular emphasis on this chapter for institutional improvement.
8	Definition and Scope of ZIDP	This chapter presents the plan and time schedule of the ZIDP. A total of 46 activities categorized into 5 groups were proposed, and the ZIDP was set out for implementation in 1998.	Every activity is brusquely put in the schedule without any evidences of possibility for implementation. The ZIDP puts off dealing with a number of issues, referring these to further consideration at implementation time.
9	Costs and Benefits	This chapter presents the costs and benefits of the ZIDP. However,	No target figures are included.

		some of paragraphs were still not complete.	
10	Monitoring and Evaluation	General description on monitoring and evaluation was given in this chapter. No concreteness is held in those descriptions.	There is a comment that "ZIDP may have to change to accommodate changes in external conditions". It is shown that nothing could be decided due to unpredictable external conditions at the time of the ZIDP formulation.
11	Conclusions and Recommendations	The ZIDP gives conclusions and recommendations. Pemba was given highest priority for a surface fed gravity smallholder irrigation schemes. Production of high value crops with private investors' enrolment was recommended in Unguja because of the incompatibility of subsistence smallholder schemes.	The description in this chapter is still unfinished.

Source: the ZIDP

"Transitioning to self-sustainability through proper institutional improvement" was put as a basic concept of the ZIDP. The ZIDP was prepared with an expectation that, "once the institutional improvement is completed, necessary operations in irrigation development would develop through the improved institutional system".

4.2.2 Progress of Implementation of ZIDP

In the ZIDP, a total of 46 activities were proposed for execution during the 15 years from 1998 to 2013. Out of these, 29 were scheduled to be completed by the end of 2001, and almost all were "Study and Research" and "Institutions and Human Resources" activities. Up until August 2002, no activity proposed in the ZIDP had yet been started, although a few schemes have been implemented or committed to implementation independently. There is an opinion that the ZIDP has not been authoritatively accepted. Although the ZIDP itself proposed the necessary steps for its finalization, none of these steps have yet been taken.

4.2.3 Problems and Constraints in Implementation of ZIDP

Besides the constraints to irrigation development, which were already identified in the ZIDP, unexpected additional constraints to be overcome have been raised relating to the change of economic and political climate. The following reasons are given for the failure of the ZIDP:

- The ZIDP itself was not completed,
- No endorsement of financial requirement for the implementation of the ZIDP was given, and
- Initiatives for promotion of the ZIDP were weak.

Weakness of the institutional capability and vulnerability of the irrigation sector was recognized in the ZIDP and a high priority was accorded to institutional

building. However, these very constraints have hampered the successful implementation of the ZIDP. This is a Catch-22 situation: activities for institutional and human resources development were proposed, but the very weakness in these areas prevents the MANREC from taking any initiative to correct them.

4.3 Present Conditions and Constraints in Irrigation Development

4.3.1 Type of Irrigation Development in Zanzibar

The current situation regarding irrigation in Zanzibar has been investigated and the identified irrigated areas in both islands are tabulated as follows:

Present Irrigated Area in Zanzibar

Island	Name of Scheme	Irrigated Area (ha)	Water Sources	Supported Donors
Pemba	Kinyakuzi	8.0	Stream flow	ILO
	Saninga	16.4	Stream flow	ILO
	Tungamaa	6.0	Stream flow	FAO
	Mangwena	10.0	Stream flow	ILO, FAO(SPFS)*
	Mipopooni	13.6	Spring/Stream flow	ILO
	Kwalempona	13.6	Spring/Stream flow	ILO
	Tibirinzi	6.0	Spring/Stream flow	FAO(SPFS)*
	Sub-total	**73.6**		
Unguja	Cheju	42.0	Groundwater	FAO
	Mwera	12.0	Stream	FAO, FAO(SPFS)*
	Bumbwi sudi	136.0	Groundwater	FAO
	Mtwango	78.0	Stream flow	FAO
	Sub-total	**268.0**		
Total		**341.6**		

Source: JICA Study Team **:presently supported*

The types of irrigation systems on the existing schemes vary depending upon the type of available water sources. In Unguja, the majority of the area is irrigated by groundwater, even though "water harvesting" is becoming popular. Unguja has significant reserves of groundwater and surface water is limited to certain seasons. In contrast, no irrigation by groundwater has been observed in Pemba due to different topographic and geo-hydrological conditions from Unguja.

In Zanzibar, even rainfed agriculture can support single cropping intensity, unlike the mainland, where rainfall is much lower. Therefore, irrigation development for Zanzibar needs to aim at more than 100% cropping intensity. Makeshift irrigation like rainwater harvesting to cope with basic needs might not be necessary in Zanzibar.

Applicability of irrigation practice varies by natural conditions, sociological condition and size of the targeted site. Advantages of the possible irrigation types in Zanzibar are summarized as follows:

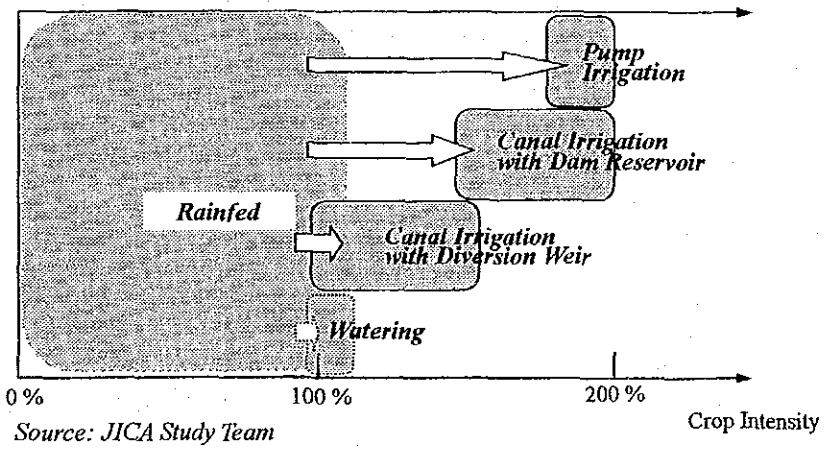
Advantages of the Irrigation Type

Classification	Advantages	Indispensable Conditions
Canal irrigation with diversion weir	Reliable water supply could be achieved with moderate investment as far as river flow is available. O&M is rather easier due to water flowing by gravity.	It highly depends upon availability and stability of river water. Basically, it is applied for perennial flow. Obtaining consent of other concerned water users is compulsory.
Canal irrigation with dam reservoir	High reliability and well workability in operation can be given because natural fluctuation of river water can be regulated by water storage.	It requires higher investment for dam construction. Site suitability for dam construction is much important, and careful consideration should be given to environmental impact.
Pump irrigation	Even highly elevated area is irrigable by lifting if pump irrigation is adopted. High irrigation efficiency is expectable because of delivering water by conduit.	Productivity of groundwater is essential for sustaining the scheme operation. High burden in O&M is inevitable, and periodic replacement of equipment is needed, too.
Watering	Basically, it is applied for spotted area having an impounding or spring as such. High irrigation efficiency is realizable by farmers' close efforts.	It requires heavy laborious work for farmers. Reliable water source is necessary otherwise, irrigable term is limited.

Source: JICA Study Team

In Zanzibar, "pump irrigation" is the most reliable irrigation type as long as groundwater is continuously exploitable and farmers' financial viability is ensured. "Canal irrigation with diversion weir" can be applied if reliable perennial stream flow is available, in which case expectable crop intensity would be moderate because the irrigable area in a dry season might be limited due to the available water in the stream. Having the same water source of stream flow, "canal irrigation with dam reservoir" might be applicable if natural conditions surrounding the project's site meet the requirements for the construction of small dam. For this irrigation type, the present crop intensity under rainfed condition could be significantly improved depending on the capacity of dam reservoir. Besides these irrigation types which would be implemented on a scheme basis to a specified area, watering could be applied by farmers themselves to their individually farmland-plot utilizing small impounding water and spring sources. Effects of irrigation in Zanzibar are schematically shown by the following irrigation types:

Schematic Figure for Achievable Crop Intensity by Irrigation Type



Source: JICA Study Team

Remarks: It shows adoptable design cropping intensity by irrigation type in Zanzibar

4.3.2 Problems with Present Irrigation and Drainage

In spite of attempting to improve irrigation development over the past 20 years, achievement have been lower than expected. In July 1990, FAO conducted a joint evaluation survey for the project of "Development of Smallholder Oriented Irrigated Rice Production". The survey results related that final development costs of the project were over US$23,000/ha. Although the project included not only construction of an irrigation scheme, but also an institutional building measure and a pilot/research study, it proved too costly compared with current standards in economic viability.

In particular, the pump irrigation scheme shows a cost significantly higher than the common value. Cost for the pump operation in the FAO project is estimated at US$330/ha/year assuming lifting discharge of 3.0 l/s/ha with lifting head of 35 m on average. It would be a heavy burden to farmers, even under nearly an increase of 200 % in cropping intensity and would be hardly affordable unless some subsidies were provided.

There are some particular technical problems. Low irrigation efficiency is sometimes problematic, and additional lining work is required for the implemented schemes. The FAO's report mentioned that conveyance efficiency averaged 50 to 60 % compared to the designed one of 70 %. Lower application efficiency is also a consequence of cascade flow field by field. Overall water use efficiency could be estimated at 20 to 30 %. This compares favourably with the Mainland, however, it should be greater because water in Zanzibar is much more valuable than on the Mainland. Another technical aspect concerns small dam construction. Although some numbers of small dams were constructed in Pemba, those do not effectively function because capacities of the dam reservoirs are extremely small compared with the requirement. This is due to inadequate topographic conditions of the sites and limitation of capital resources.

In summary, problems and constraints in irrigation development in Zanzibar are summarized below:

Problems and Constraints in Irrigation Development in Zanzibar

Problems and Constraints	Content	Reasons
Institutional and economic issues	Implementation cost of irrigation schemes was high (In case of FAO project, it was reported at US$23,000/ha.)	This is due to inexperience and institutional inadequacy of irrigation section. Although the complicated and small shape of schemes requires comparatively high cost, there is certain room to be devised.
Financial issue	In pump irrigation scheme, high pump operation cost is not affordable for the beneficiaries.	Groundwater is only reliable water resources in those areas. Proper subsidy is compulsory otherwise irrigation development is difficult in those areas.

Technical and sociological issues	Adequate irrigation efficiency is not attainable. Proper O & M is not executed.	It is caused by not only impervious material of the canal construction, but also weeds' deep roots and rats-roots. Farmers' neglectful water management is sometimes a significant cause for high water loss.
	Small dams do not function well.	Small dams in Zanzibar were constructed without rational planning and designing on the basis of sound estimation for the water requirement.

Source: Internal information in the DARI

During the rainy season, daily rainfall with high intensity occurs frequently. Drainage is a serious problem in some areas, especially in Pemba. Perimeter drainage and side slope protection for irrigation scheme development in Pemba is required.

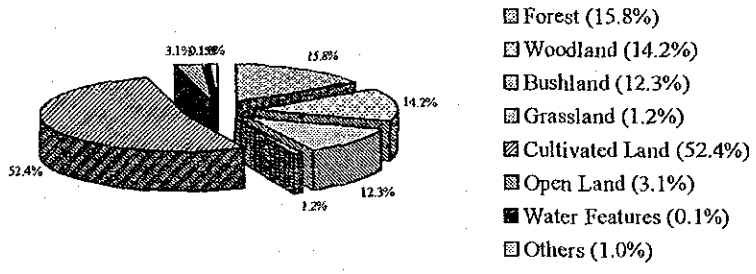
4.3.3 Land Use

(1) Present Land Use

(a) General Land Use

According to the land use data obtained through the mapping project, the present land use is categorized into eight major land types, namely; forests, woodland, bushland, grassland, cultivated land, open land, water body and others. As shown below, the total of forest and woodland occupies about 30% of the total land area of Zanzibar. The cultivated land occupies more than 50% of the land area that is equivalent to 140,000 ha. Such a high percentage of cultivated land is the major difference from the land use of the Mainland.

Distribution of Land Cover in Zanzibar



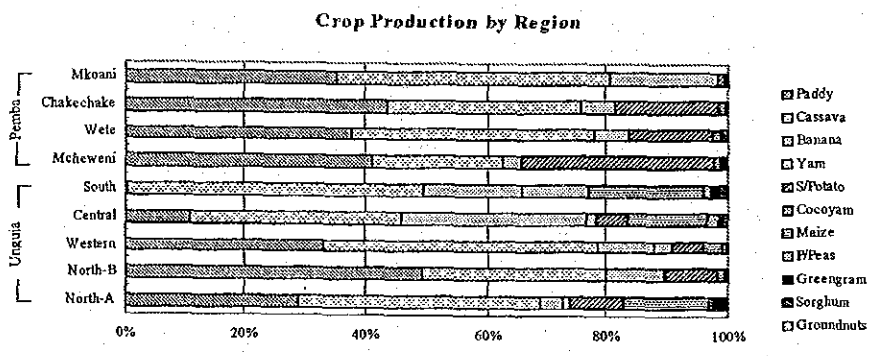
Source: National Reconnaissance Level Land Use and Natural Resources Mapping Project, Final Report 1997

(b) Crop Production

About 40% of the total cultivated land is utilized for export crops such as cloves, coconut, fruits and spices. Food crops, including cassava, paddy, sweet potato and bananas account for the remaining 60% of food crops

grown in Zanzibar are. Cassava is the dominant crop but the planted area has gradually decreased during past 10 years. Rice is the second largest food crop and the planted area is fluctuating from year to year with slightly increasing trend. Sweet potatoes and bananas are also important food crops as a part of major staples and considerable areas are utilized for these crops. The yields of these food crops are generally low due mainly to the dependence on rainfed agriculture and therefore fluctuate because of unstable rainfall.

The cropping pattern varies considerably from district to district. Cassava dominates the cropping in many of the districts accounting for as much as 50% of the food crop area in South of Unguja. Land allocated for rice is generally higher in Pemba. In Unguja, land for rice fluctuates from district to district. Land allocated for maize is generally higher in Unguja.



Source: Data obtained from Ministry of Agriculture

(c) Livestock and Rangeland

Livestock remains an important economic sub-sector in Zanzibar, and cattle, goats and chicken are the major types of livestock raised by agricultural holders. According to the statistics, it is obvious that livestock activities are important in North region of Pemba. Cattle and chicken are raised more in Pemba, while goats are raised more in Unguja. According to the data based on the aerial photographs taken in 1977, the total grazing land occupies more than 40 % of the land area in Unguja, while it occupies less than 20 % in Pemba. Since livestock raising is more active in less grazing area in Pemba, it can be considered that livestock keeping is more integrated with crop farming there.

(d) Household Characteristics

According to the results obtained from Zanzibar Agricultural Survey (1990) for different agro-ecological zones of both islands, the parcel size is about 0.15 ha in both islands. In Unguja, since the number of parcels owned by

households is less, the total land area occupied by household is less than 0.5 ha and the area is larger in plantation area than in coral rag area. In Pemba, on the other hand, the area occupied is more than 0.5 ha and is larger in plantation area. The area allocated for one person is less than 0.1 ha in both islands. In relation to livestock, each household keeps one cattle beast in the plantation area in Unguja and coral rag area in Pemba.

(2) Land Tenure

Land tenure system strongly affects the crop production and land degradation in Zanzibar. Categories of land right within the tenure system are shown in the table below.

Categories of Land Right within the Tenure System

Agro-ecological Zone	Farming System	Land Right	Contents
Plantation Zone	Shamba	Three acre plots	These plots are distributed by the Government to the former plantation workers and landless people.
		Inherited Land	This land is properly inherited under the Islamic and existing law.
		Family Plots	These plots are inherited lands belonging to several family members.
		Bought Land	These are inherited lands, which have been sold by the owner.
	Konde	Borrowed Land	These can be used for non-permanent crops and the borrower can use the land during his lifetime.
		Seasonally Allocated	These are conditionally allocated in small plots for specified land uses e.g. rice.
Coralline Zone	Shifting Cultivation	-	Ownership is acquired by clearing a piece of land and utilizing it.

Source: Evaluation of Land Resources in Zanzibar, FAO, 1990

A Shamba farmer is one who owns or has assurance by law for long term utilization of the land. He is free to cultivate permanent crops, field perennials or annuals on the land. He has the right to allow the Konde farmer to cultivate in the under-utilized portions of his land. On the other hand, a Konde farmer is primarily farming on someone else's land. He is not allowed to grow permanent tree crops but allowed to grow annual crops and field perennials. Since all land basically belongs to the government, many farmers have no interest in conservation of the land resources, thus resulting in the accelerated erosion of good soil layers and land degradation. It is also subjecting the permanent tree crops on upper and mid slopes to severe moisture stress. This is finally reflected in the gradual decline of yields during the last decade.

(3) Land Resources for Irrigation Development

There are various data on irrigated land and estimated irrigable area in the dry season in Zanzibar. Some of these data are shown in the table below.

Irrigated Land and Estimated Irrigable Area in Dry Season

Category	Data Source	Unguja	Pemba	Total
Irrigated Land in ha	Land Use Atlas (1977)	405	0	405
	Status of Irrigation Development (2001)	300	100	400
	Ministry of Agriculture (2002)	268	74	342
Estimated Irrigable Area in Dry Season in ha	Ministry of Agriculture	2,692	1,284	3,976
	Master Plan by UNDP/FAO	5,142	1,047	6,189
	Land Use Plan (1994)	3,000	2,000	5,000
	ZIDP (1997)	2,500	1,250	3,750
	Inventory Survey (2002)	4,244	596	4,840

Source : JICA Study Team

It is obvious that the area already developed for irrigation is quite limited compared to the anticipated irrigable area. The total estimated irrigable area in both islands in the dry season is said to be around 4,000 to 5,000 ha according to various past studies. This was practically confirmed through the current inventory survey under this Study. Since there is little scope for increasing agricultural production through expanding the area in Zanzibar, the irrigation development is considered to be one of the very important subjects for the intensification and improved management of the existing farmland.

4.3.4 Farming System

(1) Farming Systems

In a baseline survey for the identification of farming systems in Zanzibar, it was noted that the principal farming system in coral rag areas is shifting cultivation and tree plantations inter-cropped with perennials and annuals. Permanent cropping system is further classified into sub-systems based on the ability of cultivating trees and generating income from tree crop production in the following manner.

Factors Determining farming Systems of Zanzibar

Farming System	Konde	Shamba cum Konde		
Sub-System		I	II	III
Potential for tree crops cultivation	None	Low	Underutilized	Utilized
Constraints	Land tenure	Ecological factor, Competition between tree and food crops	Low yielding trees, Recently planted trees	No constraints

Source: A baseline survey for the identification of farming systems in Zanzibar

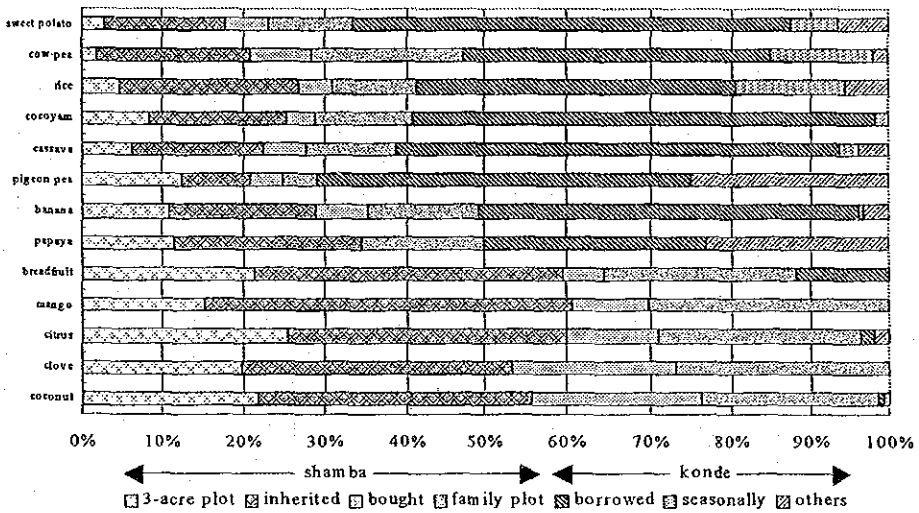
Farmers grow tree crops including cloves, coconuts and fruits usually intercropped with bananas and cocoyams. As for annuals, rainfed paddy is cultivated during rainy season, while cowpeas and sweet potatoes are cultivated as second crops. Farmers grow cassava on the lighter soils and usually intercropped with sweet potatoes, maize, cocoyams and vegetables. Most households grow vegetables such as amaranths, tomatoes, eggplant and chilies on small plots almost throughout the year.

(2) Land Tenure and Farming Systems

The land use atlas of Zanzibar presents the acreage of each land use category in cultivated land in relation to the farming system. Cultivation of tree crops including pure stand tree crops and associations of tree crops or tree crops with food crops are dominant in both islands, and other continual rotational crop and rainfed rice occupy quite substantial area of the cultivated land.

As for the relationship between land tenure systems and cultivated crops, tree crops including clove and coconut are almost exclusively cultivated by Shamba farms specifically on inherited land. Perennial and annual crops are mainly cultivated by Konde farms specifically on borrowed land. Seasonally allocated lands are mainly utilized for rice and cowpea cultivation. Distribution of land tenure system is shown as below.

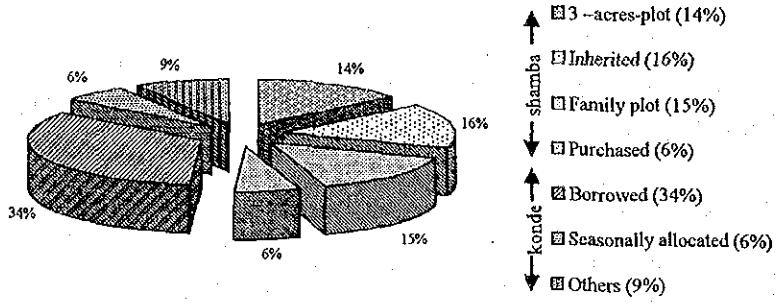
Relationship between Land Tenure Systems and Cultivated Crops



Source: A Baseline Survey for the Identification of Farming Systems in Zanzibar

Regarding the distribution of land tenure system, Shamba and Konde lands are almost equally distributed and borrowed land occupies more than 1/3 of total cultivated land as shown below.

Distribution of Land Tenure



Source: A Baseline Survey for the Identification of Farming Systems in Zanzibar

(3) Irrigated Agriculture

Farmers have been practicing simple water harvesting on Pemba and in some small valleys on Unguja for many years. It is based on the construction of bunds to permit rainwater to be collected on the fields during the rainy season. No canal systems were provided for better utilization of spring water or run-off. The then Ministry of Agriculture developed a small irrigation scheme on Unguja as early as 1955. Limited development then took place on both main islands as shown in the table below.

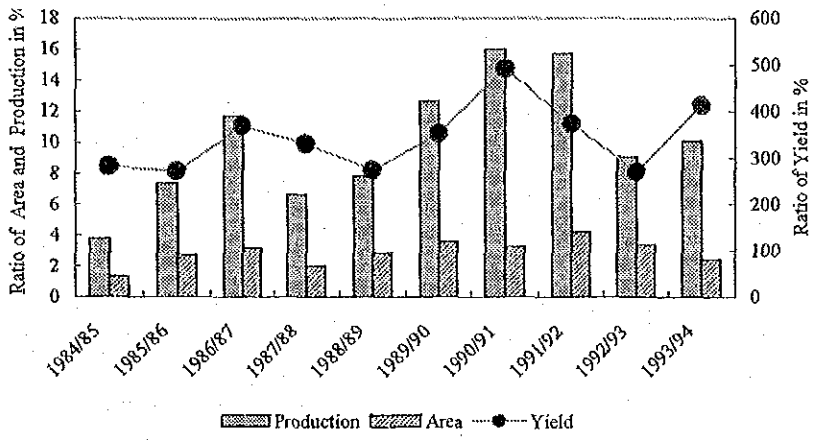
Donor Funded Activities in Irrigation Sector

Period	Donor	Project
1975-1984	UNDP	Improvement of Rice Cultivation and Extension in Food Crop Cultivation
1984	FAO/TCP	Technical Cooperation
1985-1987	UNDP	Development of Smallholder Oriented Rice Production in Zanzibar
1985-1987	ILO	Labour Intensive Special Public Work Programme
1987-1990	UNDP	Smallholder Oriented Irrigated Rice Production (Phase-2)
	UNDP/FAO	Smallholder Irrigated Rice Project

Source: Zanzibar Irrigation Development Programme, 1997

Most activities are focused on irrigated rice development. According to the change of the ratio of irrigated paddy against total paddy for production, planted area and yield from 1984/85 to 1993/94, the irrigated area for rice production is only a few percent of the total planted area. Since the yield is 3 to 4 times higher than rainfed rice, the production of irrigated rice reaches more than 10% of the total production as shown below. This fact clearly shows the importance of irrigation for the future development of agriculture.

Ratio of Irrigated Paddy against Total Paddy



Source: Status of Irrigation Development in Zanzibar, 2001 and the ZIDP

4.3.5 Marketing

(1) Marketing System

Marketing Channel

There are a variety of marketing systems for food products operating in Zanzibar. The type of marketing depends on the type of product being sold. There are different marketing systems for locally produced cereals, imported cereals, and pulses and for products like cassava and bananas. Both middlemen and producers market cereals and other foodstuffs. The buyers are shopkeepers and petty traders who travel to purchase the products in the production areas. This also occurs during shortages or when the crop is out of season. Otherwise, farmers take produce to the town markets themselves. When this happens, all the marketing costs and risks are borne by farmers.

There are different types of distribution systems for crops. Distribution starts from the farm gate and products are taken to the central wholesale markets where the produce is auctioned. Produce is then taken to retail markets or directly to the final consumer. This applies mainly for the cereal rice. However, for bananas and cassava, petty traders who serve as middlemen, purchase the products from producers and sell them at retail in semi-open air markets in the townships or vend the products from street to street usually on bicycles.

Facilities

The main agro-industries in Zanzibar are mostly small-scale plants processing the cereal products such as maize, rice, and sorghum. Zanzibar has also two large-scale industries both dealing with grains: the Zanzibar Milling Corporation (ZMC) and the Zanzibar Poultry Company (ZAPOCO). The annual capacity of

ZMC plant is 6,000 tonnes. In addition, there are small-scale feed mills like Kwahaji Tumbo and Matambuu.

Wholesale Markets

Currently there is no policy guiding the operation of wholesale markets. Unspecified numbers of middlemen are involved in acquisition and distribution of major food crops. There are also no facilities provided at the wholesale markets for storage and handling.

Retail Markets

There is similarly no policy guiding the operation of retail markets for agricultural commodities in Zanzibar. With the approval and license from the municipal council, retailers can sell their commodities in the public retail markets or at their own retail shops. There are similarly no controls and guidelines for the handling of products in retail markets. Most marketed agricultural commodities are prepared and packed using local packaging materials such as bags, tengas, polos, pakacha etc., and then sent to the market for sale. Conventional commercial fresh produce packaging and storage facilities do not exist in Zanzibar. Most farmers lack skills and knowledge for post harvest processing, hence substantial food losses occur shortly after harvesting due to ineffective handling.

(2) Pricing

Input prices

The MANREC is currently the main supplier of agricultural inputs. These include fertilizers, chemicals and seeds which are provided at subsidized prices. Tractor services are also subsidized and Extension services are also freely provided. There is an emerging private sector mainly non-governmental and community based organizations (NGOs and CBOs) involvement in the supply of agricultural inputs and some of the above mentioned services. However, their contribution in providing services and inputs is currently insignificant.

Output prices

Output prices for all food crops are free market determined. Market prices are often lower than the real cost of production. Retail prices paid by consumers for the year 2001 are shown in table below.

Fluctuations in Some Staple Food Retail Prices in Zanzibar (Unit: Tsh/kg)

Month /2001	Cassava	Irish Potatoes	Sweet Potatoes	Bananas
January	87.03	208.33	59.43	208.33
February	85.82	N/A	72.12	146.93
March	75.52	N/A	86.21	125.26
April	65.67	N/A	N/A	122.24

May	69.66	108.70	N/A	125.54
June	74.94	128.21	106.38	132.08
July	70.11	115.79	129.51	136.67
August	67.25	100.33	63.50	148.78
September	68.88	103.34	63.54	118.63
October	73.75	136.00	61.87	149.42
November	75.75	147.23	62.58	192.04

Source: Statistic Bureau of Tanzania (2002)

(3) Constraints

The current major problems for smooth market distribution are as follows:

- No regulations or guidelines for collection and distribution of agricultural produce in marketing system.
- Selling of produces to intermediate middlemen at cheaper prices due to less alternative approach to market.
- Unavailable facilities such as packaging and temporary storage, leading to an unstable pricing system.
- Lack of agricultural credit facilities, high interest rates and lack of collateral.
- Little use of formal banking system to finance agricultural production, trade and agribusiness.
- No institution mandated to control the marketing of agricultural commodities.
- Immature services and skills in marketing, particularly in the area of marketing information and marketing advice.
- Inadequate market information facilities in the Ministry of Trade, Industries and Marketing.
- Lack of infrastructure like feeder roads and market information.
- No quality control of agricultural commodities and agro-processed products due to lack of facilities for product inspection.

4.3.6 Institution

(1) Problems Identified in Recent Programme and Policy

The ZIDP drawn up in 1997 states: "the current operational state of Zanzibar's irrigation sector and the rates of irrigation scheme implementation, which are currently achievable, would suggest that existing institutions are inadequate. Marginalization, inadequate training of its professionals, inadequate and unsupervised professional experience and general under-equipping or under-resource of the institutions could all be blamed for the inadequate levels of performance." Since then, however, the concrete and institutional strengthening envisaged has not been achieved. The problem situation has basically remained unchanged.

Furthermore, the ASP, February 2000 states: "Since the role of the (then) MALNR

will be confined to public support functions, structural changes aiming at increasing productivity, developing new technology and producing new products will be required. The current institutional structure of the MALNR does not conform to the demands of the new agricultural policy. "

As the two above-mentioned statements are still applicable to the present institutional setting of the irrigation development, the ZIMP should properly respond to them.

(2) Priority Institutional Issues Identified in ZIDP

The priority issues identified in the ZIDP have essentially remained and are considered to still be of significant importance. They are as follows:

(a) All irrigating communities should be required to form water users associations (WUAs) according to the legal framework.
(b) The extension services will require strengthening, viz. the ability to train farmers in sound on-farm water management and irrigation scheme operation and maintenance.
(c) Reforming and strengthening of the Irrigation Section of the Ministry of Agriculture will be necessary.
(d) Current strengths and weaknesses of private sector consultants, contractors and manufacturers as regards their participation in Zanzibar's irrigation development should be evaluated and where necessary training programs designed and imparted.
(e) Marketing institutions (and infrastructure) should be facilitated and upgraded in line with other reforms.
(f) A comprehensive review of gender issues as they pertain to the practice of irrigation farming on Zanzibar should be carried out and any institutional shortcomings made good.
(g) Credit needs of irrigating communities should be assessed, and workable delivery and recovery mechanisms should be designed.
(h) An institution for monitoring should be established, ideally within the Irrigation Section but drawing on relevant subject matter specialists from other sections or Ministries, to monitor the performance of the sector in the broadest sense. Furthermore, the monitoring unit should be mandated and authorized to allow follow-up activities and even sectoral management, at least in an advisory sense.

(3) Obstacles for Self-Sustainability of Irrigation Development

The ZIDP commented on the issue of ownership and responsibility regarding beneficiaries in irrigation development: "Many schemes are implemented with

little internal or National financing and little, if any, community participation or consultation, in other words, insignificant contributions from the beneficiaries. Equally, there is often no charge made for the abstraction of irrigation water supplies. Thus there is very little sense of ownership or responsibility engendered amongst the benefiting community. As a result, little or no maintenance takes place and causes dilapidation of the infrastructure. This is then rehabilitated in due course, again with virtually no institutionalization of responsibility."

(4) Necessary Changes at the National and Policy Levels

The ZIDP states: "Successful transition to self-management and scheme sustainability will require more than just a conscientious and well-organized water user association. Changes will be required at National or policy level." "Thus, in terms of policy, at least five changes have to be made:

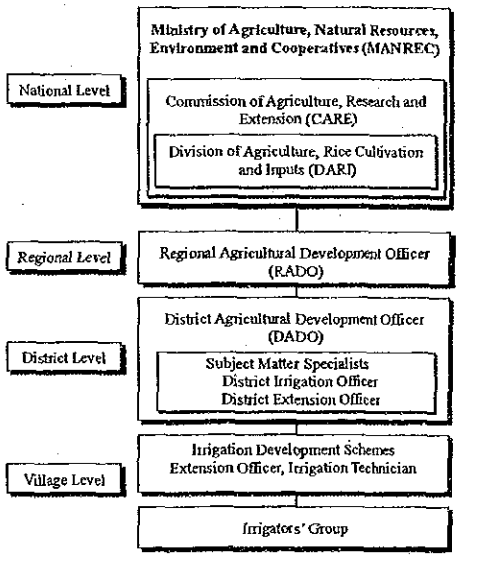
(a) The markets for agricultural products should be totally liberalized,
(b) Farmers should be given more options as regards their cropping systems,
(c) More development activities and hence responsibility should be devolved to the communities,
(d) Reasonable charges should be levied through the WUAs for the use of irrigation water, and,
(e) Land tenure conditions should be redefined to increase a farmer's sense of security."

4.3.7 Organization

(1) Overall Organizational Structure for Irrigation Development

The administrative organization structure for irrigation development in Zanzibar involves both national and local levels. The local level has a hierarchical three-tier structure: regional, district and village levels whereas the Central Government functionally covers and supervises all of the levels, i.e. from the central to village levels.

Simplified Organogram of Central and Local Governments relevant to Irrigation Farming



(2) National Level

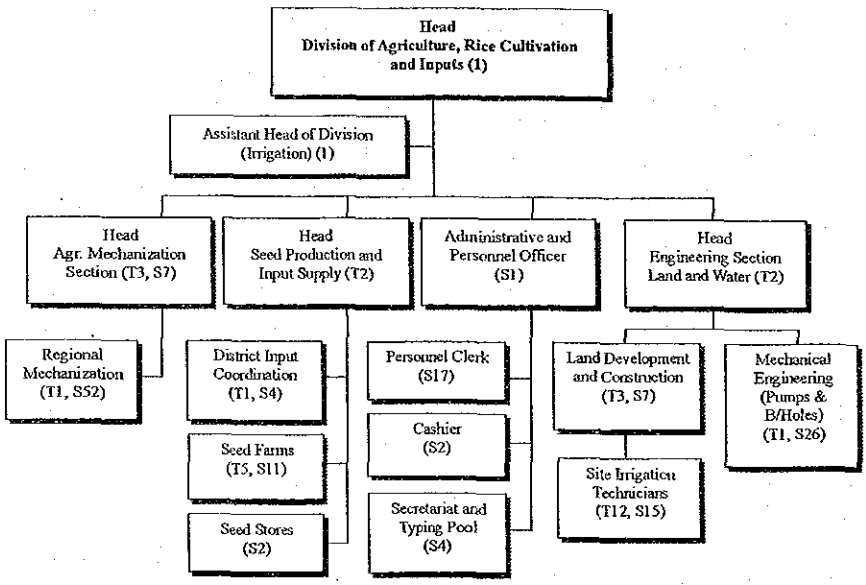
The Commission of Agriculture, Research and Extension (CARE) is now responsible for all matters pertaining to irrigation development, through the

Division of Agriculture, Rice Cultivation and Inputs Supply (DARI). The responsibility for Zanzibar irrigation development is vested in the assistant Head of Division. According to the ZIDP, unlike the situation of the Mainland, poor coordination of activities within the irrigation sector has not been identified as a significant constraint. Four possible reasons were cited. First, the areas involved are small. Secondly, the two islands are rather discrete units in themselves. Thirdly, the pace of irrigation development has been extremely slow. Fourthly, only two main donors (FAO and UNDP) have driven activities in the sector.

However, two potential problems are pointed out in the ZIDP.

- Uncoordinated donor activities could result in the introduction of different levels of irrigation technology at different locations, thereby leading to confusion and unnecessary strengthening requirements from the extension services.
- Poor coordination of the sector could also result in competition between smallholder schemes and private sector commercial farms.

Division of Agriculture, Rice Cultivation and Inputs Supply



Remarks: Number in the Parenthesis is number of the staff (T: Technical staff, S: Supporting staff)

(3) Local Level

At the regional level, the Regional Agricultural Development Office (RADO) supervises and coordinates the activities of District Agricultural Development Offices (DADOs). Only the DADO has technical staff, i.e., subject matter specialists, who supervise and assist the irrigation schemes directly. At the district level, the District Council is elected by general election and is responsible for supervising and auditing the District Administrative Offices, including the

DADO.

(4) Present Performance of Governmental Organizations

The next table shows the present performance and strengthening priority of roles and functions undertaken by the governmental organizations pertaining to irrigation development. The roles and functions are based on the report "the Division of Responsibilities of the Roles and Functions of the Agricultural Sector among the Ministry of Agriculture and Food Security, Ministry of Co-Operatives and Marketing, Ministry of Water and Livestock Development, President's Office - Regional Administration and Local Governments, June 2001", and have been adjusted for the situation in Zanzibar.

As for the present performance, only two roles are rated as "Good". One is that of the MANREC, to formulate and review policy, laws, procedures, regulations and guidelines on irrigation farming. The other is the role of the CARE to supervise the preparation of irrigation farming projects before they are implemented. The remained majority of the roles and functions are rated as "Fair" or "Poor".

According to the table, the DARI, the RADO and the DADO have relatively higher priority than the other organizations for institutional strengthening. The DARI generally needs to strengthen its supervision function through establishing evaluation criteria for irrigation projects and preparing guidelines for formation of irrigators' groups. The RADO basically needs strengthening of its coordination function with relevant organizations at regional level. The DADO needs to strengthen, in particular, its implementation capability of irrigation farming technically and institutionally and, moreover, farmer mobilization through participatory approach.

Present Performance and Priority of Strengthening of Roles and Functions

Organization		Roles and Functions	Present Performance	Priority of Strengthening
MANREC	a	To formulate and review policy, laws, procedures, regulations and guidelines on irrigation farming.	Good	High
	b	To mobilize and give advice to farmers and livestock keepers on rain water harvesting.	Poor	Medium
CARE (Commission of Agriculture, Research & Extension)	c	To supervise in the preparation of irrigation farming projects before they are implemented.	Good	Medium
	d	To receive, coordinate and prepare reports on irrigation farming and to give guidance needed.	Fair	High
DARI (Division of Agriculture, Rice Cultivation and Inputs)	e	To interpret and give advice on the policy of irrigation farming.	Poor	High
	f	To investigate and identify areas suitable for irrigation farming.	Fair	Medium
	g	To set criteria for sound/appropriate irrigation projects.	Poor	High
	h	To coordinate and evaluate irrigation schemes.	Fair	Medium
	i	To prepare guidelines for the formation of groups that intend to use water for irrigation farming.	Poor	High
	j	To coordinate identification of suitable land for irrigation farming.	Fair	Medium
	k	To give advice on how to undertake evaluation of irrigation procedures.	Poor	High
	l	To give advice on irrigation procedures.	Fair	Medium
RADO (Regional Agricultural Development Office)	a	To coordinate the use of resources in irrigation areas.	Poor	High
	b	To coordinate projects that promote irrigation farming through cooperation with MANREC (DARI)	Poor	High
DADO (District Agricultural Development Office)	a	To implement policy of irrigation farming.	Poor	High
	b	To investigate and specify areas suitable for irrigation farming.	Fair	Medium
	c	To evaluate irrigation projects.	Poor	Medium
	d	To ensure that irrigation techniques and practices are properly carried out.	Fair	Medium
	e	To ascertain the proper use of resources in irrigation areas.	Poor	Medium
	f	To involve non-governmental organizations and donors in planning and execution of irrigation projects.	Poor	High
	g	To supervise the construction of irrigation farming.	Fair	Medium
	h	To give advice to the people on irrigation farming.	Fair	High
	i	To mobilize and advice farmers on formation and management of water users associations.	Fair	Medium
	j	To prepare reports on the progress of irrigation farming.	Fair	Medium
	k	To maintain resources that sustain irrigation schemes in general.	Fair	High
	l	To mobilize farmers to contribute resources in the planning and implementation of irrigation projects.	Poor	High

Source: Modified Information by the JICA Study Team from the Division of Responsibilities of the Roles and Functions of the Agricultural Sector among the Ministry of Agriculture and Food Security, Ministry of Co-Operatives and Marketing, Ministry of Water and Livestock Development, President's Office - Regional Administration and Local Governments, June 2001

Remarks: The present performance and priority are evaluated by the JICA Study Team based on the hearing from MANREC. Grades used are "Good", "Fair", "Poor" and "High", "Medium", "Low" respectively.

4.4 Present Situations of Inventorized Schemes

(1) Inventory survey

The inventory survey of the irrigation schemes was carried out in order to understand the present situation and proposed plan of irrigation schemes including location, history, irrigation and drainage, agriculture and land use, farmers' supporting system, farmers' organization, operation and maintenance, and environment. The schemes to be inventorized were selected by the MANREC.

The inventorized schemes total 57, covering existing irrigated area of some 342 ha, and 8,521 ha of potential irrigable area in both the Unguja and Pemba as follows:

Inventorized Schemes

Island / Region	Nos. of Schemes	Existing Area (ha)	Potential Area (ha)
Unguja	**18**	**268**	**6,629**
North	6	-	2,468
South	9	54	2,512
Urban West	3	214	733
Pemba	**39**	**74**	**1,892**
North	18	68	707
South	21	6	1,185
Total	**57**	**342**	**8,521**

Source: Inventory survey conducted by ZIMP

The general features of the inventorized schemes are summarized below and more detail is given in Table 4.4.1 and Appendix A. Locations are shown in Figures 4.4.1 and 4.4.2.

(2) Classification of inventorized schemes

According to the type of irrigation, the inventorized schemes are classified into three categories, namely, gravity type by small dams, gravity type by diversion weir, and pump by groundwater, as shown below.

Classification of Inventorized Schemes by Type of Irrigation

Islands	Type of Scheme	Nos. of Schemes	Potential Area (ha)
Unguja	Gravity by Dam	4	1,200
	Gravity by Diversion weir	5	505
	Pump by Groundwater	9	4,924
	Sub-total	18	6,629
Pemba	Gravity by Dam	39	1,892
	Gravity by Diversion weir	-	-
	Pump by Groundwater	-	-
	Sub-total	39	1,892
Zanzibar Total	Gravity by Dam	43	3,092
	Gravity by Diversion weir	5	505
	Pump by Groundwater	9	4,924
	Total	57	8,521

Source: Inventory survey conducted by ZIMP

Surface water is the main water resource of irrigation schemes in Zanzibar, especially in Pemba. However, some 75 % of potential areas in Unguja are expected to be fed by groundwater.

Out of the 57 schemes, 32 have a potential area of less than 50 ha, with a total potential area of 750 ha. The irrigation schemes are categorized by size of irrigation area as shown below.

Classification of Inventorized Schemes by Size of Potential Area

Islands	Type of Scheme	Nos. of Schemes	Potential Area (ha)
Unguja	Small-scale (Less than 50 ha)	3	46
	Medium-scale (50 – 200 ha)	3	341
	Large -scale (More than 200 ha)	12	6,242
	Sub-total	18	6,629
Pemba	Small-scale (Less than 50 ha)	29	704
	Medium-scale (50 – 200 ha)	9	641
	Large -scale (More than 200 ha)	1	547
	Sub-total	39	1,892
Zanzibar Total	Small-scale (Less than 50 ha)	32	750
	Medium-scale (50 – 200 ha)	12	982
	Large -scale (More than 200 ha)	13	6,789
	Total	57	8,521

Source: Inventory survey conducted by ZIMP

Nine existing irrigation schemes with an area of some 340 ha in operation are able to be extended to about 2,100 ha by rehabilitating or improving such irrigation facilities as diversion weir, pump, and irrigation canal. Some 4,000 ha of rainfed area has the potential for future new irrigation schemes.

Classification of Inventorized Schemes by Proposed Works

Islands	Type of Scheme	Nos. of Schemes	Potential Area (ha)
Unguja	Rehabilitation of Existing Scheme	4	1,890
	Restoration of Abandoned Scheme	4	1,668
	Newly Proposed Scheme	10	3,071
	Sub-total	18	6,629
Pemba	Rehabilitation of Existing Scheme	5	254
	Restoration of Abandoned Scheme	6	773
	Newly Proposed Scheme	28	865
	Sub-total	39	1,892
Zanzibar Total	Rehabilitation of Existing Scheme	9	2,144
	Restoration of Abandoned Scheme	10	2,441
	Newly Proposed Scheme	38	3,936
	Total	57	8,521

Source: Inventory survey conducted by ZIMP

Rehabilitation (or improvement) of the irrigation canals is carried out by providing partial lining and diversion structures. The inventory survey also indicated that most of the pump irrigation schemes are constrained by shortage of funding for the scheme operation and repairs to pumps .

The results of scheme classification are summarized as follows:

Classification of Inventorized Schemes with Potential Area

Required Works	Type of Irrigation	Small-scale		Medium-scale		Large-scale		Total	
		Nos.	Area (ha)	Nos.	Area (ha)	Nos.	Area (ha)	Nos.	Area (ha)
Rehabilitation /Improvement of Existing Schemes	Dam	4	140	1	114	-	-	5	254
	Diversion weir	1	12	1	120	-	-	2	132
	Pump	-	-	-	-	2	1,758	2	1,758
	Sub-total	5	152	2	234	2	1,758	9	2,144
Restoration of Abandoned Schemes	Dam	2	46	3	180	3	1,197	8	1,423
	Diversion weir	-	-	-	-	-	-	-	-
	Pump	-	-	1	168	1	850	2	1,018
	Sub-total	2	46	4	348	4	2,047	10	2,441
Proposed New Schemes	Dam	23	518	5	347	2	550	30	1,415
	Diversion weir	1	20	1	53	1	300	3	373
	Pump	1	14	-	-	4	2,134	5	2,148
	Sub-total	25	552	6	400	7	2,984	38	3,936
Total	Dam	29	704	9	641	5	1,747	43	3,092
	Diversion weir	2	32	2	173	1	300	5	505
	Pump	1	14	1	168	7	4,742	9	4,924
	Total	32	750	12	982	13	6,789	57	8,521

Source: Inventory survey conducted by ZIMP

4.5 Irrigation Development Level

4.5.1 Need for Benchmarking of Irrigation Development Level

Available options for irrigation in Zanzibar are limited, as are alternatives in the level of irrigation development. However, knowledge on optimum irrigation development levels and suitable irrigation modality are indispensable for the success of irrigation development. Irrigation development in Zanzibar to date has been undertaken without sufficient guidelines and understanding of the appropriate irrigation development level. The Study has considered the need for knowledge on irrigation development level and irrigation modality.

Although there are not many irrigation schemes implemented so far in Zanzibar, there are significant differences in technical aspects among the implemented schemes even after considering variation in regional conditions. Allowing such variability in irrigation development levels may bring about; (i) ineffective utilization of limited resources applied to irrigation development, (ii) complaints from farmers concerned about their low-performing schemes, (iii) confusion in expansion of model effects to other areas, and (iv) complexity in supervising and monitoring irrigation schemes together with others which are under different development levels.

4.5.2 Concept of Irrigation Development Level

Some aspects of the irrigation development level include options. For example, features such as dam type (earth fill or concrete), and dimensions of dam height

and length. Conversely there are no other choices in water resource selection if available water is scarce.

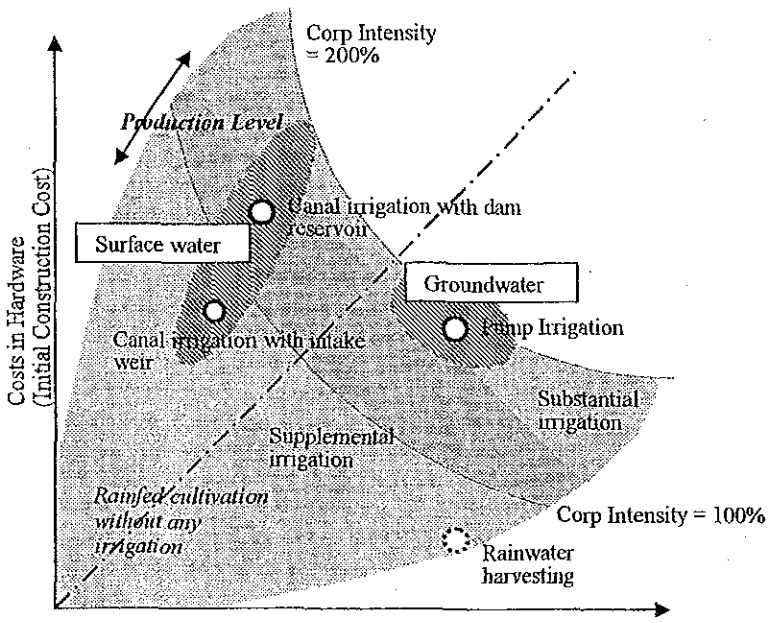
In Zanzibar, four irrigation types are proposed in general, namely, pump irrigation, canal irrigation with dam reservoir, canal irrigation with intake weir, and watering. In considering the advantages of each irrigation type, they can be ordered in terms of expectable benefits, required initial costs and required post-construction cost as follows:

Relation of Three Factors by Irrigation Type

Irrigation Type	Expectable Benefit	Required Initial Costs	Required Post-construction Cost
Canal irrigation with intake weir	Low - Medium	Medium	Medium
Canal irrigation with dam reservoir	Medium - **High**	**High**	Medium
Pump irrigation	**High**	Medium	**High**
Watering	Low	Low	Medium - **High**

Source: JICA Study Team

These situations could be characteristically shown in two-axis graph of costs in hardware aspect and costs in software aspect as shown below:



Source: JICA Study Team

Irrigation type is selected predominantly according to the scheme's site condition. In the case of canal irrigation utilizing surface water, some ranges of irrigation development level are selectable within the scope of canal irrigation system. Even for pump irrigation type, development levels in efficiency performance or

operational life of equipment etc are also selectable. Guidelines on these matters will be given in Clause 6.4.

4.6 International Relationship in Irrigation Development

Foreign assistance has remained stagnant because of lack of assistance by many bilateral donors during 1995 – 2000. This has had a significant adverse impact on economic and social indicators. According to the Common Country Assessment for Zanzibar (United Nations, July 2001), project implementation at the grassroots levels was halted by lack of assistance from bilateral donors assisting in health, water and education, malaria control, sanitation etc. – affecting negatively the delivery of services which are beneficial to the majority poor. Zanzibar continued to get some aid from the Gulf states, UN agencies, and ADB and some other donors. As the country's stability recovered in mid-October 2001, foreign assistance increased sharply as indicated in the table below. It reached roughly US$10 million in 2000 and 2001 and it is expected to increase further with the resumption of political and social stability, and successful conclusion of the ZPRP. It is apparent that many donors have started to show keen interests in supporting Zanzibar's economic recovery plan.

External Development Assistance *(unit: US$ million)*

Aid	1997	%	1998	%	1999	%	2000	%	2001	%
Multilateral	6.315	86.2	5.181	79.4	2.718	66.2	7.523	70.1	6.187	64.1
Bilateral	1.014	13.8	1.348	20.6	1.388	33.8	3.214	29.9	3.473	35.9
Total	7.329	100	6.528	100	4.105	100	10.737	100	9.660	100
Loans	2.605	35.5	2.605	39.9	2.078	50.6	6.186	57.6	4.981	51.6
Grants	4.724	64.5	3.922	60.1	2.028	49.4	4.551	42.4	4.680	48.4
Total	7.329	100	6.528	100	4.105	100	10.737	100	9.660	100
4.5% Subvention	7.600		8.600		5.900		13.100		8.600	

Source: ZPRP Background Paper

Following a 1996/97 agreement with the Union Government, 4.5% of general program aid to the Union Government (bilateral and multilateral) is provided as a subvention to the GOZ.

On-going projects with foreign assistance in Zanzibar are as follows:

On-going Projects

No.	Name of Project	Donor	Loan/Grant, Amount
1	Special Programme for Food Security	FAO	US$347,000-
2	Coconut Research Programme	GTZ, Govt. of Germany	DM40,000 (G), Tsh.16.32 million (L), Tsh.23.3 million (Local)
3	Livestock Development Project	Intern'l Atomic Energy Agency	US$ 320.3 thousand (G), Tsh. 263.0 million (L), Tsh. 14.0 million (Local)
4	National Agricultural Extension Programme Phase II	IDA	US$ 2,474 thousand (G), Tsh. 2,028.7 million (L), Tsh. 25.0 million (Local)
5	Programme for Plant Protection and Produce Inspection	FAO, ASAREC, ICIPE	US$ 182 thousand (G), Tsh. 78.1 million (L), Tsh. 35.1 million (Local)
6	Coordination for Natural Resources Supervision	Ford Foundation, Foundation of Govt. of Austria through CARE, GEF, Macarthur Fund, Mac Night Fund	US$ 552.0 thousand (G), Tsh. 452.6 million (L), Tsh. 80.0 million (Local)
7	Feasibility Study for Agriculture Sector Development	BADEA	US$ 200.0 thousand (G), Tsh. 164.0 million (L), Tsh. 25.0 million (Local)

Source: Annual Development Plan Book II Ministry of Finance and Economics

Out of the seven on-going projects listed above, only one project includes irrigation as its project components. Special Programme for Food Security with financial assistance of US$347,000 (Grant) of FAO includes improvement of several irrigation schemes, although it will be completed by 2002. For this project, the government is assumed to provide government staff to supervise the work, and the farmers are assumed to provide a substantial contribution towards the cost of construction works by providing the labor associated with the development of irrigation infrastructure such as headworks, canals, drains and non-removable equipment (buried pipes, pump houses, etc.) and some materials (sand, stones etc.). Also, the costs of some irrigation devices such as pumps are expected to be reimbursed by farmers through an appropriate financial arrangement.

The government has recognized non-government organizations (NGOs) as potential partners for the significant roles they can play in the provision of knowledge and mobilization of resources at the grass roots level. In 1995 the government enacted a law for the registration of NGOs and many small NGOs and community based organizations (CBOs) are emerging in Zanzibar. According to an Agriculture Sector Review prepared with assistance of FAO (June 1999), a total of 99 NGOs have been registered, although the review also points out that most of the agricultural related NGOs are dormant. Currently there is only one project underway in the agriculture sector, Coordination for Natural Resources

Supervision, for which participating NGOs are Ford Foundation, CARE International Tanzania, Macarthur Fund, and Mac Night Fund. There are no irrigation projects underway with the support of NGO.

4.7 Environment

Zanzibar faces serious environmental problems, some of which are summarized as follows:

Negative Impact

- Overuse of water by upstream beneficiaries to detriment of downstream beneficiaries, leading to loss of income and quality of life for downstream beneficiaries and finally accelerating over grazing and wide spread land degradation.
- Overuse of water leading to falling replenishment of groundwater reserves.
- Local flooding due to poor water control/management.
- Soil erosion leading to loss of soil cover
- Water-born diseases such as Bilharzia and Malaria.
- Increased use of fertilizer and pesticides resulting in negative impact to environment
- Deforestation for reclamation of new farming land.

Positive Impact

- Creation of cattle' grazing during periods when there are not many alternatives using end points of drains.
- Creation of an incentive for highly beneficial soil and water conservation practices through irrigation
- Reduction of damage to downstream and upstream cultivation areas, health risks associated with flooding and soil erosion by flood alleviation.

Inevitably, it is likely that any intervention that increases or changes the utilization of water in a system will bring about an impact to the environment. It is therefore important that the government adheres strictly to its policy of addressing environmental issues for any irrigation development. Similarly, the potential for conflict on water use especially for upstream and downstream beneficiaries requires careful management. Water conflicts must be monitored between the agricultural sector and other sectors, such as drinking water. The government needs to provide a proper approach to cope with such water conflicts on time from the viewpoint of appropriate river basin management.

CHAPTER 5 POTENTIAL AREA FOR IRRIGATION DEVELOPMENT

5.1 General

Zanzibar has ample water resources. However, usable water for irrigation development is restricted mainly due to the ephemeral characteristic of flow regime and topographic conditions. Limited land resources also affect irrigation development. With emphasis on these two issues, potential areas for irrigation development have been examined based on the results of the inventory survey for irrigation schemes, and a review of a existing soil survey.

5.2 Available Water Resources

5.2.1 Hydrological Environment

(1) Surface Water

River discharge has been observed since 1997 and recorded for eight major river basins in Unguja. The limited discharge data gives the following features in flow regime:

Salient Features in Flow Regime in Unguja

Name of river	Catchment Area (km^2)*	Length (km)	Annual Specific Discharge ($m^3/sec/100km^2$)	End of Outflow	Relevant Irrigation Scheme (s)
Mwera	28.0	20.0	1.70	Pokezi**	Mwera, Mtwango
Kipange	15.0	9.0	1.67	Indian Ocean	Kipange
Mwanakombo	10.0	9.2	1.78	Indian Ocean	Chechle/Mahonda
Zingwe-zingwe	9.0	25.5	0.77	Indian Ocean	-
Bwabwaja	3.6	6.0	1.33	Pokezi	Chaani
Mawe	4.5	5.3	1.07	Pokezi	Kibokwa
Kinyasini	7.6	9.7	1.10	Pokezi	Mgambo
Pangeni	8.6	23.0	1.07	Pokezi	Pangeni
Average			1.31		

Source: Report on Surface Water Availability in Unguja, by the MALNR, June 1999

**: Catchment area is not always covered full catchment, but it is area at the site of the observation.*

***: "Pokezi" means flow into coral limestone, not into Indian Ocean.*

Almost all the rivers in Unguja have several floods with peak discharge in a short time in the rainy season, but have low or no discharge in the dry season. Averaged annual specific discharge is estimated at 1.31 $m^3/sec/100km^2$, which appears high as it is five times that of the Mainland. Catchment areas are very small.

Although no periodic observation of flow discharge has been carried out in Pemba, it appears that the river regime is similar with that in Unguja, judging from meteorological and topographic conditions. Rivers in Pemba mostly form small

valleys with more complicated topographical features, so that perennial currents with delicate or intermittent flow are more likely that at Unguja.

(3) Hydrogeology

Unguja and Pemba islands are parts of the ancient Miocene Rufiji/Ruvu river delta, comprising a 2,560 m section of rhythmic sediments, and mainly marls, clays and clayey sands. Unguja is a complex junction of four blocks with evidence of past artesian leakage with ferruginous and siliceous cements, and anhydrite deposits over most of eastern Unguja. Unguja still retains extensions of Mainland structures, mainly prior stream systems. Pemba is a simple fault block and rose higher than Unguja. It is thus composed of lower stratigraphic rocks, which do not continue over the entire island. The topography of Pemba is separated into distinct landforms, which are directly related to the underlying geologic conditions.

Generally, all the Unguja and Pemba strata have aquifer potential to a greater or lesser extent, having measurable permeability and porosity. The extent of aquifers reflects hydrogeologic and topographic characteristics. In Unguja, quaternary aquifers (Q_1, Q_2 and Q_3) with proper storativity extend over more than 100 km^2, and other Lower Miocene aquifers (M_1 and M_3), which have lower storativity, also extend over about 370 km^2.

In Pemba, the quaternary aquifer does not exist, but an aquifer of elevated country rock area, similar to the Miocene M3 extends over about 650 km^2. The aquifer is extremely friable, and running sands are problematic.

5.2.2 Previous Studies on Assessment of Water Resources Potential

The comprehensive water resources potential assessment study, the Zanzibar Water Resources Development Project (ZWRDP), was carried out in 1994. The study results presented a water resources management strategy for Zanzibar including water resources utilization and constraints for development. It is still effective and useful for preparing the master plan.

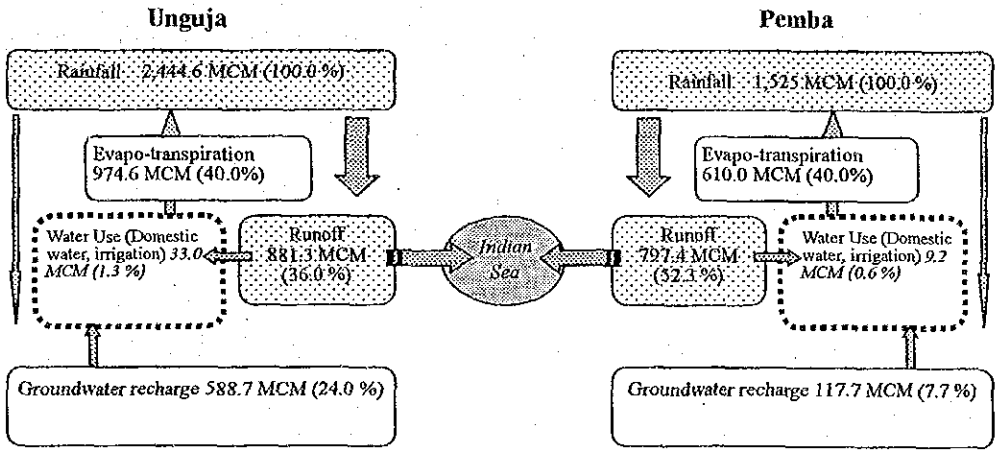
5.2.3 Macroscopic Water Balance in Zanzibar

Macroscopic water balance based upon annual hydrological cycle was studied for both islands by referring to the related information as mentioned in Appendix D. According to the study results, around 307 MCM of groundwater would be exploitable and 70 MCM of river discharge would be utilizable at maximum. The forecasted water demand in the year 2015 in Unguja is 57 MCM to be supplied by groundwater, and can be met judging from high quantitative potential of groundwater. Furthermore, surface water is still usable for irrigation development if topographic condition allows.

For Pemba, around 43 MCM of groundwater would be exploitable and 717 MCM of surface discharge would be utilizable at maximum according to the water balance study. Water demands for the year 2015 were forecasted at 11 MCM excluding irrigation purposes, which could be supplied by groundwater in Pemba. Irrigation water would be supplied from surface water. In Pemba, the potential of water resources for irrigation is not critical in quantity as far as the water balance study concerns.

The overall hydrological cycle of the both islands at the year 2002 is schematically shown as follows:

Hydrological Cycle



Source: JICA Study Team

5.2.4 Preliminary Estimate on Reservoir Volume

The inventory survey shows that there are 44 reservoir type irrigation schemes consisting of 4 schemes for Unguja and 40 schemes for Pemba. These reservoir type irrigation schemes were initially examined using the topographic maps of scale of 1 to 10,000, by the staff of MANREC. As a result, 40 schemes consisting of 3 schemes for Unguja and 37 schemes for Pemba, were confirmed, and remaining 4 schemes were not identified as suitable for dam construction.

The preliminary study shows that in Pemba, total reservoir capacity of 37 dams was estimated at 6.81 MCM, and in Unguja, that of 3 dams was estimated at 2.29 MCM. The reservoir capacity of each scheme confirmed is tabulated below:

Preliminarily Estimated Reservoir Capacity

Scheme	Capacity (10^3 m^3)	Scheme	Capacity (10^3 m^3)
Unguja		(17) Kinyakuzi	333
(1) Kibokwa	100	(18) Dobi	133
(2) Kipange	2,170	(19) Mlemele 1	417
(3) Chaani	20	(20) Mlemele 2	333
Sub-total	**2,290**	(21) Kwamavi	433
Pemba		(22) Mabieni	200
(1) Matangatwani	80	(23) Tibirinzi	76
(2) Bule	240	(24) Giriama	150
(3) Mshashani	167	(25) Masingini	90
(4) Kwalempona 1	100	(26) Mchangapwaga	83
(5) Kwalempona 2	50	(27) Kwamachigi	87
(6) Kwalempona 3	83	(28) Maumbwini	80
(7) Mangwena	67	(29) Egeani	50
(8) Mipopooni 1	133	(30) Kimbuni	117
(9) Mipopooni 2	83	(31) Mizingani	70
(10) Mipopooni 3	150	(32) Kwamkoba 1	100
(11) Chwaka	250	(33) Kwamkoba 2	367
(12) Mgwiya	367	(34) Saninga	233
(13) Tungamaa	217	(35) Makwararani	350
(14) Mleteni	100	(36) Maotwe	333
(15) Kinyasin	100	(37) Makunge	283
(16) Kwapweza	300	**Sub-total**	**6,806**

Source: Analyzed results by the DARI

It is noted that these reservoir capacities are studied only from topographic conditions because of the absence of geological data, therefore they are subject to modifications due to geological conditions.

5.3 Land Resources Potential

5.3.1 Soil Classification

In Unguja, there are five main soil categories called Mchanga, Kinongo, Uwanda, Maweni and Kinamo. Maweni soil is located in the coralline reef limestone that forms the extensive eastern and southern portion of the island. This soil covers more than 40% of arable land and supports traditional shifting cultivation. Mchanga soil is found on the western part of the island covering 20% of land area. This soil is suitable for both tree and annual crops. Uwanda soil forms the interface between the plantation area and coral reef zones covering 17% of the area. This soil is generally open grass area for unimproved grazing. Kinongo soil is the most fertile in the island and provides high potential for food crop production. Konamo soil covers only 5% of the land area and is found in the north and small patches in Cheju and Muyuni. This soil is suitable for rice cultivation.

In Pemba, there are also five main soil categories called Bopwe, Utasi, Mtifutifu, Kinako and Makaani. Bopwe soil occupies 26% of the land area mainly in the

western coast of the island. This soil is remarkably fertile and suitable for tree crops, annual crops and cloves. Mtifutifu soil occupies 29% of the land area mainly in the north and south coastal area. This is deep sandy soil and supports only coconut and short rooted crops. Makaani soil is found in the coral rag areas of the eastern coast covering 17% of the land area. Utasi soil is found on the plateau of northeastern areas and Semi Utasi soils is in the east of Utasi plateau. Both soils support tree crops. Kinoko soil covers only 9% of the land area and is suitable for rice growing.

5.3.2 Land Classification

Panchromatic aerial photographs at a scale of 1:20,000 and flown during the period of August and October 1977, were stereoscopically analyzed together with ground correction to develop a comprehensive physiographic legend based on landforms and geomorphology for both islands. A map of the physiography has accordingly been prepared with land unit as the mapping unit of which the detailed description is available in the report of "Evaluation of Land Resources in Zanzibar". Land unit is an area fairly homogenous in terms of physiography and parent materials, and is characterized by a particular soil distribution as specified by soil association.

5.3.3 Land Suitability Classification

The land suitability classification was carried out according to the FAO Soil Bulletin by applying the guidelines for land evaluation of rainfed agriculture. Since two farming systems (Shamba and Konde) are carried out on the same piece of land, the land suitability classification is needed for specified land utilization types.

The land suitability for major crops occurring within respective land utilization types was classified for each land unit in both islands. The results are shown in land evaluation and suitability classification maps for both Unguja and Pemba islands attached to the report of "Evaluation of Land Resources in Zanzibar".

5.3.4 Land Resources Potential

Beside the land evaluation and land suitability classification of both islands carried out as a part of technical cooperation programme by FAO as mentioned above, several soil project studies of specific areas were carried out.

Under the detailed soil survey for irrigated rice, for example, the detailed soil and soil suitability map was prepared based on the soil profile description and the results of laboratory analysis. Soil suitability for irrigated rice was classified into four classes under this Study.

Based on these and further investigations, a National Land Use Plan for Zanzibar was produced by the Zanzibar Commission for Land and Environment under financial assistance from Finnish Government. In this plan, the agricultural land was classified into three categories according to the suitability for cultivation. Policies on protection of agricultural land, integration of crop farming with forestry and intensification of crop production are described with strategies and recommendations. The suitable areas for sugar cane, rainfed rice, irrigated rice, tree crops & associations and ranch areas are also specified in this plan. Since most of the candidate land use schemes are located in the suitable area of irrigated and/or rainfed rice, the ZIMP can be closely related to the Land Use Plan.

5.4 Potential Area for Irrigation Development

The Inventory Survey shows the 57 irrigation schemes consisting of 17 schemes for Unguja and 40 schemes for Pemba. Judging from the topographic conditions, usable water resources, potential land resources and other past study reports, these schemes (with a total potential area estimated at 8,521 ha), are considered to provide the maximum potential area for irrigation development in Zanzibar. Features of 57 irrigation schemes are summarized as follows, and their locations are given in Figures 4.4.1 and 4.4.2:

Potential Area for Irrigation Development

Scheme Name	Water Resources	Potential Area (ha) Rainy	Dry	Scheme Name	Water Resources	Potential Area (ha) Rainy	Dry
Unguja							
Chaani	Surface Water	250	250	Koani	Surface Water	20	20
Kibokwa	Surface Water	250	250	Mchangani	Surface Water	300	200
Kilombero	Groundwater	850	373	Mwera	Surface Water	12	12
Kipange	Surface Water	400	400	Ubago	Groundwater	14	14
Mahonda	Surface Water	300	150	Mtende	Groundwater	330	165
Upenja	Groundwater	418	314	Muyuni	Groundwater	586	293
Bambi	Groundwater	168	168	Bumbwi sudi	Groundwater	560	450
Cheju	Groundwater	1,198	479	Mtwango	Surface Water	120	120
Ksima	Groundwater	800	560	Tomondo	Surface Water	53	27
Sub-total		4,634	2,944			1,995	1,301
Total of Unguja						***6,629***	***4,244***
Pemba							
Bule	Surface Water	12	12	Kwamavi	Surface Water	22	22
Chwaka	Surface Water	17	17	Kwapweza	Surface Water	62	27
Kinyakuzi	Surface Water	40	30	Mabieni	Surface Water	35	18
Kinyasini	Surface Water	23	9	Mlemele	Surface Water	73	68
Makwararani	Surface Water	114	31	Ngue	Surface Water	5	-
Matangatwani	Surface Water	19	7	Tibirinzi	Surface Water	25	7
Mgongombe	Surface Water	41	-	Donge Manyiga	Surface Water	19	7
Mshashani	Surface Water	25	15	Egeani	Surface Water	12	5
Mwanasoza	Surface Water	32	10	Giriama	Surface Water	33	14
Ngiwa	Surface Water	76	33	Kiguni	Surface Water	16	8
Saninga	Surface Water	38	21	Kimbuni	Surface Water	21	11
Gando	Surface Water	24	8	Kwamachigi	Surface Water	51	8

Kwalempona	Surface Water	53	14	Kwamkoba	Surface Water	93	42
Mangwena	Surface Water	29	6	Machigini	Surface Water	547	17
Mipopooni	Surface Water	65	20	Makunge	Surface Water	54	26
Mleteni	Surface Water	31	9	Maotwe	Surface Water	13	13
Tungamaa	Surface Water	33	20	Masingini	Surface Water	15	8
Weni	Surface Water	35	-	Masumbwini	Surface Water	29	7
Dobi	Surface Water	25	12	Machagapwaga	Surface Water	10	8
				Mizingani	Surface Water	25	6
Sub-total		732	409	Sub-total		1160	187
Total of Pemba						**1,892**	**596**
Grand Total of Zanzibar						**8,521**	**4,840**

Remarks: JICA Study Team