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RESEARCH ARTICLE

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KUWAIT FUND SUPPORTS IRRIGATED AGRICULTURE IN DEVELOPING COUNTRIES

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ABSTRACT

Irrigation plays a vital global role in increasing agricultural production and food security. Although it is facing many challenges, irrigation is expected to contribute to future food demand by the increasing world population. The ultimate goal of irrigation is to bring more land under cultivation to promote agricultural production. The aim of this article is to highlight the involvement of Kuwait Fund in financing irrigation projects in many developing countries to improve food production to help in the efforts towards economic development. The lessons that the authors derived from such projects are reflected at the end of the article.

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INTRODUCTION

One of the serious challenges facing the world is agricultural development as key to food security for assuring that all people have enough food to sustain a healthy and active life, as stipulated in the United Nations Development Sustainable Goals (SDGs) adopted by all members in 2015, to provide prosperity for all people (UN, SDGs 2015). It is an issue pre-occupying many international entities such as development, financial, scientific research and political institutions. Growing numbers of agencies are providing numerous forms of assistance to expand agricultural development for food production in diverse geographical locations, especially in low-income countries, through financing specific development projects. Some of the global challenges and constraints facing agricultural development could be summarized as follows:

- Threats from desertification and deforestation due to periodic droughts and floods, increasing use of trees and brushwood for fuel in addition to pressure on land resources due to increasing population. Hence large areas of productive land are destroyed annually.
- Vast areas of fertile lands are seriously degraded due mainly to overgrazing.

- Political instability in many countries and inadequate land tenure systems often lead to the misuse and mismanagement of productive agricultural land.

Increasing food production is only part of the food security solution and agricultural land should be protected by sustainable production to maintain soil fertility and reduce erosion. Hence, agricultural projects must achieve a greater impact on sustainability. The goals of development projects are to meet the social and economic needs of people, with minimum negative environmental impacts, especially when dealing with the conservation and sustainable management of land, soil and water resources, as in land reclamation and irrigation projects, without jeopardizing the future generations' needs. The main objective of this paper is to provide information regarding Kuwait Fund and the role it has played in financing irrigated agriculture development projects, by offering a glimpse of some of the projects in which it participated in financing and their developmental impacts, such as improving food production in developing countries. The authors have been privileged to be given the opportunities to travel to different developing countries, and to be able to exchange views with experts and agencies working on irrigation projects.

Kuwait Fund Background: The Kuwait Fund extends loans on concessionary terms to finance development projects in developing

countries to help in the efforts towards economic development, and the Fund has been active in supporting many sectors which amounted to about U.S. \$ 23.0 billion, as at the end of 2021. Since its establishment in 1961 Kuwait Fund has been involved in agricultural projects in many developing countries, where over 60% of the population depend on agriculture for their livelihood. Thus, during the last sixty years the Fund supported lending the agricultural sector by providing financing for over 150 projects related to agriculture, mainly irrigation sub-sector. The financial assistance amounted to U.S. \$ 3.0 billion, or about 13% of its total lending. Substantial sums are also lent for other projects which directly or indirectly support agricultural production and rural development, such as transport, industry, water supply and electricity projects. Table (1) shows the geographical distribution of agricultural projects financed by the Fund since its establishment.

Table 1. The Geographical Distribution of Agricultural Projects up to end of 2021

Region	No. of Loans	Amount KD. Million	%
Central Asia and Europe	6	17	1.8
Latin America and the Caribbean	3	15	1.6
East, South Asia and the Pacific	28	128	13.6
Arab Countries	68	650	68.8
West Africa	27	93	9.8
Central, South & East Africa	19	41	4.2
Total	151	944	100.0

1 K.D. = US\$ 3.3

Irrigated Agriculture: Irrigation can be defined and described as a system to supply land with water by means of canals, channels, ditches, pipes and other structures, with the main objective of securing adequate amount of water for crop growth, through the application of water to the soil for increasing the moisture content within the plant root zone (McLeod, 1990), and it is a combined technology between agronomy and civil engineering. The ultimate goal of irrigation is to promote the production of agricultural crops and yields to bring more land under cultivation. The limited availability of water and uneven distribution of rainfall which is insufficient to sustain production, there will be a need for irrigation as a supplement for productivity in rainfed farming areas. One of the key elements of irrigation schemes is the type of system which normally comprises a water source, water conveyance for delivery and transmission, in addition to irrigation and drainage fields (FAO, 2018). Water source includes reservoir dams, rivers, lakes, ponds and weirs. The water conveyance and delivery parts include water intakes, canals, pipelines, pumping stations, storage and associated structures and equipment, while the drainage fields include open or buried canals, related structures and accessories.

Irrigation Methods

The main two irrigation sources are surface water and underground water. Surface irrigation by gravity is the most dominant one within Kuwait Fund projects, as briefly described below.

- **Basin Irrigation:** The land is divided into basins, applied on flat land surface with minor leveling works. It is the most suitable for many crops, especially rice paddy.
- **Furrow Irrigation:** Farmers flow water down small trenches running through their crops.
- **Flood Irrigation:** Water is pumped directly to the flat fields and allowed to flow along the cropped ground.
- **Border Strip Irrigation:** The field is divided into strips separated by border ridges running down the slope of the field.

Also, there are other different types of irrigation practiced based on the climate, soil, crops and water resources, such as:

- **Sprinkle Irrigation:** Distribution of water from a central location by high pressure sprinklers.

- **Localized Irrigation:** Water is applied to each plant by a network of pipes under low pressure,
- **Pivot Irrigation:** Distribution of water by a sprinkler system moving in a circular pattern.
- **Drip Irrigation:** Drops of water are delivered to the root zone of the plant.

Role of Irrigation: Irrigation plays a major role in achieving food security, improving the farming families standards of living, and therefore poverty alleviation. So, irrigation is considered an important public investment in agrarian societies, where the economy is centered upon a combination of production, consumption, sale, trade and marketing of agricultural products. According to some international sources (FAO, IFAD, WFP, 2015) there is a need to invest annually additional US\$ 267 billion in agricultural projects to reduce hunger by 2030. Irrigation is playing a vital role in contributing to global agricultural production and food security, and according to a report (FAO, 2012a) more than 40% of agricultural products are produced on irrigated land which occupies about 20% of the total world arable land, and it is expected that irrigation will be the major food contributor to feed more than 9 billion world population by 2050. However, there are some challenges facing irrigation development, summarized as follows:

Water Scarcity: Irrigated agriculture is the largest water user, accounting for 70% of global fresh water withdrawal. In the coming near future it is requested to produce more food (yield) with less consumption of water, i.e. high efficiency is needed and to be maintained.

Global Climate Changes: Impacts of the alarming climate changes are bringing unpleasant weather conditions such as high temperature and shifts in rainfall patterns, causing floods in some regions and water scarcity in other areas. This is affecting the crop water requirements, which bring needs for suitable technical facilities and right strategies to approach such changes.

Soil Degradation: Inefficient irrigation practices and weak maintenance are considered to be key contributors to land degradation, where the misuse of water is responsible for soil salinization and water logging and their negative impacts on production.

Agricultural Practices: Agrarian communities are facing a shift from practicing traditional subsistence farming to more of commercialized and diversified farming activities, which require more updated and advanced services and management; however, many of ongoing projects are managed by governments institutions with poor maintenance practices and experiences, therefore, deterioration of irrigation systems is vulnerable to be observed.

Financial Allocation: Irrigation facilities need considerable investment budget in order to expand irrigated land, especially when modernizing and rehabilitating existing or constructing new irrigation systems. Hence, more financial resources should be allocated by financiers, with concessional terms.

Project Cycle: All projects financed by the Kuwait Fund go through a normal processing cycle as adopted by the guidelines of many development agencies (FAO, 2018, World Bank, 1993) and consists mainly of four phases, summarized as follows:

Identification: This is the initiating phase when the borrower proves that the project, with its clear goals and priorities, falls within the framework activities of development objectives.

Preparation: The borrower prepares relevant documentation such as design reports and feasibility studies, based on expectations of the outcomes of the project, its description with estimated financial costs of various components to be reviewed by the financiers.

Appraisal and Negotiation: Kuwait Fund's team visits the project site, in coordination and cooperation of the borrower, to ensure the identification of all components and assess all aspects of the project including technical, environmental, social, economic, financial, legal and institutional matters. Also, prepare legal document, including implementation arrangement, to be negotiated with the borrower for approval and funding agreement regarding terms of the loan.

Approval: The project's technical report is prepared and presented to the Fund's Board of Directors for approval.

Activities during Appraisal: There are many issues to be examined and evaluated during appraisal missions and prior of signing any draft Loan Agreement, such as:

- General meetings with concerned authorities and technical staff of the project, to present the overall project description and goals.
- Field visits to examine and identify the project site, water resources assessment and crop water requirement.
- Existing farming activities and production (rainfed and irrigated).
- Existing irrigation and drainage systems, and related structures.
- Data collection such as crop production, yield, cropping pattern, prices and marketing.
- Services availability (extension, training, research, storages, etc.)
- Meeting the targeted beneficiaries (farming families, water users and farmers groups)
- Discuss water right issues and official riparian notification, if necessary.
- Look into social (education and health) and environmental issues.
- Examine the facts of land acquisition, resettlement and compensation arrangement, if needed.
- Legal and technical assessment of institutional setting and functioning, in terms of organizational structures, capacity of meeting the requirements of implementation, operations and maintenance.

Role of Kuwait Fund in Developing Irrigated Agriculture: It is important to point out that different regions have a wide array of climatical and environmental conditions, with a diversity in the structural characters and design of irrigation systems, and what might be considered large size project in some countries would be as only small or medium size in other countries. For such irrigation projects, the total costs, excluding operation and maintenance are determined according, inter alia, to the following contributing factors:

- Distance of the project area from water source.
- Topographical conditions and needs for land preparation, clearing and leveling.
- Size of the field to be irrigated.
- Type of soil and nature of materials underlying it.
- Crop pattern and water requirements, and accordingly design of adequate irrigation and drainage networks.
- Machinery and Equipment needed.
- Engineering and consultancy services.
- Institutional and organizational support.
- Required settlement and resettlement, if necessary.
- Assessment of probable environmental impact (EIA)

The cost per hectare of irrigated land varies widely and investments costs of implementing irrigation projects, are usually derived from feasibility studies which up-dated during actual appraisals of the projects that financed by the Kuwait Fund, with a wide range of different characteristics. The costs of land development component and supporting items for 45 projects in 26 countries at different periods of time that the authors participated in appraising averaged of about US\$ 5,300 per hectare for all projects, while the average cost

for rehabilitation projects was about US\$ 2,650 per hectare, and for new project was about US\$ 12,369 per hectare. Differences in the costs are mainly due to the merits of the nature of the projects, i.e. rehabilitation of irrigation systems versus construction of new projects and different components involved. The water delivery infrastructure systems include inter alia, water intakes, lined and unlined canals, tunnels, storage, pumping from river, diversion and drainage related structures items, represent about 55% of the total costs of the main components, excluding infrastructures related to dams (Bahman, 2015). In general, the main common components included in irrigation projects are the following:

- Civil works for irrigation and drainage networks (water intakes, line/unlined canals, weirs, dikes.... etc.
- Pumping stations and elector-mechanical works
- Land reclamation and leveling
- Service and field roads.
- Equipment and vehicles
- Engineering designs and supervision services.

Translating Concepts into Facts: The nature of irrigation projects is either a stand-alone or integrated with other sectors and activities within rural development projects. The efforts of Kuwait Fund in supporting irrigated agricultural projects are highlighted by a brief description of some examples of projects and their contribution to improving the food situation in the countries concerned.

Sri Lanka: Mahaweli Ganga Development Project: The master plan for the development of the Mahaweli Ganga and its adjacent river basin was prepared by the UNDP/FAO during 1965-1968. It envisaged the development of about 365,000 hectares of irrigable land in the dry zone of the country. Mahaweli development programme consists of several systems (projects). System C which is partially financed by Kuwait Fund was identified as one of the most important components to be implemented under the accelerated programme.

Table 2. Mahaweli Ganga Project's Key Indicators

Parameters	
Population	
- No. of families settled	128,435
- Estimated Population	535,800
- Labour Force	289,600
- Annual Irrigated Land (ha.) at cropping intensity = 2.2	142,329
Food Production	
- Paddy (mt)	509,560
- Other Food Crops (mt)	130,376
- Milk (liters)	1,497,840
- Employment Generation through light Industries (no.)	3,000
Social Infrastructure Facilities	
Private Infrastructure	
- Houses	96,000
- Latrines	76,000
- Water Wells	34,000
Public Infrastructure	
- Tube Wells	1,254
- Schools	310
- Health Centers	216
- Cooperatives	215
- Development Centers	98
- Roads (Km)	1,298
- Irrigation Canals (Km)	8,148
- Farmer Organizations	940
- Training (Staff and settlers)	33,486
Environmental Conservation	
- National sanctuaries (nos.)	9259116
- Land Conservation (ha)	

Source : Mahaweli Authority of Sri Lanka, Planning and Monitoring unit, 1996.

The project aimed to cover 65,000 hectares of gross area of which, over 24000 hectares were found to be suitable for low land paddy,

whilst 17,000 hectares were reserved for settlement in addition to environmental land conservation. The project was funded by a donor consortium composed of Kuwait Fund and others. The project has increased food production and farm incomes, and table (2) shows the results achieved by the project as reflected by some key indicators.

Vietnam: Lower Ayun Irrigation Project: Kuwait Fund was one of the first development agencies that provided economic aid to the Socialist Republic of Vietnam after its unification in 1975 and still assisting in the development of water resources in Vietnam. The Fund extended loans to the Government of Vietnam for financing nine major irrigation projects since 1978. The impact of the national reforms of 1988 has transformed Vietnam from an importer to one of the World's exporters of rice, and the average household's share of income from crops has risen from 20 per cent before the reforms to over 60 per cent thereafter. And since 1989 Vietnam has been exporting more than a million tons of rice annually. The following section gives a brief description of the project. Lower Ayun Irrigation project is a stretch of land covering four provinces in the west of the central region of Vietnam. The majority of people in this area are communities scattered along natural streams with a very low standards of living. The lands are relatively flat with favorable conditions for agricultural development, particularly for paddy cultivation, but suffer from lack of water resources for farming. The project aimed at solving the irrigation problems by constructing a reservoir to provide water to irrigate about 13500 hectares of fertile land to produce crops to meet local demand and improve the incomes of about 11000 families (60000 persons) of which 50% are females. In addition to providing irrigation to cultivable land, the project facilitates supplying drinking water and development of fishery in the reservoir to provide extra food for local people. Moreover, the project was designed to reduce flood and drought conditions and improve the environment. According to the project's completion report, rice yield exceeded the initial target, and the cropping intensity increased from 82% before the project to 200% with the project, and only after four years of its implementation. The rice yield has been gradually increasing from an initial target of 4.5 ton per hectare at appraisal in 1993 to 8 tons per hectare in 1998; this translated into higher household earnings which resulted in improving the standard of living. Additionally, fish and poultry breeding have been developed for the first time, and floods in the lower river were reduced substantially.

Ningxia Integrated Rural Development Project: The project is the first stage of a national integrated rural development plan in Ningxia region, which consists of developing about 133000 hectares of irrigated land, by using water diverted from the Yellow river, to help the poor people living in the southern mountain areas. Ningxia is one of the nation's major minority dominated poor provinces. The first stage is limited to Hongsipu and Guhai areas and comprises about 86700 hectares of irrigated land to which over 500 million cubic meters of water is allocated yearly. The project aims at a full use of water resources and land available for farming along the river for increasing agricultural output, in addition to the settlement of about 675000 people and consequently improving their standard of living. The project also helps to stabilize the social situation and the development of the region's economy. The project consists of five main components: irrigation works, agricultural development, migration (resettlement), power supply and communication. The project execution started in the first half of 1996 and was completed by the end of the year 2002. The economic benefits of the project was improved as the cropping intensity increased from 25% to 100%, thereby increasing the grain output from 35000 tons to 276000 tons, oil crops from 2400 tons to 15700 tons, fruit production from zero to 33700 tons, in addition to timber and forage production. Also, as expected that the project benefited the fragile ecology of the environment by increasing the forest cover rate from 1% to 20% after implementation.

Burkina Faso: Bagre Irrigation Project: The project seeks to achieve the objective of the country to ensure self-reliance in respect of food and improve the standard of living of the peasant population,

via the adequate use of water resources of Nakambe river, through irrigation to develop about 30,000 hectares of agricultural land downstream area of Bagre dam as the main source of water, located in the freed Onchocerciasis (River Blindness) zone in the South-East of Burkina Faso. The Bagre dam project was co-financed by Kuwait Fund and other development agencies, and it is a multi-purpose dam designed to store about 1.7 billion cubic meters of water. The construction of the dam has been completed in 1992 and presently impounding about 1.3 billion cubic meters of good quality water. The downstream development for agriculture is divided into phases and focused on the set up of zones for irrigated agriculture for rice-growing, market-gardening, fruit and fodder production practiced in the form of farming plots, in addition to livestock breeding. The project also consists of the development of the areas neighboring the irrigated zones for the settlement of farming families, including housing, access roads, village centers, supply of drinking water, schools and health centers. A hydro power station using the water not utilized for irrigation is currently generating energy, making the project self-reliant in energy supply. Many provinces near the project area are now witnessing migration flows, attracted by the existing agro and socio-economic activities. The project zones are also attracting people from other provinces of which the majority are farmers seeking to obtain land for farming purposes.

Recent reports indicated that agricultural practices near the project area are characterized by a distribution of fields around the huts for maize cultivation, and for the production of other crops such as millet and sorghum, in addition to vegetables. In this regard, farming was based solely on rain fed crops, and extensive and sedentary animal breeding systems before the implementation of the project. The project was designed for intensifying production by using proper mechanization, improving soil fertilization, applying modern irrigation techniques, in addition to training and improving basic infrastructure. Since 1990, some of the rain fed lands have been improved, on a pilot plan basis, by protecting irrigated agriculture downstream of the dam. Experiences from the pilot plan have provided some elements of success on both the irrigation technique and the use of land. Lessons learnt from such experiences have been taken into consideration for downstream development, especially with regard to the experience that a system fully operated by gravity is more efficient and less costly than using pumping. Also, as a result of better performance, it was proposed to use lined canals instead of unlined ones as originally designed. Although the development works of the command area were progressing slowly, the project raised hopes for the next century, in a country where more than 90% of the inhabitants are farmers and where water scarcity is a problem.

Albania: Irrigation and Drainage Rehabilitation Project: The project is co-financed by Kuwait Fund and the World Bank, in addition to Albanian Government and farmers' contributions. The project aims at increasing agricultural production by raising farm productivity, through development and rehabilitation of irrigation and drainage infrastructures covering several districts in the coastal area of the country, as well as alleviating poverty by increasing income of small farmers, and creating employment opportunities in rural areas. The project started in 1994, and was completed in eight years. The project upon completion have rehabilitated 21 irrigation schemes of about 73,000 hectares of irrigable land and 18 drainage schemes covering an area of about 99,000 hectares including a demonstration scheme of canal control of about 1000 hectares. It is interesting to note that over 200 Water Users Associations (WUAs) have been formed, covering the project area with about 70,000 small holder families. The establishment of the WUAs was followed by many other WUAs outside the project area in other districts in the North and South of Albania. Such associations are playing important roles in financing proposed irrigation rehabilitation works in other districts. For this purpose, an amendment to the existing Irrigation Laws was introduced with the aim, to hand over the responsibility for secondary and tertiary canals to these consolidated WUAs. This also approved by the Council of Ministers. These WUAs have already taken over the operational and maintenance responsibility of most of the secondary irrigation canals. The Water Users Association

Programme demonstrated its value in the period of civil unrest. In contrast to the destruction of government offices, the irrigation schemes in the project area were protected by the WUAs members. Also, a series of pilot programmes have already started to transfer primary canals to Federation of WUAs in some districts, and the progress has been satisfactory. The project was successfully completed to the benefit of all farming families. The rehabilitated areas have increased the planted land and thus the income of the farmers. The area cropped with wheat, maize, potatoes, vegetables, fodder and other crops has doubled. The cropping pattern has changed, with livestock and agricultural produce at levels that could satisfy the local demand. In addition, farmers became involved in growing vegetables and other crops that improved the income of farmers and subsequently their standard of living. In general, the project had achieved good results, with the benefits exceeding the expected results by 30%, and at a cost of \$ 399 per hectare compared with a budgeted cost of \$ 470/ha. The total area irrigated by the end of 1998 was about 80000 hectares of the target. To date, drainage covers about 100,000 hectares of the project area, exceeding the target by 17%, and at an estimated cost of \$147/ha. which is within the budgeted cost of \$190/ha. It is expected that a wider range of benefits will be achieved especially when the project is well maintained.

suitability, marketability, and profitability. The cropping intensity in the proposed cropping pattern reached 200% more than before the project level. With complete irrigation and improvement of farming practices in the project area, as well as with the proper supporting services, total production of basic food grains increased by four times, and in the case of vegetables and fruits production increased 12 times. Table (3) shows crop production with and without the project. By implementing the project, farmers' income increased around 4.7 times compared with before the project situation, according to the latest progress report.

Egypt: North Sinai Integrated Rural Development: The project is one of the national mega projects covers an area extending from the East of Suez Canal to Rafah in North Sinai and aims at a comprehensive rural development. It consists of various components as follows:

- Agricultural Development
- Agro-industry and supporting services
- New Community Development for settlers
- Inland Fishery Development
- Tourism Development

Table 3. Without and With Project Annual Production

Crops	Without			With Project			
	Cropped Area (Ha.)	Yield (Ton/ha.)	Production (Ton)	Cropped Area (Ha.)	Yield (Ton/ha.)	Production (Ton)	
Maize	690	1.6	1104	860	4	3440	
Rice	480	2.6	1248	1100	5	5500	
Soybeans	-	-	-	300	2	600	
Vegetables	285	9.5	2710	2080	18	37440	
Fruit	90	6.0	540	90	11	990	
Irrigated Pasture							
For Milk	-	-	-	90	4.5	405	
For Beef	-	-	-	90	0.22	20	
Rain Fed Pasture							
For Milk	970	1.4	1358	360	2.7	972	
For Beef	970	0.07	68	360	0.13	47	

Honduras: Rehabilitation of El-Coyolar Dam and Irrigation Network Improvement Project: The aim of the project is to rehabilitate El-Coyolar Dam in order to protect the affected downstream area from floods, and to rehabilitate and improve the existing irrigation system, to increase agricultural production in an area of about 3,600 hectares on the banks of San Jose river in the Flores District within Comayagua Valley situated in the Central Western part of the country. El-Coyolaris an arch masonry dam was constructed between 1956-1965 and has been suffering from many problems hindering the stable supply of irrigation water to the project area, because it did not meet standard stability requirements. In spite of the potential for growing a variety of suitable crops, agricultural production was severely limited due to existing constraints such as lack of effective water control, ancient and disorganized irrigation and drainage networks, and most importantly poor maintenance. Under these circumstances, an extensive rehabilitation programme was initiated and the works required were completed in 1995. The rehabilitation of the dam provided an opportunity to develop a hydro-electric station, as part of a rural electrification programme. The rehabilitation of the dam protected the area from Hurricane Mitch which hit the country in October 1998, and was the most destructive in the history of Honduras. It was expected during the appraisal that the Flores irrigation improvement plan with adequate water management and the establishment of a model farm to train farmers to provide extension services for irrigated agriculture, will contribute to enhancing the profitability of agricultural land all year round and will benefit about 10,000 people, mostly small farming families. Due to shortage of water, the irrigated area in the dry season does not exceed about 800 hectares. Nevertheless, the project contributed to the improvement of agricultural activities, including the improvement of pastureland. In addition, basic food grain crops, vegetables and fruits, cash and pasture crops have been selected according to soil

The implementation programme was formulated based on the following priority components:

- El Salam Canal extension including a siphon crossing the Suez Canal.
- Land Reclamation including new-community development, agro-industry and supporting services.

The reclamation area of the project is about 400,000 feddans (168,000 hectares) east of the Suez Canal, near the coastal area along the Mediterranean Sea. The developed area will contribute to absorbing about one million people as new settlers, and to improve their standard of living through employment opportunities. The project includes the construction of an inverted siphon under the Suez Canal in order to convey irrigation water obtained after mixing the Nile water with agricultural drainage water at 1:1 ratio which will be conveyed by gravity and pumping, to newly reclaimed lands for food production to meet local demand and for export. The annual water requirement for the project was estimated to be about 1.8 billion cubic meters for crop production only. The project land use pattern has been gradually under development since the end of the last war in the Sinai Peninsula. Agriculture in this area is limited by the availability of irrigation water. Many parts of the project area have virtually no agricultural activities, and are located in the remote desert with nearly depleted water resources, and where irrigated agriculture is dependent on ground water. The cropped area was estimated at about 70,000 hectares in 2018 as irrigated agriculture. Total production is centered on fruits and vegetables, and about 25-50 percent of these products are marketed outside the North Sinai Governorate. Rain fed cereal crops have poor yields and low profitability, and consequently are cropped for self-consumption only. In some areas, agricultural products are cultivated under the drip irrigation system, covering

about 3000 hectares. Also, date palm plantations are scattered between sand dunes. Natural vegetation in the project area is very poor and pastureland is decreasing as a result of over-grazing. Large and small scale sand dunes occupy a considerable area. The potential for agricultural development in the project area is considered high in view of the vast land and suitable climate conditions. The project's development plans are on-going, and in the event of sufficient water being supplied to the area, integrated rural development based on agriculture could be accelerated. Also, there is a good potential for the development of fisheries since the area has two large hyper-saline lakes, in addition to a long coastline on the Mediterranean Sea, which are considered to be suitable for fishery and tourism development. The agricultural plan aims at improving productivity, by coupling crop production with livestock. Crops include fodder to increase vegetative coverage on the reclaimed land, and crop by-products to be utilized for livestock feeding, whereas, livestock by-products would be used effectively to supply manure to farm lands. The crop selection is made from among food crops, fodder crops, oil crops, vegetables and fruits. As regards livestock, intensive and extensive systems are proposed for beef and dairy cattle, sheep and goats. It is expected that crop yields will increase over time after full reclamation, provided all necessary inputs became available. Crop yield is targeted to increase by increasing cropping intensity to 200 percent, i.e. two crops a year, resulting in greater water use efficiency, and minimization of barren land. The expected annual total crop production estimated at about 4.6 million tons, in addition to 14,000 tons of red meat. In related activities a coordination between international research agencies and national agricultural research institution, studies have been conducted during the past 2 decades showed that irrigation water consumption in farm fields fell by about 30%, labor cost fell by 35%, and farmer's net income increased by 15% in comparison with conventional irrigation in the project area (ICARDA, 2011).

Enhancing Food Security Project: Kuwait Fund co-financed an irrigation project deals with regional activities in 10 Arab countries under the supervision and implementation of ICARDA, aims at conducting applied research to study water use efficiency and productivity of stable crops for domestic consumption. Results showed that wheat yield can be increased by the use of improved technologies, i.e. supplemental irrigation, improved seed varieties and improved management practices, as compared to the use of farmer's traditional practices. An average yield increased by 28% was achieved across all countries involved, and maximum yield increased was over 75%. The increase was much higher under full irrigated systems, followed by the supplemental irrigation and rainfed systems. The research showed that in the Arab region 80% of the water resources are used for agriculture, and farmers over irrigate wheat by 20-60%. Other results showed an average of 25% saving in irrigation water, with 74% improvement in water use efficiency. The advantage of improved practices on wheat yields averaged 18.5% in rainfed fields and 36.7% under irrigation systems. The project focused on improved wheat production and yield in a cereal (wheat) based production systems practiced in the Arab countries (ICARDA, 2014).

Tanzania: Irrigation Project in Luche Valley: The project aims to support the economic and social development of the Luche Valley, by developing a total of about 3,000 ha of new agricultural lands from current wet lands and by providing the required and sustainable water to irrigate the land from the Luiche river. Thus, increasing crops production, improving farmer's income, and supporting the national food security strategy. The project consists mainly of civil and electro-mechanical works to develop the targeted agricultural lands and to construct irrigation system. The work includes construction of a concrete dam, flood protection dykes, irrigation canals, field access roads and an access bridge. The project also includes consulting services for the preparation of detailed design, tender documents and project supervision. In addition, land acquisition, environmental, social, health and safety protection and management and farmers training, capacity building and farmers association support.

The project contributes in increasing the main crops yields by 67% and cropping intensity from 12% to 200% to benefit directly over 5600 farming families make up about 35,000 persons.

Tajikistan: Dangara Valley Irrigation Project (Phase 2): The project aims at increasing the agricultural production, provide employment opportunities in the project area, and enhance the economy of the country, covering a net area of about 1750 ha, located in the southern part of the country. The project consists of the following main components:

- Rehabilitation works for the main Dangara canal (about 2.5 Km), and branch canals (about 14 Km.).
- Construction of extended canal of about 31 Km, and a siphon with a length of about 3.1 Km and the related structures, in addition to the development of about 1750 ha by constructing the necessary irrigation and drainage networks and their related structures.
- Engineering services to review the designs, tender documents and provide assistance to the Project Implementation Unit (PIU) for tender evaluation and supervision of construction.
- Procurement of vehicles, and necessary engineering and office equipment for the Project Implementation Unit (PIU) and Tajik water management design institute.

This project is part of a very important larger project covers about 6,000 ha. that has been divided into three phases. The net area of Phase 1 is 2500 ha. And for Phase 2 and 3 are 1,750 ha. each. For each of these phases, irrigation networks, drainage system have been designed and the related tender documents separately. Irrigation water is supplied from Nurek water reservoir from Dangara Irrigation tunnel. It also provides water for domestic uses in the urban areas surrounding the irrigated lands. Throughout the life of the project (3 Phases), is expected that the outcome will facilitate for social stability, better education, better health care which affect the quality of life of the new settlers, and better economic situation of local people after being involved in permanent jobs.

Lessons Learned: Every development project is considered as a new chapter in a book that leads for learning useful experiences and lessons. A brief reflection of the authors regarding main lessons derived from the irrigation projects that the Kuwait Fund participated in financing in different geographical locations of developing countries will be summarized in the following section.

1. Irrigation is a key for food security and agricultural development, and the beneficiaries of the farming communities are very often eager to adopt irrigation practices for more production. As long as farmers have access to water, they are willing to convert from traditional rainfed to irrigated agriculture, and this makes their income more sustainable.
2. Successful adoption of irrigation lies in the capacity building of the nationals, providing extension and training services to the farmers, with access to credits for purchasing required inputs.
3. Establishing proper water users associations and farmers groups from the beginning play a vital role in the involvement of the management for planning, operations and maintenance of irrigation projects, specially that many projects lack good maintenance and local expertise.
4. Many projects are hindered because the irrigation sector is managed by more than one public authority, i.e. ministries of agriculture or irrigation, rural development or water and natural resources, ...etc. Also, by major changes of project's staff during implementation which affect negatively the progress of any project. For new projects funded by Kuwait Fund, it is very often the progress is delayed due to unfamiliarization of project staff with the Fund procurement procedure guidelines.
5. It is important to pay special attention to small farmers, by securing their land tenure and participation in decision making.

6. Emphasis should be given to rehabilitation and upgrading of existing projects over new ones, and apply simple and suitable engineering designs for irrigation and drainage networks to reduce operation and maintenance costs.
7. Attention should be paid for drainage works to avoid irrigation system problems, where poor drainage leads to water logging, soil salinization and negative environmental impacts.

CONCLUSION

Irrigated agriculture is an important tool to increase productive land, for sustainable farming practices and fight against hunger and poverty in developing countries. There are many challenges that countries must combat for the purpose of development goals, and the agricultural projects must achieve a greater impact on sustainability. The concerned authorities should help farmers, especially the small ones, by supporting them with availability of inputs, facilities to ensure their stability, improve the levels of food production, and thus living conditions of their families. Some of the challenges facing irrigation development and should be tackled are water scarcity, climate changes, land and soil degradation, in addition to more financial resources should be allocated for irrigated agriculture projects, especially that irrigation accounts for a large portion of agricultural investment. Operation and maintenance tend to be best under the management of financially autonomous authorities such as water users association or farmer groups. Also, applying suitable engineering designs that promote sustainability is highly recommended, to reduce operation and maintenance costs.

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