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OUTLINE OF A PROJECT FOR  
AGRICULTURAL MECHANISATION  
IN LEBANON

MFN=721

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## I. INTRODUCTION

In 1982, the agricultural sector accounted for an estimated 8 percent of Lebanon's gross domestic product as compared to 9.4 percent in 1972 and 12 percent in 1965, and agricultural production in real terms has declined at an average annual rate of 2.1 percent in recent years. The proportion of the active labour force employed in agriculture also declined from an estimated 30 percent in 1965 to less than 13 percent in the early Eighties.

These figures are indicative of the problems facing Lebanese agriculture, particularly the increasingly serious flow of rural-urban migration, the high cost of agricultural labour, and urban encroachment on agricultural land. This is quite apart from the fact that the hostilities in Lebanon since 1975-76 have resulted in the destruction of agricultural capital, the neglect of crops and orchards, and the frequent interruption of overland export routes.

While Lebanon's agricultural potential is relatively limited, it is still far from being fully exploited. The total cultivable area in 1981-82 was around 330,000 hectares, or nearly one-third of Lebanon's total land area. Of this only 18 percent was irrigated and the rest rainfed, which means a significantly lower yield. Another 100,000 hectares are considered reclaimable for agricultural production, but reclamation costs are quite high.

On a per capita basis, the cultivable area averaged around 1,100 square meters in 1981-82, whereas it is considered that agricultural self-sufficiency requires a minimum of 6000 square meters per capita on average. Accordingly, Lebanon is considerably dependent on imports of food products, and this dependence has tended to increase in recent years. Imports of food products amounted to around LL 1 billion (\$326) in 1977 and increased to LL 2.5 billion (\$730) in 1980, and if this trend continues unchecked such imports are projected to reach LL 8.3 billion (\$ 1,743)\* by the year 2000. Lebanon's self sufficiency ratios for major food commodities as estimated by the FAO for 1970 and 1980 are shown in Table 1.

Lebanon's food supply problems are in fact symptomatic of a similar problem facing the neighbouring Arab countries where agricultural production has generally followed a downward trend in recent years. And with the continuing rapid growth of the world population and the stagnation of agricultural production in the developing countries and the Soviet Union, countries producing a surplus of food products such as the United States, Canada and Australia are expected to face increasing strains in supplying world food requirements by the year 2000 or earlier. This could have serious implications for Lebanon, the Arab countries and other countries dependent on food imports, particularly that the cost of such imports is expected to rise considerably.

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\* At the average exchange rate prevailing in January 1983.

Given its limited agricultural potential, Lebanon obviously cannot hope to become self-sufficient in food production, but its increasing dependence on food imports could be limited or contained through a series of measures and projects to expand the cultivated area, increase the intensity of land utilisation, and raise agricultural productivity. In this respect, and as part of the wider effort of reconstruction and economic revival in the various sectors, the Lebanese government now envisages the implementation of a series of agricultural development projects in the period up to the end of this decade. These include:

- a. The reclamation of an additional 100,000 hectares of agricultural land.
- b. Expanding the area under irrigation by building irrigation reservoirs and canals and spreading the use of sprinkler and drip irrigation systems.
- c. The widespread introduction of "new techniques" including fertilisers, pesticides, and improved strains.
- d. Expanding the farm road network.
- e. The mechanisation of agricultural production through the widespread introduction of tractors and related implements.

These projects are interlinked and interdependent, and it is envisaged that they would be undertaken in stages subject to the availability of funds which are to be obtained from a number of international lending institutions.

The "farm mechanisation project", which is outlined in this report encompasses the introduction of tractors and related implements (ploughshare, disc harrow, trailer, insecticides sprayer) on a wide scale into Lebanese agriculture. This project is of particular importance and urgency, as it would help overcome the shortage of agricultural labour which has reached a crisis point in some areas, and would also improve agricultural yields and farm incomes.

## II. THE BACKGROUND

### II.1. Land Tenure and Farming Patterns

The last agricultural census in Lebanon was carried out in 1970 and indicated that land holdings are predominantly small-sized. Of the approximately 95,000 farm holdings surveyed, nearly 50 percent were of less than 1 hectare of arable land, and nearly 46 percent of all farm holdings were of less than two hectares total farm area and covered around 9 percent of the total area of farm holdings. Another 12 percent of all holdings were of 10 hectares or more and occupied 58 percent of the total farm area. Detailed surveys of the different agricultural regions also indicated that in the central Bekaa and south Lebanon, 47 and 58 percent of all holdings, respectively, measured less than two hectares of arable land and in the Koura-Zghorta region, nearly 50 percent of all holdings were smaller than 5 hectares of arable land.

While accurate and up to date data is not available, it is believed that some consolidation of agricultural property has taken place since the early Seventies as a result of extensive and large scale purchases of agricultural land by invading urban capital and remittances from abroad. Members of farm families who have left the villages for more lucrative employment in the cities or in the Gulf countries have in many cases invested part of their increased earnings in land purchases. But while this process has reduced the scale of land fragmentation the land so acquired has been left idle in

many cases because of agricultural labour or because its owners continue to be employed in the cities or outside Lebanon.

FAO estimates in fact indicate that in the mid-Seventies, renting, share cropping and mixed farms of land management concerned up to 50 percent of all agricultural land, particularly in the plains of Akkar and the Beka'a, and in south Lebanon. An estimated 85 percent of the contracts so concluded are seasonal or annual and made verbally.

Another important feature of the agricultural sector in Lebanon as observed by the FAO is the part-time involvement of a substantial part of the population engaged in agriculture and the reliance of many families on sources of income other than agriculture, namely remittances from family members working outside Lebanon, and employment in the cities or in the relatively well developed services sector: in the rural areas. This phenomenon has in fact considerably influenced the modernisation of agriculture (land development, irrigation systems, poultry projects, greenhouses, etc...) which has been largely financed from extra-agricultural capital.

## II.2. Agricultural Areas and Production

Because of its diversified topography and climatic conditions, Agro-ecological conditions vary considerably in the different regions of Lebanon, and since the cultivated area is distributed among the narrow coastal strip,



the Mount Lebanon area, the Akkar Plains in the North, the Beka'a Valley and the South, a variety of crops are grown depending on soils, climate, availability of water, and land tenure conditions.

Around 20 percent of the total cultivable area is under perennial irrigation (or around 67,000 hectares) and receives an estimated 669 million cubic meters of water annually. Around 42,000 hectares are irrigated by surface water, and another 24,700 hectares by underground water.

Irrigation projects being implemented or under study envisage an expansion of the area under permanent irrigation by around 96,000 hectares to 163,000 hectares.

Lebanon's different agricultural areas can be classified into four basic classes from the point of view of present and potential mechanisation. These are:

- a. The Narrow Coastal Strip - extending from Tripoli in the North all the way to Tyre in the South. This strip is devoted mainly to small holder intensive horticultural production. From Damour, south of Beirut downwards, citrus fruit and banana plantations abound though sprawl and the destruction of orchards during the fighting since 1975-76 have reduced the area of such plantations significantly. The cultivation of vegetables in greenhouses has grown considerably in recent years, and

most crops grown in this area are usually irrigated. The total cultivable area along the coast is around 19,800 hectares

- b. The Plains of Akkar and the Central Beka'a Valley - The Akkar plains located in the north-western tip of Lebanon and bounded by the coast and the Syrian frontier are devoted to the intensive cultivation of cereals, vegetables, forage and industrial crops (tobacco, ground nuts) and citrus fruit and grapes. Land holdings are small to medium sized and irrigation is widespread either from streams or artesian wells.

The Central Beka'a Valley is the most developed agricultural region in Lebanon. Large areas here are under rainfed crops but irrigation is also used extensively both from the Litani river and from artesian wells. Crops grown include grains, sugarbeet, vegetables and potatoes. The total cultivable area in the plains of Akkar and the central Beka'a Valley is around 161,300 hectares.

- c. The Mountainous Region - especially the Mediterranean side of the Mount Lebanon chain extending from Jezzine to Tripoli. This area is characterised by steep valleys cut into the mountain range where deciduous fruits are grown in narrow terraces up to an altitude of 2000 meters. Some

heated greenhouses have been built in this area in recent years for growing vegetables and cut flowers. The cultivable area in Mount Lebanon is estimated at around 86,000 hectares.

- d. Other Areas - comprising the gentle slopes that surround the western side of the Beka'a Valley, the terraced region between Tripoli and the plains of Akkar on the lower slopes of northern Mount Lebanon, and the calcareous terraced hills of south Lebanon. The total cultivable area in these regions is estimated at around 62,000 hectares.

In the slopes surrounding the western side of the Beka'a, the cultivated area is allocated mainly to the production of grapes. The terraced region near Tripoli is planted mainly with olive trees, while in the southern hills olives, almonds, cereals, tobacco and legumes are grown.

### II.3. Degree of Mechanisation Attained.

The total number of tractors of different sizes in use in Lebanese agriculture is not known with any degree of accuracy but is estimated at around 2000 tractors. Data on other types of agricultural machines is also not available. Of the total number of tractors estimated to be in use in 1981-82, a substantial proportion is not employed in agriculture--at least on a full time basis--but are used for other purposes, as for example on construction sites.

A large number of tractors and other agricultural machines and equipment were destroyed or stolen during the hostilities which swept Lebanon from 1975-76 to 1982. And while it is difficult to assess precisely the number of machines lost in this fashion, it is known that the most serious loss was of irrigation pumps and engines and that losses were particularly high in the Bekaa Valley, the Akkar Plains, and south Lebanon.

A 1980 study of agricultural mechanisation prepared by the FAO surveyed levels of mechanisation attained on the basis of available data in the different agricultural areas or zones, and with reference to typical cropping situation. The main findings of the study in this respect may be outlined as follows:

- a. Extensive rainfed agriculture - This is largely confined to the Bekaa Valley where wheat, barley, lentils, and beans are grown as winter crops. The land is prepared by means of share ploughs and secondary cultivation is carried out to a limited extent using spring tire cultivators. Seed is broadcast by hand or spinner broadcaster. Combine harvesters are used on the few large farms.
- b. Sugarbeet and potatoes - These crops are also largely grown in the Bekaa Valley in two seasons, the second extending into the rainy season. The full mechanisation of these crops has been well researched, but the small size of plots and the traditional system of basin irrigation has limited actual mechanisation to date.

- c. Orchards and vineyards - A relatively high level of mechanisation has been achieved in orchards and vineyards in the Beka'a Valley. This covers soil tillage, weed control, complete spray programs and crop transport. The level or gently sloping land has allowed easy access for machines.
  
- d. Deciduous fruits - These are grown on narrow terraces in the mountains and present some problems for mechanisation. Only light garden tractors and portable spray machines can be employed and mechanisation in this case is still limited.
  
- e. Citrus, bananas and olives - The mechanisation of citrus and banana plantations has been confined to spraying operations since close planting has made the use of tractors difficult. In olive groves, cultivation is undertaken by tractors where available, otherwise only spraying is mechanised. The younger groves are frequently interplanted with vegetable and forage crops and small conventional tractors are used for land preparation. There is a demand for tree shaking and collection at harvest time and this has become very costly using hand labour.
  
- f. Small holder mixed cropping - This covers areas where a wide range of winter, spring, and summer crops are grown under irrigation, as for example

in Akkar, on the coast, and in some parts of the Beka'a. Crops grown include tomatoes and potatoes, tobacco, and groundnuts. Land not irrigated is allocated to winter cereals. Soil preparation by tractors, using ploughs and/or rotary cultivation is common, particularly that the terrain is suited for mechanisation. Very few of subsequent operations are mechanised, however, (planting, weed control, harvesting). Tractors with trailer transport are often used for crop collection and transport to market.

- g. Fodder crops: These crops are not grown extensively and mechanised production has not extended much beyond the experimental farm operated by the American University of Beirut and located in the Beka'a Valley.

#### II.4 Constraints on Agricultural Mechanisation Expansion

It is estimated that around 2,000 tractors are currently in use in Lebanon or around one tractor for each 165 hectares of cultivable land. As will be shown later, an average of one tractor is needed for a maximum of 40 hectares if soil preparation and cultivation are to be fully mechanised. A similar shortage is indicated in crop spraying equipment. This implies that the level of mechanisation attained in Lebanese agriculture is considerably below what is required for optimal utilization of the limited area of cultivable land. This situation is the result of several constraints which limited the process of agricultural mechanisation in Lebanese agriculture.

The shortage of long term agricultural credit has so far been the main obstacle to the spread of mechanisation. With the predominance of small land holdings, farmers are financially incapable of financing the purchase of tractors and their implements through short term credit. Needless to say, commercial banks are also hesitant to provide credit to farmers particularly those with small land holdings.

On the other hand, and in view of the predominance of small land holdings, tractors are liable to be underutilized and accordingly the resultant saving in ploughing costs using tractors are believed to be insufficient to induce farmers to undertake such an investment. Agricultural cooperatives through which farmers can collectively utilize tractors and achieve considerable saving in ploughing costs, are not yet widely spread.

Moreover private institutions supplying tractors and their implements are not well aware of the type of tractors required in each agricultural region; accordingly their technical advice to farmers has generally been misleading if not totally erroneous.

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increasing dependence on food imports which has resulted in a sharp rise in Lebanon's food imports bill, and a corresponding increase in the balance of trade deficit.

III.2 Reducing requirements for labour and farm animals. -

In recent years agricultural production in Lebanon has suffered considerably from the increasing shortage of farm labour, and the consequent rise in labour costs. The increasing inavailability of foreign labour (mainly Syrian and Palestinian) is expected to make this problem worse in coming years and labour shortages during peak season periods are expected to become more active. Draft animals, which were the main stay of Lebanese agriculture in the 1950's and 1969's, are also becoming increasingly in short supply and this largely because of the high cost of keeping them, particularly that Lebanon is not self-sufficient in animal fodder.

In view of this situation, it may be clearly argued that the mechanisation of agriculture in Lebanon is essential to prevent a further decline in agricultural output, and to circumvent the serious phenomenon of the neglect of agricultural land which has been observed in recent years.



Mechanisation would help reduce production costs over the medium and long term reducing the need for labour and farm animals. The need for seasonal hired labour would be particularly reduced and the possibility of labour shortages during peak season periods reduced or eliminated.

III.3 Improving the quality of agricultural produce. -

By allowing the farmer to plough and plant at the proper time, and by improving crop protection and the timely harvesting and transport of produce, mechanisation would also make possible a substantial improvement in the quality of produce. This in turn would be reflected in the price the farmer can obtain for his products and hence his income. Mechanisation would also reduce harvesting and processing losses.

III.4 Increasing farm incomes and reducing the rate of rural urban migration. -

By raising yields and increasing the intensity of land utilisation, the mechanisation of agriculture in Lebanon, together with the other important agricultural development projects which are envisaged to be implemented in coming years (land reclamation, farm roads, irrigation schemes), are expected to increase farm incomes considerably and hence to reduce the presently high rate of rural-urban migration which will have serious implications for Lebanese agriculture if it continues unabated.

#### IV. PROJECT DESCRIPTION AND SCOPE

##### IV.1. Project Description - General

The project would involve the introduction of the following types of farm machines into Lebanese agriculture:

- a. The necessary number of additional tractors of different types and sizes (depending on the area in which they are to be used) to make possible the full mechanisation of ploughing and other land preparation operations. The area to be covered includes cultivable lands that has an estimated area of 330,000 hectares, plus an additional 100,000 hectares which are to be reclaimed. Implements required with each tractor include a plough, a disc harrow, and power takeoff (propellor shaft).
- b. Power crop sprayers in numbers sufficient to ensure proper crop treatment and pest control in all the agricultural areas.
- c. Farm transport equipment, and specifically tractor wagons. It is estimated that one wagon will be required for each four wheel tractor in use to ensure the timely transport of crops to the market or to processing centers.

To ensure the successful implementation of the project, farmers would have to be trained in the use and maintenance of the machinery and equipment. The project also encompasses the establishment of a number of maintenance and repair centres in the various agricultural areas. In view of the predominance of small land holdings, it is to be expected that the machinery, especially tractors, would in many cases be purchased for multi-farm use. This would be done either through existing cooperatives or by the establishment of new cooperatives in areas where these are non-existent.

As will be shown below, the number of machines (especially tractors) required for the achievement of the project's objectives in their entirety is large and capital costs are accordingly quite high. For this reason, the project may be undertaken in two or three phases or stages with financing secured for each phase separately.

#### IV.2. Number and Cost of Tractors and Related Equipment

Given the varied nature of agricultural land in Lebanon, two types of tractors would be required depending on the region or area in which they are to be used.

In the plains of Akkar and the Beka'a, the gentle slopes around Chtaura and Baalbeck, the coastal areas, and the hills of southern Lebanon, tractors with capacity of 45-50 HP are considered most appropriate.

Studies have shown a wheeled tractor of this class has a capacity of 14,400 square meters per day in the plains of Akkar and the Beka'a, and in the area around Chtaura and Ba'albeck, where the total cultivable and reclaimable area is estimated at around 218,500 hectares. During peak seasons, the land must be prepared within a period of 40 days at most, which means that the total number of tractors required for the full mechanisation of land ploughing operations in these areas is around 3,790 tractors. This works out at an average of one tractor for each 57.6 hectares.

In the coastal areas and in southern Lebanon, where the total cultivable and reclaimable area is estimated at around 82,150 hectares, the ploughing capacity of a 45-50 HP tractor is less, at 10,000 square meters per day, because the cultivated and cultivable spaces are narrow. This means that the total number of tractors required to complete land ploughing operations within 40 days in these areas is around 2,050 tractors, or an average of one tractor for each 40 hectares.

In the terraced mountain regions, where the total area of cultivable and reclaimable land is estimated at around 129,000 hectares, smaller tractors of 15-20 HP capacity would be more suitable as they can be easily accommodated on the relatively narrow terraces. In view of its size and the nature of the land in which it is to be used, such a tractor can plough around 6,000 square

meters per day. This again means that a total of around 5,375 tractors would be needed to complete the ploughing of the land within a period of 40 days, or an average of one 15-20 HP tractor for each 24 hectares of cultivated land.

In the light of all the above, the minimum number of tractors required for the mechanisation of ploughing operations on cultivable and reclaimable areas is around 11,215 tractors of which around 5,840 tractors would be of the 45-50 HP class and the remaining 5,375 tractors of the 15-20 HP class.

Of the present machinery park which is estimated to be around 2000 tractors, around 20 percent only are considered to be in sufficiently good condition to be deducted from the total number of tractors required as given above. The remaining 80 percent are either completely depreciated or are in need of considerable repairs

It is assumed, in the absence of reliable data, that of the 400 tractors which are in good shape, 50 percent in the 15-20 HP class, and the remaining 50 percent in the 45-50 HP class, the total number of additional tractors required on the cultivable and reclaimable areas is 5,640 tractors in the 45-50 HP class, and 5,175 tractors in the 15-20 HP class.

The implements required with each tractor include: a ploughshare, a disc harrow for soil levelling, a power takeoff, a pesticides and fungicides sprayer, and a trailer for the transport of inputs and produce.

The capital costs of each tractor and its related implements at 1982 prices are detailed in Table 5. These include the cost of a shelter which is estimated at LL 5000 for a 15-20 HP tractor, and LL 6000 for a 45-50 HP tractor. Capital costs are estimated based on the assumption that all tractors would be of the four wheel type and thus included the cost of a wagon to be used in the transport of produce. Accordingly, the total capital cost of the tractors and related implements required for cultivable and reclaimable areas is around LL 650 million or around \$157 million (at exchange rate of LL 4.15 for each \$1). This includes an estimated LL 119 million (\$28.67 million) that would be required to cover the capital cost of the 2000 tractors required for the area to be reclaimed.

#### IV.3 Annual Fixed and Operating Costs of Tractors

The annual fixed and operating costs of tractors to be employed in the different agricultural regions are shown in Table 6. These differ between a 15-20 HP class tractor, which will be employed in the mountainous areas and a 45-50 HP class tractor which is suitable for use in the other agricultural areas.

Fixed annual costs include the following:

- a. Interest on loan: It is assumed that farmers would cover the entire capital cost of the tractor by a loan at an interest rate of 9.5 percent per annum.

- b. Wages of driver and assistant. Each tractor requires a driver and an assistant to be operated. The assistant is required for an average of 10 months each year. The monthly wage rate of the driver is LL 1,300 and that of the assistant LL 800. Where the tractor is purchased for multi-farm use, these costs would be distributed among farmers. If on the other hand, the tractor is purchased and operated by a single farmer, the cost of the driver is imputed and represents the farmer's opportunity cost.
- c. Insurance. This covers the driver of the tractor up to LL 10,000 in medical expenses, or LL 100,000 in payment to beneficiaries in case of death due to an accident while driving the tractor, or LL 500 as a weekly indemnity in case of incapacity as a result of an accident.
- d. Miscellaneous expenses. These are assumed to be 5 percent of annual fixed costs.

Variable costs on the other hand, include the cost of fuel, maintenance and greasing and a depreciation allowance.

Fixed and variable costs per hour of operation are calculated on the basis of the total number of hours of tractor operation required in the various regions or areas. These are detailed in Table 3.

Apart from ploughing, a tractor would also be used for land levelling in the spring season and crop spraying. Accordingly, the total number of hours of tractor operation required annually per hectare is 64 hours in the mountain areas, 35 hours in the Beka'a Valley, the Akkar plains, and the areas around Ba'albeck and Chtaura, and 41 hours in the coastal area and south Lebanon.

In the plains of Akkar and the Beka'a and the areas around Chtaura and Baalbeck where a 45-50 HP tractor would be operated for 35 hours per hectare per annum, or a total of 2,012 hours to complete the ploughing and leveling of the 57.5 hectares allocated to each tractor, fixed costs per tractor hour would be around LL 17.53. The cost of the fuel for this type of tractor is LL 4.8 per hour which is the cost of the 4.3 litres it uses up per hour on average. Greasing and maintenance expenses are estimated at around 15 percent of fuel costs. With depreciation estimated at around LL 5.82 per hour, the total cost of operating a 45-50 HP tractor per hour in the regions mentioned above is estimated at around LL 28.85.

In the coastal areas and in south Lebanon, fixed costs per hour for a 45-50 HP tractor are estimated at around LL 21.50 since each tractor in these areas would have to be operated for around 1,640 hours per year to plough and level the 40 hectares allocated per tractor. Fuel and maintenance costs are LL 5.5 per hour, while depreciation is around LL 5.82 per hour. Thus, total operating cost is LL 32.82 per hour.



In the mountains, fixed costs per hour are estimated at LL 21.14 since each 15-20 HP tractor would be operated for around 1,534 hours a year to cover the area of 24 hectares allocated per tractor. Fuel and maintenance expenses are estimated at LL 0.35 per hour, and depreciation is LL 3.82 per hour. Accordingly, total cost per hour of operation is around LL 27.7.

IV.4 A comparison of ploughing costs per hectare in the various agricultural regions--tractor versus traditional methods

In the light of the cost estimates given above, it is possible to compare ploughing costs per hectare using tractors versus the cost per hectare of traditional ploughing methods (by the use of draft animals or hand labour). Assuming a working day of 8 hours and an average ploughing capacity per hectare of 14,400 square meters per day in the Beka'a, 10,000 square meters per day in the coastal area and 6,000 square meters per day in the mountains, tractor ploughing costs are estimated as follows: For a 45-50 HP tractor, ploughing cost averages LL 160 per hectare in the Beka'a Valley, the slopes around Baalbeck and Chtaura, and LL 263 per hectare in the coastal area and south Lebanon. For a 15-20 HP tractor, on the other hand, used in the terraced mountain areas, ploughing cost totals LL 369 per hectare.

With respect to draft animals, ploughing capacity varies from 1,500 square meters per day in areas under fruit orchards to 2,500 square meters per day in areas cultivated with vegetables.

For areas cultivated with fruit orchards, two labourers are needed, a ploughman and an extra labourer for tillage around orchards which should be protected from likely damage by the ploughshare. Daily wage for the ploughman varies from LL 200 in Mount Lebanon to LL 175 in other agricultural areas; while the wage of the extra labourer is estimated at around LL 100 per day in Mount Lebanon and LL 75 in other agricultural areas. Accordingly, total ploughing cost amounts to LL 300 per day in Mount Lebanon and LL 250 per day in other areas. Given ploughing capacity as detailed above, ploughing cost per hectare is LL 2,000 in Mount Lebanon and LL 1,665 in other agricultural areas.

In regions of vegetable cultivation, mainly along the coasts and in the Beka'a Valley, the cost of ploughing by draft animal would be cheaper at around LL 175 per day since only one labourer would be needed. At the higher ploughing capacity of 2,500 m<sup>2</sup> per day, ploughing cost per hectare would be around LL 700.

Soil tillage is estimated to require 3-4 men per day to complete 1,000 square meters. The cost per hectare would, therefore, range between LL 3,000 to LL 4,000 in Mount Lebanon and from LL 2,250 to LL 3,000 in other regions.

The comparison of ploughing and tillage costs are detailed in Table 7 below.

## V. ORGANISATION AND MANAGEMENT

### V.1 Project Phasing

The total capital cost of the mechanisation project as described above is estimated at around LL 650 million at 1982 prices or \$ 166.24 million. This excludes the cost of establishing maintenance and repair centers in the various agricultural areas which is estimated at around LL 7 million.

The large outlay required makes it imperative that the project be implemented in at least three or possibly four phases or stages, such that the capital cost of each phase would be around LL 162.5 - 215.6 million, and such that the project would be completed before the year 2000.

### V.2 Mode of Finance and Loan Repayment

It is envisaged that the funds allocated for each phase would be evenly disbursed in the form of soft loans to beneficiaries in the different agricultural areas or regions so as to allow them to purchase the necessary machinery and equipment.

Applications for loans would be invited from farmers and cooperatives where the type of tractor or other equipment required in each case would be determined in close consultation with experts from the Green Plan.

Since it is estimated that one tractor is required, for each 57.5 hectares in the plains of Akkar and the Beka'a, 40 hectares in the coastal areas and south Lebanon, and 24 hectares in mountainous areas, and since the average size of

land holdings in Lebanon is only a fraction of that, this means that in most cases tractors would be purchased for multi-farm use and that loans would have to be advanced in most cases to cooperatives rather than individual farmers. In areas where such cooperatives are non-existent, loans would be granted only on condition that farmers group themselves in cooperatives. The objectives of such cooperatives may extend beyond the simple ownership and operation of a tractor to the packaging and marketing of produce.

In all cases, loans would be advanced against collateral most likely in the form of a land mortgage, and would be repayed over a period of 8 years with a two-year grace period. The repayment period is equal to the estimated life time of the agricultural machinery to be purchased.

Where loans are advanced to cooperatives for the purchase of tractors, the cooperative would be required to ensure the prompt payment of the annual instalment on the loan by requiring members to contribute their share of the total cost.

The rate of interest charged on loans is expected to be 9.5 percent. It is envisaged that the loan would cover the entire cost of the tractor and related implements required by farmers and/or cooperatives. Typical loan repayment schedules for 15-20 HP and 45-50 HP tractors are shown in Tables 8 and 9.

### V.3 Training, Maintenance and Repair Centers

Paper implementation of the farm mechanization project requires adequate farmer training in the use of tractors and implements. Otherwise, execution of the whole project would be impeded since the improper use of machines would result in a shorter useful lifetime.

Through cooperative efforts between the Green Plan, the Ministry of Agriculture and suppliers of tractors, special training programs would be organized. One to two training centers would be set up in every Mohafazah, each staffed by at least one specialized mechanic and an assistant mechanic. These centers will cooperate closely with farmers providing them with all maintenance and repair services.

A total of 10 centers are thought to be sufficient for serving all beneficiary farmers. Establishment costs of each center are estimated at around LL 700,000 at 1983 prices making the total cost of these centers around LL 7 million.

A special long-term soft loan from the Lebanese government would be sought to cover the establishment costs of these centers. It would be repaid from the maintenance and repair services charges of these centers.

## VI. PROJECT RISKS

Several risks involved in the project under study may occur and disrupt its smooth implementation or stand in the way of the full achievement of its objectives.

A major risk relates to non-suitability of tractor ploughing to some agricultural lands, where terraces may be very narrow or soils stoney. This risk has been generally accounted for by providing that 15-20 HP tractors would be used in the mountainous areas. Nonetheless, some plots may not even accommodate such tractors, because the terraces are too narrow or the soil stoney. To overcome this problem, the Green Plan would reclaim such lands, or alternatively hand-held motorised cultivators may be used.

Adverse climatic conditions pose another threat in that they could have adverse effects on yields and outputs and hence reduce the ability of farmers to repay loans. However, Lebanese farmers tend to cultivate a variety of crops in their lands, affected differently by adverse climatic conditions. Moreover, cooperatives buying tractors include large number of farmers and, therefore, the cooperative would meet outstanding payments to the lending agency on behalf of those farmers defaulting due to unfavourable weather conditions that might occur in any year.

In view of the capital and operating costs of tractors and their higher ploughing capacity as compared to traditional ploughing methods, it is envisaged that the implementation of the project would result in extensive savings in ploughing costs. Assuming that tractors are

fully exploited, a 45-50 HP tractor would handle an average area of 57.5 hectares in the Beka'a, Akkar and the slopes around Baalbeck and Chtaura, and 40 hectares in the coastal area and south Lebanon; 15-20 HP tractors, on the other hand, would be allocated an area of 40 hectares per tractor in the mountainous regions. Based on the above, it is estimated that a minimum of 10,815 tractors are required.

The risk exists however, that each tractor may not be utilized fully for a number of reasons. This would mean higher operating and capital costs per hectare than was indicated earlier. Nonetheless, even if the situation arises, the use of tractors would still be more profitable in view of the large difference in tractor ploughing costs as compared to traditional methods. It is only when tractors are underutilized to the extent that each tractor handles 8.79 hectares in plots in Beka'a, Akkar and Baalbeck cultivated with vegetables, or 4.37 hectares in orchards in coastal areas or 3.53 hectares in the mountainous plots, that tractor ploughing costs would be equivalent to traditional ploughing costs.

## VII. CONCLUSIONS

1. The agricultural mechanisation project would contribute considerably to Lebanese agriculture through:
  - a. Increasing agricultural productivity and the intensity of land utilization.
  - b. Reducing requirements for labour and farm animals.
  - c. Improving the quality of agricultural produce.
  - d. Increasing farm incomes and reducing rural urban migration.
  - e. increasing job opportunities and incomes in related industries and services.
2. A total of 10,815 tractors would be needed for the implementation of the project, 5,640 tractors of the 45-50 HP class and 5,175 tractors of 15-20 HP class. The total capital costs of the envisaged project is LL 650 million.
3. It is advisable that the project be implemented in at least 3-4 phases and that funds allocated be disbursed in the form of soft loans of 8 years to farmers and cooperatives with a two-years grace period and at 9.5 percent interest.



4. Given that each tractor would be allocated an area of 24 hectares in mountainous regions, 40 hectares in coastal regions and 57.5 hectares in the Beka'a, tractor ploughing would be considerably cheaper than traditional methods. Compared to a total of LL 48,000, the cost of ploughing 24 hectares by draft animals in mountainous regions, a 45-50 HP tractor would cost LL 8,856. In coastal regions tractor ploughing would also be much cheaper at LL 10,520 for 40 hectares compared to LL 66,600 by draft animals; while in the Beka'a valley tractor ploughing costs of the 57.5 hectares allocated to each tractor would be around LL 9,200 compared to a ploughing cost of LL 40,250 for the same area, using draft animals.

Accordingly, the savings in ploughing costs that would be realised by farmers or agricultural cooperatives using tractors would be sufficient to enable them to meet their yearly loan repayment dues; this quite apart from the advantages of tractor ploughing in raising land productivity and improving the quality of produce that would in turn generate extra income for farmers.

T A B L E S

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Table 1

Self-Sufficiency Ratios for  
Major Food Commodities

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(Domestic Production as a Percentage  
of Domestic Consumption)

<u>Commodity</u>	<u>1970</u>	<u>1980/a</u>
Wheat	13.3	12.7
Pulses	45.5	47.6
Raw Sugar	19.4	5.0
Vegetable Oils	41.8	30.3
Potatoes	162.4	▲ 175.4
Citrus Fruit	315.4	368.4
Other Fruits	156.8	178.0
Beef and Veal	10.3	14.7
Mutton and Lamb	29.9	21.2
Poultry Meat	94.0	100.0
Eggs	325.6	160.0
Milk and Dairy Products	28.8	16.8

Source: FAO, Agriculture and Development, June 1981,  
Number 4.

a/ On the basis of maximum demand and production  
estimates.

Table 2

Ploughing and Land Levelling Capacity of  
45-50 and 15-20 HP Tractors in the Various  
Agricultural Regions

		Capacity Per Hour	Capacity per Day (8 hours)
45-50 HP Tractor	<u>Ploughing</u>		
	a- Coastal Regions	1,250 m <sup>2</sup> /hour	10,000 m <sup>2</sup> /day
	b- Chtaura, Beka'a, Akkar	1,800 m <sup>2</sup> /hour	14,400 m <sup>2</sup> /day
	<u>Levelling</u>		
	a- Coastal Regions	1,000 m <sup>2</sup> /hour	8,000 m <sup>2</sup> /day
	b- Chtaura, Beka'a, Akkar	1,300 m <sup>2</sup> /hour	10,400 m <sup>2</sup> /day
15-20 HP Tractor (Mountain Regions)	<u>Ploughing</u>	750 m <sup>2</sup> /hour	6,000 m <sup>2</sup> /day
	<u>Levelling</u>	630 m <sup>2</sup> /hour	5,000 m <sup>2</sup> /day

Total Number of Hours of Tractor Operation Required  
Annually for the Ploughing and Levelling of Land and  
Crop Spraying in the Different Agricultural Regions

	Ploughing (Hours/Hectare)	Levelling (Hours/Hectare)	Treatment-Spraying* (Hours/Hectare)
15-20 HP Tractor Mountain Region			
Autumn Season	14	--	3-4
Spring Season	14	16	
Total	28	16	15-20
45-50 HP Tractor Beka'a, Akkar, Baalbeck			
Autumn Season	6	--	2-3
Spring Season	6	8	
Total	12	8	10-15
45-50 HP Tractor Coastal Region and South Lebanon			
Autumn Season	8	--	
Spring Season	8	10	2-3
Total	16	10	10-15

\* Five treatments per year.

Table 4

Summary of Tractor Requirements  
on Cultivable and Reclaimable  
Agricultural Regions -

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1. Beka'a, Akkar and the Slopes around Ba'albeck and  
Chtaura:

Area: 218,440 Hectares  
Tractor Type: 45-50 HP  
Average Fuel Consumption 30 litres/7 hours  
of Operation  
Average Ploughing Capacity 14,400 m<sup>2</sup>/day  
Total Number of Tractors: 3,790  
Hectares per Tractor: 57.5

2. Coastal Area and South Lebanon:

Area: 82,150 Hectares  
Tractor Type: 45-50  
Average Fuel Consumption 30 litres/7 hours  
of Operation  
Average Ploughing Capacity 10,000 m<sup>2</sup>/day  
Total Number of Tractors: 2,050  
Hectares per Tractor: 40.

3. Terraced Mountain Areas:

Area: 129,000 hectares  
Tractor Type: 15-20 HP  
Average Fuel Consumption: 15 litres/7 hours  
of Operation  
Average Ploughing Capacity 6,000 m<sup>2</sup>/day  
Number of Tractors: 5,375  
Hectares per Tractor: 24

Table 5

Capital Costs of Tractors and  
Related Implements

(at prices prevailing in the First Quarter of 1983)

<u>15-20 HP Class Tractor</u>	<u>LL</u>
1. Tractor	26,000
2. Ploughshare	2,500
3. Propeller Shaft	300
4. Disc Harrow	6,000
5. Insecticides Sprayer	4,500
6. Trailer	1,000
7. Shelter	5,000
TOTAL	45,300
<u>45-50 HP Class Tractor</u>	
1. Tractor	50,000
2. Ploughshare	5,000
3. Propeller Shaft	1,000
4. Disc Harrow	6,000
5. Insecticides Sprayer	4,500
6. Trailer	1,000
7. Shelter	6,000
TOTAL	73,500



Table 6

Fixed and Variable Operating  
Costs of Tractors in the Various  
Agricultural Regions

	(LL)		
	15-20 HP Tractor (Mountain Areas)	45-50 HP Tractor (Beka'a, Baalbeck and Chtaura)	45-50 HP Tractor Coastal Area and South Lebanon
<u>Annual Fixed Operating Costs</u>			
Driver	15,600	15,600	15,600
Assistant Driver (1)	8,000	8,000	8,000
Interest on Loan	4,303	6,982	6,982
Insurance	3,000	3,000	3,000
Miscellaneous Expenses	1,545	1,679	1,679
Total	32,448	35,261	35,261
Total Fixed Costs/hour of Operation (2)	21.12	17.53	21.50
<u>Variable Cost Per Hour of Operation</u>			
Fuel (3)	2.40	4.80	4.80
Maintenance and Greasing	0.35	0.70	0.70
Depreciation (4)	3.82	5.82	5.82
Total	6.57	11.32	11.32
<u>Total Operating Costs Per Hour</u>	27.69	28.85	32.82

(1) The assistant driver is employed for 10 months a year.

(2) The total number of hours of operation required per annum are 1,535 hours in the mountains, 2,012 hours in the Beka'a Valley, Ba'albeck and Chtaura, and 1,640 hours in the coastal area and South Lebanon.

(3) Fuel Consumption is 2.14 litres per hour for a 15-20 HP tractor and 4.29 litres per hour for a 45-50 HP tractor. The cost of fuel is LL 1.120 per liter.

(4) Annual depreciation rates are as follows: 12.5 percent for the tractor, 20 percent for the ploughshare, propeller, disc harrow, and trailer, 10 percent for the sprayer, and 4 percent for the shelter.

Table 7  
Comparison of Ploughing Costs

I. Tractor Ploughing:	Ploughing Cost (LL per Hectare)
1. 45-50 HP Tractor utilized in the Beka'a and Southern Lebanon	160
2. 45-50 HP tractor utilized in coastal regions	263
3. 15-20 HP tractor utilized in mountainous regions	369
II. Ploughing By Draft Animals:	
1. Land cultivated with fruit trees in Mount Lebanon	2,000
2. Land cultivated with fruit trees in other mountainous areas, the coastal regions and the Beka'a Valley	1,665
3. Levelled fields on the coast and the Beka'a cultivated with vegetables	700
III. Soil Tillage (by hand)	
1. Mount Lebanon	3,000 - 4,000
2. Coastal area and the Beka'a	2,250 - 3,000

Table 8. Loan Repayment Schedule  
for 15-20 HP Tractors \* (In LL)

Year	Debt Outstanding	Interest	Principal	Total
1	45,300	-	-	-
2	45,300	4,303	-	4,303
3	45,300	4,303	5,945	10,250
4	39,355	3,738	6,510	10,250
5	32,845	3,120	7,129	10,250
6	25,716	2,442	7,806	10,250
7	17,910	1,701	8,548	10,250
8	-	889	9,360	10,250

Table 9. Loan Repayment Schedule for  
for 45-50 HP Tractors\* (In LL)

Year	Debt Outstanding	Interest	Principal	Total
1	73,500	-	-	-
2	73,500	6,982	-	6,982
3	73,500	6,982	9,647	16,630
4	63,853	6,066	10,563	16,630
5	53,290	5,062	11,567	16,630
6	41,723	3,963	12,666	16,630
7	29,057	2,760	13,869	16,630
8	-	1,442	15,186	16,630

\* An 8 years loan with two years grace period and at 9.5 percent annual interest rate.