2. AGRICULTURE

Lebanon's agriculture offers environmental opportunities for green space, landscaped terraces, and fresh and healthy produce. At the same time, improper agricultural practices lead to soil erosion and impoverishment, depletion of underground water resources, water pollution and health impacts from inappropriate use of pesticides and fertilizers, and environmental pollution from haphazard dumping of slaughter waste and animal farms. Agriculture is also "losing ground" to rampant urbanization, such as in parts of the Bekaa Valley and the coastal plains. The GoL's policies appear targeted to increasing the availability of irrigation water, especially in the South, and controlling the use of pesticides, with no or little investment or incentives for water- and soil-conserving irrigation techniques. The private sector is gradually taking advantage of new but timid opportunities offered by organic farming and high-value agricultural produce.

2.1 Targeted Description

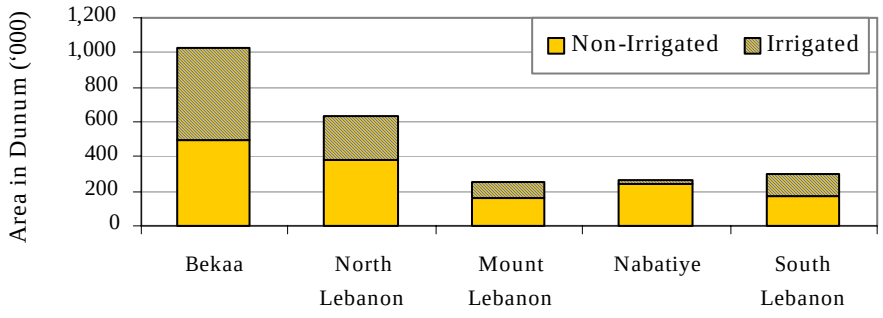
In 1995, the agricultural sector contributed about US$1.5 billion to Lebanon's Gross Domestic Product (GDP), or 12.4 percent (up from 9.4 percent of GDP in 1973). A recent survey provides up-to-date information on the agricultural sector in Lebanon (MoA / FAO, 2000). However, many professionals have questioned the validity and reliability of the data generated by this survey (see box below for an example).

2.1.1 Lands under cultivation

In 1999, 248,000 hectares of lands were cultivated (24 percent of the Lebanese territory), of which 42 percent were irrigated and two percent were under greenhouse production (MoA / FAO, 2000). An additional 53,137 hectares were fallow lands abandoned for more than five years. Almost 42 percent of the exploitable agricultural land is located in the Bekaa, which also accounts for 52 percent of the total irrigated land (see Figure 2.1).

The MoA Survey estimated greenhouse production at about 5,000 hectares. In contrast, the Methyl Bromide Alternatives Project, hosted by the MoE, reports only about 2,018 hectares of greenhouse production (or 0.81 percent of total cultivated area)!

Figure 2. 1
Irrigated and Non-Irrigated Lands By Mohafaza



Source: MoA / FAO, 2000

More than half of the farms are small in size and less than two percent exceed 100 dunums (see Table 2.1). Almost 75 percent of farmers cultivate an area less than 10 dunums each and account for 20 percent of total cultivated land. The average farm size in Lebanon is 12.7 dunums: it ranges from 6.1 dunums in Mount Lebanon to 29.3 dunums in the Bekaa.

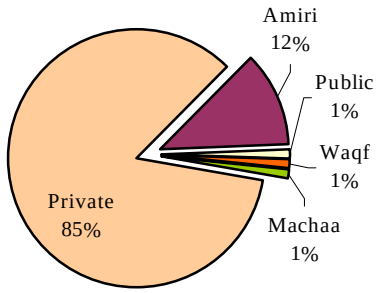
Table 2. 1
Exploitable Agricultural Lands By Farm Size Category

Farm size category (in dunum)	*Percent of farmers*	*Percent of total cultivated area*
Smaller than 5	53.0	9%
5-100	45.4	61%
Larger than 100	1.6	30 %

Source: MoA / FAO, 2000

The vast majority of farms are on private land (see Figure 2. 2). Public lands, *machaa, amiri* and *waqf* holdings combined represent about 15 percent of the total cultivated area in Lebanon.

Figure 2. 2
Distribution of Cultivated Lands by Land Tenure



Source: MoA / FAO, 2000

The agricultural sector employs about 195,000 farmers, up from 143,000 in 1961 (MoA / FAO, 2000). Twenty-nine percent of farmers are in the North, followed by Mount Lebanon (21.6 percent) and the Bekaa (18 percent). About 66 percent of farmers have second, non-agricultural jobs. The share of cultivated land is almost equally divided between farmers who work exclusively in agriculture and farmers who also work elsewhere.

2.1.2 Agricultural production and geographic distribution

Lebanon produces crops in five major categories: cereals, fruits (not including olives), olives, industrial crops (e.g., sugar beet, tobacco), and vegetables. Fruit and olive trees occupy 45 percent of the total cultivated area, and have increased by about 230,000 dunums in the past 10 years (Table 2. 2). The area covered by greenhouse production has also significantly increased over the past years, from 6,700 dunums in the late 1980s to almost 50,000 dunums in 1999. Agricultural production in greenhouses is more intensive than in open fields and requires more agro-chemicals (pesticides and fertilizers).

Agricultural production is concentrated in the Bekaa, which accounts for 42 percent of total cultivated land. The Bekaa hosts 62 percent of the total area used for industrial crops (including sugar beet, tobacco, and vineyards) and 57 percent of the total area used for cereal production (see Table 2. 3). The North (Akkar and Koura regions) host 40 percent the area used for olive production in the country. Fruit trees cover 24 percent of the total cultivated area. Box 2.1 presents a case study on the remarkable cherry production system in Arsal, Bekaa.

Table 2. 2
Area Cultivated by Major Crop Type

Crop Type	*Area cultivated (dunum)*		*Percent change*
	Period 1980-1995 [a]	1999 [b]	
Cereals	(1989) 1,020,000	518,420	- 49%
Fruit trees	(1989) 560,000	595,147	+ 6%
Olives	350,000	524,213	+ 50%
Industrial crops	n / a	247,265	n / a
Vegetables	(1988) 230,000	452,320	+ 97%
Other	n / a	142,000	n / a
Total	**(1980) 2,850,000**	**2,479,365**	**- 13 %**
	(1986) 2,740,000		**- 9.5 %**

[a] Source: METAP / ERM, 1995 (reported values cover different years)
[b] Source: MoA / FAO, 2000

Table 2. 3
Land Used for Major Types of Crops by Mohafaza (Dunums)

Mohafaza	*Cereals*	*Fruit Trees*	*Olives*	*Industrial crops*	*Vegetables*
Mount Lebanon	3,140	97,820	77,678	1,613	31,100
North	120,380	135,685	209,628	37,769	128,584
Bekaa	297,737	217,570	31,443	153,232	259,743
South	37,638	123,304	89,340	14,625	20.753
Nabatiyeh	59,525	20,768	116,124	40,026	12,141
Lebanon	**518,420**	**595,147**	**524,213**	**247,265**	**452,321**

Source: MoA / FAO, 2000

2.1.3 Livestock production

The total number of livestock in Lebanon has increased about 38 percent from 1980 to 1999. Because goats are hardier than sheep, they can survive in degraded areas with little vegetation. The presence of goat flocks grazing in rangeland is an indication that the land is degraded and unfit for more profitable livestock, such as sheep.

Livestock production is an important activity, particularly in the mountains and in the Baalbeck-Hermel area on the eastern mountain chain where soil fertility is relatively low. While the number of goats has been relatively stable for more than two decades, sheep production has risen sharply. In recent years, livestock production (goats and sheep) has relied increasingly on feed blocks and feed supplements, thereby reducing dependence on wild grazing and ultimately leading to more sedentary animal production. Bovines and dairy production is becoming increasingly popular. In the past five years, several medium-to large-scale dairy farms have been established in the North and in the Bekaa. Farmers have also been encouraged to expand dairy production through several grant and loan agreements (e.g., USAID).

Table 2. 4
Evolution of Livestock Production (1980 – 1999)

Category	*1980*	*1999*	*Variation (%)*
Cows	55,612	75,874	+ 36
Sheep	145,068	378,050	+ 160
Goats	444,448	435,965	- 2
Total	**645,128**	**889,889**	**+ 38**

Source: MoA / FAO, 2000

In addition to local production, 367,395 livestock animals were imported in 2000, up from 344,275 animals in 1999.[1] While some of these animals are destined for dairy production, the majority is probably transported directly to slaughterhouses (see Section 14.4.3 for information on slaughter waste).

About 26,630 farmers produce almost 10 million broilers and 4.5 million layers annually (MoA / FAO, 2000).[2] The vast majority are small, backyard farming systems for local consumption only (village and households). A small number of poultry farms accounts for almost 87 percent of total production. The largest poultry farms are located in Zahle, Batroun, Jbail and Koura.

Box 2. 1
Fruit Production in the Highlands of Arsal (Bekaa Region)

The village of Arsal extends over about 350 km^2 of marginal lands, at altitudes ranging from 1,100 meters to 2,300 meters. The average annual rainfall is 300 mm in the highlands, mostly in the form of snow. The population of Arsal (about 30,000) depends on agriculture as the main source of income.

Arsal, like other villages in the marginal slopes of the Anti-Lebanon mountains, survived until the first-half of this century in a traditional agro-pastoral economy based on small-scale farming and seasonal migration of livestock. Since the late 1960s, agriculture in the highlands of Arsal has been shifting from strict agro-pastoral practices to non-irrigated fruit production. Through the farmers' own initiative, cereal production has declined sharply, replaced with cherry and, to a lesser extent, apricot trees. An estimated two million fruit trees have been planted since the mid 1960s – probably the largest afforestation project to date in Lebanese drylands. This remarkable explosion of fruit trees in the bare highlands (1,200-2,200 meters) has modified the landscape and provided a seemingly sustainable, low-input agricultural system (i.e., rainfed, no fertilization).

How this shift to horticultural fruit production might affect soil erosion in the area is yet to be determined. In the long run, lack of fertilization might also lead to mineral depletion and decreased yields. Meanwhile, the rapid increase in the number of orchards is introducing exotic pests. Potentially destructive infestations have already been reported. In addition to linkages with international donor agencies, continued research, ecotourism, and micro investments in rural development projects (e.g., weaving, fruit processing, marketing of agricultural produce) would bring Arsal closer to a unique, sustainable fruit production system in Lebanon.

Source: Based on Talhouk et al., 1996 and a research & development project in Arsal funded by the IDRC

[1] CAS Bulletin / No.1,2000; No. 1,2001

[2] These estimates appear to be too low. Lebanon's leading poultry farms, including *Hawa Chicken*, *Tanmia* and *Shuman*, produce more than 15 million broilers a year, with a daily production between 10,000 to 40,000 broilers. Other estimates indicate that total annual production is closer to 60 million broilers.

2.1.4 Fishing

The "Regional Socio-Economic Development Programme for South Lebanon" report (HRC / IAURIF, 1999) indicates that Lebanon has 3,000 to 4,000 fishermen. Annual fish production amounted to 4,485 tonnes in 1996: 4,110 tonnes of sea fish and 375 tonnes of freshwater fish (mostly in fish farms). This production level is twice the average fish production in Lebanon over the previous 10 years. While sea fish production in Lebanon compares to that of neighboring countries on a kilometer-of-coastline basis, freshwater fish production continues to lag behind (see Table 2.5). There is no breeding of sea fish along the coast (coastal current too strong in most places). Offshore fishing of pelagic fish (tuna, blue fish, etc.) using draglines has become trendy in the past decade, mostly among sports amateurs equipped with motor speedboats.

Freshwater fishing is very limited in Lebanon. In addition to sporadic fishing in rivers (e.g., Litani, Ibrahim), mostly for recreational purposes, only fishing in the lake of Qaraoun seems to produce significant quantities. About 30 fishermen practice net fishing with about 15 traditional small boats, producing about 30 tonnes per year (mainly carp and common trout).

Table 2. 5
Fish Production in Lebanon and Neighboring Countries (1996)

Country	*Sea fish production (tonnes)*	*Freshwater fish production (tonnes)*
Lebanon	4,110	375 (mostly rainbow trout)
Syria	1,941	7,290 (mostly carp)
Palestine (Gaza)	1,229	--
The Occupied Territories	2,939	17,568 (mainly carp and tilapia)

Source: HRC / IAURIF, 1999

Nets and fishing lines are the main fishing gear used today. Anecdotal evidence would suggest that dynamite use, a common practice during the war, has been reduced sharply. In Tyre, two-thirds of fishing is done with trammels and dragnets, and one-third using long lines (HRC / IAURIF, 1999). There are no restrictions on mesh size or net dragging, or seasons for fishing. Fish are therefore caught indiscriminately (without regard for size) and at any time (without regard for breeding). In fact, it seems that enough information among the scientific community on the location grounds and seasons of breeding is not available to develop effective geographic and seasonal restrictions on fishing.

2.2 Pressures on the Environment

Crop production relies heavily on agro-chemicals, including several pesticide derivatives and fertilizers. Agriculture in Lebanon is also increasingly shifting to irrigated production, thereby putting added pressure on dwindling water resources. Increased irrigation implies more groundwater pumping, leading to salinity buildup in the soil matrix. Off-farm production (i.e., grazing) is a potential source of pressure on plant cover and may retard the natural regeneration of forests. Farm production (poultry and dairy farms) generate substantial amounts of solid and liquid waste. Abattoirs and poultry houses produce large quantities of slaughter waste.

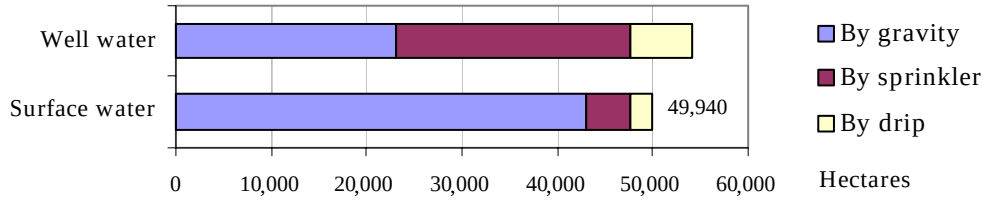
2.2.1 Water consumption

The agricultural sector is by far the largest consumer of available water resources in Lebanon (see Section 8.4 for information on water consumption by sector). While the total land area under cultivation has remained fairly constant during the past decades, irrigated lands have more than doubled, from 40,775 hectares in 1961 to 104,009 hectares in 1999 (MoA / FAO, 2000). This reflects the intensification of agricultural practices (i.e., producing more per unit area). Moreover, the gradual substitution of traditional and wild cultivars with new crop varieties constitutes an added pressure on limited water resources. Compared to traditional crops, new imported varieties usually consume more water and are more drought sensitive. They are also more susceptible to diseases and agricultural pests (see Section 10.2.3 for a discussion of agro-biodiversity).

Irrigation water is provided from both surface and groundwater. Figure 2. 3 reveals that irrigation water is almost equally supplied from surface water and well water (48 and 52 percent, respectively). The number of farms that have private water wells is believed to be increasing rapidly although there are no data on water wells to support this claim. Moreover, many farms have more than one well.

Unimpeded construction of bore wells and water abstraction from wells have led to a significant drawdown of the water table in many regions, particularly in the Bekaa.

Figure 2. 3
Distribution of Irrigated Lands By Water Source and Irrigation Method



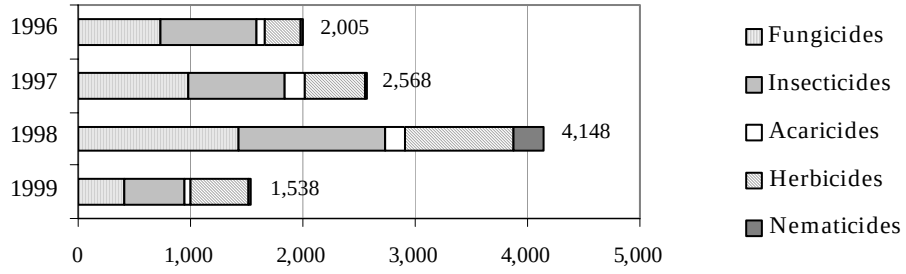
Source: MoA / FAO, 2000

Another concern with the expansion of irrigated agriculture is the high dependence on gravity irrigation. Gravity irrigation accounts for 64 percent of the total irrigated land and is the predominant method of irrigation with surface water. Compared to sprinkler and drip irrigation, gravity irrigation inherently carries high water losses, due to low system efficiencies and high evaporation losses. While efficiency of gravity irrigation could be significantly improved using optimal water and crop management schemes, the majority of farmers in Lebanon lack basic agricultural training.

2.2.2 Agro-chemicals

In 1999, Lebanon imported 1,530 tonnes of pesticides [3] and almost 32,000 tonnes of fertilizers. [4] Fungicides and insecticides represent the largest share of imported pesticides, followed by herbicides, acaricides, and nematicides (see Figure 2.4). Although Lebanon no longer imports a whole range of persistent pesticides (see Section 2.3.2), Lebanese soils are potentially contaminated from persistent chemicals and residues, the result of many years of unrestricted application of dangerous pesticides. Many pesticides that were commonly used in Lebanon contain compounds that persist in the environment for more than 20 years. While current pesticides do not contain such chemicals, they may however react in the soil to produce new persistent compounds that potentially pollute the soil and groundwater.

Figure 2. 4
Annual Imports of Pesticides By Type (Tonnes per Year)



Source: Data supplied to ECODIT by MoA / Department of Export, Import, Control and Quarantine, 2001

Pesticides usually include a combination of active ingredients, surfactants (viscous compounds used to improve the application and distribution of the active ingredients) and inert liquids to dilute the final product. Surfactants and inert liquids are non-toxic and may represent up to 99 percent of the pesticide on a volume basis. It is difficult to estimate the total quantities of active ingredients released into the environment because pesticides have very diverse chemical compositions. Nevertheless, Table 2.6 provides a good indication of the application rates of active ingredients for different types of crops.

Table 2. 6
Pesticide Use Reported in kg/ha or liter/ha of Active Ingredient per Type of Culture

Type of culture	*Cultivated Area*	*Year 2000*	
	Ha	kg / ha	l / ha
Stone fruits	59,515	7.9	2
Citrus		5.9-6.2	n / a
Olive	52,421	5.0	n / a
Tobacco	24,730	10.7	n / a
Sugar beet		8.6	n / a
Vineyards		1.2	3.0-3.3
Banana	n / a	1.1	n / a
Vegetables	45,232	16.7	17.5

Source: ASSPLANT (LEDO Indicator #31)

[3] Data supplied to ECODIT by MoA / Department of Export, Import, Control and Quarantine, 2001
[4] CAS Bulletin No.10 / 2000

Pesticide application is a hazardous activity (see, for example, Box 2.2). Inadequate and / or excessive application has been observed and frequently reported. Although the MoA and several NGOs are focusing more efforts to training farmers on sound handling and use of pesticides, a high rate of illiteracy among farmers remains an obstacle to effective communication and training.[5] For example, illiterate farmers often use excessive application rates because they cannot read the instructions on the labels. Furthermore, many small scale vendors and retailers dilute the pesticide to achieve higher revenues. Since application labels don't change accordingly, farmers may observe reduced efficiencies and resort to increasing application rates based on personal judgment. This unfortunate practice also leads to excessive rates of application. It has also been reported that farmers do not respect minimum withdrawal periods (i.e., crops are sprayed a few days before harvesting). Clearly, the health impacts of such practices are alarming and should not be under- estimated.

Agricultural extension is the responsibility of the Ministry of Agriculture, Department of Agricultural Extension and Guidance. Chronic lack of funds and human resources have limited the Ministry's scale of intervention. Meanwhile, many local (e.g., Green Line, MECTAT) and international NGOs (e.g., YMCA, World Vision) are providing targeted extension programs to local farmers in a variety of agricultural disciplines (e.g., irrigation, biogas production, organic farming, handling of pesticides) and in many parts of the country.

Box 2. 2
Costs and Benefits of Methyl Bromide Use

Greenhouse farmers in Lebanon have long used methyl bromide (CH_3Br) for its unequalled efficacy. According to a field survey conducted in 2000 by the MoE Methyl Bromide Alternatives Project, Lebanon consumed on average about 394 tonnes of methyl bromide per year between 1995 and 1998. Rates of application in Lebanon are commonly high, varying between 80-100 kg / dunum (normal rates of application in other countries range between 50-60 kg / dunum). Unfortunately, methyl bromide is also an ozone depleting substance (depletion potential of 0.6) and poses serious occupational hazards to uninformed farmers. It is banned in many countries including several Middle Eastern countries such as Syria. Furthermore, the use of this non-selective (wide spectrum) agrochemical destroys beneficial soil-borne organisms, such as nitrogen-fixing bacteria, and thus forces farmers to regularly supply their land with organic amendments enriched with microorganisms. Soil amendments are an added cost to the farmer.

Source: *Pers comm* Haroutunian G, Methyl Bromide Alternatives Project, Ministry of Environment, 2001

2.2.3 Grazing

Grazing has long been regarded as one of the main causes of deforestation and land degradation in Lebanon. No study has estimated the carrying capacity of each locality and the distribution of grazing flocks in space and time. However, several factors have recently affected grazing arrangements in Lebanon, providing important clues to assess the overall impact of grazing on plant cover.

[5] Sixteen percent of farmers are illiterate and 61 percent have completed only primary school (MoA / FAO, 1999)

As indicated previously (see Table 2.4), some 800,000 sheep and goats graze in rangeland covering about 40 percent of the Lebanese territory. Rangelands include sparse guarrigue, open forests, and semi-degraded lands. The impact of grazing on plant and forest cover is a function of grazing density and grazing arrangements. Potential impacts include a reduction in total biomass and a decline in the natural rate of regeneration. Potential benefits, however, include natural pruning of oak forests (guarrigue and maquis), reduction in forest fires (as a result of reduced biomass, and when grazing corridors may act as small fire belts), and nutrient cycling.

Although the number of sheep and goats has been fairly constant over the past 20 years, the impact of grazing on the environment is uncertain and a function of grazing management. Table 2.7 summarizes actual interactions between grazing and the environment.

Table 2. 7
Grazing Constraints and Associated Environmental Pressures

Constraint	*Examples*	*Associated Pressure*
Breakdown of traditional grazing arrangements	Municipalities and local village councils traditionally employed communal "guards". These guards monitored grazing and decided on the permissible flock size each season based on the site's carrying capacity	In the absence of communal guards, shepherds graze their flocks without any form of control. They have open access to rangelands that are potentially sensitive to grazing
Encroachment of agriculture on grazing lands. Fragmentation of rangelands	In Arsal, rainfed fruit production has removed a significant proportion of rangeland from ruminant production. Orchards are fenced with rocks, and pastures beyond them are no longer accessible	Flocks are confined to narrower rangeland, which may result in severely degraded grazing corridors
Migration of flocks from Syria	Flocks migrate across the Anti-Lebanon, where rangelands are already degraded and exhibit a low carrying capacity	Grazing density increases causing further biomass erosion in already degraded lands

Source: *Pers comm* Hamady S, Chairman of Department of Animal Sciences, Faculty of Agricultural and Food Sciences, AUB. 2001

In general, these constraints are transforming traditional agro-pastoral systems into more sedentary ones. Whereas some 20 or 30 years it was very common to meet shepherds tending their flock far from home (as much as 150 km), today transhumance pastoralism is very rare. Under more sedentary agro-pastoral systems, an ever smaller proportion of the animal's diet comes from grazing. Today, shepherds and livestock producers provide up to 80 percent of the animals' diet with feed supplements. This development would tend to reduce the pressure on the environment. Moreover, the mad cow scare has also impacted grazing by shifting consumer preference in favor of sheep and goat products, which could reverse the trend away from agro-pastoralism.

Box 2. 3
Restructuring the Ruminant Production Sector

The livestock / ruminant sector is undergoing transformations in response to changes in land use systems. The first *Cooperative for livestock producers* in Lebanon was established in Arsal in 1999, followed by a second cooperative in Deir el Ahmar in 2000. The role of these cooperatives is to reorganize the ruminant production sector by:

- *Securing feed resources*: providing alternative feed from agro-industrial by-product, intercropping (legumes such as vetch under fruit trees), and rangeland rehabilitation (using drought resistant plant varieties such as *Atriplex* sp. and *Arboria* sp. to restore biomass);
- *Improving productivity*: which could encourage farmers to own smaller flocks; and
- *Improving marketing strategies*: developing marketing channels and storage / processing capacity for animal products.

While it is too early to assess the ultimate impact of such cooperatives on the environment, achievements to date are promising and may constitute the framework for reconciling livestock / ruminant production and the environment.

Source: *Pers comm* Hamady S, AUB. 2001

2.2.4 Soil erosion and loss of terraced heritage

Abandoning agriculture is leading to the degradation of agricultural terraces, some of which date back hundreds of years. To conserve water and to prevent soil erosion from washing down the slopes, the Phoenicians crafted the mountains into giant staircases (Zurayk, 1994). Occasionally, forests were cleared to increase arable surface areas, and were transformed into terraced fields. Today, the maintenance of terraced lands is labor intensive and requires communal efforts when carried out on a large scale. Over recent decades, and particularly during the years of conflict (1975-1990), neglect and rural-urban migration lead to land degradation. Terrace walls fail unless properly maintained, potentially leading to very high rates of soil erosion. Little is know on the current state of land degradation and soil erosion due to the abandoned terraces. This concern prompted the GoL to establish the Green Plan, in 1964, with the support of the Food and Agricultural Organization of the United Nations. The Green Plan's mandate includes the protection of erosion-prone lands and the rehabilitation and construction of terraces. This was estimated at between US$4,800 and US$6,400 per terraced hectare (Zurayk, 1994).

2.2.5 Animal waste

Farms produce substantial quantities of animal waste. Some of that waste (especially goat manure) has great economic value and can fetch up to US$60-80 per tonne.[6] Cow manure (dung) is less appreciated but also used by farmers. Local processing plants use animal manure (mostly dung) and other agricultural by-products (e.g., olive cake from olive mills) to produce commercial organic amendments. Local brand names include *Humobacter* and *Dubaline.* Poultry litter, on the other hand, is high in urea nitrogen. Urea-Nitrogen is very soluble and therefore not appreciated by farmers because it may harm the crops. Poultry litter can also harbor disease vectors.

[6] Dry goat manure is usually sold in large wheat sacks (approximately 300 liters) for about LBP 3,000.

2.3 Key Policies and Actions

The agricultural sector is struggling to survive in a competitive regional market. Through loans and grant agreements, the GoL has implemented large-scale irrigation projects that will increase the share of irrigated lands. Also, the MoA has taken steps to ban a long list of hazardous pesticides. However, effective extension programs, use of water-conserving irrigation techniques, and rational use of agro-chemicals (pesticides and fertilizers) are still scant or localized. Moreover, there are no policies or incentives for adequate management of agro-industrial waste by-products such as olive residues from olive mills, litter from poultry farms, and slaughterhouse-waste.

2.3.1 Government spending on the agriculture sector

Between January 1992 and December 2000, the GoL has awarded 89 contracts in the agricultural sector (not including irrigation) worth a total of US$13.6 million. It has awarded an additional 46 projects in the irrigation sector, worth US$51.8 million (CDR, 2001). Contracts include consultancy and design, as well as works and equipment supply. Capital investment in the agricultural sector includes the rehabilitation of the Ministry of Agriculture, land reclamation projects, as well as the rehabilitation of agricultural schools and research stations.

Under the Irrigation Rehabilitation and Modernization Project (IRMP), partially funded by a World Bank loan, distribution schemes have been completed in Qassmieh / Ras el Ain (3,800 ha.), Yammouneh (5,600 ha.), and Akkar el Bared (800 ha.), while others in Dennieh (5,000 ha.) and the south Bekaa (2,000 ha.) are under execution. Together, these projects will cost an estimated US$71 million and potentially will irrigate 17,200 hectares, which may be further expanded to 20,000 hectares. Undoubtedly the most ambitious irrigation scheme to date, Canal 800 will potentially modify the agricultural sector in south Lebanon.

Box 2. 4
The Canal 800 Irrigation Project for South Lebanon

Canal 800 is a series of surface water distribution networks that will irrigate 15,055 hectares of arable land in South Lebanon, stretching from the Qaroun lake to the southern border with the occupied territories. The main distributor (about 56 km) originates at the Taybeh pumping station (from a derivation of the Litani River). An additional 56 km of secondary distribution lines bring the total length to 112 km. The target area is divided into 12 irrigation zones distributed across the Cazas of Marjaayoun (two zones covering 2,569 hectares), Nabatiyeh (one zone covering 1,570 hectares), and South Qassmieh (nine zones covering 10,916 hectares). Canal 800 is designed to supply irrigation water at the rate of 6,600-7,000 m^3 per hectare per season. The project is expected to cost an estimated US$100 million, to be funded partly by the Arab Fund for Social Development (AFSD). Originally an old project design, the feasibility study for Canal 800 is currently being updated and detailed designs are under preparation. Execution of Canal 800 (main distributor, irrigation networks, land leveling) will require at least 10 years.

Source: Nasrallah, 2000 and *Pers comm* Yaktine R, CDR, 2001

2.3.2 Banning dangerous pesticides

In May 2001, the GoL signed the Stockholm Convention on persistent organic pollutants. In 1998, the MoA banned 110 pesticides (Decision 94/1, dated 20/5/98), including aldrin, dieldrin, endrin and DDT, all of which are known to be very potent and persistent in the environment (see list in Appendix C and Section 8.3.3 for information on trace levels of select pesticides in marine and well water, respectively). Customs have been instructed to monitor incoming pesticide shipments and seem to be complying efficiently. The decision however, did not set fines or provide for legal action against offenders.

2.3.3 Safe handling of obsolete pesticides

Pesticides have a limited shelf life, after which the compound usually looses potency or starts undergoing chemical transformations. Improper handling and storage (temperature, sunlight) may shorten the shelf life resulting in obsolete pesticides stocks which need getting rid off. In 1998, FAO supported a project (US$101,000) to assist the GoL to eliminate a stock of 8.5 tonnes of pesticides and train the staff of the Agricultural Research Institute to manage and handle the pesticides stock (UNDP, 2000). No information was available on project implementation or other cases of obsolete pesticides.

2.3.4 Phasing out methyl bromide

Pursuant to the Montreal Protocol (ratified by Lebanon on Sept. 16, 1987) the MoE initiated the Methyl Bromide Alternatives Project in May 1999. This initiative was followed by the ratification of the Copenhagen amendment in December 2000. Funded by the Multilateral Fund (MLF) of the Montreal Protocol, and managed by the UNDP, this project aims to phase out methyl bromide in Lebanon even before the deadlines set by the Montreal Protocol for 2015. The project has demonstrated the efficiency of all available alternatives to methyl bromide over four consecutive growing seasons in 19 sites around the country, totaling 52 greenhouses covering a total area of 20.5 dunums (See Table 2.8).

Table 2. 8
Chemical and Non-Chemical Alternatives to Methyl Bromide

Chemical Alternatives	*Approximate Cost (US$ per dunum)*	*Non-Chemical Alternatives*	*Approximate Cost (US$ per dunum)*
Dazomet	546	Soil solarization	130
1-3, Dicholopropene	300	Bio-fumigation	45-145
Fenamiphos	35-70	Grafted plants	375
Oxamyl	228	Resistant/tolerant varieties	not estimated
Cadusafos	44-88		

Source: *Pers comm* Haroutunian G, Methyl Bromide Alternatives Project, Ministry of Environment, 2001

While researching for suitable alternatives to methyl bromide, the project considered the following factors: (1) effectiveness, (2) cost, and (3) environmental impacts. Whereas the cost of methyl bromide lies between US$ 550-600 per dunum (including purchasing and application costs), all alternatives proved to be cheaper, with costs varying between US$ 130-500 per dunum.

The Methyl Bromide project carried out demonstration trials over four growing seasons, using strawberries, cucumbers, tomatoes and eggplants. Most alternatives resulted in yields almost similar to those obtained with methyl bromide, varying between 85 percent (for strawberries) to 115 percent (for tomatoes). It has been estimated that if methyl bromide alternatives can achieve yields at least equal to 90 percent of the yields obtained using methyl bromide, then the alternatives are economically viable.

Lebanon must document methyl bromide consumption. Previously estimated at an average of 277 tonnes per year, revised estimates put the base line consumption at about 400 tonnes, which could entitle Lebanon to US$1.5 million (US$15 per kg of CH_3Br) of additional aid from the MLF to further support the phase-out of methyl bromide. The challenge will be to promote the use of methyl bromide alternatives based on local conditions and site specificities. For instance, while soil solarization was successfully demonstrated in the low-lying coastal plains of South Lebanon (up to 300 meters), it is unsuitable for greenhouse production in the Bekaa region. This is because (1) soil solarization removes lands from production during the warm summer months (between June and August) and (2) planting in the Bekaa after August would expose late crops to frost occurring in the fall.

Building on the success of the Methyl Bromide Alternatives Project, the GoL recently (November 2001) secured US$4.4 million from the MLF of the Montreal Protocol to finance the Methyl Bromide Investment Project (MBIP). This project will seek the gradual phase-out of Methyl Bromide consumption in Lebanon between 2002 and 2007. The MoE will implement the project in coordination with two partners as follows: the UNDP, to phase out 186.1 Ozone Depleting Potential (ODP) tonnes of Methyl Bromide used in the sectors of vegetables, cut flowers and tobacco at a cost of US$2.6 million; and UNIDO, to phase out 50.4 ODP tonnes of Methyl Bromide used in the production of strawberries, at a cost of US$1.8 million. The MBIP will also develop pertinent legislation to control the import of Methyl Bromide and will provide technical and financial incentives to enable farmers to adopt efficient alternatives.

2.3.5 Land reclamation projects

The Green Plan falls under the authority of the Ministry of Agriculture. The Green Plan was established in the mid 1960s to implement a project for "the improvement of the Lebanese mountains", through land reclamation, irrigation and reforestation activities. *Land reclamation* is a general term used to describe the process of restoring or reclaiming agricultural lands. In Lebanon, this involves building new access roads to agricultural fields (or to link existing agricultural areas), the construction of hill lakes and ponds to capture rainfall and snow water, and the construction of terraces (or rehabilitation of existing terrace walls). Based on its annual report for 2000, the Green Plan has (Green Plan, 2000):

- Provided assistance, either financial or technical, to 1407 farmers;
- Reclaimed 756 hectares of abandoned lands;
- Supported the construction of several earth-lined hill lakes (total capacity of 5.3 million m^3) and cement reservoirs (total capacity 0.5 million m^3) ; and
- Terraced approximately 15,690 hectares. This is equivalent to 6.3 percent of the total surface area currently under cultivation.

In addition, between 1965 and 2000 the Green Plan has constructed more than 235 agricultural roads with a total length of 630 km.

2.4 Outlook

The agricultural sector is in a transition. Its capacity to adapt to changing markets and technologies will depend primarily on how water will be managed in the future. In South Lebanon, after 22 years of occupation, water needs are expected to reach 45 million m^3 per day, to irrigate 4,250 hectares, plus 14 million m^3 per day to satisfy domestic and industrial demand (HRC/IAURIF, 1999). Other means to promote agricultural development may include organic farming and concerted efforts to protect coastal agricultural from urban expansion, especially along the coast (see Box 2.5).

2.4.1 Improving water management

Other things being equal, Canal 800 and the IRMP will convert/add 32,255 hectares to irrigated agriculture. These irrigation schemes are designed to tap surface water resources and may therefore alleviate current demand pressure on groundwater. However, excessive diversion of surface water could reduce base flows further thereby affecting freshwater habitats. This may alter floral association and faunal populations in freshwater bodies. Moreover, any improvement to the irrigation infrastructure in Lebanon must be accompanied by improved water management, as agriculture already accounts for 70 percent of total water consumption.

2.4.2 Revitalizing the agricultural sector in South Lebanon

Increasing water supply for irrigation will not be enough to revitalize the agricultural sector in South Lebanon. Potential obstacles include lack of infrastructure, poor water management and marketing skills, land fragmentation, etc. Table 2.9 summarizes the overall strengths, weaknesses, opportunities and challenges for agriculture in South Lebanon.

Table 2. 9
Agriculture in South Lebanon: Strengths, Weaknesses, Opportunities and Challenges

Strengths	**Weaknesses**
Adequate areas suitable for cultivation Water availability Attachment to the land Agricultural tradition Suitable climate	High cost of irrigation infrastructure Poor technical management Absent commercial channels Land fragmentation Dependence on tobacco agriculture
Opportunities	**Challenges**
Production decline in neighboring countries Strategic position of South Lebanon Organic farming Agro-tourism and agro-biodiversity	Competition from countries with cheaper labor Competition from countries with higher productivity

Source: Adapted from HRC/IAURIF, 1999

2.4.3 Promoting organic farming

Organic farming is not new to Lebanon, since many traditional farmers never used chemical fertilizers and pesticides. Modern-day farmers are introducing organic farming because there is a growing demand for organic and natural produce on the local market. There is also remarkable demand for Lebanese organic products in Europe. This prospect can open tremendous possibilities for Lebanese farmers to export their produce to European markets at favorable prices and hence bypass local competition created by the import of low-value agricultural produce. The underlying difficulty is the lack of a national certification and labeling system for organic produce, which must be certified to contain no chemicals and residues (in addition to meeting other quality standards). The Middle East Center for the Transfer of Appropriate Technology (MECTAT) and Green Line Association (GLA) are each working on developing a certification and labeling system for organic produce, with technical support from the International Federation for Organic Agricultural Movement.

Box 2. 5
Why Protect Coastal Agriculture?

Protecting agricultural fields in the coastal plain of Lebanon is of the greatest interest for the nation at large and more specifically for preserving environmental quality and landscape beauty. Except for the Akkar plain in the north and the Kasmieh plain in the South, the Lebanese coastal strip does not cover any vast expanses of land to grow cereals or industrial crops on a competitive scale. Since competition for agricultural produce is fierce (e.g., Syria and Egypt), only the specialization of high quality agricultural produce can guarantee the survival of the rural economy in Lebanon. Such a type of agricultural specialization can profit from two important assets, water and sunshine, rarely found together in the Middle East.

A high quality and specialized agriculture in the coastal plain is economically viable. The semi-tropical climate, especially in the south, facilitates the production of early export crops as in some neighboring countries (Cyprus exports spring potatoes to Great Britain while Israel produces grapefruit and avocado for the European market). Availability of water enables growing such specialized crops as bananas, apricots and citrus fruits.

Apart from the direct economic benefit of maintaining agriculture in coastal Lebanon, coastal agriculture offers, at minimum, the following long-term opportunities:

- Agriculture, even in urbanized societies, is essential for a balanced and sustainable land use. In coastal Lebanon, the disappearance of agricultural land would lead to reduced water infiltration in the soil, faster runoff of rainwater in the urbanized belt, flooding in the lower coastal plain in case of heavy rainfall, soil erosion, and loss of biodiversity (in case of urban expansion).
- The conservation of agriculture contributes to landscape quality. Today, the coastal belt from Damour, south of Beirut, to Berbara (north of Jbeil) consists of a continuous urbanized belt with various unsightly buildings and eyesores. The long-term preservation of agricultural fields (as well as green areas), especially between agglomerations, will contribute to visual amenity and give a distinct landscape character to the rural spaces between towns.

Existing planning regulations thus need to be refurbished to avoid land speculation and to guarantee the long-term rural land use of existing agricultural fields. In addition to preserving the large agricultural plains of Akkar and Kasmieh, at least 40 percent of land should be earmarked for agriculture, forestry or conservation in unplanned areas.

Source: Adapted from CDR / ECODIT-IAURIF, 1997