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Arab Organization for Agricultural Development  
by

Volume No-1  
Executive Summary

Final Report

Technical and Economic Feasibility Study of the  
Utilization of the Great Man-Made River Waters (Phase II)  
Along the Conveyance System and Al-Jabal Al-Gharbi Regions

Arab Organization For Agricultural Development



Authority for the Utilization  
of Jabal Al Hasana Al Jafara Water System of the Great Man-Made River



## FORWARD

Since the advent of El-Fatih Revolution, the Libyan Arab Jamahyria, has been witnessing a radical change, which at first targeted alleviation of all constraints and obstacles hindering the development of the different economic sectors, by prescribing a well conceived and crucially studied ambitious developmental plans and programmes.

The implementation of these plans have resulted in a rapid expansion of reclaimed and cultivated agricultural areas, which inturn contributed in more improvement in the Libyans standards of living and increased the per capita income, as an outcome of increase, in both crop and animal production. This improvement has been coupled with enhancement in food self-sufficiency. The efforts could be attributed to the improvement of the infrastructures, supporting services, adoption of modern agricultural technologies and upgrading of human resources in all relevant fields.

Despite these outstanding achievements, the Libyan leadership has pinpointed some more serious developmental constraints of which the most important and pressing relate to the availability of irrigation water, needed for success of these ambitious developmental plans.

To mitigate the problem of irrigation water shortage, it has been decided to establish the Great Man Made River Project. This project is considered as one of the most ever known huge projects in the world. Its full capacity when it is completely implemented is estimated at about six million cubic meter per day. The total lengths of the conveyance system stretches to about 4000 km. Owing to the importance of this huge project the Libyan government has devoted all needed financial facilities to bring this project into reality, and exploiting all possible means for proper and most efficient utilization of its waters.

According to the agreement between the AOAD and the Great Man-Made River Utilization Authority, the study covers the Conveyance System and AL-gabal Al-Gharbi areas, which encompass 16 sites, in addition to another two additional sites proposed by the River Utilizational Authority. As agreed upon, the general frame work of the study includes three main volumes in addition to an executive summary, to be implemented in three interrelated and subsequent phases. Phase I, deals with building of basic data base on locations and regions to be covered by the study, specifically the status of agricultural activities, socio-economic and demographic situations. Phase (II) deals with designing the integrated developmental plans, with their detailed different sound alternatives. Phase (III) provides the financial and economic analysis of the first best developmental alternative plans.

Both phase (I) and (II) have been implemented at field level and all the needed facilities were offered to the AOAD team of experts. Phase III of the study (financial and economic analysis), has been done at the AOAD Headquarters, purposely to benefit from the available computer facilities.

According to the adopted methodology, the study plan was conducted in a sequential manner, starting with the building up of the information data base, followed by setting of criteria for selection and identification of the most suitable developmental alternatives and finally under taking the financial and economic analysis of the best alternative.

The study team initiated and hence benefited from the wide-range of discussions and conversations with various Libyan specialists, in addition to convening workshops and meetings with the Libyan counterparts and other national specialists, so as to give room for different point of views and opinions that could help in improving the final product.

AOAD has been keen to submit after completion of each study phase, a draft report to the Libyan Authority for review and comments, then incorporating the proposed amendments before the report being approved

by the River Utilization Authority. When all the study phases were completed, the AOAD organized a work-shop for discussing all parts of the study. Needless to emphasize that the study has been enriched by the valuable contributions and comments offered during the proceedings of the workshop.

The study comprises four volumes as follows :

**Volume I** : Comprises the executive summary (both is Arabic and English), which concisely outlines the main findings and recommendations that could help the decision makers to start the project.

**Volume II** : Presents and reviews the existing agricultural, economic and social status and situations in the regions covered by the study, as far as natural resources, population, the agricultural, economic activities and climatic conditions are concerned. This is in addition to the status of vegetation cover, social activities and the existing infrastructure.

**Volume III** : Discusses the integrated development plan for the utilization of the Great Man-made River Waters-Phase II, which comprises five parts, (part I, describes the main directives and considerations of development activities, Part 2: outlines the integrated development plan for Eastern Branch Region, in addition to part 3, which covers the Central Branch Region, Part 4, that covers Al-jabal Al-Garbi Region, and finally Part five which comprises the appendices).

**Volume IV** : Embodies the financial, economic, environmental and social analysis of the project components, inputs and out puts, in addition to the proposed financial plan and the suggested organizational structure of the project. In addition, this

volume reviews the investment priorities in the different sites and locations, according to certain technical and economic indicators.

Finally, AOAD has the pleasure of introducing this commendable and voluminous study which we consider a valuable addition to our previous accomplishments, with hoping that the study will meet its final objectives in achieving a prosperous future agricultural development

We also extend our thanks to the team of Arab experts for their outstanding contribution and ceaseless effort in preparation of the study.



**Dr. Yahia Bakour**  
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# **Technical and Economic Feasibility Study of the Utilization of the Great Man-Made River Waters - Phase II Along the Conveyance System and Al-Jabal Al-Gharbi Regions**

## **EXECUTIVE SUMMARY**

### **Introduction :**

1- During the last two decades, and specifically between mid Seventies and mid Nineties, the Libyan population has increased from less than 2.5 million to about 5 million , and it is expected to reach 10 million by the coming two decades or even before that . The impact of excessive population growth on environment and natural resources will be augmented due to developing social and economic conditions of the population, and consequently will increase the consumption and demand of goods and services.

In this context, it is of vital importance to envision a comprehensive and integrated perspective on the relationship between population, environment, and available resources.

This relationship has become more challenging in the process of present and future development, accentuated by the potential imbalances of population increase and growing demand on one hand and the limited or scarce resources on the other hand.

2- Under the prevailing conditions in Libyan Arab Jamahyria, water resource is considered the most valuable among the list of scarce economic resources, and as such is pivotal in the process of economic development especially in the promotion of the agricultural sector. Due to this, water resource development has been given special consideration when formulating development policies and programmes .

Two approaches have been adopted to develop water resources:

First; directing the national efforts towards developing various water resources by all possible traditional and modern means, to achieve an appropriate balance between the resources available and that needed for consumption and utilization and to avert the risk of water crisis.



Second; the attainment of maximum possible rationalization of water use and optimum water distribution in a manner that achieve enhancement of economic efficiency and sustainable development.

3- The project of the Great Man-made River is one of the main achievements in the field of ground water development and utilization in Libyan Arab Jamahyria. From the heart of the Libyan desert, about 6 million cubic meters of water flows daily to urban areas to be utilized for different purposes that serve integrated rural and agricultural development .

4- As the financial burdens of such a formidable project will be incurred by the Libyan peoples, the Libyan Government is very keen to utilize the River waters in the most profitable purposes, and in the most needed area in an economic, technical, social and environmental principles to be spelled out in detailed comprehensive feasibility studies for the investment of all phases of the project.

The Authority for the Utilization of Jabal Al Hasauna Al Jefara Water System of the Great Man-made River contracted the Arab Organization for Agricultural Development (AOAD) to undertake the technical and economic feasibility study of the utilization of the Great Man-made River waters - Phase II along the Conveyance System and Al Jabal Al-Gharbi regions.

#### **General Framework of the Study :**

5- According to the Agreement with AOAD, the study includes 3 main volumes in addition to the executive summary, to be prepared in three interrelated and subsequent phases as follows :

**Phase I** of the study deals with building of the basic database on locations and regions to be covered by the study with regard to agriculture, economic, and demographic situations, in addition to general information required for the study.

**Phase II** of the study deals with designing the integrated developmental plan which is composed of detailed regional developmental plans of the regions to be covered by the study, according to potential and sound alternatives for the cropping patterns and other farm activities, in addition to main features of supporting development policies to such activities as credit, research, extension and agro-industry .

**Phase III** deals with financial and economic analysis for the developmental plan for the first best alternative, which is to be selected in light of technical, economic and environmental parameters. This phase also includes analyses of prices, production costs, farm budget, cash flow, investment, feasibility and evaluation indicators, and sensitivity analysis of probable changes in prices, production costs and world market developments. Also, this phase deals with suggestion of financial plans, assessment of environmental, social, and economic impacts, and identifying administrative aspects, organizational structure, and policies in order to increase the efficiency of water management and investment especially in research, extension and training.

6- As a part of its concern to conduct the study according to the best international standards, AOAD formulated a team of outstanding group of experts specialized in various disciplines of the study as agronomy, horticulture, animal production, poultry, agricultural mechanization, water resources and irrigation systems, agricultural economics, environment, agricultural marketing, financial and economic analysis, social science, food industries, electricity, roads, health, and education.

7- The scope of the study includes the Water Conveyance System and Al Jabal Al-Gharbi regions. The Water Conveyance System is divided into two regions namely the Eastern Branch and the Central Branch.

Accordingly the study actually covers 3 regions composed of 18 locations for prospective development as follows:

**Region I :** The Eastern Branch which includes 3 locations: Adafniah-Naima, Tomaina-AlKrariem and M. Emhemed Almagarif.

**Region II :** The Central Branch which includes 7 locations: Tarhunah, Weshtatah, Sawfajjin-Graret Algtaf, Gararat Shaddaf-Zamzam, Alazoumi-Ras Atabel, Ashweref, Wadi Azazimmit and Wadi Bey alKabir.

**Region III :** Al-Jabal Al Gharbi which includes 8 locations: Irrigated Jandoubah, Jandouba-Algdamah, Alasabaa and Alqualish, Gharyan and outskirts, South Yefren, Aryaina and South Azintan, Arojban and Jadu and Zahir Arhibat.

8- The study contains detailed analysis of the integrated development plan for

the 18 separate locations, the integrated development plan for the three regions of the study and for the project as a whole.

AOAD conducted the study in detailed and precise manner to match all technical and administrative purposes. The study is composed of 4 volumes as follows :

**Volume I :** The executive summary (both Arabic and English), containing the main findings and recommendations.

**Volume II:** Study of Existing Agricultural, Economic and Social Situation in the Regions covered by the study under Consideration.

**Volume III :** The Integrated Development Plan for Utilization of the Great Man-made River Waters-Phase II. This volume is composed of 5 parts as follows :

**Part 1 :** The Main Directives and Considerations of Development Activities.

**Part 2 :** The Integrated Development Plan for Eastern Branch Region.

**Part 3 :** The Integrated Development Plan for the Central Branch Region.

**Part 4 :** The Integrated Development Plan for Al-Jabal AlGharbi Region.

**Part 5 :** Technical Appendices for the Integrated Development Plan.

**Volume IV:** The Financial, Economic, Environmental and Social Analysis of the project, including appendices .

#### **Methodology and General Outline of the Study:**

9- The study team was well acquainted with the methodology, components and objectives of the study as well as with economic conditions of the Libyan people, their achievements and aspirations.

The study was based on a methodology of interaction between the prevailing environmental factors in the study regions and followed various methods of research, data collection , statistics, diagnostic studies, which could be summarized as follows:

- \* Reviewing of the available studies, reports and publications of relevance to the study .
- \* Conducting field tours to all locations and regions covered by the study, also the study team had various meetings and discussions with responsible personnel and villagers in the project regions.
- \* Collecting information and data from both published and non-published from different official sources.
- \* Holding meetings and discussions with concerned authorities, senior officials in different localities and institutions.

10- The study team initiated a wide-range of discussion and conversations with various groups, in addition to convening of workshops and meetings with Libyan counterpart team and other national specialists, so as to give good opportunity for different point of views and opinions. All reports of the study were well revised and reviewed by the study team .

11- The study plan of work was conducted sequentially according to the scheduled methodology of the study as follows:

- \* Building information database on the existing situation at the country, region and location levels .
- \* Setting up of the main considerations and directives governing selection and identification of alternative developmental activities.
- \* Designing and formulating of alternative farm activities for different regions taking into consideration the prevailing conditions and identifying suggested irrigation systems required, and monthly and yearly water consumption.
- \* Implementing the development plan at regional and location levels, by including the basic infrastructure, agricultural facilities, public services, and supporting activities to the existing plant and animal activities.
- \* Selection and identification of the appropriate developmental alternative, according to the highest return per water unit consumed and reasonable farm incomes.
- \* Analysing the financial and economic situation of the farm in each location, through establishing farm budget which included establishing input/output relation, cost-benefit analysis using prevailing prices and through the project life span, which includes farm investment indicators, sensitivity analysis of market conditions and others.
- \* Formulation of the appropriate development plan alternative and its components at region, location and the whole project levels.

- \* Reviewing and analyzing the development plan at the location level, emphasizing on its developmental activity components, assessment of inputs and outputs, capital and current investment cost elements, expected returns, investment analysis, financing plan and its resources, and estimating the feasibility indicators and conducting sensitivity analysis.
- \* Reviewing and analyzing the development plan at the region level and its components, investment elements, implementation time frame, and estimation of aggregated inputs and outputs.
- \* Reviewing and analysis of the whole project including different locations and regions, with its components, policies, organizational structure, inputs and outputs, financial analysis indicators and economic analysis in the context of international changes. Also, the economic, social and environment impacts and implications of the project were assessed. The general indicators for the project feasibility and priorities, of all locations and regions were examined as well.

#### **Main Considerations and Directives Identifying the Development Activities:**

12- The study depends on a group of directives and considerations in selection of alternative cropping patterns and its conformity with various environmental factors, in addition to public directives and objectives. Among these considerations are the international changes in world markets and their impact on agricultural prices, and lessons learned from previous development projects in the Jamahyria or in other Arab countries, especially those issues related to development strategies, economic and agricultural policies, and technology transfer and adoption.

13- With regard to policy and regional situations, a degree of compatibility with agricultural policies was given special consideration when selecting the developmental activities alternatives. Also the direction of development, policy reforms were considered, particularly those related to individual incentives, market mechanisms, and resources and environment conservation in a framework of sustainable development.

14- Among the considerations are the current and expected situations of food commodity balance, food surplus, food gap, consumption, production, and the expected contribution of the Great Man-made River Project in its previous phases. Also, the link between industrial capacities and production cycles, job opportunities and income generating activities were given special emphasis.

15- The water resource utilization and its efficient use considered to be the key factor in the process of formulating, selecting and identifying the appropriate al-

ternative with highest return per water unit consumed, and generating reasonable family income.

#### **Bases of the Analysis :**

16- As the objective of the study is to identify the feasibility of utilizing the waters of the Great Man-made River in the development of locations and regions according to an appropriate development plan, a variety of measures which include financial and economic analysis were undertaken based on the following set of criteria:

- The available water resources to be utilized in agricultural investment in all locations and regions covered by the study has been identified by concerned authorities through technical studies already conducted.
- The local ground water resource, if available, is considered as a part of the national water resources which should be utilized only if economically feasible compared to the waters available from of the Great Man-made River.
- The area identified for development is subject to decrease or increase according to water resources efficiency use, coupled with limitations of soil analysis and classification. The targeted area for investment was considered to be of best soil type .
- To rationalize the use of water resources from the Great Man-made River or from ground water, water requirement in all cases were estimated based on the full utilization of the effective rain water, when available.

17- The study relied on detailed methodology based on principles of analysis according to international standards. The following are outlines of what has been followed :

- The maximum return per water unit consumed is the main focus of analysis .
- The selected developmental models are designed to establish an appropriate degree of compatibility between the public objective of maximizing the return per unit water and the earned family farm income .
- The study analysis was based on integrated development plans (economically, socially and environmentally). At the farm level, the animal and plant practices were integrated, while at location and region levels agricultural services, marketing and processing activities were integrated, and the public utilities and services, as irrigation, roads, electricity, education and health all integrate to-

gether, in addition to, extension and research programmes in order to attain the objectives of the development plan.

- The development plan falls within a reasonable framework of institutional support and agricultural policies to achieve its objectives. The same case is true for financial institutions and policies, agricultural credit, water resources management, agricultural extension, agricultural research, production input, and others.
- The family and the farm represent the primary basic unit of the development plan. The farm unit should have a definite area to generate a farm income at least equal to that of alternative opportunity cost of family labour in non-agricultural activities. The family should be composed of a reasonable individuals to fulfil two units of work of the family labour, and to render more self-dependence on the family individuals .

#### **Levels and Methods of the Analysis:**

18- The study followed different levels of financial and economic analysis so as to give better judgement on investment feasibility of the whole project or even for a location or a region of the project, to allow for comparison and setting of priorities . Accordingly an appropriate technical alternative analysis at farm level in every region was considered the starting point at that level, then comes the analysis at regional level in the 18 locations, in addition to other components of the development plan including water network, irrigation network, roads, electricity, agricultural machinery stations, and others. Also the study reviewed in detail the investment plans at the level of the three regions including its components, duration , financial resources and input and output.

The detailed analysis of the project as a whole with its different locations and regions includes evaluation of return on water investment and its capacity to contribute in food security and national income and its capacity to generate job opportunities. Also, sensitivity analysis to international price changes, farm inputs, infrastructure, agricultural subsidiary services and public services were analysed. The impact of the project on Government budget, foreign currency, and environment was assessed as well.

19- The financial and economic analysis depend on two methodologies. The first namely; Farm Budget Analysis, has been restrictedly applied to farm level according to the appropriate development alternative. This methodology included a description of the resource base and a variety of plant animal integrated activities, quantifiable monetary measures for expenditure, farm output, depending on

available and expected prices in changing economic and agricultural policies. Also, this methodology included monitoring of farm financial situation, farm income, and estimation of return per invested water unit .

The second methodology is the farm and agricultural investment methodology, which aims at evaluation of investment feasibility indicators, and rate of return on capital investment. Also well known indicators and parameters were used as the Internal Rate of Return (IRR) and the Net Present Value (NPV) and Benefit/Cost (C/B) Ratio. This methodology was also applied in the investment analysis at farm level, regional level, private economic activity level and at the project general level. This methodology aims at finding numerical indicators to assist in decision making during transition from the stage of detailed study to project execution, and in setting priorities list, and in selection of locations and regions. It is worth noting that this methodology at the project general level includes financial analysis based on the prevailing prices at farm and region levels, and economic analysis based on shadow prices network according to known international standards and measures.

20- The analysis of different methodologies and standards depended on detailed principles reviewed by the study to explain the technical formulations and the physical quantities of input - output elements. The study reviewed the monetary value of cost and benefit of input/output in light of the prevailing market prices.

### **Region I : The Eastern Branch of the Conveyance System :**

#### *Characteristics, General features and Agricultural Background :*

21- This region is a natural extension of Jafara plain and lies East of Al Garabulli district in the coastal strip located north of latitude 32°, and between longitude 14:5-15:5 from East to West, and nearly between Misratah city and Sabkhat Tawurgha in the East and Al Khums city in the West . It is of high population density and economic activities. This region produce a variety of vegetables, fruits, cereals and other agricultural products. The agricultural development programmes of the First and the Second Transformation Plans have given special consideration to this area and many development projects were sited in this region, either through allotment of agricultural land as in Adafniah, Tomeina, and Alkrariem or through reclaimed land as in Naima, and through specialized agricultural projects as in M Emhemed Almagarif farm (fodder farm) .

22- The climate in the region is moderate, and the monthly mean temperature



ranges between 15 - 26°C , the mean of relative humidity is about 61% near Al Khums and about 72% near Misratah city.

The annual mean of precipitation ranges between 270 to 313 mm, mainly in winter and scarcely in summer. With the exception of some area of moderate and high salinity, most of agricultural land is considered of good characteristics and the soil has sandy texture to sandy-loamy texture with a deep suitable profile. The rainfed agriculture constitutes about 40% of the cultivable land, and its increasing is due to overpumping groundwater resources. It is estimated that discharge from groundwater are about 4 - 6 times as much as the rate of recharging . The water table is decreasing annually by about 2 - 5 meter, which has resulted in sea water creep by about 70 meter annually.

23- Due to the high population density and economic importance of the Eastern Branch region, it is well-served by public utilities and services and excelled other regions in energy sources, roads, transport , freshwater, education and health. The region is well equipped with electricity networks, and big electricity power stations as in Misratah and Al Khums, and this will be good facility services for education, health and agriculture. The area is linked by paved roads to main cities as Tripoli and other cities. A variety of economic and population activities are practised in this area. Agricultural activities represent about 20% of labour force, despite the constraints facing the agricultural sector as water scarcity and quality deterioration of groundwater . The average land holdings range between 12 - 30 ha (with the exception of M Emhemed Almagarif farm) .

The average holdings under permanent irrigation is about 5 ha. The main irrigated crops are fodder crops, vegetables, legumes and other crops, and in some areas fruit crops, mainly as olives.

#### *The Main Features of Development Plan of Region I:*

24- Due to the economic importance of this region and problems associated with water resources, 3 locations were included in the agricultural development plan depending on the utilization of the Great Man-made River Waters, namely Adaf-niah-Naima, Tomeina-Alkrariem, and M Emhemed Almagarif locations. The area included in the developmental plan for the three regions is about 6.37 thousand ha requiring about 44.59 million cubic meters of the River waters to accommodate different agricultural activities.

25- Based on the prevailing agricultural conditions, and according to the consid-

erations and prescription of designing agricultural activities alternatives , it was decided to select some of agricultural activities that suit the development plans in this region as improving fruit trees, particularly olives, in addition to integrated plant/animal activities for raising dairy cows on fodder byproducts and other feed crops. Also growing food crops as wheat , and of vegetables in smaller areas, especially tomatoes for processing. Also, other appropriate alternative includes growing of food legumes in limited areas (Table 1) .

26- In order to integrate this development plan on a base of plant/animal activities, it should incorporate utilities and services at the farm, region and location levels to facilitate the process of development activities and to assist in attaining the stated economic and social objectives. Table (1) includes components and elements of development plan of Region I, which could be outlined as follows:

- \* At the farm level the assets and farm utilities include the basic production inputs : advanced irrigation systems as sprinkler irrigation systems, water tanks, ( 50 m<sup>3</sup> capacity for each farm), cow sheds which differ according to herd number and regions, and other farm facilities as milking machines and cooling equipments. Farmers' housing is one of the main components of development plans. However, the location of M Emhemed Almagarif is the only area that could accommodate farmers' residence for settlement.
- \* At the region level, development plan includes establishing of some utilities, provision of agricultural and public services and developing and rehabilitating the already existing utilities.

As the already existing utilities and public services include : roads, electricity, health and education services, and agricultural cooperatives, it is planned to improve these services and utilities to upgrade their efficiency and performance so as to attain the targeted objectives of the development plan (table1) . Other utilities will be established as irrigation facilities at the region level, which include water networks, water tanks and water distribution networks from the water tanks to farms, as well as agricultural drainage systems at public and field levels.

- \* The Development plan at the region level, included introducing economic activities to be integrated with agricultural activities and to be carried out by private sector as individuals, cooperatives or joint ventures. These activities include agricultural mechnization, maintenance and spare parts services, cheese processing units with a capacity of 1 ton milk/day. Numbers of these units were studied according to nature and type of each activity, region , and according to

**Table (1)**  
**Compenents and Elements of Development Plan for different**  
**Locations of the Eastern Branch Region**

Components	Locations	Unit	Adafniah-Naima	Torneina-Alkrariem	M Emehed Almagarif	Total for the Region
Invested and developed area		ha	2775	3315	275	6365
No. of farms		farm	555	663	55	1273
Annual required River water		million m3	18.02	21.50	5.07	44.59
<b>Plant Activities:</b>						
Improving fruit trees		ha	832.5	994.5	-	1827
Wheat		ha	971	1160	55	2186
Fooders		ha	971	1160	248	2379
Tomato for processing		ha	278	332	-	610
Vegetables and legumes		ha	278	332	55	665
<b>Animal Activities :</b>						
Cows		head	2775	3315	825	6915
<b>Farm Facilities:</b>						
Sprinkler irrigation system		ha	2775	3315	275	6365
Farms Reservoir tanks 50m3		Tank	555	663	55	1273
Houses		House	-	-	*55	55
Sheds		Unit	555	663	55	1273
Milking machines and coolers		Unit	555	663	110	1328
<b>Agricultural Services:</b>						
Machinery and Maintenance stations		Station	1+1	1+1	0+1	2+3
Ag. cooperatives		Cooperative	support	support	support	support
Milk Processing units (ton/day)		Unit	9	11	3	23
<b>Basic Agricultural Utilities:</b>						
Main and secondary water pipes		Kilometer	15	7	1.5	23.5
Reservoirs water tanks		Million m3	2.3	2.7	1.3	6.3
Distribution networks		Network	√	√	√	3
Agricultural drainage systems		Network	√	√	√	3
Paved + accessible roads		Kilometer	7+8(support)	-	3 (support)	18
Electricity grid , stations and transformers		√/x	x	Support+Dev	x	Support+Dev.
<b>Public Service Utilities:</b>						
Fresh water networks and Tanks		Kilometer	25+T	40	-	65+T
<b>Region Agircultural Services:</b>						
Research Station		Station	-	-	-	1

\* In case of distributing land in the location for farmers' settlement

availability and capacities of facilities such as farm equipment, processing units for tomatoes, cheese, vegetables and legumes with the objective of utilizing the available resources on economic bases .

- \* At the regional level, the development plan includes an integrated agricultural research station linked with production in the locations in the region and complements existing research institutions and policies.

#### *Inputs and outputs of Development Plan of Region I :*

27- Table (2) indicates requirements of the development plan inputs which can not be availed from the farm. The table also shows the marketable final outputs which can be obtained from production activities. This reflects the proposed role that can be played by the agricultural cooperatives which need all the support and necessary improvements as visualized in the development plan. On one hand, those cooperatives will make available appropriate inputs with respect to quantity, quality, timing and methods. On the other hand they will contribute in collection, handling and marketing of major products, particularly, perishable products. The development plan requires at the regional level about 5.1 thousand tons of various chemical fertilizers, including nitrates, phosphates and potassium, and about 29 thousand litres of insecticides, fungicides and weedicides, in addition to about 490 tons of improved seeds of different crops. If the machineries and the proposed maintenance centres are made accessible to the individuals in the region, this will facilitate various mechanical operations, and hence the three locations in the region will require about 11.6 thousand hired working days apart from what can be contributed by the families. It is also planned that the agricultural cooperatives will have a major role in securing inputs related to veterinary services, packing and packing materials.

28- In case of outputs, it is envisaged that developing that locations will contribute to the national agricultural product a sizeable amount of basic food commodities estimated to be about 30 thousand tons of milk, which can be processed and consumed, 1.1 tons of meat, 10 thousand tons of wheat, 15 thousands tons of tomatoes, which can be processed, 5 thousand tons of olives from which oil can be extracted, 1.4 thousand heads of female cows, in excess of what is left for raising in the farms, and about 30.6 thousand cubic meters of organic fertilizes in excess of what is needed by the farmers.

The achievement of the expected magnitude of produce from all proposed loca-

**Table (2)**  
**Inputs and Outputs of Production Activities of the**  
**Development Plan of the Eastern Branch Region**

Inputs & Outputs	Locations	Unit	Adafniah -Naima	Tomaha- Alkharim	M Emhed Almagarif	Total for the Region
<b>Main Inputs :</b>						
Seeds of Cereals & Legumes		Ton	150.5	180.0	12.1	342.6
" " Forages		"	59.7	71.3	10.5	141.5
" " Vegetables		"	1.8	2.2	0.2	4.2
Various Chemical Fertilizers		"	2184.0	2609.0	300.8	5093.8
Various Pesticides		000 liters	12.6	15.0	1.4	29.1
Hired Labour		000 day	2.5	3.0	6.1	11.6
Tractors & Combines		000 hour	26.4	31.6	5.9	63.9
Harvestors						
Protection Machineries		"	4.2	5.0	0.2	9.4
Wheat Straw Baling		"	20.0	23.9	2.7	46.6
Veterinary Services for Cows		head	2775	3315	825	6915
Various Packages and Pack- ing materials		000 package	833	995	83	1911
<b>Main outputs :</b>						
<b>Plant products :</b>						
Cereals (wheat)		000 ton	4.37	5.22	0.25	9.84
Legumes		Ton	-	-	55	55
Tomatoes for Industry		000 ton	6.94	8.30	-	15.24
Various Vegetables		"	6.10	7.30	0.61	14.01
Olives		"	2.25	2.76	-	5.01
<b>Animal Product :</b>						
Milk		Mill. litre	12.2	14.6	3.6	30.4
Meat		Ton	4447.0	533.7	133.0	1113.7
Cows (Female for raising)		Head	577	690	172	1439
manure (Surplus)		000 M <sup>3</sup>	11.8	14.1	4.7	30.6

tions targeted for development still remains basically dependent on the efficient and integrated capacity of the project during its various stages and implementation of its components, particularly in the following areas :

- \* Flexibility and efficiency of facilities of integrated services in the areas of research, extension and in areas that avail requirements needed for sufficient production of good quality at the appropriate time.
- \* Efficiency of applying appropriate production technologies particularly for various operations and treatments at the field level.
- \* Efficiency of application and flexibility of marketing system and marketing and extension facilities with special consideration to those which result in the reduction of risks normally faced by the producers and which would have otherwise, discouraged them to improve postharvest operations and treatments in the form of damages and losses at the field level.

#### *Required Investments for the Development Plan of Region I :*

29- The execution of the development plan for Region I requires a preliminary estimate of about L.D. 77.3 million; of which L.D. 35.3 million is allotted for developing and improving the Tomeina-Alkrariem location; and about L.D. 32.8 million for Al Adafniah-Naima location, and about L.D. 8.8 millions for M Emhemed Almagarif location. And because this region is characterized by the availability of most of the private and public service utilities, hence most of the investment is directed towards improving, supporting and implementing farm and public irrigation facilities. The farm investments represent about 49.1 % of the total investment, followed by investments on the infrastructure, including public irrigation networks, establishing reservoirs and distributary networks, which account for about 42.6 % of the total investment. The rest of the development plan activities are left with about 8.3 % of the total investment as shown in Table (3).

30- Within the framework of the time scheduled for executing the development plan, the allotted investments will be distributed in the order of about 40.3 % during the first year, 40.7 % during the second year and the rest of about 19 % will be allocated for the third year. With regard to the required investment financing plan, it is distributed between the share of those beneficiaries from the development and improvement projects in the region, which is estimated at

**Table (3)**  
**Investment Requirements for the Development**  
**Plan of the Eastern Branch Region, Phasing**  
**and Financing Structure**

Items	Locations	Unit	Edfinia-Naima	Tomeina-Elkrariem	M Emhemed Almagarif	Total for the Region
<b>Total of investment requirements :</b>		Mill. D.	32.79	35.65	8.83	77.27
Farm investments		"	15.25	18.23	4.44	37.92
%		-	46.50	51.10	50.30	49.10
Infrastructure utilities		"	14.92	14.36	3.68	32.96
%		-	45.50	40.30	41.60	42.60
Agric. Services		"	2.03	2.27	0.70	5.00
%		-	6.20	6.40	8.1	6.50
Public services		"	0.60	0.80	-	1.40
%		-	1.80	2.20	-	1.80
<b>Phasing of investments :</b>						
1st year		%	43.10	37.90	40.10	40.30
2nd year		%	38.40	41.70	45.10	40.90
3rd year		%	18.50	20.40	14.80	19.00
<b>Financing structure :</b>						
Self financing of beneficiaries		%	21.00	26.60	20.50	23.50
Credit financing		%	31.10	30.2	35.30	31.20
Governmental Financing		%	47.90	43.10	44.20	45.30

about 23.5 %, and the funding secured by the credit facilities of agricultural banks or others, and this is estimated to be of about 31.0 %. The balance, i.e. 45.3 %, will be secured by Governmental fund. Evidently, these percentages vary in accordance with location, relative importance of the components and elements of the development plan as reflected in Table (3).

#### *Indicators of Water Use Efficiency and Feasibility of Investments :*

31- Analysis of water use efficiency of the Great Man-Made River in the Eastern Branch region showed that the capacity of the development plan of producing a net income based on the unit of water use varies from 0.273 dinnars/M<sup>3</sup> as in the location of M Emhemed Almagarif and 0.314 Dinnars/M<sup>3</sup> in the other two locations. The rates are based on the activities of the integrated agricultural production without including any cost related to availing water resources. The variations in these rates are considered insignificant and cannot be a base for giving priorities of using water efficiently in one location rather than the other. However, indicators of the feasibility of investment may be more apparent with variation in locations, since the value of these indicators tend to be relatively high with regard to the location of M Emhemed Almagarif as compared to the other two locations, which share the same magnitude of the indicators. In the location of M Emhemed Almagarif, the value of the internal rate of return (IRR) on the investment amounts to about 17 %, but decreases to about 14 % on the investment at the location level. However, the (IRR) on the farm investment amounts to 14 % in Adafniah-Naima and Tomeina-Alkrariem locations and it decreases to about 7 % and 6 % at the location level for each respectively as shown in Table (4). In all cases and for the different locations the investments indicators at the location or farm level justify to a large extent the importance of including the locations of this region in the targeted executive plan for development and improvement .

32- In addition to the previous indicators, there are other criteria that reflect the capability of the farm for supporting and improving the economic conditions of the family, it seems obvious that M Emhemed Almagarif location is noticeably better off in this respect, with a net annual farm income of about L.D. 16.6 thousand, compared to about L.D. 6.3 thousand as a net annual farm income for each of the other two locations. This could be attributed to the high rate of agricultural intensification due to availability of water and the access to green fodder, which



**Table (4)**  
**Major Indicators of Water Use Efficiency**  
**and Feasibility of Investments in different**  
**Locations of the Eastern Branch Region**

Indicators	Locations	Unit	Edafniah - Naima	Tomeina- Elkrariem	M Emhemed Almagarif
Net Income per Water unite		L.D/M3	0.314	0.314	0.273
Net Farm Income (excluding family labor)		1000 L.D/ year	6.30	6.30	16.60
" " " (including family labor)		"	8.70	8.70	21.20
<b>Indicators of Farm investment Analysis:</b>					
Farm Share in Total Investments		1000 D.	59.10	53.80	160.60
IRR		%	14.00	14.00	17.00
N.P.V		1000 D	47.50	44.00	151.00
B/C		%	1.25	1.23	1.37
<b>Indicators of Locations Investment Analysis</b>					
IRR		%	6.00	7.00	14.00
N.P.V.		Mill. D.	0.70	8.70	7.10
B/C		%	1.01	1.06	1.32
<b>Farm Situation when charged with annual shares of the agricultural utilities investment:</b>					
Farming Utilities Investment		Mill. D.	14.92	13.36	3.68
Total Share of the Farm		1000 D.	26.90	20.10	66.90
Annual Installment of the Farm (20 years)		"	1.35	1.01	3.35
Farm Income (including family labour)		"	8.70	8.70	21.20
Farm Income (after sharing cost of basic investments)		%	7.40	7.70	17.80

in turn help increasing herd size, and contributed substantially in whole farm income.

33- Table (4) shows another indicator which reflects the total investments required for a single farm unit in each location. This indicator could be helpful in setting priorities needed for taking decisions regarding expansion of areas and number of farms with minimum investment outlays. In this respect, it becomes apparent that average farm investment share in Tomeina-Alkrariem location, which amounts to about L.D. 53.8 thousand is relatively low compared to Adafni-ah-Naima and of M Emhemed Almagarif locations, where this average amounts to L.D. 59.1 thousand and 160.6 thousand respectively. In this context, decision makers may look into the possibility of participation of beneficiaries in the development efforts by contributing in the investment cost of some of such agricultural infrastructure that serve directly agricultural production, such as irrigation services, energy and roads. Table (4) includes analysis of status of net farm income and indicators of farm investment, in view of participation of each farm in the investment costs for these infrastructural components. It becomes evident from this analysis that farmers in the various locations will be able to accept this financial burden as an annual installment distributed over 20 years of the project life time. This will make the net farm income at some reasonable levels ranging between L.D. 17.8 thousand in M Emhemed Almagarif location, to about L.D. 7.5 thousand in the other two locations.

#### **Region II : The Central Branch of the Conveyance System :**

##### *Characteristics, General Features and Agricultural Background :*

34- Compared to the other two regions covered by the study, the Central Branch is considered the widest with extensive length and breadth lying between longitudes 13:41 and 14:12 and latitudes 30 and 32:18. It is relatively far from the coastal line and extends southwards till Ashweref. It includes three administrative municipalities, Muzda in the South and Bani Walid and Tarhunah in the North. This region includes, with respect to the development plan, seven locations which are proposed to be part of the investment. These are: Tarhunah-Weshtatah, Sawfajjin and Graret Algtaf, Graret Shaddaf and Zamzam, Alazoumi and Ras Atabel, Ashweref, Azazimmit and Bey alkabir. Since the region is so large and the locations are far away from each other, the locations vary in their features, climat-

ic characteristics, soil and water resources characteristics and availability of public service and utilities.

35- Most of the locations in the Central Branch have been targeted for some studies which provided some information that could be relied upon in categorizing the locations in three groups. The first one includes Tarhunah-Weshtatah with general features and characteristics closer to the Eastern Branch region. The rate of rainfall is relatively high (about 266 mm). Temperature is relatively moderate reaching 18 °C on the average. Class I soils are quite enough for selecting an area to be developed appropriately for agriculture. However, the status of ground water in Tarhunah-Weshtatah is not enough or suitable for any agricultural development (according to a report by the Public Water Authority).

36- The locations of Sawfajjin and Graret Algtaf, Graret Shaddaf and Zamzam, Alazoumi and Ras Atabel share common features as they have dry climate with an annual average rainfall of about 70 mm. The average temperature ranges between a minimum of about 15.1 °C and a maximum average of about 34.9 °C. In spite of this, these three locations still have good features for agricultural development. These constitute the vast areas of class I soils. Beside the potentiality of the development is based on the Great Man-made River waters, the underground water adds new venues to establish the targeted development in those locations. This will help in achieving efficient use and better distribution of water resources at the regional level.

37- The third group of locations in the Central Branch includes Ashweref, Azazimmit, Bey alkabir which are characterized by receiving lesser rainfall than the previous group. The upper limit of the annual rate of rainfall is about 59 mm. in Ashweref and it declines to about 45 mm. in Azazimmit and Bey alkabir. In spite of the availability of underground water in these locations (according to official reports), which support the development potentialities, the soil type in addition to high level of aridity and tough climate, constitute important limiting factors which have their effect on the economic feasibility of development in these locations. This can be noticed in Ashweref, where the agricultural soils are dominated by class III and Class IV. In Azazimmit the best available soil is of class II, but because such soil is of limited areas, extension has to include soils of class III and class IV. The availability of class I soil in Beyalkabir location can hardly exceed 50 hectares, hence about 95 % of areas targeted for the development in this location

must be extended to lands of lower quality.

38- The Central Branch region has a vast area which is sparsely populated. About 120 thousand people are involved in various economic activities comprising mainly rainfed agriculture, and to some limited extent irrigated agriculture from underground water. They grow wheat, barely, olives and dates, some other fruit trees and some vegetables which all irrigated from wells. They also raise some animals including sheep, goats and camels.

*The Main Features of the Development Plan of Region II :*

39- The development plan in the Central Branch region is based on the available water resources, whether from the Great Man-Made River or from underground resources for initiating agricultural development in a total area of about 6.87 thousand ha, distributed over the seven locations in the form of small irrigated residential farming units of about 5 hectare each. Accordingly about 1374 new farming units can be settled in the region. The total water requirements of this region are estimated to be within the range of 89.8 million M<sup>3</sup>/year, of which 11.8 million M<sup>3</sup> could be obtained from the River for Tarhunah-Weshtatah location, while the rest of the requirement (about 78 million M<sup>3</sup>/year) is to be obtained from the available underground water resources in the other locations.

It is worth mentioning that this study has included recommendations of the importance of conducting detailed studies regarding underground reservoirs in each location, to ensure their suitability, for the targeted development. These are required during the phase of preparing the detailed technical and economic feasibility studies prior to the execution of the projects at each location.

40- In view of the special features of the Central Branch region and the variations in their locations, and according to the criterion of maximizing returns from the unit of water, a group of alternative cropping patterns, which constitute the production base for the development plan were defined. These include activities which give much interest to forage and integrated animal production (cows or sheep) depending on condition and characteristics of each location.

Cow raising has been found to be more suitable for Tarhunah-Weshtatah location, whereas raising sheep is proposed to be the animal activity for the rest of the

locations. Forage production occupies an area of about 3.3 thousand ha of the total area of the locations. Cereals, either wheat and barely with equal areas, or barely alone, occupy about 2.1 thousand ha. Vegetables and legumes occupy an area of 1.47 thousand ha, most of it in Sawfajjin, Tarhunah-Weshtatah, Alazoumi and Ras Atabel. Fruit trees, especially olives and dates occupy about 2.4 thousand ha in four locations, but they are not included in locations where soils are not suitable for growing fruits like Ashweref, Azazimmit and Bey Alkabir. This is shown in table (5).

41- The development plan at the farm level includes a number of components, utilities and farm assets. Housing facilities constitute one of the main utilities in the various locations, since they are considered as part of the new development. However, Ashweref is exempted, since houses are already existing from previous projects. Animal sheds are considered important only in Tarhunah-Weshtatah, where they are used for raising milking cows, which require providing the farms with milking machines and coolers. On the other hand, all locations require appropriate modern irrigation systems. Of these, the sprinkler systems to cover an area of about 4.46 thousand ha, and drip irrigation systems to cover about 2.41 thousand ha. In each farm, a suitable farming reservoir will be established to sustain daily supplies of water. The wind breaks built around farms, especially the horticultural farms, constitute one of the main component in the development plans.

42- The components of the development plan vary in number and type at the location level. They consist of facilities and essential services associated directly with the agricultural activity. Also utilities and public services are associated with the residents, wherever they are found. On top of the basic agricultural utilities comes the establishment of 97 wells, and main water supplies to Tarhunah-Weshtatah extending for 1 km. from the Great River to the reservoir, which is about 3 millions  $M^3$  of water. In all locations, irrigation distributary network is required, in addition to drainage networks at public and farm levels. Also obstruction dams are required for all locations except at Ashweref. The total length of these dams is estimated to be about 16 km. Electric power networks and roads are also considered as essentials in the development plan. About 83 km . of agricultural compacted or paved roads will be constructed in the various location, except Tarhunah-Weshtatah. Each location also requires the establishment of electric lines and transformers, and in some cases power generating stations or

**Table (5)**  
**Components and Elements of Development Plan**  
**for different locations of the Central Branch Region**

Components	Locations	Unit	Tarhunah- Weshtatah	Sawfajjin & Grati El gtaf	Grati Shaddaf Zamzam	Alazoumi Ras Atabel	Ashw eref	Zazim mit	Beyalk abir	Total
<b>Invested and Developed Area</b>		ha.	1050	2150	480	1350	440	600	800	6870
No. of farms		farm	210	430	96	270	88	120	160	1374
Annual water req. from River		mill. M3	11.84	-	-	-	-	-	-	11.84
Annual water req. from wells		"	-	30.3	6.8	19.2	2.8	8.1	10.8	78.0
<b>Plant Activities :</b>										
Fruit trees		ha.	420	1075	240	675	-	-	-	2410
Wheat & barely		"	315	573	144	405	-	300	400	2101
Fooders		"	473	788	120	338	264	570	760	5722
Vegetables & Legumes		"	210	731	120	338	-	30	40	1469
<b>Animal Activities :</b>										
Cows		head	1260	-	-	-	-	-	-	1260
Sheeps		"	-	9460	1440	4050	1584	5880	7840	30254
<b>Farm Facilities :</b>										
Sprinkler irrigation		ha.	630	1075	240	675	440	600	800	4460
Drip irrigation		"	420	1075	240	675	-	-	-	2410
Farm reservoir (Tank) 50 M <sup>3</sup>		tank	210	430	96	270	88	120	160	1374
Houses		house	210	430	96	270	-	120	160	1286
Sheds		shed	210	-	-	-	-	-	-	210
Wind break		farm	210	430	96	270	-	120	160	1286
Milking machines & coolers		unit	210	-	-	-	-	-	-	210
Wool cutting machines		"	-	10	2	5	3	6	8	34
<b>Agric. Services :</b>										
Machinery and maintenance stations		station	1 + 1	4 + 0	1 + 0	3 + 0	1 + 0	1 + 0	2 + 0	13 + 1
Ag. Cooperatives		coop.	1	1	1	1	1	1	1	7
Milk industry units (ton/day)		unit	8	-	-	-	-	-	-	8
Olive processing units		"	-	4	2	2	-	-	-	8
<b>Basic Agric. Utilities :</b>										
Water domestic lines		km.	1	-	-	-	-	-	-	1
Wells		well	-	37	9	24	4	10	13	97
Reservoirs(water tanks)		mill. M <sup>3</sup>	3.0	-	-	-	-	-	-	3.0
Distributary network		network	√	√	√	√	√	√	√	7
Obstruction dams		km.	2.6	5.4	1.2	3.4	-	1.5	2.0	16.1
Farm drainage network		Network	√	√	√	√	√	√	√	√
Paved roads		Km	-	20	20	30	3	5	5	83
Electric lines stations & transformers		X/√	√	√	√	√	√	√	√	√
<b>Public Servicing Utilities :</b>										
Educational services		class room	17	20	12	18	6	12	12	97
Health units Erection (E) & Improvement (I)		unit	I (1)	E (1)	-	-	-	E (1)	E (1)	I(1)E(3)
Domestic water lines and tanks		km+tank	14+T	20+T	30+T	T	20+T	T	T	84+7T
<b>Agric. services for the region :</b>										
Research station.		station	-	-	-	-	-	-	-	1

otherwise, make use of the excess power from locations within the vicinity. However, since these areas were almost not inhabited before, hence it is of vital importance to provide the inhabitants with the essential public services. This will include about 97 class rooms or about one school of about 6 to 20 class rooms in each location. Also will include 4 new health clinics, besides improving and supporting the existing unit in Tarhunah-Weshtatah. Also about 84 km of domestic water supply pipes, together with about 7 reservoirs (fresh water tanks) need to be provided for the various location. Table (5).

43- The agricultural services include 7 integrated cooperatives, one for each location. They also include 13 machinery service stations, which will be distributed among the locations based on the area and the needs, in addition an agricultural machinery repairing and maintenance centre at Tarhunah-Weshtatah should be established. It will also include special production units, 8 of them for milk industry in Tarhunah-Weshtatah, 8 for olives pickling, distributed at Sawfajjin-Graret Algtaf, Graret Shaddaf-Zamzam, Elazoumi and Ras Atabel. All of the agricultural services will be integrated with the establishment of a research station at the level of the region. It will be concerned with the improvement and solving problems inherited in the region due to its production activities and environmental conditions. This besides its role in collaborating and integrating with other agricultural research stations.

#### *Inputs and Outputs of Development Plan of Region II :*

44- Table (6) shows the main components and elements of production inputs needed for the development plan of the different locations of the Central Branch region, besides expected different outputs of the production activities. The physical quantities of the accumulated inputs, at the region level, are estimated at 7.9 thousand tonnes of different chemical fertilizers, about 76 thousand litres of insecticides, herbicides and fungicides and about 1.4 million seedlings of fruit trees, mainly olives, date palms and grapes, about 332 tonnes of wheat, barely and legumes seeds, and about 187 tonnes of forages seeds and about 210 tonnes of potato seeds, besides about 4 tonnes of different vegetable seeds.

45- On the inputs side, locations will together need the service of about 82 thousand working hours of different agricultural machinery such as tractors and harvesters, besides about 48.5 thousand working hours of hay-packing machines and

**Table (6)**  
**Inputs and Outputs of Production Activities**  
**of the Development Plan of the Central Branch Region**

Locations Inputs & Outputs	Measuring Unit	Tarh unah- Weshata ta	Sawfajjin- Graret Elgtaf	Graret Shaddal- Zamzam	Alazoumi- Ras Atabel	Ashweref	Azazim mit	Bey alkabir	Total for the Region
<b>Main inputs:</b>									
Off-Shoots and seedlings	000 unit	1073	161	36	101	-	-	-	1371
Seeds of cereals & legumes	Ton	50.0	82.8	22.8	64.0	-	48.0	64.0	331.6
Seeds of forages	Ton	25.0	47.3	6.2	17.4	19.5	30.6	40.8	186.8
Seeds of vegetables	Ton	0.3	1.3	0.5	1.4	-	0.2	0.3	4.00
Seeds potatoes	Ton	210	-	-	-	-	-	-	210
Chemical Fertilizers	Ton	1470	2418	580	1631	290	648	864	7901
Pesticides	000 liters	5.67	10.24	3.00	8.37	0.40	20.64	27.22	75.54
Hired labour	000 day	-	20.6	-	-	-	-	-	20.6
Mechanical operations	000 hr.	23.7	22.7	5.3	15.0	1.6	5.8	7.7	81.8
Pesticide spraying	000 hr.	-	5.6	-	-	-	-	-	5.6
Hay baling	000 hr.	10.0	2.4	3.3	9.2	3.6	8.6	11.5	48.5
Vetrinary services for Cattle	head	1260	-	-	-	-	-	-	1260
Vetrinary services for Sheep	head	-	9460	1440	4050	1584	5880	7840	30254
Packing material & Packages	000pack	63	323	144	405	-	18	24	977
<b>Main outputs:</b>									
Plant production :									
Cereals (Wheat & Barely)	000Ton	1.4	0.9	0.6	1.8	-	1.2	1.6	7.5
Legumes	Ton	-	1.3	-	-	-	-	-	1.3
Olives	000Ton	3.8	9.7	2.2	6.1	-	-	-	21.8
Dates	000Ton	-	3.8	0.8	2.4	-	-	-	7.0
Other fruits	000Ton	2.5	-	-	-	-	-	-	2.5
Potatoes	000Ton	2.6	-	-	-	-	-	-	2.6
Other vegetables	000Ton	2.6	2.9	2.9	8.0	-	0.66	0.88	44.0
Offshoots & seedling	000 unit	-	23.7	4.8	13.5	-	-	-	42.0
<b>Animal production:</b>									
Milk	M.liters	5.5	0.9	0.1	0.4	0.2	0.6	0.8	8.5
Meat	Ton	203	397	60.5	170	66.5	247	329	1473
Wool	Ton	-	14.2	2.2	6.1	2.4	8.9	11.8	45.6
<b>Females for raising:</b>									
Cows	000heads	0.3	-	-	-	-	-	-	0.3
Sheep	000heads	-	6.3	1.0	2.7	1.1	3.9	5.2	20.2
Manure (surplus)	000C.M.	1.5	0.1	-	-	3.8	13.2	17.6	36.2



about 5.6 thousand working hours of pesticides spraying machines. All these services will be provided in the frame-work of the suggested plan, through the agricultural machineries service stations which will be established as production activities by private individuals such as co-operatives or joint ventures. The cooperatives will avail the needs of the region from the packing materials and different packages which are estimated at one million packages, beside providing veterinary services for the cows and sheep, at the different locations, with total of about 1260 head of cattle and about 30 thousand head of sheep.

46- The production activities will yield, through the utilization of services and different inputs of the different components and elements of the development plan, an annual flow of plant and animal products which will be estimated, at the production stability stage, to about 7.5 thousand tonnes of wheat & barely, 21.8 thousand tonnes of olive, 7 thousand tonnes of dates, 2.5 thousand tonnes of grapes, 2.5 thousand tonnes of potatoes, 44 thousand tonnes of vegetables, 1.3 thousand tonnes of food legumes, 42 thousand seedlings of fruit trees. As for the animal products, the region will provide about 8.5 thousand tonnes of milk, 1.5 thousand tonnes of cow and sheep meat, 46 tonnes of wool. In addition to this, about 300 head of cows, 20 thousand heads of ewes will be produced for raising. A surplus amounts of about 36 thousand cubic metre of animal manure will be produced.

#### *Required Investments for the Development Plan of Region II :*

47- The development plan of the Central Branch Region, comprises total investment amounts to about L.D. 162.6 million, distributed among the different locations, where a logical relationship between the size of investment and the area of the location is observed; the largest location area (Sawfajjin and Graret Algtaf) has the largest investment of the whole area, which is estimated at L.D. 49.1 million. This value decreases to the minimum at Ashweref location till it reaches a value of L.D. 5.2 million. Table (7) shows the details of the total requirements of investment at each location. It shows that the total investments for the region distributed between agricultural investments (59.1 %) and investments in general agricultural infrastructures (28.2 %) at the locations, e.g. tube-wells, main water-pipe lines, reservoirs (tanks), water distribution network, dams, drainage system, power station and roads.

**Table (7)**  
**Investment Requirements for the Development Plan of the**  
**Central Branch Region, Phasing and Financing structure**

Items	Location	Measuring Unit	Tarh unah-Weshata	Sawfajjin-Graret Elgtaf	Graret Shaddaf-Zamzam	Alazoumi-Ras Atabel	Ashweref	Zazi mmit	Bey alkabir	Total For the Region
Total Investment Requierment		M.D	30.79	49.08	11.03	33.60	5.16	15.61	17.36	162.64
Farm investment		M.D	16.50	33.89	3.67	21.11	2.00	8.14	10.85	96.16
		%	53.6	69.0	33.2	62.8	38.7	52.1	62.5	59.1
Infrastructure utilities		M.D	10.47	9.95	4.92	9.10	1.52	5.68	4.19	45.83
		%	34.0	20.3	44.6	27.1	29.5	36.4	24.1	28.2
Agric. services		M.D	2.05	2.40	0.82	1.87	0.77	0.77	1.30	9.98
		%	6.6	4.9	7.5	5.6	15.0	5.00	7.50	6.1
Public services		M.D	1.78	2.85	1.62	1.51	0.87	1.02	1.02	10.66
		%	5.8	5.8	14.7	4.5	16.8	6.5	5.9	6.6
Phasing of Investments										
1 st Year										
2 nd Year		%	39.35	24.50	59.03	30.47	46.91	42.59	29.14	33.88
3 rd Year		%	43.15	53.05	18.16	49.06	36.87	46.73	57.09	47.30
4 th Year		%	14.31	17.29	16.89	15.73	16.22	10.68	13.77	15.33
5 th Year		%	2.09	2.39	2.37	2.20	-	-	-	1.73
6 th Year		%	1.09	1.68	1.67	1.54	-	-	-	1.14
		%	-	1.09	1.08	1.00	-	-	-	0.61
Finance Structure:										
Finance by beneficiaries		%	11.4	14.1	7.1	13.0	8.9	10.6	13.2	12.3
Credit finance		%	47.6	59.2	30.9	54.5	39.9	44.9	55.4	51.7
Government finance		%	41.0	26.7	62.0	32.5	51.2	44.5	31.4	36.0

In addition, an approximate amount of 6.1 % will be devoted to investment in agricultural services, and about 6.6 % for investment in general services. Naturally, these percentages will vary from one location to another, according to specific relative importance, and of each component of the development plan in each location.

48- The investment requirements for the locations, as well as the region, will be distributed according to the implementation period, which will extend to six years. The first three years, in actual, represent the basic execution years, while the rest represent the period for establishment of the orchards, which need six years to give the first production. Table (7) also shows that about 96.5 % of the total investment will be spent during the first three years of the project life span, out of which 36.9 % will be spent during the first year, 47.3 % during the second year and about 15.3 % during the third year. The main source of finance is expected to be derived from credit source, which contributes to approximately 51.7 % of the total investment expenditure, followed by the government financing, which is expected to contribute to about 36.0 %, then contribution of the individual beneficiaries of the project, which amounts to about 12.3 % of the total investment expenditure at the regional level.

#### *Indicators of Water Use Efficiency and Feasibility of Investments :*

49- The value of the average net return rate from the water unit, which is used to reflect the efficiency of use of such resource, varies clearly between the different locations of the Central Branch Region. This value is high at the Tarhunah-Weshatata location (about 0.323 L.D/Cubic metre), while it decreases at the locations of Sawfajjin-Graret Algtaf, Graret Shaddaf-Zamzam, Alazoumi and Ras Atabel, where they are nearly the same (about 0.240 L.D/cubic metre on the average). Averages of this rate decrease appreciably in the other three locations namely, Azazimmit and Bey Alkabir 0.134 L.D/m<sup>3</sup> in each, and 0.083 L.D/m<sup>3</sup> in Ashwerf. The water use efficiency criterion, i.e. returns per water unit, differentiates the locations of the Central Branch Region into three relatively different groups. This difference is also explained by the criterion of the net farm return rates, where Tarhunah-Weshatata solely representing a group, in which this rate reaches to about L.D. 14.6 thousand per year. The second group comprises Sawfajjin, Graret Algtaf, Graret Shaddaf, Zamzam and Alazoumi and Ras Atabel with an average return of about L.D. 12.1 thousand per year. The third group

comprises the locations of Zazamet and Bea Alkbeer with an average of about L.D. 6.2 thousand annually. As for Azazimmit location, it is considered out of these groups, where average farm return is estimated at a negative value of about L.D. 200, which can only be substituted by the returns from the family work, allowing the annual farm returns to increase to about L.D. 1300, as shown in table (8).

50- Since the region is considered as new area, the average value of farm share in total investments reaches to about L.D. 114 thousands. This value is greater than that of the other regions, where capital investments and utilities needed for development are available. This will help decrease needed investments of each farm. As for the feasibility of investments at the locations of the Central Branch, it reflects accepted levels to justify the feasibility of allocating those investments in the majority of locations, except Ashweref and Azazimmit, where investment returns indicators are less than their opportunity cost. This decreases, greatly, the importance of financial criteria in taking decision to invest in development of such areas. It may even call for reconsidering its inclusion within the development plan or to look for other alternative development suggestions, or even leave it to later stages of the implementation programme.

51- The locations which found to be of reasonable feasibility will stand to a reasonable degree, capable to charge their farms with shares in the public utilities investments, where total farm returns (including the value of family work), varies between L.D. 8.3 thousand to about L.D. 16.4 thousand after payment of its annual share in these investments, as shown in table (8).

As for Azazimmit location, the farm return decreases to about L.D. 7 thousand after charging the public investment costs, while this return is just about to vanish at the farms of Ashweref location.

### **Region III : Al Jabal Al Gharbi**

#### *Characteristics, General features and Agricultural Background :*

52- Out of the three regions covered by the study, Al-Gabal Al-Gharbi region is characterized by a special environmental conditions different from the other regions, specifically those related to topography, climate, soil and population, as

**Table (8)**  
**Major Indicators of Water Use Efficiency and Feasibility**  
**of Investments in different Locations of Central Branch Region**

Indicators	Locations	Unit	Tari-unah-Weshtah	Sawfajin-Graret-Elgtaf	Graret-Shaddaf-Zamzam	Alazoum-Ras Atabel	Ashweref	Azazimmit	Bey alkabir
Net returns per water unit		D/m <sup>3</sup>	0.323	0.249	0.235	0.235	0.083	0.134	0.134
Net farm income (family work not included)		000D/year	14.6	12.0	12.2	12.2	- 0.2	6.2	6.2
Net farm income (family work included)		000D/year	18.9	15.8	16.6	16.6	1.3	9.6	9.6
<b>Indicators of farm investment analysis</b>									
Farm share in total investment		000D	146.6	114.1	114.9	124.4	58.6	130.1	108.5
IRR		%	12	11	19	10	9	10	10
N.P.V.		000D	116	100	136	89	- 0.2	47	47
B/C		%	1.37	1.37	1.61	1.32	1.00	1.18	1.18
<b>Indicators of locations investment analysis:</b>									
IRR		%	7	9	9	7	0	4	6
N.P.V.		M.D.	11.5	29.3	6.8	12.5	- 2.4	- 1.2	2.2
B/C		%	1.36	1.35	1.26	1.15	0.78	0.97	1.05
<b>Farm situation when charged with annual shares of the agricultural utilities investment:</b>									
Value of invest. of agric. utilities		M.D.	10.47	9.95	4.92	9.10	1.52	5.68	4.19
Total farm share		000D	49.8	23.1	51.3	33.7	14.3	47.3	26.2
Annual farm installment (for 20 yers)		000D	2.49	1.16	2.57	1.69	0.89	2.37	1.31
Farm income (with family work)		000D/year	18.9	15.8	16.6	16.6	1.30	9.6	9.6
Farm income after charging the investments share installment		000D/year	16.4	14.6	14.0	14.9	0.4	7.2	8.3

well as agricultural activities. This region is situated at the North Eastern side of the Jamahirya, between longitude 13:15 and 15:10 and latitude 31:40 and 32:05. The largest hills of the country are found in this region, with height of 300 to 870 metres above sea level and separated from the sea shore by Sahl El-Gafara. The topography of the region varies from land that suits annual cultivation to moderate slopes, which is suitable for trees cultivation, and to steep slopes where utilization for agricultural purposes is not viable. Similarly, there are variations in nature of the soil, its types and depth; where one could find sediment lime soil, soils that contains calcium salts, lime soil and sandy soil. The soil depth varies from very deep soil (150 cm and more), deep soil, medium and shallow soil (less than 50 cm). The soil studies of Al-Jabal Al-Gharbi are generally limited, except the case of irrigated Jandoubah location. This situation pays the attention to the need for such studies before executing any of the development project in this region.

53- Due to its mountainous nature and to the elevation above sea level, Al-Jabal Al-Gharbi region is characterized by a mild climate with regard to temperature, the average annual temperature is about 18 °C. Period of low temperature, in some locations within this region avail suitable conditions for cultivation of some fruit trees, especially apples. Average relative humidity varies between 68 % and 72 %. Average rainfall varies according to the geographical direction, with a general annual average of about 200 mm. A maximum of about 350 mm of rains falls on Aryaina and only 220 mm on Azintan. Rainfall is considered as the main water source for rainfed agriculture, which dominates agricultural production type in the region.

The limited irrigated agriculture depends on natural water springs while the tube-wells water is used as a source of drinking water for both human and animals use.

54- Due to the traditional importance of Al-Jabal Al-Gharbi in certain agricultural production fields, it has been a target for many land reclamation development projects which vary from settlement production projects, range land development projects and mixed projects. Within the general framework of development in this region, great attention has been given to projects of water harvesting, construction of dams and water reservoirs. The development process also comprises

pavement of roads, construction of houses for beneficiaries who are assigned reclaimed agriculture lands. Environmental protection projects like terraces and embankment of dams has been also executed.

55- In spite of the importance of the total population of Al-Jabal Al-Gharbi region, yet they live in small scattered communities depending on the nature of the soil, land topography and its suitability for cultivation. The majority are concentrated in the cities, while their density decreases as one goes west from Aryaina to Zahir Arhibat. Agriculture is not considered one of the important activities in this region, since it employs limited proportion of only about 9.4 % of the total manpower. Land topography and soil play important role in determination of size of farm, which varies widely. Nevertheless, average farm holding is estimated at 8.6 ha, of which only 6.5 ha is suitable for cultivation. The agriculture activity, in the area, is mainly concentrated on fruit trees. Apple fruit trees represents about 35 %, followed by olives (35 %), then come almonds (14 %), grapes (12 %), figs (9 %) and stone-seed fruits (6 %). Besides, small percentage of date palm, pomegranates and some other fruit trees. Barely is produced during high rain fall seasons. Low density of trees, which sometimes reach 32 trees per ha, has been the general pattern of cultivation. The density, usually, decreases towards the western direction with the decrease in the amount of rain fall. Change in the type of the trees is also observed, where importance of drought tolerant trees, like date palm, increase in the far west areas.

Due to lack of forages, animal production activity depends on rangelands of the surrounding areas, where emphasis is concentrated on raising sheep and goats, in addition to limited number of camels. Cattle are found in very limited numbers.

#### *The Main Features of Development Approach for AlJabal Al Gharbi Region :*

56- Within the framework of agricultural importance of Al-Jabal Al Gharbi region, its special environmental conditions, and importance of water as a basic limiting factor in agricultural production, many locations of this region were suggested for water investment projects from the Great Man-made River, where construction works to assure supply of the far end of the Central Branch of the conveyance system, so as to reach these locations that extends west till Al-Rrhibat and which, sometimes has a height of 870 metres above sea level. The water de-

voted to agricultural use in the Al-Jabal Al-Gharbi region is estimated at 87.6 million cubic metres per year so as to avail irrigation water for development of the existing agriculture in about 3 thousand farms with an area to talling about 17.4 thousand ha, scattered in eight locations; namely Irrigated Jandoubah project, Jandoubah and Algdamah, Alasabaa and Algualish, ghrian and its outskirts, south Yafren, Aryaina and south Azintan, Zaher Arojban and Jadu and Zahir Arhibat.

57- Suggestions about the way to avail water for agricultural purposes in Al Jabal Al Gharbi region depend on the storage of water in (29) reservoirs, with a capacity of 5 thousand cubic metres each, distributed along the sides of the main line that extends to about 120 kilometers, adjacent to Ghrian/Arhibat road. It has been observed that the water investment plan for Al-Jabal Al Gharbi region, has not allocated fixed amounts of water to each of the locations selected for development and improvement. Also, it has been observed that canal networking for the distribution of water to the farms does not exist, since the responsibility of the Authority of the Great Man-made River waters ends with the availing of water in the public reservoir. Also, it has been observed that with the exclusion of irrigation water required for the Irrigated Jandouba location, the rest of the devoted water for the rest of sites within Al-Jabal Al-Gharbi will allow only about 3630 cubic metres of water per hectare. This quantity of water is not adequate for development and improvement of the targeted areas, according to a permanent irrigation system and an intensified agriculture. Accordingly, the study gave attention to the analysis and comparison of technical and economic feasibility of four different alternatives concerning the distribution of water and its conveyance from the public reservoir to the scattered farms. According to the topography of the region, it was found that the most suitable, and the least economical method to carry water from the public reservoir to the farms, is to use mobile tanks of 6 cubic metre capacity. These tanks can be owned either by the farmers or through the services availed by the cooperatives or joint ventures.

58- In accordance to the previous considerations, which were emphasized by those consideration related to conservation of nature and type of agricultural production in Al-Jabal Al Gharbi region, avoidance of expected exposure of the area to environmental hazards due to changes into permanent irrigation and intensified agriculture, the study team leant to a methodology of development in the locations of this region except Irrigated Jandouba, relying on delivery of water to all farmers in the suggested development locations by tractors to irrigate the fruit



trees during the critical stages of growth, and during drought and scarcity of rains, so as to protect the stock of the fruit trees wealth in a good condition and to attain reasonable rate of productivity.

59- Within the framework of the targeted area for development and improvement at the locations of Al-Jabal Al-Gharbi region, and according to development method, obtained results showed that water requirements for Al-Jabal Al Gharbi region is estimated at about 40 million cubic meters per year, out of which about 31.3 million cubic meters for Irrigated Jandouba location, and about 8.7 million cubic meter for the rest of the locations, which means an excess of about 47.6 million cubic meters of water for this region. It is difficult to decide that targeted area for development at the rest of the locations at Al-Jabal Al Gharbi region (except Irrigated Jandouba), which accounts for about 15.5 thousand hectares, out of the total area of these loactions which reaches about 73.8 thousand hectares, to be the only area which is suitable or eligible for development and improvement. It is also difficult, in reality, to discriminate between farmers in water distribution so as to be limited to owners of the targeted farms only. Such situation might be contradicted in veiw of equity and justice in distribution of a common and vital resource like water. Taking this into consideration, the study team prefers the expansion of the targeted areas at Al-Jabal Al Gharbi, to include all areas suitable for development (after conduction of the detailed soil studies), where the study showed that associated government cost of such expansion to cover all the area not exceed two million Dinnars. The expansion will depend on the surplus of the available water, and it will help yielding high economical, social and environmental benefits as increase in fruit production, more jobs opportunities (more than 1.5 million working day). It can also achieve more equity in water use, and improvement of incomes for the farmers and their families, besides protection of the tree wealth from degradation and other undesirable environmental and economic impacts.

#### *The Main Features of the Development Plan of REgion III :*

60- In light of what has been presented, one would distinguish Al-Jabal Al Gharbi according to pattern of development and type of agriculture into two parts; the first is represented by the irrigated Jandouba location, while all the other locations are related to the second part. The development plan, at the irrigated Jandouba, covers a region of 1850 hectare, distributed into 370 farms, that require,

according to the permanent irrigation system, about 31.3 million cubic meters of water from the Great Man-made River. This water and land resources are used in different plant and animal activities, which comprise cultivation of about 1.3 thousand ha of forage crops to support about 3.7 thousand milking cows, cultivation of 740 ha of wheat and maize, about 463 ha of food legumes, and 463 ha of fruit trees (mainly apples), in addition to about 278 ha of different vegetables. The farms will use modern irrigation systems (463 ha with drip irrigation and the rest with sprinkler irrigation). The development plan also comprises building residence, sheds, farm water reservoir for all farms in the location (370 farms), besides equipping each farm with a milking unit and refrigeration units. At the location level, the plan includes establishment of 10 kilometers of water pipes, irrigation network, electric lines, pavement of 27 kilometers of roads. For providing the agricultural services, the suggested plan includes establishment of a modern cooperative, at the irrigated Gandouba location, that will provide extension, marketing and veterinary services, besides three agricultural machinery stations and ten milk processing units. In addition, it proposed to establish a health unit as part of the general services needed for development in the location. Details of components and elements of development plan at irrigated Jandouba location are shown in table (9).

61- As for the rest of the location of Al Jabal Al Gharbi, the development plan includes intensification of fruit trees in a total area of about 15.5 thousand ha. This area is distributed to about 2.7 thousand farms at the seven locations. The development of such area requires about 8.7 million cubic meters per year of water conveyed from the Great Man-Made River to irrigate the existing trees, and the new additions, during critical periods. The numbers of the new seedlings needed for increasing trees density at these sites is estimated at 985 thousand seedlings of different kinds of fruit trees, comprising about 262 thousand seedlings of apples, 282 thousand seedlings of olives, 112 thousand seedlings of grapes, 138 thousand seedling of almonds, and 136 thousand seedlings of figs, in addition to about 55 thousand seedlings of other fruit trees. Due to the availability of most public services in the development locations at Al Jabal Al Gharbi, the development plan will concentrate on water transporting units which are estimated at 2.7 thousand units, in addition to maintenance centers for farm machinery which are estimated at 17 centers of both mobile or stationary units.

Four new cooperatives, need to be established in some locations, beside support

**Table (9)**  
**Components and Elements of the Development Plan**  
**for Irrigated Jandouba location and their Main Inputs and Outputs**

Components and Elements	Measuring Unit	Quantity and Number	Inputs and Outputs	Measuring Unit	Quantity and Number
Area of investment and improvement	Hectare	1850	<u>Main inputs:</u>		
No. of farms	Farm	370	Seedlings	000 unit	462.5
Annual needed water from the River	M.m3	31.31	Seeds of cereals and legumes	Ton	129.5
			Seed of forages	Ton	79.6
<u>Plant activities:</u>			Seeds of vegetables	Ton	0.84
Improvement of fruit trees	Hectare	462.5	Chemical fertilizers	Ton	3894
wheat & maize	Hectare	740	Pesticides	000 L.	17.02
Fooders	Hectare	1295	Hired labour	000 day	30.8
Legumes	Hectare	462.5	Different mechanical operations	000 hr.	57.25
Different vegetables	Hectare	277.5			
<u>Animal activities : Cows</u>	Head	3700	<u>Main outputs:</u>		
<u>Agric. utilities : Irrig. system (sprinklers)</u>	Hectare	1387	Cereals (wheat & Maize)	Ton	2313
: Irrig. system ( drip)	Hectare	463	Legumes	Ton	925
Farm reservoir tanks (50 m3)	Tank	370	Vegetables	Ton	6938
Houses	Unit	370	Apples	Ton	6958
Sheds	Unit	370	Milk	M.L.	16.25
Milking machines & coolers	Unit	370	Meat	Ton	596
Agric. services machinery & maintenance stations	Station	0+3	Cows (Female for raising)	Head	770
Ag. cooperatives	Coop.	1	Manures (surplus)	000 m3	11.1
Milk processing units	Unit	10			

and improvement of three of them already existing. The development plan includes establishment of an agricultural research station, to serve all locations, including irrigated Jandouba location (Table 10).

***Inputs and Outputs of Development Plan of Region III :***

62- Table (11) shows the production inputs needed in all locations of Al Jabal Al Gharbi region. The fruit trees seedlings represent an important part of these inputs. Their number is estimated at 1.44 million seedlings of different kinds of fruit trees, in addition to about 129.5 tonnes of cereal and legume seeds, about 79.6 tonnes of forage seeds, 0.8 tonnes of vegetables seeds. Production inputs also include about 104 thousand cubic meters of organic manures, 10.6 thousand tonnes of chemical fertilizers, and about 50.6 thousand liters of insecticides and fungicides. The inputs include besides the family labour, about 188 thousand man/day of hired labour and about 91 thousand working hours of the different agricultural machineries, mainly tractors for farm service and transport of water, in addition to harvesters, pest control implements and hay packing machines.

63- In the outputs side, the development plan in Al Jabal Al Gharbi will yield a group of agricultural products, of both plants and animals, the foremost of which are the fruits which represent the most important products of this area, due to its production nature and the development and improvement plan of these crops. The total production of fruits in the region, is estimated at about 67 thousand tonnes, about 58.2 % of which come from olives, 21.5 % from apples and the balance includes figs, grapes and the other fruits (table 11). Irrigated Jandouba location yields, in addition to the fruits, other plant and animal products out of which about 2.3 thousand tonnes of cereals (mainly wheat), about 6.9 thousand tonnes of different vegetables, and about 900 tonnes of legumes, in addition to about 16.3 thousand tonnes of milk, about 590 tonnes of meat and about 770 heads of cows. Besides, this location will produce excess amount of organic manures estimated at about 11 thousand cubic meters.

***Required Investments for the Development Plan of Region III :***

64- The total investment requirements needed for the implementation of the development plan in the different locations in Al Gabal Al Garbi region are estimated at L.D. 93.5 million , of which a sum of L.D 44.3 million is to be allocated for

**Table (10)**  
**Components and Elements of Development plan**  
**for the Rest of the Locations of Al-Jabal Al Gharbi Region**

Components	Locations	Measuring Unit	Jardoubah & Algdamah	Alasabaa & Algalish	Gharyan & Outskirts	South Yefen	Aryaina & South Azintan	Zahir Arojban & Jadu	Zahir Arhibat	Total Area
Area targeted for development		Hect.	2500	1500	2900	3000	2200	2000	1400	15500
No. of targeted farms		Farm	581	200	707	349	489	206	187	2719
Water needed for targeted areas		000m <sup>3</sup> /year	1589	635	3388	864	957	746	503	8682
<b>New Seedling of fruit trees :</b>										
Olives		000 unit	69.5	27.3	62.4	29.7	39.6	34.2	19.6	282.3
Grapes		000 unit	21.5	9.0	58.0	15.3	5.3	1.8	0.7	111.6
Apples		000 unit	21.0	8.1	226.2	6.3	-	-	-	261.6
Figs		000 unit	12.5	5.7	12.5	27.9	27.1	23.8	26.6	136.1
Almonds		000 unit	13.5	7.2	34.4	31.5	29.0	11.4	8.4	138.4
Others		000 unit	7.0	2.7	20.6	9.9	11.2	2.4	0.7	54.5
<b>Total</b>		000 unit	145.0	60.0	417.0	120.6	112.2	73.6	56.0	984.4
Water transporting units		Unit	581	200	707	349	489	206	187	2719
<b>Agric. services :</b>										
Fixed Mach-maint. stations		station	1	1	2	1	1	1	1	8
Mobile Mach. maint. stations		station	2	1	2	2	1	1	1	9
New ag. cooperatives		coop.	1	1	-	-	1	-	1	4
Support ag. existing coops.		coop.	-	-	1	1	-	1	-	3
<b>Agric. services for the region</b>										
Research station		station	-	-	-	-	-	-	-	1

**Table (11)**  
**Inputs and Outputs of Production Activities**  
**of the Development Plan of Al-Jabal Al-Gharbi Region**

Locations Inputs & Outputs	Unit	Irrigated Jandou- bah	Jandoubah & Algdamah	Alasabaa & Algualish	Gharyan & Surra	South Yefren	Eryaina & south Azintan	Zahir Arojban & Jada	Zahir Arhibat	Total for the Region
<b>Main inputs :</b>										
<b>Fruit seedlings:</b>										
Olives	000 unit	-	69.3	27.3	62.4	29.7	39.6	34.2	19.6	282.3
Grapes	000 unit	-	21.5	9.0	58.0	15.3	5.3	1.8	0.7	111.6
Apples	000 unit	462.5	21.0	8.1	226.2	6.3	-	-	-	724.1
Figs	000 unit	-	12.5	5.7	12.5	27.9	27.1	23.8	26.6	136.1
Almonds	000 unit	-	13.5	7.2	37.4	31.3	29.0	11.4	8.4	138.4
Others	000 unit	-	7.0	2.7	20.6	9.9	11.2	2.4	0.7	54.5
Seeds of forages	Ton	79.6	-	-	-	-	-	-	-	79.6
Seeds of vegetables	Ton	0.84	-	-	-	-	-	-	-	0.84
Seeds of Cereals & Legumes	Ton	129.5	-	-	-	-	-	-	-	129.5
Chemi-fertilizers	000 ton	3.9	0.95	0.4	3.38	0.66	0.65	0.37	0.25	10.56
Organic fertilizers	000 m3	-	15.1	6.0	52.3	9.1	11.2	6.0	4.3	104.0
Pesticides	000 Liters.	17.02	6.4	2.4	14.1	3.1	4.4	1.9	1.3	50.6
Hired labour	000 man/day	30.8	25.0	12.2	79.9	14.0	13.7	6.8	5.6	188.9
Mechan. work (hired)	000 hrs	57.25	6.4	2.4	14.1	3.1	4.4	1.9	1.3	90.8
<b>Main outputs:</b>										
<b>Plant products :</b>										
Olives	000Ton	-	9.4	3.7	11.3	3.6	4.8	4.1	2.1	39.0
Graps	000Ton	-	0.4	0.2	1.2	0.2	0.1	0.03	0.01	2.14
Apples	000Ton	6.9	0.4	0.2	6.7	0.1	0.04	0.01	0.01	14.4
Figs	000Ton	-	1.0	0.5	1.0	1.5	1.3	1.1	1.2	7.6
Almonds	000Ton	-	0.1	0.1	0.4	0.2	0.2	0.1	0.1	1.2
Others	000Ton	-	0.5	0.2	1.4	0.5	0.5	0.1	0.03	2.7
Cereals (wheat& maize)	000Ton	2.3	-	-	-	-	-	-	-	2.3
Legames	000Ton	0.9	-	-	-	-	-	-	-	0.9
Vegetables	000Ton	6.9	-	-	-	-	-	-	-	6.9
<b>Animal products:</b>										
Milk	M.Liters	16.3	-	-	-	-	-	-	-	16.3
Meat	Ton	596	-	-	-	-	-	-	-	596
Cows (Female for raising)	Head	770	-	-	-	-	-	-	-	770
Manure (surplus)	000m3	11.1	-	-	-	-	-	-	-	11.1

the irrigated Jandoubah location. The remaining investments are proportionally distributed among other locations in the region in accordance with total area included in their development plan. Each location's share varies between a maximum of about L.D. 14.6 million in Ghrian and its outskirts and a minimum amounting to L.D 3.8 million in some other locations as shown in table (12).

According to the nature of the development in most locations in that region, the basic investments represent the farm investments, which amount to about 81.5 % of the total investments, while about 8.4 % is allocated to agricultural services and about 10.1 % to the agricultural infrastructure utilities.

65- The investments of Al Jabal Al Garbi region are distributed over five years period, during which the development is to be accomplished. About 6.2 % of the total investments are allocated for the first year to execute some public utilities, particularly in the irrigated Jandoubah location, while the largest part of the investments is developed to the second year, which includes most of the investment expenditure at the farm level, in addition to the part of the expenditure related to the public agricultural services. The share of the second year is estimated at about 78.2 % of the total investments. Remaining investments which represents about 15.6 %, will be spent in successively over the next three years to accomplish the development of the root stocks, which take a relatively longer period to reach the productive stage.

Naturally, the pattern of investment phasing schedule varies among locations. The variation is more clearly in the case of irrigated Jandoubah location as shown in table (12).

As for sources and pattern of financing investments of the development plan in Al Gabal Al Garbi region, the major portion is expected to be provided by the potential beneficiaries in the different locations either by contributing their share of self finance which amounts to 29.3 % of the total investments or through credit facilities, which amount to 57.2 % of the total investments. As for the remaining ratio (about 13.5 %), it will mainly depend on the government financing sources.

#### *Indicators of Water Use Efficiency and Feasibility of Investments :*

66- As Al Jabal Al Garbi region is characterized with certain environmental and agricultural conditions, it also has special situation regarding levels of efficiency indicators, particularly those related to water resource utilization, which makes

**Table (12)**  
**Investment Requirements For the Development Plan of Al Jabal**  
**Al Gharbi Region, Phasing and Financing Structure**

Items	Locations	Unit	Irrigated Jandoubah	Jandoubah & Algdamah	Alasabaa & Algualish	Gharyan & Outskirts	South of Yefren	Aryaina & Azintan	Zahir Arojban & Jadu	Zahir Arhibat	Total for the Region
<b>Total Investment Requirement:</b>		Million Dinar	44.3	9.8	3.8	14.6	5.9	7.6	3.8	3.6	93.5
Farm investments		Million Dinar	30.6	9.1	3.3	14.1	5.5	7.1	3.4	3.1	76.1
Agric. Service Investment		%	69.0	93.5	86.6	95.1	93.0	93.2	89.1	85.8	81.5
		Million Dinar	4.2	0.6	0.5	0.6	0.4	0.5	0.4	0.5	7.8
Agric. infrastructure utilities investments		%	9.6	6.5	13.4	3.9	7.0	6.8	10.9	14.2	8.4
		Million Dinar	9.5	-	-	-	-	-	-	-	9.5
		%	21.4	-	-	-	-	-	-	-	10.1
<b>Phasing of Investments:</b>											
First year		%	7.9	3.8	9.6	2.0	4.6	4.9	7.1	10.3	6.2
Second year		%	69.4	86.6	81.7	89.3	86.0	87.3	83.4	78.8	78.2
Third year		%	18.5	4.0	2.9	3.4	3.6	2.7	3.4	4.1	10.6
Fourth year		%	2.1	2.8	2.9	3.4	3.5	2.7	3.4	4.2	2.7
Fifth year		%	2.1	2.8	2.8	1.9	2.3	4.7	2.7	2.6	2.3
<b>Financing Structure :</b>											
Self financing of beneficiaries		%	25.9	31.6	31.0	34.6	32.1	29.5	32.3	32.3	29.3
Credit financing		%	50.5	64.8	59.9	63.7	63.7	65.9	61.1	58.0	57.2
Gov. financing		%	23.6	3.6	9.1	1.7	4.2	4.6	6.6	9.7	13.5



this region incomparable to other regions. This is mainly due to the limited quantities of water used in the locations of this region (except irrigated Jandoubah location) which accordingly increase the rate of return per unit of water vary between 0.82 and 1.72 Dinnars for each cubic meter. This rate amounts to about 0.247 Dinnar per cubic meter in the irrigated Jandoubah location, where development patterns approaches are the same as in the other regions.

As for the level of farm family income, it increases to reach about L.D. 20.0 thousands per annum in the irrigated Jandoubah, while it decreases sharply to amount to about L.D. 3.1 thousands in other locations, as in Zahir Arhibat, and increases to about L.D. 7.6 thousands as in Ghriahan location. The farm income varies between these values in the other locations.

These levels of income might be acceptable and suitable in the context of a rain-fed agriculture and limited utilization of water and under the critical circumstances of those locations, this conclusion has been supported by the financial analysis indicators, which reflect reasonable levels of feasibility of investment in these locations beside the irrigated Jandoba location.

In the irrigated Jandoba location the IRR for the farm investment is estimated at 19 %, and decreases to 15 % for the total investment at the location level. In the other locations, this rate varies between 8 % and 18 %, depending on level of investment, i.e. farm or location level, as shown in table (13). Given such levels of IRR, all locations in Al Jabal Al Gharbi region are considered suitable and acceptable for agricultural investment according to the proposed development methods for each location.

67- A number of indicators have been provided to allows for ranking of different locations. Those indicators include efficiency of water utilization, capacity to generate farm income and fulfillment of returns on investment. As irrigated Jandoba ranks high in terms of those indicators, it has been excluded and accordingly these locations were divided into two main subgroups. The situation in the first one is better off as compared to the second. However, the first subgroup includes Gharyan and its outskirts, south of Yefren, while the second subgroup includes Alasabaa and Alqualish, Gandoubah and Algdamah Zahir Arojban and Gadu, Aryaina and South Azintan and Zahir Arhibat. It is noticed that the efficiency and feasibility indicators almost descend according to the geographical ordering of the locations, and they tend to increase towards the west.

68- As for the development locations under permanent irrigation system, the de-

**Table (13)**  
**Major Indicators of Water use Efficiency and Feasibility**  
**of Investments in Different Locations**  
**of Al Jabal Al Gharbi Region**

Locations Indicators	Unit	Irrigated Jandou- bah	Jandou- bah & Algdama mah	Al asa- baa & Alguali sh	Ghary an & Outski rts	South of Yefren	Aryaina & South Azintan	Zahir Arojba n & Jadu	Zahir Arhib at
Net Return/Water Unit	L.D./m3	0.247	0.780	0.820	1.090	1.720	1.400	1.120	0.970
Net Farm income (Excluding Family Labour)	L.D./Year 1000	19.9	2.9	4.4	7.6	6.0	3.7	5.3	3.1
Net Farm income (including Family Labour)	L.D./Year 1000	24.9	6.2	8.2	14.0	9.4	6.3	8.5	6.1
<b>Farm investment analysis indicators</b>									
Farm share in total invest- ment	1000 L.D.	119.7	16.8	19.2	20.7	17.0	15.5	18.4	19.3
IRR	%	19	10	10	18	16	13	12	10
NPV	1000 L.D.	199	13.6	14.9	45.2	36.3	22.6	22.2	13.6
B/C ratio	%	1.50	1.14	1.13	1.24	1.37	1.31	1.19	1.14
<b>Location Investment analy- sis Indicators</b>									
IRR	%	15	10	9	17	15	12	11	8
NPV	Mill-L.D.	62.3	7.3	2.4	2.8	11.8	10.1	4.1	2.0
B/C ratio	%	1.42	1.14	1.11	1.22	1.36	1.29	1.17	1.12

cision maker may view that each farm has to bear its share in the agricultural infrastructure investment. In such case, the total investment of that type is estimated in the irrigated Jandoubah at L.D. 9.5 million. Thus, the farm average share amounts to about L.D. 25.7 thousands. If this amount to be paid over 20 years, with no interest are charged, the farm annual installment is estimated at L.D. 1.28 thousands. With such annual payment, the farm net income decreases to L.D. 18.6 thousands (excluding the value of family labour).

### **The Development Plan of the Project :**

69- The analysis on the general level of the project under study, including the three regions, the Eastern Branch, the central Branch and Al Jabal Al Gharbi, aims to show the whole general situation of the project, its general features as an integrated development plan, its requirements of investment expenditure, the main effects and implication of the project and indicators of financial and economic analysis, in addition to presentation of comparable situations for the different locations according to the indicators of water use and investment efficiency for each location.

Although the study has previously provided an adequate analysis for each region, it seems that general analysis and presentation for the project might help decision makers identifying its preliminary feasibility of the project at large in conformity with the nature and level of the study at its current stage. This is also useful to set the priorities or determine the options between regions and location.

#### *Main Features of the Project Development Plan :*

70- The general development plan of the project covers an area, which is estimated at 30.6 thousand ha, out of which an area of about 6.4 thousand ha is to be developed in the Eastern Branch Region, and a new area of about at 6.9 thousand ha in the Central Branch Region, while the area to be developed in Al Jabal Al Gharbi region accounts for about 17.3 thousands ha.

Those areas include about 5.74 thousand farms. Farms under permanent irrigation accounts for about 1273 farms in the first area, about 1374 farms in the second area, and 370 farms in the irrigated Gandoubah location in Al Jabal Al Gharbi region. The remaining locations of Al Jabal Al Gharbi will be developed by providing them with limited quantities of water in the critical period and low rainfall levels. The development of areas and farms in the different regions re-

quires annually of about 174.4 million cubic meters of water. The under ground water source in the Central Branch locations, except Tarhunah and Weshatatah, will provide about 78 million cubic meters of those requirements, while the remaining quantity, amounting to about 96.4 million cubic meters will be provided by the Great Man-Made River waters.

71- Table (14) shows components and elements of the general development plan of the project under study in the different regions and locations. They include aggregate production activities, farm assets and utilities and agricultural and public services and utilities in the different locations and regions. Production activities of the development plan include establishment and development of various fruit plantation in approximately 4.7 thousand ha, in addition to about 1.63 million trees in Al Jabal Al Gharbi region. It also includes the production of wheat and barley in 4.83 thousand ha, maize in 0.2 thousand ha, tomatoes for processing in 0.6 thousand ha, potatoes in 0.1 thousand ha and other vegetables and legumes in about 2.8 thousand ha. In addition, different fodder crops will be cultivated in an area of about 6.9 thousand ha to be self used for integrated animal production activities, including about 11.88 thousand heads of cows and about 30.25 thousand of sheep.

72- The different components of the general development plan, i.e. farm assets and utilities, agriculture infrastructure, and public services are integrated, as shown in the previously mentioned table (14). The execution, establishment and provision of the different components and elements of the development plan is to be carried out at the different levels (farms, locations and regions) in a logical sequence, is determined by technical considerations, and the overlapping and inter-relationship among these components. If it has been decided to execute the project after conducting the needed detailed feasibility studies, the consequential implementation and establishment of the development plan components will be as follows:

**Project First Year :**

- \* Public irrigation and drainage utilities (main and secondary networks, wells, balance reservoir at locations, farm distribution networks and obstruction dams).
- \* Other agricultural infrastructure (road construction, establishment of electricity

**Table (14)**  
**Components and Elements of the Project Development Plan**  
**(Aggregate For All Regions)**

Investment Components	Unit	Qua.	Investment components	Unit	Qua.
Total area of the project	000 Ha	30.6	Milking machines	000 unit	1.91
New area	000 Ha	6.9	Coolers	000 unit	1.91
Development area	000 Ha	23.7	Wool cut machine	Unit	34.0
Total farm numbers within the Project	000 Farms	5.736	<u>Agric. utilities</u>		
New farms	000 Farms	1.374	Water main and secondary	km	34.5
Developed farms	000 Farms	4.362	Pipe line		
Water requirement from the Great Man-Made River	million m3/year	96.4	wells	Well	97
Water requirements from underground sources	million m3/year	78.0	Balancing tanks	Million m3	9.3
Total water requirements	million m3/year	174.4	water distribution networks	Network	11
			Drainage networks	network	11
			Obstruction dams	km	16.1
			Paved roads	km	128
			Power line, station and transformers	Netwrok	9
<u>Agric. Production Activities</u>			<u>Agric. Service</u>		
Fruits (areas)	000 Ha	4.7	Machinery service station	Station	18
Trees plantation & develop. in Al Jabal Al Garbi	million trees	1.63	Maintenance centers	Center	21
Cereals (mainly wheat)	000 Ha	4.83	Water transporting Units (G.G)	000 unit	2.72
Maize	000 Ha	0.20	Coop & Mark. Centres (const.)	Cooperative	12
Tomatos	000 Ha	0.61	Coop & Mark. Centres (Develop.)	Cooperative	6
Potatoes	000 Ha	0.11	Research stations	Station	3
Other vegetables & legumes	000 Ha	2.76			
Fodders	000 Ha	6.99	<u>Public Service Facilities</u>		
<u>Animal Production Activities</u>			Education Institutions	Class	97
Cattle (cows)	000 heads	11.85	Health units (const.)	Unit	3
Sheep	000 heads	30.25	Health units ( Develop.)	Unit	2
			Drinking water Pipelines	km	149
<u>Farm Assets &amp; Utilities</u>			Tanks for drinking water	Tank	9
Sprinkler irrigation system	Ha	12212			
Drip irrigation system	Ha	2873			
Farm tanks	Tank	3017			
Housing	House	1656			
Animal sheds	Shed	1853			

network stations and transformers).

- \* Public service utilities (education - health - drinking water).
- \* Construction and preparation of regional research stations.

#### **Project Second year :**

- \* Establishment and development of cooperatives and related services.
- \* Construction of farm housing, and animal sheds.
- \* Execution of farm reservoirs, developed field irrigation systems and field drainage systems.
- \* Establishment of machinery service stations, maintenance centers and water transportation units.

#### **Project Third Year :**

- \* Preparation of root stock trees and animal breeds.
- \* Provide farms and locations with milk production machines, milk collers and wool cutting instruments.
- \* The establishment of processing activities of special nature (cheese processing and olives pickling).

#### **From Year Four to Year Six :**

- \* The completion of developing the farm assets of fruit trees until reaching the stable production stage.

#### ***Total Inputs and Outputs of the Project Development Plan :***

73- Policy of securing production inputs and associated institutional, organizational and administrative efficiency are considered the most important determinant of the project success and its general efficient performance. In this respect, the project requires, annually-and during its production life span, to secure timely and in adequate quantities, and suitable quality and specification of all inputs including seeds, seedlings, fertilizer, pesticides, labour, mechanization, veterinary services, packing materials ...etc. Table (15) shows that the project needs a total of about 2.8 million seedlings for fruits and date palms, about 1.4 thousand tons of seeds for different crops, about 23.6 thousand tons of chemicals fertilizers, and

about 155 thousand liters of various pesticides. In addition, the project requires about 237 thousand labour units (man/day) as hired labour, besides what is available as family labour. Also, the project requires about 457 thousand machinery work-hours, distributed between tractors, harvesters, plant protection tools, and 1.2 million work hours for the hay pressing machine, besides the veterinary services, packing materials and other secondary inputs.

74- The project contributes to increasing the national production capacity of the strategic food and agricultural products and commodities, which is estimated at 19.7 thousand tons of cereal, of which wheat represents the most important component, about 83 thousand tons of vegetables, about 65.6 thousand tons of olives, about 7 thousand tons of palm dates, and about 30.8 thousand of fruits (grapes, apples... etc.), in addition to 2.3 thousand tons of legumes, and about 42 thousand fruit trees seedlings.

As for animal production, the project contribution is estimated at about 55 million liters of milk, about 3000 tons of meat, and about 46 tons of wool. It also contributes by 2.5 thousand of cows and about 20.2 thousand of ewes for breeding, as shown in table (15).

#### *The Project Investment Requirements and Financing Sources :*

75- Data in table (16) indicates that volume of the total investments needed for the project is estimated at about LD 337.8 millions, out of which about 62.2 % for farm investment, about 8.1 % for the agricultural services, and about 26.1 % for the agricultural infrastructure. The remaining (about 3.6%) is required for investments of public services for settlers. It is estimated that the project constructions and basic utilities will be completed within three years. During this period, about 97 % of the total investment expenditure will be spent, while the investment expenditure will be extended until year six to accomplish the establishment and development of some farm assets, mainly fruit trees.

With respect to the proposed financing structure, government financing contribution is estimated at L.D. 110.7 million, which represents about 32.8 % of the total investment expenditure, while self financing of farmers benefiting from the project represents 19.4%. The balance, amounting to about L.D. 161.7 millions, will be availed through credit provided by agricultural as well as other relevant banking institutions to those farmers. This contribution represents about 47.8 % of the total financial requirements of the project.

**Table (15)**  
**Inputs and Outputs of the Production Activities**  
**of the Project Development Plan**

Inputs & Outputs	Regions	Unit	Eastern Branch Region I	Central Branch Region II	Al Jabal Al Garbi Region III	Total
<b>Main inputs :</b>						
Seedlings		000 seedlings	-	1371.0	1449	2820
Seeds (Cereal & Legumes)		Ton	342.6	331.6	129.5	803.7
Seeds (Foder)		Ton	141.5	186.8	79.6	407.9
Seeds (Veg.)*		Ton	4.2	214.0	0.8	219.0
Chem., fertilizers		000 Ton	5.1	7.9	10.6	23.6
Pesticides		000 Liter	29.1	75.7	50.6	155.4
Hired labour		000 W/D	11.6	20.0	204.9	236.5
Family Labour		000 W/D	389	1466.0	793.3	2648.3
Mech. Labour		000 W/H	63.9	83.3	133.8	281.0
P.Protection Tools		000 W/H	9.4	5.6	41.3	56.3
Baling Machines		000 W/H	46.6	48.5	24.9	120.0
V.Service (Cattle)		Head	6915	1260.0	3700	11875
(Sheep)		Head	-	20254.0	-	20254
Packing material		000 Unit	1911	977.0	-	2888
<b>Main Outputs</b>						
Cereals		000 Tons	9.8	7.6	2.3	19.7
Legumes		Ton	55	1290.0	925	2270
Vegetables		000 Tons	29.3	46.7	6.9	82.9
Seedlings		000 seedlings	-	42.0	-	42.0
Olives		000 Tons	4.9	21.8	38.9	65.6
Dates		000 Tons	-	7.0	-	7.0
Other Fruits		000 Tons	-	2.5	28.3	30.8
Milk		million liter	30.4	8.6	16.2	55.2
Meat		Ton	1114.	1473.0	596	3183.0
Cows		000 heads	1.4	0.3	0.8	2.5
Ewes		000 heads	-	20.2	-	20.2
Wool		Ton	-	45.6	-	45.6

\* Including potatoes



**Table (16)**  
**Investment Requirments for the Project Development Plan**

Items	Regions	Unit	Eastern Branch	Central Branch	Al Gabal Al Garbi	Total
<b>Total Investment Requirments:</b>		million Dinar	78.3	164.1	94.9	*337.8
On farm investments		million Dinar	37.9	96.2	76.1	210.2
		%	48.1	58.6	80.2	62.2
Agric. infrastructure investment		million Dinar	33.0	45.8	9.5	88.3
		%	41.8	27.9	10.0	26.1
Agric. service investments		million Dinar	6.5	11.5	9.3	*27.3
		%	8.2	7.0	9.8	8.1
Public service inverstments		million Dinar	1.4	10.7	-	12.1
		%	1.8	6.5	-	3.6
<b>Investment Time Phasing</b>						
First year allocations		%	40.3	33.9	6.2	28.6
Second year allocations		%	40.7	47.3	78.2	53.7
Third year allocations		%	19.0	15.3	10.6	14.6
Fourth year allocations		%	-	1.7	2.7	1.6
Fifth year allocations		%	-	1.1	2.3	1.2
Sixth year allocations		%	-	0.6	-	0.3
<b>Financing Structure</b>						
Self Financing of Beneficiaries		%	23.5	12.3	-29.3	19.4
Credit Financing		%	31.2	51.7	57.2	47.8
Gov. Financing		%	45.3	36.0	13.5	32.8

\* Includes L.D. 4.5 millions for research service at the project level located in the three regions.

### ***Economic, Social and Environmental Impacts and Implications of the Project :***

76- It is always the case with national large-scale projects, that they are having several economic, social or environmental impacts and implication. This characteristic supports the importance and feasibility of the project from the society point of view, and decision makers perspective, despite the absolute value of the indicators which are reflected by the investment analysis. The project impacts on production and its reflection on the agricultural product, and consequently on the national product are considered of paramount importance.

In light of the previously mentioned estimates for the project outputs, its contribution to the gross national product is estimated, according to prevailing price levels used in the study, at about L.D 100 million annually. In fact, this contribution tends to increase indirect impact which increases the value added, as well as national product from other sectors, like industry, trade and services, through the sectoral inter-relationship and inter dependency between agriculture and other sectors, are to be taken into consideration.

77- The project impact on production extends to affect foreign trade structure, and decreases dependency on imports, particularly red meat, milk, cereal, legumes and tomato paste. The percentage of the project contribution to substitute food imports is estimated at 3 % for cereal (especially wheat), about 7 % for legumes, and about 13 % for red meat. This percentage increases to a higher level of self sufficiency for several vegetable and fruit crops, milk and milk products. Also it contributes to decrease tomato paste imports by almost 6 %. In addition, olive production can contribute in decreasing the importation of other vegetable oils which is currently estimated at more than 100 thousand tons.

Furthermore, the good quality and abundant production of vegetables and fruits, as well as olives may offer favourable opportunity for exportation of some fruits, olive oil and potatoes. Regardless of the potentiality of export, which irrespective of depends mainly on developing marketing and export systems and institutions, it is expected that the project production will annually decrease import burden of the similar products by a sum of about L.D. 36 millions in foreign currency equivalent.

78- The project net impact on foreign currency balance should take into consideration the project requirements at its early stages, which is estimated at L.D. 135

millions representing about 40.0 % of the total investment requirements. Also, some requirements for the project throughout its production life span to replace or spare some of its components and elements. The study estimates that the net impact for the total balance of foreign currency, as expressed by the net present value of both the project import requirements and its contribution in import replacement, is considerably positive. This conclusion emphasizes the importance and feasibility of the project.

79- The project has important social impacts represented by availing numerous job opportunities, improving standards of living for many families, motivating rural women participation in production activities and improving level and efficiency of many public services and utilities.

In quantitative terms it is estimated that the project will accommodate about 1700 new farm families, comprising almost about 8.5 thousand individual, beside families of the existing farms. Thus, the project will contain in the new areas about 3.4 thousands family work units, and non-family labour which is estimated at approximately one thousand work units annually. On the other hand, the project analysis indicates that annual family farm income at permanent irrigation location is estimated at L.D. 10.2 thousands on the average, i.e. about L.D 850 monthly. This is considered a reasonable income under local conditions. It is possible to increase family income through the extension programs, which encourage rural women to involve in some income generating activities based on utilizing the agricultural or farm residues or on some farm production like poultry, or picking of olives, .. etc. depending on type and pattern of production and the environmental conditions, at the different locations.

The project also has social implications where it gives great interest to establishment of suitable houses and supplied with drinking water, electricity and support the locations with paved roads, health and education services, such matter will certainly contribute in raising and promoting living standards and social life in general.

80- Based on many considerations, the project development plan ensures the principles of integration and coordination between the different production activities cycles and the agricultural sectors as well as the other sectors.

In this respect, one of the important implications of the project is to create new job opportunities and new activities, e.g. milk processing or the machinery services and maintenance stations. Also, increases the capacity to benefit from existing

investments and economies, specially in milk processing industry, processing of tomato paste, and fruit vegetable canning, and olive oil industry. This is particularly needed, since these existing industries are now suffering either from complete disorder or idle capacities. The project will avail for such units about 15.5 thousand tons of tomatoes for canning, sizable amounts of vegetables and legumes, and about 30 thousand tons of milk.

The development plan intends to develop, modernize and increase performance efficiency of the agricultural services, specially procurement, marketing and extension services, through the development and support of the agricultural cooperatives and machinery services. The project developmental plan includes establishment of 18 units of machinery service stations and 21 maintenance centers, which are considered as economic activities of special type based on cooperation or participation. The project also has an impact on supporting and activating agricultural research services and authorities in each area of the project three regions.

81- In the framework of the increased concern of the environment aspect, the study laid down different principles and considerations regarding safety of the local environment and conservation of the natural resources. These are included in the developmental plan as well as the development alternatives and the project general policy.

In this regard, the study approached two integrated directions, one of them is to avoid any environment hazards and resource over exploitation, while the second ensures improvement and development the existing situations. An example for avoiding the environmental hazards is that the study emphasized the importance of supplying the Eastern Branch region with water from the Great Man-Made River in order to stop any harmful practices affecting balance of the under ground water and sea water creep. An example of avoiding of resource over exploitation is that the study has focused on importance of utilization of the under ground water resources in some locations in the Central Branch region, as far as the water is suitable and sufficient, in order to save and rationalize the utilization of the Great Man Made River waters.

This is also applied on the proposed development approach for Al Jabal Al Gharbi, which aims at rationalizing water use, besides the main objective to keep and maintain the special environmental nature of this region, and avoiding any substantial changes concerning its formation and traditional agriculture, which might cause environmental hazards. Additionally, the project intends to promot-

development of some regions of low population density prevailing in most locations of the Central Branch region. This will lead to better population distribution and expansion of vegetation in these regions, and consequently improving the environmental conditions.

In the framework of the development plan, and in order to maintain the important biological resources, annual water requirements from the Great Man-Made River is estimated at 96.4 million cubic meters, which represent only 42 % of the total project allotment which, amounting to about 228 million cubic meters annually.

### *The Financial and Economic Analysis Indicators of the Project :*

82- The financial analysis assumes that the life period of the project is 36 years, and the establishment period is three years starting at the beginning of the project life period. The production will start during the third year depending on the nature of the activities and production seasons, although some crops will be produced during the second year in some of the development locations. Also, normal (prevailing) prices were used to prepare agricultural budgets and investments used in the financial analysis of the project. The outflows include all investment cost items with their replacement and renewal, and the current operational costs of all agricultural production activities. Physical and price contingencies amounting to 20 % of investment and operating costs were added so as to meet any unforeseen changes in quantities and prices of the assets and inputs. Inflows of the project were included, which expressed as value of the final agricultural products, including home consumed products. The prices used for calculating the values are the prevailing prices at farm level. In evaluating the values of inflows, the time sequence for including some products that are produced after several years was considered. Also in evaluating these inflows in the development locations, the net incremental returns were included.

83- Depending on results of the analysis of the positive and negative financial flows of the project, the investment in the whole project was found to be financially feasible in general, as the Internal Rate of Return (IRR) is estimated at about 8 %, and the Net Present Value (NPV) at about L.D. 140 million, and the Benefit Cost Ratio at more than one (1.12) which means that, the present value of returns represents 112 % of the costs. All these indicators positively confirm and justify the feasibility of the investment in such project. The sensitivity analysis assured

the ability of the project to adjust to any changing situation. In case of cost increasing by 10 %, the IRR was found to be 7 %, and this rate decreases to 5 % when the returns decreased by 10 %. On the other hand, when costs are increased by 10 % and returns are decreased by 10 %, at the same time, the IRR will become lower than the opportunity cost of capital, and lower than the common feasibility indicators for similar projects in the developing countries. Table (17) shows the financial feasibility indicators of the project under normal conditions and when exposed to unfavourable conditions.

84- The study conducted an economic analysis for the whole project assuming freeing the economy from the price distortions. In other words, the analysis aimed at evaluating the feasibility of the project using prices that reflect the real values of the best alternative use of the commodities and services from the society point of view, which known as the "shadow prices". For this purpose, the study calculated the values (at farm gate) using world prices in local currency equivalent. The study differentiated between tradable and non-tradable outputs and inputs. International prices and price indices for foreign trade of low and medium income countries were used. These prices and price indices were obtained from the World Bank publications during the period 1995-1996. Also, the study based on available external trade data published by official Libyan sources.

85- The Economic analysis revealed that the Economic Internal Rate of Return (EIRR) is estimated at about 6 %, the NPV for the project at about L.D. 107 million, and the B/C Ratio at about 1.06. The values of these analysis indicators emphasize the fact that the project is also feasible from the social point of view. The ERR decreased to 6 % when costs were increased by 10 %, and it decreased to 4 % when the returns were decreased by 10 %. This last value is less than the opportunity cost of capital. As shown in table (17), the EIRR decreases substantially if the project is to be faced with reduction in returns and an increase in costs simultaneously .

### **Production Activities with Special Nature :**

86- The development plan of the Great Man-made River included a number of necessary economic activities under the horizontal and vertical integrated framework of the project. These activities are mutually dependent with the agricultural production one, and are necessary for achieving efficiency and success of the pro-

**Table (17)**  
**The Financial and Economic Analysis Indicators and**  
**the Sensitivity Analysis of the Project**

Item	IRR	NPV (Million LD)	B/C Ratio
<b>Financial Analysis Indicators</b>			
Basic analysis	8	140.4	1.12
When costs increase by 10 %	7	110.9	1.09
When returns decrease by 10 %	5	6.7	1.01
When costs and returns change at the same time	3	- 113.0	0.91
<b>Economic Analysis Indicators</b>			
Basic analysis	6	106.6	1.06
When costs increase by 10 %	6	51.1	1.03
When returns decrease by 10 %	4	- 93.9	0.95
When costs and returns change at the same time	2	- 283.9	0.86

ject. In addition, these special activities will be able to generate economic returns, therefore the development planner assumed that they could be implemented by individuals or in the framework of cooperative or partnership associations. These activities include agricultural machinery service stations, maintenance centers, white cheese processing units, and olive pickling units. Although these special activities are important, they were not included in the analysis of the project, but they were evaluated as separate entities. Analysis results showed that these activities are feasible and thus encourages private and joint investments in such activities.

87- The evaluation of the agricultural machinery service stations, either the ones that are specialized in horticultural production or for mixed, i.e. field crops and horticultural, production, and for the maintenance centers, showed that the IRR is ranged between 14 % and 33 %. The IRR for the white cheese processing units with a capacity of one ton of milk/day is estimated about 17 %, while for olive pickling units with an annual capacity of 20 tons, is about 30 %. The results of the sensitivity analyses were acceptable and emphasize the ability of these projects to generate reasonable return, and to face the unfavourable conditions.

### **Proposed Policies Related to Agricultural Services and Rational Use of Water:**

88- The study devoted special part for the economic policies of the project, and for reviewing different aspects of the prevailing policies, in order to propose different alternative policies needed to support the effectiveness and efficiency of the project. Meanwhile, the study give's weight to the most appropriate alternatives according to objective considerations and justification. These policies include input procurement policies, agricultural research policies, agricultural cooperative policies, rationalizing water use policies, farm size and land tenure policies, and transference the burden of the public investments policies.

89- Regarding the input procurement policy, the study recommends that the existing institutions would take the responsibility to procure production inputs to the project on contractual basis, and that government nurseries would provide the project with different kind of seedlings on the same basis, so as to decrease the elements of risk and to benefit from the available experts of these local institutions. The project should also benefit from the current extension services follow-



ing the same approach, meanwhile, the project would contribute in developing and supporting these services. The study proposed three alternatives for the credit policy: (1) to continue with the current policy; (2) to include some amendments in the current policy by alleviating some lending constraints and conditions; and (3) to establish a special credit programme for the project under the umbrella of the current system. The study recommended the last alternative, because it helps in achieving the mutual interest of both, the project and the financial institutions. The administration of the project in this case can act as guarantor for the loans provided to beneficiary farmers within a deal with the agricultural bank.

90- Since agricultural research is a crucial for maintaining sustainable development in all technical aspects, including application of farm inputs, agricultural practices, irrigation and post harvest treatments, the project has to make full use of the available research capacities and reach to some sort of agreement with the existing research institutions to conduct the different agricultural research programmes needed by the project. On the other hand, the project would help these institutions financially, physically and technically to establish new research stations of conduct appropriate programmes according to the nature and pattern of production in the project regions.

91- The policy of the agricultural cooperation is of special importance, where cooperatives could be considered as the main vehicle for the provision of production inputs, also they can help in marketing the project products, conduct the main extension activities, provide veterinary services, ... etc. The existing agricultural cooperatives structure, which is held responsible for marketing process, would be assigned to achieve these tasks. This is conditioned, where the project should support and develop these cooperatives to efficiently perform those functions and tasks. In addition, these cooperatives should be the focal point in each location and carry on the main functions related directly to the agricultural activities. For example, the cooperative could include centers for production input distribution, marketing, milk collection, veterinary service, agricultural extension, and others depending on the nature and type of the activities in each location.

92- Within the water use policy, the study proposed different irrigation policy scenarios to help in rationalizing irrigation water application. In addition, the study discussed different approaches to estimate to what extent can the farm contribute to the cost of availing water services. Also the study evaluated charging

fees to cover the costs of availing water to the farmers depending on water productivity. Three levels were estimated, 0.067, 0.089, and 0.111 LD/cubic meter, on the basis that water share of the net farm income constituted about 30 %, 40 % and 50 % respectively. Analysis of the impact of charging these values showed different responses in the different locations. All project locations, show clearly their ability to afford participation in water provision charges, with a percentage up to 30 % of the farm income (equivalent to 0.067 L.D/ M<sup>3</sup>), table 18. The average annual farm income after adding these charges will amount to an average of L.D 12.6 thousand, with a minimum of about L.D 6.5 thousand as in Adafniah/ Naima and Tomeina/Alkrariem, and a maximum of about L.D. 19.2 thousand at irrigated Jandoubah. In general, the ability to afford charges of water provision decreases when higher values are be charged, and differs from location to another, depending on levels of farm income. Nevertheless, levels of farm income in a greater number of locations decrease whenever the shares of water charges increase in general as shown in table (18).

93- According to the agricultural and economic policies of El Jamahyria, and if it has been decided within the project policy, that farmers have to charge share of water provision costs, the study in this regard suggested that the permanent irrigated location should be different from those when are provided with water only at the critical periods, particularly at Jabl Al Gharbi. At the permanent irrigated locations, also it should be of paramount importance to distinguish between the locations that receive water form the Great Man-made River, and those depending on the underground water sources. In all location of Jabel Al Gharbi, except irrigated Jandoubah, the study suggested that, farmers would charged only the proposed rate for water provision (L.D. 0.043 /M<sup>3</sup>) since they pay the expenses of transporting water to their farms.

As for the locations which may depend on the underground water, it will be reasonable for farmers to bear the share of each farm in the total investment allocated for the irrigation utilities, as an annual installment without interest, such sahre is estimated at about L.D. 0.022 /M<sup>3</sup>, in addition to proposed value of provision of water for agricultural purposes (L.D. 0.043 /M<sup>3</sup>).

In the locations that provided with water from the Great Man-made River, the share would be in the vicinity of L.D. 0.067 Dinar/M<sup>3</sup>). However, these suggested value represents the critical level which should not be surpassed, and in all cases, this issue will remain subjected to the economical and political aspects, with the emphasis on ensuring equity among different locations according to their production and returns conditions.

**Table (18)**  
**Impact of Charging Farmers Alternative Costs of Availing**  
**Great Man-made River Water on Farm Incomes<sup>(1)</sup>**

Location	Estimated value of farm contribution (000 L.D)				Remaining farm income after deduction of water charges (000 L.D)			
	at a level of:				at a level of:			
	0.043 <sup>(2)</sup> LD/M <sup>3</sup>	0.067 LD/M <sup>3</sup>	0.089 LD/M <sup>3</sup>	0.111 LD/M <sup>3</sup>	Basic <sup>(2)</sup> Situation	0.067 LD/M <sup>3</sup>	0.089 LD/M <sup>3</sup>	0.111 LD/M <sup>3</sup>
Adafniah/Naima	1.4	2.2	2.9	3.6	8.7	6.5	5.8	5.1
Tomeina/Alkrariem	1.4	2.2	2.9	3.6	8.7	6.5	5.8	5.1
M Emhemed Almagarif	4.0	6.2	8.2	10.2	21.2	15.0	13.0	11.0
Tarhunah/Weshtata	2.4	3.0	4.0	5.0	18.9	15.9	14.9	13.9
Irrigated Jandoubah	3.6	5.7	7.5	9.4	24.9	19.2	17.4	15.5
General Average	2.6	3.9	5.1	6.4	16.5	12.6	11.4	10.1

- (1) The value of 0.111 L.D./M<sup>3</sup> reflects farm contribution by approximately 50 % of income, while contribution amounts to 40 %, at the value level of 0.089 and 30 % at the value level of 0.067.
- (2) The value of 0.043 L.D./M<sup>3</sup> (basic situation) represents the proposed value for agriculture water use as a farm contribution in the management and operation cost by the conveyance system.

94- The study has considered the economic and social aspects, in addition to the current situation and other similar projects, when proposing farm size and land tenure policies. Accordingly, the study proposed five-hectare farm size as a tenure pattern. This size is considered suitable to generate adequate income without any kind of government intervention or subsidy. On the other hand, and since this holding size might not be attractive for the settlement of farmer families in the new locations, the question of proposed larger holdings could be addressed in the next phase of the detailed study.

95- The study estimated the government share in the total investment costs at about L.D. 111 million, representing about 32.8 % of that total. Although the prevailing agricultural policy in Libya is in the favour of subsidizing and supporting farmers and the agricultural activities, yet the study investigated the possibility of the farmers sharing in public projects investment costs, where this issue is raised now. Also, and in order to help decision makers reaching sound decisions, the study investigated the effect of this argued policy on farmers' incomes. The study estimated average infrastructure investment costs for each location at L.D. 7.9 million. If this amount is distributed evenly between farmers over 20 years (no interest is charged), each farmer will pay annual installments amounting to L.D. 1.77 thousand. This amount will not affect the farm income or investment feasibility. This policy should not be approached if farmers are to be charged water delivery costs. The only locations that can endure the burden of the two costs in the same time are Tomeina-alkrariem, and M. Emhemed Almagarif in the Eastern Branch Region, Tarhunah-Weshtatah in the Central Branch Region and irrigated Jandoubah in Al Jabal Al Gharbi. Table (19), shows the status of farm incomes in the different locations after deducting their shares in the basic agricultural investment, as annual installment for a period of 20 years.

#### **The Comparative Situation of the Development Plan in Different Locations According to Efficiency and Feasibility Indicators :**

96- Tables (20, 21, 22) presents comparative analysis for the eighteen development locations according to a group of indicators, which include irrigation water use efficiency and the investment feasibility at the farm and the project levels. To reach sound conclusions that help in setting priorities and preferences of the locations, the following aspects should be taken into consideration:

**Table (19)**  
**Farm Income (with the farm in permanent irrigation)**  
**After Deduction of share in Investment**  
**in Agricultural Infrastructure**

Value : L.D. 1000

Location	Value of basic agricultural investment	Average Farm share	Value of annual installment	Farm income	Income after deduction of public investment share
Adafniah/Naima	14.918	26.9	1.345	8.7	7.4
Tomeina/Alkrariem	13.358	20.1	1.205	8.7	7.7
M. Emhemed Almagarif	3.678	66.9	3.345	21.2	17.8
Tarhunah/Weshtatah	10.465	49.0	2.490	18.9	16.4
Sawfajjin & Graret Algtaf	9.953	23.1	1.155	15.8	14.6
Graret Shaddaf & Zam-zam	4.921	51.3	2.865	16.6	14.0
alazoumi & Ras Atabel	9.103	33.7	1.685	16.6	14.9
Ashweref	1.521	17.3	0.865	1.3	0.4
Azazimmit	5.680	47.3	2.365	9.6	7.2
Beyalkabir	4.190	26.2	1.310	9.6	8.3
Irrigated Jandoubah	-	25.7	1.285	24.7	23.6
General Average	9.495	35.3	1.765	13.8	12.0

**Table (20)**  
**Efficiency Indicators and Investment Feasibility for Different Project Locations of Al-Jabal Al Gharbi which depend on Water Supplies at Critical Periods**

Location	Jandou- bah and Algdam ah	Alasabaa and Al- gualish	Gharyan and Yefren	Southern Yefren	Aryaina & Soutern Azintan	Zahir Arojban and Jadu	Zahir Arhibat
<b>Water use indicators:</b>							
Utilized areas (ha)	2500	1500	2900	3000	2200	2000	1400
Targetted farms (No.)	531	200	707	349	489	206	187
<b>Annual water needs (1000 m<sup>3</sup>):</b>							
Farm	2.73	3.18	4.79	2.48	1.96	3.62	2.69
Location	1589	635	3388	864	957	746	503
Net return per water unit (L.D/M <sup>3</sup> )	0.78	0.82	1.09	1.72	1.40	1.12	0.97
<b>Investment expenditure indicators:</b>							
Total investment for location (000 L.D.)	9768	3842	14631	5932	7580	3788	3603
Average farm share (000 L.D.)	16.8	19.2	20.7	17.0	15.5	18.4	19.3
Total Government investment expenditure (000 L.D.)	350	350	250	250	350	250	350
Average farm share (000 L.D.)	0.6	1.8	0.4	0.7	0.7	1.2	1.9
<b>Indictors of annual farm income:</b>							
Net farm income (1000 L.D.)	2.9	4.4	7.6	6.0	3.7	5.3	3.1
Gross farm income * (1000 L.D.)	6.2	8.2	14.0	9.4	6.3	8.9	6.1
<b>Indictors of Farm Financial Analysis:</b>							
Internal Rate of Returns (IRR)	10	10	18	16	13	12	10
Net present value (NPV)	13996	14879	45181	36275	22562	22238	13588
Benefit/ cost ratio B/C	1.14	1.13	1.24	1.37	1.31	1.19	1.14
<b>Indictors of Location financial Analysis:</b>							
Internal Rate of Return (IRR)	10	9	17	15	12	11	8
Net Present Value (NPV)	7269	2449	28012	11783	10124	4099	1036
Benetit /Cost Ratio (B/C)	1.14	1.11	1.22	1.36	1.29	1.17	1.12

\* including value of family labour.

**Table (21)**  
**Efficiency Indicators and Investment**  
**Feasibility for Different Project Locations Irrigated**  
**by the Great Man-made River Waters**

Location	Adafniah /Naima	Tomema Alkrariem	M. Emhemed Almaqarif	Tarhunah/ Wesh- tatah	Irrigated Jandou- bah
<b>Water use indicators:</b>					
Utilized areas (ha)	2775	3315	275	1050	1850
Targetted farms (No.)	555	663	55	210	370
<b>Annual water needs (1000 m<sup>3</sup>):</b>					
Farm	32.5	32.5	92.2	45.2	84.6
Location	18020	21500	5070	11842	31311
Net return per water unit (L.D/M3)	0.314	0.314	0.273	0.323	0.247
<b>Investment expenditure indi- cators:</b>					
Total investment for location (000 L.D.)	32791	35650	8833	30790	44307
Average farm share (000 L.D.)	59.1	53.0	160.6	146.6	119.7
Total Government investment expenditure (000 L.D.)	15732	15382	3905	12641	10445
Average farm share (000 L.D.)	28.3	23.2	71.0	60.2	28.2
<b>Indictors of annual farm income:</b>					
Net farm income (000 L.D.)	6.3	6.3	16.6	14.6	19.9
Gross farm income* (000 L.D.)	8.7	8.7	21.2	18.9	24.9
<b>Indictors of Farm Financial Analysis:</b>					
Internal Rate of Returns (IRR)	14	14	17	12	19
Net present value (NPV)	47.5	44	151	116	199
Benefit/ Cost ratio B/C	1.25	1.23	1.37	1.37	1.5
<b>Indictors of Location Finan- cial Analysis:</b>					
Internal Rate of Return (IRR)	6	7	14	7	15
Net Present Value (NPV)	732	8689	7124	11490	62264
Benetit/ Cost Ratio (B/C)	1.01	1.06	1.32	1.36	1.42

\* including value of family labour.

**Table (22)**  
**Efficiency Indicators and Investment**  
**Feasibility for Different Project Locations In Different**  
**Permanent Irrigation Locations Using Sources**  
**of Local Underground Waters**

Location	Sawfajin and Graret Algtaf	Graret Shaddaf and Zamzam	Alazoumi and Ras Atabel	Ashweref	Azazimit	Beyalkabir
<b>Water use indicators:</b>						
Utilized areas (ha)	2150	480	1350	440	600	800
Targetted farms (No.)	430	96	270	88	120	160
<b>Annual water needs (1000 m<sup>3</sup>):</b>						
Farm	7044	71.0	71.0	31.3	67.8	67.8
Location	30289	6820	19182	2756	8130	10840
Net returns per water unit (L.D/M3)	0.249	0.235	0.235	0.083	0.134	0.134
<b>Investment Expenditure Indicators:</b>						
Total investment for location (000 L.D.)	49084	11031	33598	5161	15612	17359
Average farm share (000 L.D.)	114.1	114.9	124.4	59.6	130.1	108.5
Total Government investment expenditure (000 L.D.)	13099	6840	10914	2641	6949	5459
Average farm share (000 L.D.)	30.5	71.3	40.4	30.0	57.9	34.1
<b>Indictors of annual farm income:</b>						
Net farm income (000 L.D.)	12.0	12.2	12.2	- 0.2	6.2	6.2
Gross farm income (000 L.D.) *	15.5	16.6	16.6	1.3	9.6	9.6
<b>4/ Indictors of Farm Financial Analysis:</b>						
Internal Rate of Returns (IRR)	11	19	10	5	10	10
Net present value (NPV)	100	138	89	- 0.2	47	47
Benefit/ Cost ratio B/C	1.37	1.61	1.32	1.00	1.18	1.18
<b>Indictors of Location Financial Analysis:</b>						
Internal Rate of Return (IRR)	9	9	7	0.0	4	6
Net Present Value (NPV)	29312	6838	12487	- 2399	- 1223	2168
Benetit/ Cost Ratio (B/C)	1.35	1.26	1.15	0.78	0.97	1.05

\* including value of family labour.



- The analysis does not depend on only one criterion of efficiency or feasibility, but a group of criteria are to be used together.
- In addition of using the efficiency of water use and investment feasibility indicators, the technical background, and the characteristics of each location related to agriculture and agricultural development, such as soil, climate, population ... etc. should be taken into consideration.
- Arranging priorities and preferences based on technical and economic aspects does not mean elimination of other factors related to the general policy concerning water and financial resources distribution which should be taken into consideration to accept or reject one or more locations within the project.
- The comparative analysis, as shown in tables (20), (21), (22) depends on the basic considerations and assumptions of the study. If by any means, these assumptions are altered, or certain policies were implemented, as charging the farmers with the general investment costs or share of water delivery costs, then the indicators could be changed (this has been discussed before).
- The comparative analysis and the derived indicators are primary results. they depend on available information and technical studies. These results, including priorities, could be changed when the proposed detailed studies on soil and water resources in many locations are conducted.

97- Based on the different indicators presented in tables (20), (21) and (22), and taking into consideration the economic, social and environmental aspects of the different study locations, the following findings are concluded:

**First :**

Due to environmental aspects, some locations should be included in the first place in agricultural development process, which based on the Great Man-made River water, since feasibility indicators, efficiency of water use, expected farm income are accepted and reasonable to justify investment. These are the three of the Eastern Branch Region. Their significant contribution in agricultural production, as well as previous allocated investments and the necessity to protect them from deterioration and desertification could justify giving them priority for development.

**Secondly :**

Efficiency indicators for Al Jabal Al Gharbi (excluding irrigated Jandoubah) re-

flect reasonable efficiency of water use and investment feasibility at both location and farm levels. These factors justify investing in development of those locations especially because:

- \* Investment in these areas results in more economies of water use.
- \* Investment cost is expected to be low especially average farm share in government investment expenditure.
- \* The environmental aspects assumes developing those locations within this plan as that will eventually lead to conserve their fruit tree assets and promoting their productivity, and as long as the development approaches will help protecting the environment. Meanwhile, there are potential for horizontal expansion based on the results of soil survey.

#### **Thirdly :**

The different efficiency and feasibility indicators for irrigated Jandoubah and Tarhunah/Weshtatah place them as potential locations for development with high rank compared to other locations, therefore it is important to be included in the development plan as the study recommends to give them priority for that matter. If it is necessary, however, to phase development, then development of those locations can be delayed without serious economic, social and environmental problems despite their substantial importance, regarding their contribution to production, climate and soil conditions.

#### **Fourthly :**

In the locations of Central Branch Region (except Tarhunah-Weshtatah), development is recommended to be based on the availability of underground water (an outcome of the results of detailed study is to indicate water suitability, i.e. sufficiency and quality). These locations are characterized by relatively low levels of efficiency and feasibility indicators. They also require comparatively high investment where infrastructure and services are rare. Such investment are funded by the government. In addition, efficiency and feasibility indicators are widely varied.

As for Ashweref location, which represents the worst case, it is recommended to be developed (economically and socially) without emphasizing agriculture i.e. so-

cial aspects should be given priority. The availability of water in this location as well as few other locations in this region, is not only sufficient to justify (technically and economically) the agricultural development.

With respect to such locations of reasonable indicators, but relatively low, as Azazimmit and Beyalkabir, they can be given later priority among the other locations of this region, if development phasing is necessary. Generally, all locations of the Central Branch region can be given later priority if the comprehensive development cannot be achieved due to investment technical or institutional constraints or limitations.

### **General Recommendations :**

98- It has to be stressed that all the findings and results obtained in analyzing the different regions and at different levels indicate preliminary estimates which have to be verified by conducting detailed studies prior to the start of implementing the project. The situation might call the need for undertaking basic studies in such disciplines as soil analysis, agricultural drainage and under ground water, resources availability especially for locations deficient of those studies.

Furthermore, it is suggested that prior to implementation of the project, it might be necessary to establish pilot farms in different locations to verify the technical agricultural parameters mentioned in the detailed feasibility study. The results of those applied experiments could help in reaching final investment decisions.

In addition and within the framework of implementing the whole project, it is suggested to give priority to units of production and/or to rely on existing capital and infrastructure stock as a way to lessen imports and reduce investment outlays of foreign component. Such an endeavour will further improve the economic viability of the project and allow reasonable level of complementarity between agriculture and other sectors.

Finally it has to be pinpointed that training in such areas as agriculture, irrigation and water management is very crucial to the success of the project.

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 Dr. Muhamed Mustafa Esmaiel  
 Dr. Muftah Azouz  
 Dr. Abu Bakir Bin Mahmood  
 Dr. Abdel Salam Shinaishin  
 Ing.r Meelad El Warshafi  
 Ing. Abdel Salam El Said

### Thirdly : Arab Experts Participated in the Workshop:

Ingineer Ibrahim Saad Hagra	Egyptian
Dr. Kamal Abdalla Agabawi	Sudanese
Dr. Abduh Kasim	Syrian
Ing. Muhamed Belhaj Omer	Tunisian
Dr. Muhamed El Bashah	Tunisian
Dr. Ashraf Hashim Bargawi	Egyptian
Dr. Muhamed Hassan Amer	Egyptian
Dr. Muhamed El Saied Rudwan	Egyptian
Dr. Muhamed Lutfi Yousif Nasr	Libyan
Dr. Abd Allawi Rasheed	Libyan
Mr. Muhamed El Balgeesi	Libyan
Dr. Ali El Egab	Libyan
Dr. Hindi El Sanousi	Libyan
Dr. Abdel Hameed El Gazali	Libyan