REPUBLIC OF IRAQ
MINISTRY OF WATER RESOURCES

SPECIAL ASSISTANCE FOR PROJECT IMPLEMENTATION FOR "IRRIGATION SECTOR LOAN" THE REPUBLIC OF IRAQ

FINAL REPORT (SUMMARY)

FEBRUARY 2016

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NIPPON KOEI CO., LTD.

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Location Map

Meeting with MOWR

Kick-off Meeting
(1st Field Work in Basrah)

Discussion with MOWR Staff
(1st Field Work in Basrah)

Kick-off Meeting
(1st Field Work in Basrah)

Group Picture
(1st Field Work in Basrah)

Discussion with MOWR Staff
(2nd Field Work in Amman)

Discussion with MOWR Staff
(2nd Field Work in Amman)

Meeting with MOWR

Discussion with MOWR Staff
(3rd Field Work in Basrah)

Discussion with MOWR Staff
(3rd Field Work in Basrah)

Discussion with MOWR Staff
(4th Field Work in Basrah)

Discussion with MOWR Staff
(4th Field Work in Basrah)

Discussion with MOWR Staff
(4th Field Work in Basrah)

Discussion with MOWR Staff
(4th Field Work in Basrah)

Irrigation Sector Loan Project (Phase 1)

Badra Jassan No. 1 Irrigation Pump Station
Installed new pump (front two units)

Badra Jassan No. 2 Irrigation Pump Station
Installed new pump motor and local switch panel

Badra Jassan No. 2 Irrigation Pump Station
Existing suction pit diverted by metric pumps

Badra Jassan No. 3 Irrigation Pump Station
Installed new control panels

Badra Jassan No. 4 Irrigation Pump Station
Installed new pump motors (back two units)

Shakha No. 8 Drainage Pump Station
Existing immersed condition (Pump floor)

Irrigation Sector Loan Project (Phase 1)

Shakha No. 10 Drainage Pump Station
Preparation of base plate for pump

Shakha No. 13 Drainage Pump Station
Existing condition

East Gharraf Drainage Pump Station
Measurement of existing pump pit

East Gharraf Drainage Pump Station
Existing pump motor floor

Study Area

Small Irrigation Pump by Farmers
(Thi-Qar Governorate)

Dates Farm along the Euphrates River
(Thi-Qar Governorate)

Agricultural Tractor by Farmers
(Thi-Qar Governorate)

Furrow Irrigation
(Thi-Qar Governorate)

Agricultural Experimental Station
(Basrah Governorate)

Drip Irrigation
(Basrah Governorate)

Study Area

Local Market
(Missan Governorate)

Interview from Farmers' Group
(Missan Governorate)

Existing Pump Facility
(Missan Governorate)

Waterlogging Area by Poor Drainage
(Missan Governorate)

Pump Irrigation at Terminal Irrigation Area
(Missan Governorate)

Center Pivot Irrigation
(Missan Governorate)

SUMMARY

Background

1. There are approximately 9.2 million ha of land (21% of the entire land) used for agriculture in Iraq. Of this, 40%, located in the northern region of Iraq, is cultivated under rainfed conditions while 60%, located in the central and southern region of Iraq, is irrigated from the Tigris and Euphrates rivers.

The annual rainfall, which is approximately 600 mm in the northern region and 200 mm in other regions, is not sufficient for developing agriculture. Irrigation facilities are therefore necessary in Iraq; however, only 1.2 million ha of irrigable land is actually irrigated.

The deterioration of the agricultural infrastructure facilities, salt accumulation in the farmland, and lack of farming technique and knowledge resulted in low agricultural productivity. In addition, the lack of maintenance of irrigation and drainage facilities, machineries, and equipment have significantly undermined the capacities of irrigation facilities. It is feared that if nothing is done to alleviate this situation, the irrigated area of land used for farming will further decrease.

From the viewpoint of the importance of agriculture and the necessity of irrigation development for the Iraqi economy, the Government of Iraq (GOI) adopted the rehabilitation of irrigation facilities as one of the priority projects in the national development strategy.

Objectives of the Study

2. The objectives of the Study are as follows:

1) To confirm and analyze the status, constraints, and lessons learnt from the Project Phase 1.
2) To formulate the implementation plan for the Irrigation Sector Loan Project (the Project Phase 2) to rehabilitate/improve and construct the irrigation and drainage systems.

National Profile and Development Plan

Natural Condition

3. Iraq mostly belongs to a continental, semi-tropical and semi-dry climatic zone. The annual precipitation is around 200 mm on average and the wet season is from December to February. The Euphrates and the Tigris rivers, which across the country from north-west to south-east, are the primary sources of surface water in Iraq.

4. The Euphrates-Tigris-Shatt al Arab basins are shared by several Arab countries in Western Asia as shown in Table 1.

Table 1 Shared River Basins in Euphrates-Tigris-Shatt al Arab System

Shared River	Countries	Main Shared Tributaries
Euphrates	Turkey, Syria, Jordan, Saudi Arabia, Iraq	Sajur River, Jallab/Balikh River, Khabour River
Tigris	Iran, Turkey, Syria, Iraq	Feesh Khabour River, Greater Zab River, Lesser Zab River, Diyala River
Shatt al Arab	Iran, Iraq	Karun River, Karkheh River

Source: The United Nations Economic and Social Commission for Western Asia

Because there is no international convention for the apportionment of the waters between Iraq and the upstream countries so far, water levels in Iraq's rivers have rapidly decreased to less than a third of their normal capacity as shown in Table 2. Such serious limitation of water resources is caused by climate changes like the lack of rainfall on one hand and by the increasing exploitation of river discharges such as storage construction and irrigation development in upstream countries on the other hand. The present ratio of river inflow into Iraq is 42% for the Euphrates, 36% for the Tigris, 9% for the Diyala, 8% for the Greater Zab and 5% for the Lesser Zab.

Table 2 Annual Inflow Changes of Euphrates and Tigris at Iraqi Borders

River	Cause of Flow Reduction	Annual Average Inflow	Period	Reduction Rate
Tigris	Inflow before dam construction in Turkey and Syria	30 00 billion m^3	1932 - 1972	
	Inflow after construction of Keban dam	23.50 billion m^3	1973 - 1989	21.7%
	Inflow after construction of Ataturk dam	19 00 billion m^3	1990 - 1999	36.7%
	Irrigation development in upstream countries as well as climate changes	15.20 billion m^3	2000 - 2013	49.3%
Euphrates	Normal inflow	21.20 billion m^3	1932 - 1998	
	Irrigation development in upstream countries as well as climate changes	14.98 billion m^3	1999 - 2013	29.4%

Source: MOWR and MOA, Iraq

5. The above continuous reduction of inflow has triggered increasing river water salinity, especially in the most downstream reach of the Euphrates as well as the whole reach of Shatt al Arab, resulting in worse drinking and irrigation water quality.

The current condition and future prediction of fresh water utilization in Iraq are shown in Table 3:

Table 3 Current Condition and Future Prediction of Fresh Water Utilization in Iraq

Utilization Purpose	Current Water Consumption 2014	Future Water Consumption in 2035
1. Municipality and industry	8%	13%
2. Agriculture	64%	63%
3. Fisheries and livestock	1%	1%
4. Marshlands consumption	8%	10%
5. River surface evaporation	1%	2%
6. Reservoir surface evaporation	13%	6%
7. Outflow from the mouth of Shatt al Arab	5%	5%
Total	100%	100%

Source: MOWR and MOA, Iraq

6. The present land use condition in Iraq is 18% for rain-fed farm land, 3% for irrigated farm land, 27% for bush land, 48% for non-arable land and 4% for forestry.

7. In the Mesopotamia plains formed by the Euphrates and Tigris, irrigated farming during the dry climatic season has been performed for a long time. Due to the lack of proper and sustainable

drainage control in the farm land, however, soil salinity has considerably risen in the downstream part of the plains.

Soil salinity classification with the response of crops in Iraq is summarized in Table 4.

Table 4 Soil Salinity Classification in Iraq

Soil Salinity Class	Salinity Range (EC dS/m)	Crop Response
S0: Non saline	0 - 2	Negligible salinity effects on yield
S1: Slightly saline	2 - 4	Reduced yield of very sensitive crops
S2: Moderately saline	4 - 8	Reduces yield of many crops
S3: Highly saline	8 - 16	Satisfactory yield of only tolerant crops
S4: Severely saline	16 - 32	Satisfactory of halophytes and a few very tolerant crops
S5: Extremely saline	Over 32	Land is often bare and only very salt-tolerant halophytes grown

Source: International Centre for Agricultural Research in Dry Areas

Socio-economic Condition

8. Iraq's economic growth is considered to be unsustainable due to its high reliance on oil related revenues, although it has been positive over the last few years. In 2013, oil export revenue shared 38% of the gross domestic product (GDP) and also supported public service expenditure accounting for 23% of GDP, resulting in 61% GDP share of oil-related industry. Consequently, the national fiscal position has been largely dominated by the movement of oil trading prices in international markets.

9. According to the Central Intelligence Agency (CIA) World Fact Book, Iraq's total population as of July 2014 is estimated to be 32.59 million, 18% of which lives in Missan, Dhi-Qar, Al-Muthanna, and Basrah governorates of the south region. The share in the total population is 36.7% for the group aged below 14 years, 19.6% for the group aged 15 to 24, 30.3% for the group aged 25 to 54, 4.2% for the group aged 55 to 64 and 3.2% for the group aged over 65.

10. The land holding system in Iraq is a mixture of owner operator, lease holder and share cropper. The size of land holding depends upon the type of land. The maximum holding size is limited to 75 ha in rain-fed area in accordance with the agricultural reform regulation of 1990. There are two types of state-owned lands. One is reserved lands and the other is lands that have been exploited by individual owners or cooperatives with an official land registration title. As of 2001, 67% of the latter type was rented out or distributed by the Ministry of Agriculture (MOA) to private operators and 33% was privately owned. Due to changes in social condition since then, it is difficult to verify ownerships resulting in Iraq's instability.

11. In the south region, the share of the population below the official poverty line of USD 2.20 a day is high according to the World Bank (WB) report issued in 2011 on "Confronting Poverty in Iraq".

Although per capita gross national income (GNI) in Iraq reached to the level of middle income class during the peak time of international oil market prices, the fact is that the rural people accounting for 30% of the total population are compelled to live at lower income level as shown in Table 5. Hence, it is a pressing need to boost up their income level through the improvement of agricultural productivity.

Table 5 Share in Total Household Expenditures

Household Group	Population Composition (%)	Food (%)					Daily Goods (%)	Services (%)
		Cereals	Fruits and Vegetable	Other Crops	Processed Foods	Total		
Rural	29.2	1.9	14.1	1.2	16.1	33.3	16.9	49.8
Female-head	*2.0*	2.0	15.4	1.3	14.5	33.2	16.3	50.5
Quintile 1	*12.6*	2.2	19.3	1.7	19.1	42.3	15.8	41.9
Quintile 2	*6.3*	1.7	14.3	1.3	16.5	32.9	17.2	49.9
Quintile 3	*4.3*	1.9	12.2	1.1	16.6	31.8	18.6	49.6
Quintile 4	*2.7*	1.7	9.8	0.8	13.2	25.5	18.3	56.2
Quintile 5	*1.3*	1.5	6.8	0.5	9.8	18.6	15.8	65.6
Urban	70.8	0.9	7.4	0.7	10.6	19.6	13.4	67.0
Female-head	*7.6*	0.9	8.1	0.7	11.9	21.6	14.1	64.3
Quintile 1	*12.0*	1.2	14.9	1.4	15.4	32.9	13.5	53.6
Quintile 2	*13.6*	1.2	11.2	1.1	14.3	27.8	14.1	58.1
Quintile 3	*14.0*	1.0	9.2	1.0	13.7	20.9	14.5	64.6
Quintile 4	*13.0*	0.9	7.2	0.6	11.8	20.5	14.9	64.6
Quintile 5	*10.6*	0.7	3.7	0.2	6.2	10.8	11.6	77.6

Source: USAID

12. The status of the Millennium Development Goals in Iraq by 2015 is summarized in Table 6.

Table 6 Current Situation of Millennium Development Goals in Iraq

Goal		Current Situation
Goal 1	Eradicate extreme hunger and poverty	Achieved poverty target (11.5% of population with income below USD 2.5 per day), but the current food security level of 6% at the national level is consuming less than the recommended daily energy intake.
Goal 2	Achieve universal primary education	Current enrollment rate is 95% for primary education and 48.6% for secondary education, and completion rate of primary education is 95.5%.
Goal 3	Promote gender equality and empower women	Percentage of girls to boys enrolled in primary education is 94% and 85% in secondary education. Percentage of women in non-agriculture paid employment is 14.7% at the national level.
Goal 4	Reduce child mortality	Current mortality rate is 32 deaths per 1,000 births, which is doubled the goal of 17 deaths per 1,000 births by 2015.
Goal 5	Improve maternal health	Current rate of deliveries under qualified physician is 90.9% at the national level and 84.5% in rural area.
Goal 6	Combat HIV/AIDS, malaria and other diseases	91.5% of women knows about HIV/AIDS resulting from the success of national information, education and communication programs.
Goal 7	Ensure environmental sustainability	Current rate of population with sustainable access to an improved water source is 70.8%, but only 38% for good or very good source.
Goal 8	Develop a global partnership for development	Current rate of households with a fixed telephone line is 5.1%, but 94.3% has mobile phone, 96% has satellite TV, and 17.2% has PC.

Source: UNDP

Agricultural Production

13. Iraq's major crop planted area, yield and production records in 2014 are summarized in Table 7 by referring to the internal information of MOA.

Table 7 Crop Planted Area, Yield and Production in Iraq for 2014

Crop	Area (ha)	Yield (ton/ha)	Production (ton)	Crop	Area (ha)	Yield (ton/ha)	Production (ton)
Cereals and Permanent Crop							
Wheat (irrigated)	1,458,810	2.6	3,779,229	Barley (irrigated)	352,580	1.5	536,281
Wheat (rain-fed)	673,201	1.9	1,275,882	Barley (rain-fed)	805,486	0.9	741,515
Rice	79,312	5.1	403,028	Dates	139,000	5.5	770,000
Vegetables and fruits							
Tomato	34,820	22.1	770,564	Cucumber	31,185	8.8	273,005
Watermelon	22,732	13.2	300,309	Egg plant	22,301	19.5	434,322
Okra	16,695	7.4	123,583	Melon	14,720	10.3	151,753
Broad Bean	13,914	7.8	108,194	Onion, green	13,809	15.0	207,422

Source: MOA, Iraq

Food Supply

14. Aiming to meet the food security needs, the government introduced the Public Distribution System (PDS) in 1991, consisting of a food-ration system for basic food items. This PDS involved procuring strategic food crops from domestic producers at fixed prices, and selling them to consumers at much lower prices. The PDS is intended to provide a minimum standard of living for the entire population in amounts calculated to be sufficient to meet 100% of each household member's daily caloric needs.

According to the World Food Program (WFP) Iraq Office's report on food security, living conditions and social transfers in Iraq, 1.9 million Iraqis or 5.7% of the population are food deprived, consuming less than the average dietary requirements of 2,161 kilocalories per day. A further 4 million Iraqis or 14% of the population are vulnerable to food insecurity. Such situation clearly reveals that there exist people who are not benefitted by the PDS to a considerable extent. The proportion of food-deprived population by district in four governorates in the south region is as shown in Table 8.

Table 8 Food Deprivation in South Region

Governorate	Population (person)	Percentage of Food-deprived Population			
		0 - 5.0%	5.1 - 15.0%	15.1 - 30.0%	30.1 - 51.0%
Missan	971,448	-	All districts	-	-
Dhi-Qar	1,836,181	-	4 districts	-	1 district
Al-Muthanna	719,068	-	All districts	-	-
Basrah	2,531,997	-	1 district	5 districts	1 district

Source: World Food Programme

In 2014, the Council of Ministers, following the recommendations of the Poverty Reduction Strategy (PRS) for 2010 to 2014, has approved a plan presented by the government's High Committee for PDS Reform that contains the detailed actions to be taken to implement PRS. This includes a phased five-year plan to reduce the number of PDS beneficiaries to cover only the poor population by 2015. Also, the services provided through social safety net will be expanded and improved in order to strive for lightening the government's financial load.

Supplemental Import of Foods

15. Iraq has imported 2 to 3 million tons of wheat every year to make up for the deficiency of the staple food and further met the domestic demand for meats, rice, cooking oil, milk, tea and sugar with imports. For vegetables, 60% to 70% of the domestic consumption is supplemented by importing products from the neighboring countries. Records of imported major cereals and vegetables for the previous ten years from 2002 to 2011 are summarized in Table 9.

Table 9 Imported Major Cereals and Vegetables in Previous Ten Years

Year	Cereals (ton)				Vegetables (ton)			
	Wheat	Wheat flour	Rice	Maize	Potato	Pulses	Onion	Tomato
2002	2,417,464	5.616	116,200	0	19,398	23,909	683	1,576
2003	1,276,667	530,900	43,350	4	77,411	344,122	20,501	50,166
2004	2,501,412	294,751	65,164	475	120,761	49,873	5,123	30,803
2005	2,535,529	1,206,740	83,063	84,200	166,146	76,810	18,000	60,100
2006	2,838,813	958,337	132,908	27,286	114,796	12,037	105,379	251,892
2007	2,423.713	534,938	73,590	8,897	168,962	31,806	45,007	655,481
2008	2,963,320	489,000	105,191	26,569	94,383	48,493	83,466	112,129
2009	3,050,409	820,000	109,956	27,000	67,482	70,147	71,704	148,220
2010	1,854,525	894,553	112.316	2,840	180,535	73.992	75,664	371,630
2011	2,888,833	850,419	84,263	2,017	61,774	76,265	52,272	109,310

Source: FAOSTAT

Estimate of Food Demand for 2020

16. Assuming that Iraq's population in 2020 will increase to 42 million and per capita annual consumption of wheat will be 213 kg based on the average level between 1998 and 2008, the demand of wheat is predicted at 8 million tons. If risks of climate changes like reduction of rainfall and rise of temperature become apparent, the unit yield of wheat in Iraq is recognized to decrease by about 12.5%. Considering that Iraq's people obtain 40% of their daily food intakes from wheat flour and its processed foods, Iraq's dependence on imported wheat will reach 70% in 2020. Unless the current dwindling situation of domestic wheat production is stopped, there is a strong probability that Iraq's food security will go over the critical level. Therefore, it is indispensable to reconstruct the domestic food supply condition from short-, medium- and long-term viewpoints for improving the self-sufficiency rate of food.

Improvement of Agricultural Production Base

17. The Ministry of Water Resources is responsible for the following: (i) water management, (ii) conducting of studies and design of irrigation and drainage projects including water resources development, (iii) construction of dams, (iv) construction of irrigation and drainage projects, (v) exploiting of groundwater to sustainable levels, and (vi) operation and maintenance (O&M) of irrigation and drainage facilities including dams. MOWR is organized into six directorates and six general commissions, which are under the command of the Minister. MOWR has its regional office in each governorate in Iraq.

18. The Ministry of Water Resources selected 110 candidate sites and formulated the future long-term irrigation development plan with the target year of 2034. The plan consisted of 78 surface irrigation schemes covering 9.11 million ha, 21 ground water irrigation schemes commanding

0.17 million ha, and 11 rain-fed sites extending over 0.51 million ha for which irrigation system was under consideration. Total target area is 9.8 million ha, which includes 3 million ha of reclamation for non-arable land.

Until 2013, MOWR has developed 1.22.million ha in total, comprising 1.21 million ha for the surface irrigation scheme and 0.01 million ha for the ground water irrigation schemes. Table 10 shows the number and area of planned irrigation schemes as well as the developed area and progress rate.

Table 10 Outline and Progress of Irrigation Development in Iraq

Water Source	Number of Schemes (nos)	Target Area of Schemes (1,000 ha)	Irrigation Area Developed (1,000 ha)	Progress as of 2013 (%)
Surface Irrigation Scheme				
Euphrates River	26	3,900.0	758.0	19.4
Greater Zab River	4	92.0	0.0	0.0
Lesser Zab River	4	252.0	110.0	43.6
Diyala River	9	503.4	17.0	3.4
Udhaim River	1	160.0	0.0	0.0
Eastern Tributaries	3	5.0	0.0	0.0
Tigris River	31	4,193.2	321.0	7.7
Sub- total	78	9,105.6	1,206.0	13.2
Ground Water Irrigation Scheme				
Spring	10	45.0	10.0	22.2
Well	11	127.0	0.0	0.0
Sub-total	21	172.0	10.0	5.8
Sites under Consideration on Irrigation System				
Rain-fed	11	511.0	0.0	0.0
Sub-total	11	511.0	0.0	0.0
Total	110	9,788.6	1,216.0	12.4

Source: MOWR, Iraq

19. In Iraq, MOWR is fully responsible for the operation, maintenance and management works of all irrigation systems after their completion and hence, it covers the necessary expenditure for executing such works through the allotment of necessary amount from its own annual budget. For the time being, MOWR has no plan to collect water charge from water users of irrigation schemes, and considers sharing system of operation and maintenance (O&M) cost of irrigation system in the future.

Aiming to cope with limited availability of water resources in the country, MOWR has set up its policy target to promote saving methods of irrigation water use through the introduction of closed pipeline system at tertiary level and drip irrigation system at on-farm level in a combined manner. As one of the promotional activities, MOWR has encouraged beneficiary farmers of irrigation schemes to establish a water users association (WUA). So far, 63 WUAs in total have been established covering 27,383 ha, and 2,503 beneficial farmers have been organized throughout the country.

20. In implementing farm land development or improvement works in Iraq, drainage facilities should be principally constructed prior to provision of irrigation facility, aiming to protect salinity accumulation in the surface soil layer. Up to 2013, MOWR had almost completed drainage

schemes included in its drainage development plan as shown in Table 11.

Table 11 Outline and Progress of Drainage Development in Iraq

River Basin	Number of Schemes (nos)	Target Area of Schemes (1,000 ha)	Drainage Area Developed (1,000 ha)	Progress as of 2013 (%)
Euphrates River	5	857.0	857.0	100.0
Greater Zab River	1	42.0	42.0	100.0
Lesser Zab River	1	662.0	6620.0	100.0
Diyala River	4	617.0	609.0	98.7
Tigris River	21	2,076.0	2,0760	100.0
Total	32	4,254.0	4,246.0	99.8

Source: MOWR, Iraq

Agricultural Supporting Services

21. In 2003, the four state companies having a monopoly on agricultural input procurement and supply under the jurisdiction of MOA were divided and reorganized into 30 state-owned companies trading in a specific commodity such as seeds, chemical fertilizers, insecticides, fungicides, herbicides, plastic films, irrigation pumps, tractors, harvesters, farm machinery parts, animal feeds and veterinary medicines. Since then, some enterprises have been merged, and eight enterprises were operating their import and selling business activities of agricultural inputs under the direction of MOA in 2008. Among them, the largest is the General Company for Agricultural Supplies (GCAS), an autonomous body, with branches in each governorate and 1,774 agents. Adding commissions equivalent to 2% of imported prices, agricultural inputs are sold to farmers through these channels.

There is no standard on seeding quantity and fertilizer dosage by crop in Iraq. By referring to FAO's statistics on fertilizer production and import as well as annual cropped areas, annual application volumes of fertilizer for the period from 2004 to 2012 are analyzed as shown in Table 12.

Table 12 Annual Application Volume of Fertilizer in Iraq

Item		2004	2005	2006	2007	2008	2009	2010	2011	2012
Planted Area ('000 ha)		3,264	4,324	3,257	3,342	1,946	1,815	2,865	2,703	2,352
Nitrogen Fertilizer (ton)	Product	9,845	13,894	15,172	11,022	14,930	14,122	9,660	12,880	12,328
	Import	426	1,494	1,530	1,620	1,620	720	1,138	956	1,836
	Total	10,271	15,388	16,702	12,642	16,550	14,842	10,798	13,836	14,164
Phosphate Fertilizer (ton)	Product	0	24,450	15,900	18,140	22,240	0	0	0	2,300
	Import	736	3,818	3,910	4,140	4,140	1,840	2,438	2,438	4,692
	Total	736	28,268	19,810	22,280	26,380	1,840	2,438	2,438	6,992
Potassium*	Import	9,845	13,894	15,172	11,022	14,930	14,122	9,660	12,880	12,328
Element Applied (kg/ha)	N	3.15	3.56	5.13	3.78	8.50	8.18	3.77	5.12	6.02
	P	0.22	6.54	6.08	6.67	13.56	1.01	0.85	0.90	2.97
	K	3.02	3.17	4.66	3.30	7.67	7.78	3.37	4.77	5.24

*Note: *; unit ton Source: FAOSTAT*

22. In accordance with the comprehensive farm mechanization policy in 2007, MOA partly opened GCAS's monopolized business of importing and selling farm machinery for the private sector and formulated a roadmap to strengthen supporting services covering soft components as follows:

- To allow international companies to open branches in Iraq for producing agricultural machinery and equipment;
- To implement a special lending fund aiming to provide newly entering private enterprises with financial support to import agricultural machinery and equipment;
- To reduce/remove trade regulations interfering with importation of agricultural machinery by the private sector;
- To establish a technical facility to test any imported agricultural machinery and equipment so as to ensure quality and compliance with the agricultural needs and characteristics of the various regions and soil types of Iraq;
- To encourage the private sector to establish a business model for providing agricultural machinery services to farmers; and
- To establish training centers for young people focusing on operation and utilization of modern agricultural machinery and irrigation equipment.

23. Until 2003, the main pillar of Iraqi Government’s agricultural policy was PDS which unifies agricultural input supply to and procurement of major food crops, oil crops, and industrial crops from farmers. As a result, agricultural products handled by the private sector market were limited to vegetables and fruits, and a nation-wide marketing system with a function of trading agricultural products was thoroughly disregarded in Iraq coupled with poor transportation network throughout the country. In regional private markets trading locally produced fruits and vegetables where operations of suppliers and consumers were free from government regulations, private markets brokers, wholesalers and retailers had specific roles to fulfill. Among them, wholesalers who were frequently engaged into exporting agricultural products took the initiatives to set the prices on trading goods. Based on such wholesalers’ prices, private market brokers decided their purchased prices of the products from farmers by deducting their service commissions for packing and cleaning works.

The mass supply of strategic commodities through the PDS channel for almost no charge lowered their market prices. The widespread distribution of subsidized foods has discouraged the development of transparent markets and especially resulted in depressed domestic producer prices leading to price disincentives particularly for wheat growers.

MOA identified policies oriented to improve the functioning of agricultural markets in 2007. The objective of these policies was to raise the effectiveness of commodity markets through the following:

- Classification and grading of agricultural commodities;
- Adding value and packing of agricultural commodities;
- Expansion of agro-industry transformation and processing facilities;
- Modernization of cooling and refrigeration storehouses; and
- Strengthening of information networks to promote competitiveness.

So far, these policies have yet to be realized.

At the moment, MOA is playing an indirect role in stabilizing the retail prices of agricultural products. However, the fluctuation of Iraqi currency, which is closely linked with the changes of

oil trading prices in the international commodity market, has clearly prevented the stabilization of domestic commodity prices in an effective manner.

24. Similar to other Arab countries, Iraq has a comparatively long history of cooperatives. The first law on cooperative societies was issued in 1922, and the first consumer cooperative society was established in 1937. New cooperative laws were developed in 1977 (No.202) and in 1999 with the aim of revitalizing the cooperative sector.

Administratively, the General Cooperative Department under the Ministry of Labor and Social Affairs was dismantled in 1980, and its functions were transferred to the General Cooperation Union, being administratively and financially independent from the Government. The Union consisted of four craft unions and their memberships in the 2000s were as follows:

- Consumer Cooperative Societies: 186 consumer cooperatives with members exceeding 1.5 million, including 13 societies dealing with agricultural marketing;
- Productive-Worker Cooperatives: 62 societies with members including 35,000, working mainly in the textile industry, roses, ceramics and carpentry;
- Services Cooperatives: 62 societies with members bordering 250,000; and
- Housing Cooperatives: 29 societies with members totaling 2.4 million, aiming to construct or make available housing at affordable prices to help address the housing crisis in Iraq.

Since 2008, the Iraqi government with technical and financial assistance of the United States Government has initiated to form agricultural associations. The functions are to buy fertilizer and seeds, to hire drivers, to rent equipment for harvesting wheat and barley, and to make arrangements for selling agricultural products directly to the public in Baghdad. The status of cooperative recovery works is summarized as follow:

- Local agricultural cooperatives: 881 societies with 205,037 members;
- Consumer cooperatives: 221 societies with 887,270 members;
- Collective farms: 3 societies with 169 members; and
- Specialized cooperatives: 49 societies with 16,397 members.

25. Because the distribution systems of seeds and fertilizers have been monopolized by the state company, no indigenous private sector credit delivery systems targeted for agriculture became popular in Iraq, particularly a selling on credit system of farm inputs and collecting debt on crop harvests.

The government in coordination with GCAS established a specialized lending fund for the private sector to import and supply small machines and irrigation facilities needed by small to medium farmers. The performance of this fund is as shown in Table 13.

Table 13 Lending Performance of Specialized Lending Fund

Item	2008	2009	2010	2011	2012	2013	Total
Beneficiaries (person)	8,265	12,301	14,057	31.473	22,177	6,455	94,728
Loan amount (Billion IQD)	81.0	142.0	216.0	507.0	470.0	255.0	6,124.0
Loan amount per person (Million IQD/person)	9.80	11.54	15.37	16.11	21.19	39.50	64.65

Source: MOWR and MOA, Iraq

26. In 2011, MOA formulated the new agricultural research policy focusing on the following items:

- To undertake specific research in those agricultural crops that have low yields, diseases and are important for food security;
- To undertake research beyond the agronomic field, and using multidisciplinary teams to study problems that farmers are facing such as marketing, domestic and international prices, storages, transportation, commodity chain, manufacturing, and social dimensions;
- To improve coordination with extension services;
- To improve facilities required for coping with local characteristics and promoting decentralized research works;
- To analyze agricultural technologies developed in other countries and adopting them in such a way that these technologies are tailored to the needs of Iraqi farmers;
- To expand research on the reuse of agricultural residues in the establishment of environment oriented recycling systems;
- To promote research of bio-fertilizers and bio-salinity treatments to overcome land degradation problems; and
- To strengthen research for developing and breeding new drought-tolerant- and salt-tolerant crop varieties.

27. The State Board of Agriculture Extension Cooperation, a part of MOA, is responsible for extension activities and has offices at the governorate and district levels. In 2011, aiming to encourage farmers to grow vegetables and other specific commodities, the government banned the import of concerned agricultural products. The main activities of agricultural extension services are to distribute imported farm inputs to farmers. Without lack of inspection systems, however, proper quality control and quarantine works have yet to be performed.

In parallel with its primary function, GCAS also performs an extension function by encouraging farmers to adopt modern technologies.

Agricultural Development Issues

28. Major issues in the land resources, water resources and agricultural production sectors that Iraq is currently facing are summarized in Table 14.

Table 14 Major Issues of Land Resources, Water Resources and Agriculture Sectors

Sector	Issues
Land resources	• As 70%, more or less, of farmland is affected by soil salinity, Iraq needs to reclaim at least 2 million ha through the development of an effective on-farm drainage networks which is connected with the existing drainage pump stations and main drainage canal systems. • Calcareous soils with $CaCO_3$ ratio of 25-35% cause problems in the availability of nutrients to crops. • Gypsum rate up to 20% in soils causes problems in the readiness of nutrients and affects the balance of inorganic elements in addition to soil cracking and hardness. • Soil organic content of less than 0.5% reflects negatively on soil physical features and decreases soil fertility.

Sector	Issues
Water resources	• Decrease in surface water across the Tigris and the Euphrates rivers triggers to alter the farming patterns so that farmers need extension and guidance services for coping with new circumstances. Establishment of water users associations is one tool to do so. • The pressing needs are to accelerate the development of irrigation schemes including the construction of new main and branch canals in proposed irrigation areas as well as prevention of seepage loss in the existing earth canals. • The urgently required measures are equal utilization and saving of limited irrigation water through the modernization of old fashioned irrigation water distribution system.
Agricultural production	• Renovation of old agricultural production practices needs to develop a communication system to provide useful information to farmers so that MOA is requested to do so with sustainable efforts. • The need for farm mechanization is much stronger compared in the neighboring countries. • Shortage of electric power coupled with the rising prices of fuel, seeds, fertilizers and pesticides reduces the competitiveness of local agricultural products. • Lack of national and foreign investors in agricultural sector continues for a long time. • Due to Iraqi farmers' poverty and low entrepreneurial spirits in adopting modern technologies, they still need to be taken care of by the state and the institutions of MOA. • The majority of Iraqi farmers are still unaware of the importance of the economy planned by the state which focuses on the market economy based on the competition in quality and prices in the market.

Source: MOWR and MOA, Iraq

Agriculture and Water Resources Sectors of National Development Plan 2013-2017

29. The essential points of agriculture and water resources sectors set up in the National Development Plan (NDP) 2013-2017 are summarized in Table 15 (challenging targets), Table 16 (quantitative indicators for crop production) and Table 17 (means to achieve goals).

Table 15 Challenging Targets in Agriculture and Water Resources Sectors under NDP

Sector	Challenging Target
Agriculture	• Increase in cultivated areas of wheat by 67%, rice by 15% and vegetables by 40% for the NDP period aiming at import substitution and strengthening of market competitiveness through the improvement of food self-sufficiency rate • Increase in utilization rate of cultivable land resources by 25% and more • Improvement in fragmentation of land ownership and small agricultural holdings causing uneconomic farm operation and encroaching of preserved green areas • Prevention of desertification, sand dune spreading and land degradation • Putting the brakes on declining productivity of farm land and animal husbandry • Building up of skills in agricultural sector and ability of human resources aiming to secure to learn and practice new cultivation technologies by the farmers themselves • Promotion of investment by public and private as well as domestic and international fund sources in agricultural sector, especially for land reclamation, water resources development and agro-processing industry
Water resources	• Achievement of agreement guaranteeing a just share of river discharge by the countries concerned as a basic measure to cope with insufficient irrigation water supply, insufficient municipal and industrial water storages, decline of water quality of the Tigris and Euphrates rivers • Increase in storage capacity of limited water resources for securing water use by public sector • Improvement of random and irrational water usages in agriculture, industry and urban services through establishment of internal coordination system among governorate offices and awareness of water consumers on water usage • Introduction of spray and drip irrigation systems as well as closed pipeline system as

Sector	Challenging Target
	effective measures for water saving and increase in irrigation efficiency • Improvement of water quality of the Shatt al-Arab River through the treatment of waste water from the urban area and industries • Operation of completed dams for coping with water demand of all sectors • Action taken for coping with climate change particularly for increase in temperature and lack of rainfall

Source: MOP, Iraq

Table 16 Quantitative Indicators for Crop Production during NDP Period

Major Crop	Present Condition as of 2013			Target Condition for 2017		
	Planted Area ('000 ha)	Crop Yield (ton/ha)	Production ('000 tons)	Planted Area ('000 ha)	Crop Yield (ton/ha)	Production ('000 tons)
Wheat	1,697	2.23	3784	1,863	3.06	5,697
Rice	55	3.20	176	55	4.78	263
Barley	981	0.97	953	1,100	1.12	1,236
Yellow corn	196	4.05	794	262	6.01	1,571
Tomato	98	16.80	1638	108	31.22	3,356
Potato	58	18.38	1057	88	32.41	2,836
Onion	19	10.96	211	22	12.00	267
Dates	127	5.35	679	175	6.00	1,050

Source: MOP, Iraq

Table 17 Means to Achieve Goals under NDP 2013-2017

Means to Achieve Goals		Components
1.	Increase agricultural land and boost production and productivity	Completion of main drain channels in eastern Euphrates, western Euphrates, east Tigris and east Al-Gharraf for implementing 1.27 million ha of land reclamation
2.	Integrated land reclamation	Implementation of 125,000-ha projects every year during the NDP period for the target of 425,000-ha land reclamation and 200,000-ha irrigation facility improvement
3.	Fighting desertification and sand dune spread	• Stabilization of sand dunes through minimum 2,500-ha clay coverage every year, annual production of 1.75 million seedlings, annual collection of minimum 30-ton seeds, annual digging of 30-km canal, and establishment of 7-desert oases with an area of 50 to 200 ha; • Development of plant coverage in desert areas by cultivating drought-tolerant plants • Establishment of pastoral seed collection farms for replanting seeds in other areas to restore plant cover • Implementation of 78 stations for pastures and nature preserves reaching 250 ha by 2015
4.	Optimal exploitation of water resources	• Commencement of measures for increasing water storage volume by about 22 billion m^3 over the long term • Construction of small dams with storage capacity of 150-200 m^3 on tributaries of the Tigris River • Implementation of 750,000-ha irrigation system modernization measures by introducing effective ways to limit waste and increase field irrigation efficiency such as spray irrigation, drip irrigation, closed pipe irrigation, closed channels and lining channels, and improvement of 31% of existing 47,000-km irrigation canals through lining or replacement with closed pipe • Utilization of salt water and reuse of treated sanitation water for agricultural purpose • Reviving and development of marshlands coping with social and environmental conditions • Investment in renewable ground water • Execution of research, studies and field experiments in relevant research bodies coping with irrigation system modernization

Means to Achieve Goals		Components
		• Implementation of periodic maintenance works for 126,000-km irrigation and drainage canals as well as for more than 200 pump stations by securing necessary amounts from the federal budget • Development of human resources
5.	Supporting development in Iraq's countryside	Support to multidisciplinary measures needed for economic and social development of rural communities
6.	Sustaining national development programs and projects	Introduction and practice of various innovative technologies for increasing unit yield and self-sufficiency rate in the agricultural, animal husbandry and fishery sectors
7.	Foreign and domestic private sector support for agricultural sector investment	Making of preparations to receive private sector's investment in agriculture through the development of agricultural producing zones, animal raising zone and agricultural processing and storage zone, and introduction of finance and insurance services as well as the implementation of producer support measures such as agricultural input supply and import restriction of competitive products
8.	Adopting policies and programs for agricultural guidance and awareness	Utilization of visual, audio and printed media as guidance and education means for investment in and extension of modern agricultural technologies
9.	Comparative advantage	Investment in the relative and specialized advantage of agricultural regions instead of being oriented toward diversifying and cultivating marginal land with various crops leading to reduced harvest rates for crops grown in unfavorable environments
10.	Interest in post-harvest operations	Provision of integrated complexes for promoting agricultural marketing with hard measures in terms of processing, packing, transportation, and storage, and soft measures like regulations, grading, market prices, trading volume, information release as well as the importation of agricultural finance and insurance
11.	Biological and environmental diversity	Implementation of biological diversity measures and control of aquatic animals and plants causing environmental deterioration
12.	Legal reform and the required legislative environment	Reform, abolition or amendment of the existing laws and related provisions in agriculture and water resources sectors constituting obstacles to implement the above measures

Source: MOP, Iraq

Outline of Related Projects

Irrigation Sector Loan Project (the Project Phase 1)

30. The objectives of the Project Phase 1 are to improve and upgrade the existing irrigation systems by the rehabilitation of pumps and related facilities and provision of necessary equipment and machineries for the operations and maintenance (O&M), thereby contributing to increasing agricultural production, creating medium-term and long-term job opportunities, and accelerating regional development.

31. The original scope of the Project Phase 1 was planned to consist of: i) procurement of irrigation and drainage pump, ii) procurement of O&M machinery and equipment; and iii) procurement of generators.

1) Procurement of Pump

- Procurement and installation of pump units for Badra Jassan Irrigation Project, Al Dijila Irrigation Project, and East Gharraf Drainage Project
- Supply of horizontal metric pumps and submersible pumps

2) Procurement of O&M Equipment and Machinery
   - Procurement of construction equipment
   - Procurement of trucks
   - Supply of mobile batching plants
   - (Additional) Procurement of trucks and mobile dosing stations
   - (Additional) Procurement of construction equipment

3) Procurement of Generator
   - Procurement of generators

Implementation of the Project Phase 1

32. MOWR as a whole is taking responsibility for all the activities in the Project Phase 1 such as sub-project site selection, overall project coordination, procurement management, asset management including tracing and reporting of each item to be procured under the Japanese official development assistance (ODA) loan, financial management including checking of all accounts and preparation of disbursement requests to JICA, arrangement of audit, monitoring and evaluation, and preparation of reports such as progress reports.

The Project Management Team (PMT) has been established in MOWR Headquarters in Baghdad after the Loan Agreement (L/A) for the Project Phase 1 became effective and is headed by the General Director of Planning and Development (later transferred to Legal and Contracts Directorate) of MOWR, which shall manage and control the Project Phase 1 exclusively.

In the installation stage of pump rehabilitation, the regional office in Wasit, which is selected as the office in the sub-project area, is responsible for the sub-project. As for procurement management, the PMT of MOWR Headquarters continues to take responsibilities.

Lessons Learnt from the Project Phase 1

33. The Japan International Cooperation Agency (JICA) Guidelines such as: i) Guidelines for Procurement under Japanese ODA Loans; and ii) Evaluation Guide for Prequalification and Bidding under Japanese ODA Loans, were explained by the Consultant in the workshop only for the members of PMT.

The members of the evaluation committee are selected from the various directorates in the ministry. Not only the members of the committee but also the related directorates in the ministry must understand the JICA guidelines for procurement and bid evaluation. Firstly, the minister should instruct the committee to evaluate the bid under the Japanese ODA loan strictly in compliance with the JICA guidelines.

34. The requirements and specifications for the bidding documents were discussed and finalized between the members of PMT and the Consultants through the meeting held in Amman. But some of the agreed requirements did not suit the actual site conditions.

Especially for the rehabilitation projects, the person in charge of operation should participate in

the meeting between PMT and the Consultants to incorporate the site requirements into the specifications.

35. The Consultant explained the results of the bid evaluation to the members of the evaluation committee including the JICA guidelines. Because the members of the evaluation committee were selected from the various directorates in the ministry, the meeting of evaluation committee was hardly held due to the inconvenience of the members. The members should be given time to concentrate on the evaluation for a short period. The minister should instruct the members to complete the evaluation on time.

36. The Director General of Legal & Contract Directorate had attended all the contract negotiation and signing in Amman. During the contract negotiation, the director often modified the contents of the standard bidding documents, which had been concurred by JICA. In many cases, such modifications were only the correction of wordings without any change on basic idea of contract, accordingly, the contractor agreed with the modifications.

However, the review of bidding documents should not be made during the contract negotiation. Even if the contactor signed the contract after the conclusion of negotiation, the director did not sign the contract in Amman because of the regulation of the ministry. It is acceptable for the director to sign the contract in Baghdad, but the unnecessary modification of contract documents, such as modification of wording, should not be made during the contract negotiation. If there is difference between the JICA standard bidding documents and the rule/regulation of the ministry, such difference should be coordinated during the preparation of the bidding documents before the concurrence of JICA.

37. For the rapid case of L/C opening, it took nearly two months. For the longest case of L/C opening, it took one year. The process of L/C opening has been much improved due to the assistance of the United Nations Development Programme (UNDP). The ministry should appoint a person in charge to complete the process within the decided period.

38. It was very difficult to arrange the resident assignment of the Consultant at the site because of the budgetary limitation. The Consultant will sometimes visit the site and only check the progress. Although the rehabilitation work is mainly for the equipment and not for the civil works, the existing civil structures often do not meet the new equipment with regard to the actual dimensions due to lack of precise survey and/or discrepancy in dimensions between the as-built drawings and the actual structures. In such case, the Consultant should timely survey the site and study the method of solution.

For the construction supervision, a sufficient quantity of man-months for national consultants should be provided at first in case the international consultants cannot enter into the site. Furthermore, the direct cost of accommodation and transportation should be considered for the national consultants to perform the site supervision. As for the accommodation, hotels at the capital of the governorate near the site should be considered. For the transportation, a four-wheel drive (4WD) vehicle must be provided.

JICA Technical Cooperation Project on Water Users Associations (WUA)

39. Agriculture is a major sector in Iraq, as it constitutes approximately 10% of the gross domestic product (GDP). The oil industry is the largest sector. However, the productivity of agriculture in Iraq remains low due to many reasons, including the deterioration of agricultural infrastructure due to age, salt accumulation in the irrigated land, and lack of knowledge and techniques on agriculture. In addition, the situation has become even worse due to the reduced inflow in the rivers in Iraq, as neighboring countries such as Turkey and Syria have recently constructed large dams and developed vast areas of irrigated agricultural land. The reduced water availability due to inappropriate water management has also become a big issue. Therefore, some urgent tasks are needed to facilitate a more efficient use of water including the following: strengthening the capacity for O&M of irrigation and drainage infrastructure; fair and optimal water distribution; awareness-building for water conservation; and introducing water saving technology. It is said that the agriculture sector uses plenty of water, so it is essential to improve the efficient use of water in the agriculture sector and to take a comprehensive view of water resource management.

The Iraqi side has been conducting the Spreading Water Users Association Project (the Iraqi WUA Project) using their own budget. In the Iraqi WUA Project, 18 governorates are divided into four groups. The construction/rehabilitation of irrigation facilities and capacity development of the relevant persons are included. The Technical Cooperation Project entitled, “Project for Spreading Water Users Associations for the Efficient Use of Irrigation Water”, implemented by JICA targeted 15 governorates of the Iraqi WUA project aiming for synergy effect.

JICA Technical Cooperation Project Purpose and Activity

40. The project purpose is to develop the capacity of the relevant agencies on irrigated agriculture to develop the capacity of WUAs for irrigation water management in the pilot project sites.

Activities of the project are as follows:

1-1 Training for relevant officials on project management

1-2 Monitoring of pilot projects and advice for relevant officials on project management

1-3 Sharing the lessons from each pilot project among stakeholders through reporting and/or workshops

2-1 Training for relevant officials on establishment and O&M of WUA

2-2 Training for relevant officials on O&M of water management facilities

2-3 Training for relevant officials on extension skills for 2-1 and 2-2

2-4 Monitoring of the pilot project and advice for relevant officials for 2-1 and 2-2

2-5 Training for key farmers from the pilot project sites on WUA activity

3-1 Training for relevant officials on improved farming practices under irrigated condition.

3-2 Training for relevant officials on extension skills for 3-1

3-3 Monitoring of the pilot project and advice for relevant officials for 3-1 and 3-2

3-4 Training for key farmers from the pilot project sites on improved farming practices under irrigated condition

Implementing Organization Structure of JICA Technical Cooperation Project

41. MOWR is the main project implementation organization on the Iraqi side. Related institutions, ministries, and agencies are the Prime Minister's Supreme Commission of Agricultural Initiative, Ministry of Planning, Ministry of Agriculture, and Project Management Team (PMT) of the Iraqi WUA Project in each governorate.

Neighboring country training is implemented in collaboration with the regional JICA offices (Jordan, Turkey, and Egypt) and training implementation institutes (Jordan: National Center for Agriculture Research and Extension (NCARE), Turkey: General Directorate of State Hydraulic Works (DSi), Egypt: Central Department of Irrigation Advisory Services (CDIAS).

Achievement of JICA Technical Cooperation Project

42. The Objectively Verifiable Indicators (OVI) of the project purpose are 60% of the approved WUAs in the pilot project sites implement their action plans as planned and 80% of PMTs of Phase 1 and Phase 2 implement their water extension plans as planned. The achievement of each OVI of the project purpose is shown in the following Table 18.

Table 18 Achievement of the Project Purpose

Objectively Verifiable Indicators (OVI)	Achievement	Achievement of OVI
1. 60% of the approved WUAs in the pilot project sites implement their action plans as planned	Nine of the 13 WUAs established (69%) started activities according to their action plans.	Attained
2. 80% of PMTs of Phase 1 and Phase 2 implement their water extension plans as planned.	Seven of the targeted 11 PMTs, excluding 3 PMTs due to the deterioration in the security situation, implemented their water extension plans (87%).	Attained

Source: Final Report of JICA Technical Cooperation Project entitled, "The Project for Spreading Water Users Associations for the Efficient Use of Irrigation Water"

Lessons Learnt from JICA Technical Cooperation Project

43. According to the final report of the JICA Technical Cooperation Project entitled, "The Project for Spreading Water Users Associations for the Efficient Use of Irrigation Water", the participants in the farmers' training seemed to be influential persons in their governorate and not the farmers who actually worked in the fields. While these people could help to expand the project activities to many other farmers in their governorates, the practical application of what the participants learned in the training course might not have materialized without the participation of farmers who engage in the agricultural work in the field. In the 2nd and 3rd years of the project, some young farmers were selected as participants in the farmers' training. In implementing the technical training and/or seminar, it is essential that the participants be composed of responsible persons who engage in actual field agriculture in addition to local influential persons.

44. Due to the deterioration in the security situation, visit to Iraq apart from some regions was banned, monitoring at the site was cancelled, and a ministerial order was not granted. As a result, security situation made an impact on the project output.

In the final report, it is mentioned that project activities might have advanced more with the implementation of site monitoring. It is mentioned that direct instruction from Japanese experts might have motivated beneficiaries more and made beneficiaries learn specialized techniques.

Also, it is mentioned that project activities at the four governorates in the southern region relatively went well because the security situation at these governorates is stable.

It is essential to consider that the project shall have a minimum impact on outputs in spite of the security deterioration.

45. In the final report, the importance of face-to-face communication is mentioned. In the Technical Cooperation Project, monitoring was one of the most difficult matters and Japanese experts were not allowed to visit the target areas. Basic information for monitoring was obtained from monthly monitoring sheets and monitoring workshop.

In the first year, the submission rate of monitoring sheets was low and the monitoring workshop was held only twice. Consequently, project activities could not be grasped adequately. It is mentioned that the reasons for this are: i) PMT members having insufficient command of English and personal computer skills, and ii) difficulty in establishing a new reporting system (submission of a monthly monitoring sheet through the monitoring site).

After the second year, the submission rate of the monthly monitoring sheets was improved with the employment of a monitoring consultant and more frequent implementation of monitoring workshop.

It is also mentioned that through the monitoring workshop, mutual trust between the Japanese side and the Iraqi side was strengthened. Thus, it seemed that the project increased its momentum.

It is important to consider face-to-face communication as well as continuous effort for improvement in implementing the Project.

46. To achieve the overall goal, it is necessary that WUAs shall be established and actively operating the improved irrigation facilities. For pilot project sites where construction work is delayed, it will be necessary to aim to complete the construction as soon as possible. Where WUAs have not been established at the pilot project sites, they need to be established as quickly as possible, and it will be necessary for them to operate equal and efficient distribution of irrigation water.

In Iraq, WUAs are being legally established under the Instruction (Legislation) No. (1) on associations of users of shared water resource enacted in April 2014.

It is considered to be important to have new WUAs established one after another, and for these established WUAs to continuously evolve and develop.

Water Saving Irrigation Techniques

Background

47. Irrigation methods that are widely practiced in Iraq are surface irrigation, sprinkler irrigation, and drip irrigation. According to the Ministry of Agriculture (MOA) data, surface irrigation covers 81.4% of the irrigated area, drip irrigation covers 18.2%, and sprinkler irrigation is only very marginally employed at 0.4% of the irrigated area in Basrah Governorate.

Since the amount of the flow from the upstream countries is decreasing continually in recent years, water saving is an urgent issue. In particular introduction and dissemination of water saving irrigation methods are especially important because agricultural sector accounted for 64% of the total water usage. An improvement of water application efficiency is required by replacing and improving traditional irrigation to a more advanced way at the field level.

Irrigation Method

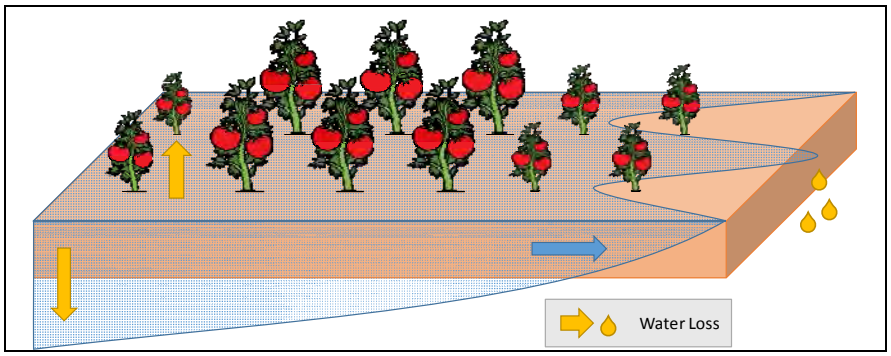
48. There are several irrigation methods applicable in Iraq. The selection of the most suitable irrigation method depends on several factors such as climate, soil type, cultivated crop, and water availability. Other factors, in addition to the above environmental factors, include economic efficiency, workability in the field for operation and maintenance, complexity for farmers, and previous experiences of farmers. The representative irrigation methods are classified below:

- Surface irrigation (furrow irrigation, border irrigation, basin irrigation)
- Sprinkler irrigation
- Micro irrigation (micro-sprinkler irrigation drip irrigation)

Water Saving with Surface Irrigation

49. Surface irrigation is an irrigation method where the applied water is distributed over the soil surface and spread to the entire field by gravity. This method is one of the most primitive irrigation methods. Major surface irrigation which is applicable in the target area includes furrow irrigation, border irrigation, and basin irrigation.

The major causes in the decrease of water application rate are evaporation from wet soil surface, deep percolation, and surface runoff. Evaporation loss can be larger than micro irrigation since these irrigation methods wet a large part of the soil surface. Since irrigation water starts percolating before the water reaches the end of the furrow, deep percolation are more likely to occur around the inlet if water takes time to reach the end, and it is difficult to avoid non-uniform irrigation depth.



Source: JICA Study Team

Figure 1 Water Loss in Surface Irrigation

Despite these disadvantages, surface irrigation is widely practiced in Iraq because this method requires very small initial investment cost and simple operation and maintenance (O&M) by farmers.

50. In Iraq, surface irrigation methods that are widely practiced furrow irrigation, border irrigation, and basin irrigation.

51. Special attention to the following points can improve the application efficiency of the surface irrigation methods which have low water application efficiency:

The water loss from deep percolation can be suppressed by avoiding too large irrigation rotation block.

Irrigation practice in the late afternoon can avoid water loss due to evaporation from the wet soil surface. However, this is sometimes difficult to apply considering the schedule of farmers who are using pumps by rotation area.

If there are irregularities in the field, excessive percolation occurs at the depressed area when convex area is irrigated at the required amount.

The appropriate length of the furrow to achieve uniform irrigation application becomes short in the field which has high water permeability based on the table above. In the field which has high water permeability the irrigation block should be divided into upstream block and downstream block in order to shorten the length of the furrow which is irrigated at once, or consider alternative irrigation methods.

Since salt accumulation at soil surface easily occurs due to relatively large evaporation from soil, sufficient leaching is necessary before cropping. It is better to avoid planting at the edge of the wet area such as the top of furrow where heavy salt accumulation is likely to occur.

Table 19 presents the important points to consider upon the introduction of surface irrigation.

Table 19 Important Points to Consider Upon the Introduction of Surface Irrigation

Item	Applicable Condition
Crop	No special restrictions
Soil	The water intake rates of soils should be less than 75 mm/h
Salt accumulation	No serious accumulation should occur
Water quality	No special restrictions
Ground-water level	No concern of water-logging
Geography	Flat and no steep gradients

Source: JICA Study Team

Water Saving with Sprinkler or Micro-sprinkler Irrigation

52. Irrigation water is sprayed circularly from sprinkler nozzle and applied to the crops. The water is converted to each nozzle, which is arranged inside the field, through pressurized water distribution pipes. The arrangement of the nozzles is designed according to the area to be irrigated. It is possible to irrigate the entire field uniformly by installing several sprinklers so that the spreading area overlaps with each other. It is also possible to irrigate locally with micro-sprinkler head located near the crop.

Compared with the surface irrigation method, sprinkler and micro-sprinkler system can avoid water loss from deep percolation since there is no infiltration during delivery inside the field and without any effect from the non-uniformity of the field elevation and sandy soil.

The sprinkler irrigation method can irrigate a large area if necessary with the wide range-type

nozzles. The wide range sprinkler can reduce the number of sprinkler head where the nozzle is attached to and it eases the utilization in the field especially with the use of agricultural machineries. It is suitable for extensive crops such as potato and cereals. However, these wide range sprinklers require high pressured water with pump. Micro-sprinkler head is widely used for soft vegetable, flowers, and seedlings in greenhouse and tree crops. Compared with wide range sprinkler, micro-sprinkler can be applied in a limited area or soft crops.

Distribution nozzle can be buried in order to improve workability in the field. Sometimes, the entire system is laid on the ground to maintain its flexibility for adjusting the cropping rotation.

53. The sprinkler and drip irrigation system was introduced in Iraq during the Desert Development Project in 1974. MOA plays a central role for the extension of the water saving irrigation techniques at the field level to achieve water saving in the irrigation sector. In 1991, under the North Al-Jazeera Irrigation Project in the northern part of Iraq, liner move sprinklers have been installed for 60,000 ha with water source coming from Mosul Dam. In addition, 35,000 sprinkler systems were distributed across the country in order to achieve the target of 3.6 billion m^3 water saving by 2013.

54. Irrigation water which has high salinity content of more than 13,000 ppm is not applicable for sprinkler irrigation since the salt from the water will remain on the fruits or leaves which can damage the crops. Gray water is also not appropriate for sprinkler irrigation from sanitary point of view. Compared with surface and drip irrigation, sprinkler irrigation requires higher cost for installation and O&M.

Table 20 presents the important points to consider upon the introduction of sprinkler irrigation.

Table 20 Important Points to Consider Upon the Introduction of Sprinkler Irrigation

Item	Applicable Condition
Crop	No special restrictions
Soil	No special restrictions
Salt accumulation	No special restrictions
Water quality	Salinity should be less than 13,000ppm
Ground water level	No special restrictions
Geography	No special restrictions
Others	Pressurized water

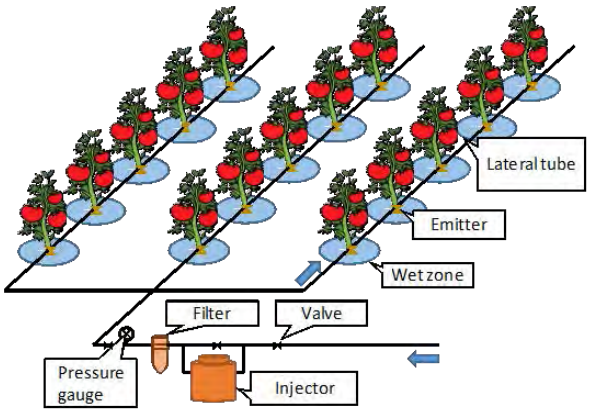
Source: JICA Study Team

Water Saving with Drip Irrigation

55. Drip irrigation is one of the localized irrigation methods which involves dripping water onto the soil at a very low rate (2-20 L/hr). Drip irrigation is also called micro irrigation or trickle irrigation.

Irrigation water is limited to the root zones of each plant. Irrigation water is distributed through lateral tubes which are small diameter plastic pipes installed along the crop lines, and dripped from fitted laterals with outlets called emitters or drippers.

Drip irrigation has been developed in arid countries such as Israel, the United States of America, and Australia. Some developed countries in non-arid regions also introduce drip irrigation techniques especially for intensive crops to use the capability of precision agriculture in those days.



Source: JICA Study Team

Figure 2 Drip Irrigation System

Since drip irrigation limits the wet surface around each crop, and application rate is designed to be equal to the evapotranspiration rate, water loss from deep percolation, evaporation, and runoff are exceedingly small compared with other irrigation methods. If drip irrigation is introduced in greenhouse, it will keep the humidity low due to low evaporation rate and decrease the risk of diseases. Water application rate is easy to control with a valve. Irrigation system can be used for fertilizer application with fertilizer injector. Water will dissolve the fertilizer and should not be applied between plant rows. It is possible to suppress the overgrowth of weeds.

Drip irrigation requires a low pressure to operate. Farmers can use small pump to raise the water to the tank, which is located a few meters above the ground. Low flow rate and pressure require small size facilities and it is easy to introduce the technique to farms with existing facilities.

Special attention is required if irrigation water has a lot of sedimentation or its pH is higher than 8.0. Emitters are easy to be clogged with silt, sand, and calcium composition. Regular maintenance such as flushing the lateral tube and filters are required in such cases. Lateral tubes laid on the ground disturb mechanization during cultivation period. Installation and removal work is required for mechanical seeding or harvesting.

56. MOA has been conducting extension activities to achieve the long-term target of 2009-2015 of 750,000 ha of extension of drip irrigation. Other donors are also conducting several extension activities for drip irrigation not only for vegetables but also for dates and grapes. Small-scale drip irrigation kits named "Family Drip Irrigation System" are also developed for small farmers whose land ranges from 100 m^2 to 200 m^2

57. Table 21 presents the important points that should be considered upon the introduction of drip irrigation.

Table 21 Important Points to Consider Upon the Introduction of Drip Irrigation

Item	Application Condition
Crop	No special restrictions
Soil	No special restrictions
Salt accumulation	No special restrictions
Water quality	No heavy floating suspended substance pH is less than 8.0
Ground water	No special restrictions
Geography	No special restrictions
Others	Mechanization work is difficult during cropping period

Source: JICA Study Team

Other Water Saving Techniques

58. In addition to the introduction of the irrigation facilities as mentioned above, combination of the following farming practices allows further water saving.

Table 22 Water Saving Techniques in Farming Practice

Item	Description	Advantage / Disadvantage
Appropriate O&M of facilities	Monitoring of water leakage and non-uniform irrigation due to damages of facility, water leakage, erosion, and clogging.	Advantages Growth of uniform crop Prevention of salt accumulation and water logging due to excessive irrigation
Suppression of evaporation from the soil surface by mulch.	Application of mulch with plastic sheet, organic matter, rock, and gravel can reduce evaporation from soil surface. Lateral tube should be laid under the plastic, as plastic mulch is impermeable to water.	Advantages In addition to water saving, mulch is effective for weed control, protection of soil erosion, solar heat soil sterilization Disadvantages Surface irrigation and sprinkler irrigation are not applicable on mulched field Material cost Environmental pollution without proper disposal after harvesting
Proper design of irrigation rotation intervals and blocks	Frequent but small irrigation applications so as to correspond to the change in weather in the field	Advantage Does not require large irrigation facilities renovation and installation Disadvantage Depending on the irrigation system, the required labor force for operation increases
Monitoring of soil moisture content	Decide the water application amount according to the soil moisture content measured by moisture meter such as tensiometer	Advantage Able to optimize irrigation amount based on weather condition, growing stage, and soil condition

Source: JICA Study Team

59. Other advanced water saving techniques for further study or research are shown in Table 23.

Table 23 Other Advanced Water Saving Techniques

Item	Description	Advantage / Disadvantage
Sub-surface irrigation	Irrigation method that applies irrigation water from buried laterals or plastic tube and applies irrigation water to root zone directly.	Advantages Higher water saving due to very small evaporation loss Good workability in the field No degradation of lateral tubes from UV Disadvantages Combination with other irrigation method is required in the beginning of growing stage Difficult to detect clogging Cost for installation is higher than other method
Sub irrigation	Irrigation water is applied from below the root zone by raising the groundwater level. Sub drains are used for irrigation and drainage.	Advantages Sub drains can control groundwater level Applicable to cereals It is machine friendly since there are no objects on the field Disadvantage Easy to raise groundwater level at high penetration field

Source: JICA Study Team

Salt Accumulation

60. Sixty percent of Iraq's agricultural land was estimated to be seriously affected by salinity; and 20-30% had been abandoned in 1950. The salinity content is rising especially in the lowest part of the Euphrates River and the Shatt al-Arab River with the decrease of inflow from the upstream, and worsening quality of water for irrigation and domestic use.

An efficient irrigation without proper drainage system raises the groundwater level and increases the evaporation from the soil surface. The salt which is contained in the soil or irrigation water remains on the surface as evaporation occurs. This accumulated salt causes damage to the crops. Salt crust and even salt crystals can be observed on the soil surface in the serious accumulated area. The soil contains salt not only at the surface but also at 50-60 cm depth in the southern part of Iraq. The high salinity is observed even in the same area where the water table is relatively high along the rivers.

61. Rising water table leads to wet soil which damages the crop. Groundwater tables higher than 1 m almost saturate the soil at the root zone resulting in insufficient oxygen condition, which essentially suffocates the plant roots. There are few gravel and sand, and deep silt layer at more than 1 m depth existing in the Mesopotamian floodplain.

Leaching with Irrigation

62. Salt accumulated during the cropping season should be leached out from the root zone before starting the next cultivation season. Leaching by irrigation is the basic salt removal technique. The salt is removed by the applied water which is moving down by gravity below the root zone. Drainage to keep the water table lower than the root zone is necessary for efficient leaching process.

The efficiency of leaching per irrigation amount decreases with the increase in the total amount of applied water, and excessive water just raises the groundwater level. Therefore, the estimation of the leaching requirement (LR) is important.

63. While the water table decreases, the LR becomes more efficient, the risk of waterlogging becomes lower, and the cost for drainage by pump increases. The recommended groundwater level depth is generally from 150 cm to 250 cm in Iraq. A drain depth of 150 cm is generally recommended where year-round cropping is practiced, whereas for areas where seasonal cropping is more common, deeper drain depth of 200 cm is recommended.

64. Other advanced desalination techniques for further study or research are shown in Table 24.

Table 24 Other Advanced Desalination Techniques

Item	Description	Advantage / Disadvantage
Dehydration method	Laying the collection sheets soaked with water on the ground surface to absorb and collect salt sufficiently to remove it from the system	Advantage Water requirement is less than the usual leaching Disadvantages Fewer case studies Material cost
Surface delamination method, scraping method	Removal by civil engineering measures of salt crust and soil with high salt concentration	Advantages No irrigation water is required in removal Water saving can be achieved by combining with

Item	Description	Advantage / Disadvantage
		other leaching method Disadvantages Labor cost applied to large area Treatment of the removed soil containing accumulated salt
Soil remediation	Applying potassium or organic matter for increasing permeability of sodic soil	Advantages Mitigation of toxicity of sodium Modification of soil structure Prevention of waterlogging Disadvantage Material cost

Source: JICA Study Team