

Citrus production in Lebanon

Pre-Feasibility Study of IPM of Citrus

(IAM – Bari)

Zinette Moussa & Abdel Kader el Hajj
LARI – Lebanon
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Introduction

Despite of its small area of about 10,452 square kilometers, Lebanon is typically characterized by an extremely variable range of microclimates due to the complexity in his topography (Figure 1), that changes from one region to another, leading to a big diversity in vegetation and agricultural products.

Lebanon has in general a Mediterranean climate; the costal area is characterized by a rainy winter and a hot summer with high humidity. Frost is occasionally during winter. In Mount Lebanon, which is running parallel to the coast, the temperature decreases as the altitude increases, providing cold winter with more precipitations and snow. Frost is frequent during winter and the summer is less humid. The Bekaa Valley and the Anti-Lebanon Mountains are shielded from the influence of the sea by Mount Lebanon, characterized by less precipitation and low humidity with a wider variation in daily temperatures.

This diversity provides the best condition for growing citrus along the costal area, apple and stone fruit trees in Mount Lebanon, while vegetables, potatoes and grapes are mainly concentrated in the plain of Bekaa.

Citrus is a very important fruit produced in Lebanon and it occupies the first rank in the Lebanese export. But this crop faces many obstacles that affect the citrus production due to old plantation, high production cost, absence of quarantine control, bad agricultural practices, pest and disease problems, improper use of pesticides and fertilizers and lack of postharvest processing. Agriculture sector was neglected for many years by the Lebanese governments, where, less than 1 % of the Government budget is devoted to this sector. In addition farmers tend to intensify the treatments without having satisfied results while increases the level of pesticide residue in fruits and increases the cost of production. These problems result primary from the successive wars that have lead to significant damages to this sector for thirty years.

In this context, it is necessary to study the current situation of citrus production in Lebanon and carry out the major problems in the aim of proposing a solution to improve the quality of the production.

Information was collected from the administrative and technical services at the Ministry of Agriculture MoA (Directorate of Study and Coordination), from Lebanese Agriculture Research Institute LARI, and private institutions. The foreign trade data was obtained from the Custom Service at the Ministry of Economy and Trade. To be noted that the new statistic data of citrus production will be elaborated by the Ministry of Agriculture at the end of this year.

1- Cropping data

According to the last statistic data done by the Directorate of Study and Coordination at the Ministry of Agriculture in 2007, Citrus orchards are located along the coastal zone of about 210 km (Figure 2) and the area of production was estimated by 23 % of the total area of cultivated fruit trees.

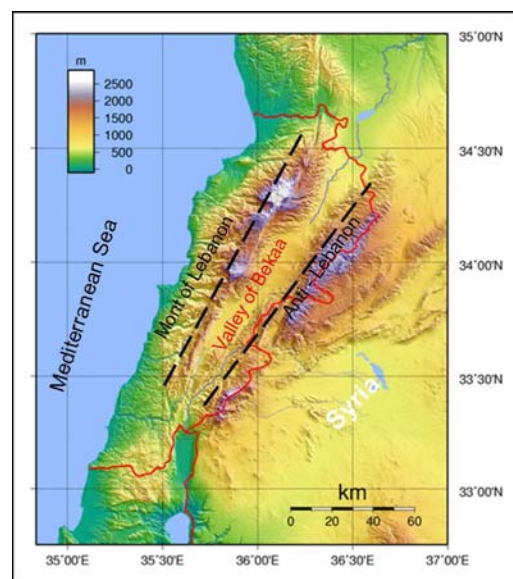


Figure 1. Topography of Lebanon

Citrus are predominant mostly in the South with 65 % of the total area allocated for citrus production followed by the North with a value of 26 %. Nowadays, the area of citrus production is decreasing in the South for the favor of banana production which has better economic revenue.

In the South, Citrus are cultivated mainly in Cazas of Tyr and Sidon reaching 80 % and 73 % of the total area respectively. While in the North, this value reached 39 % in Akkar and 39 % in Zgharta (Directorate of Study and Coordination, MoA, 2007).

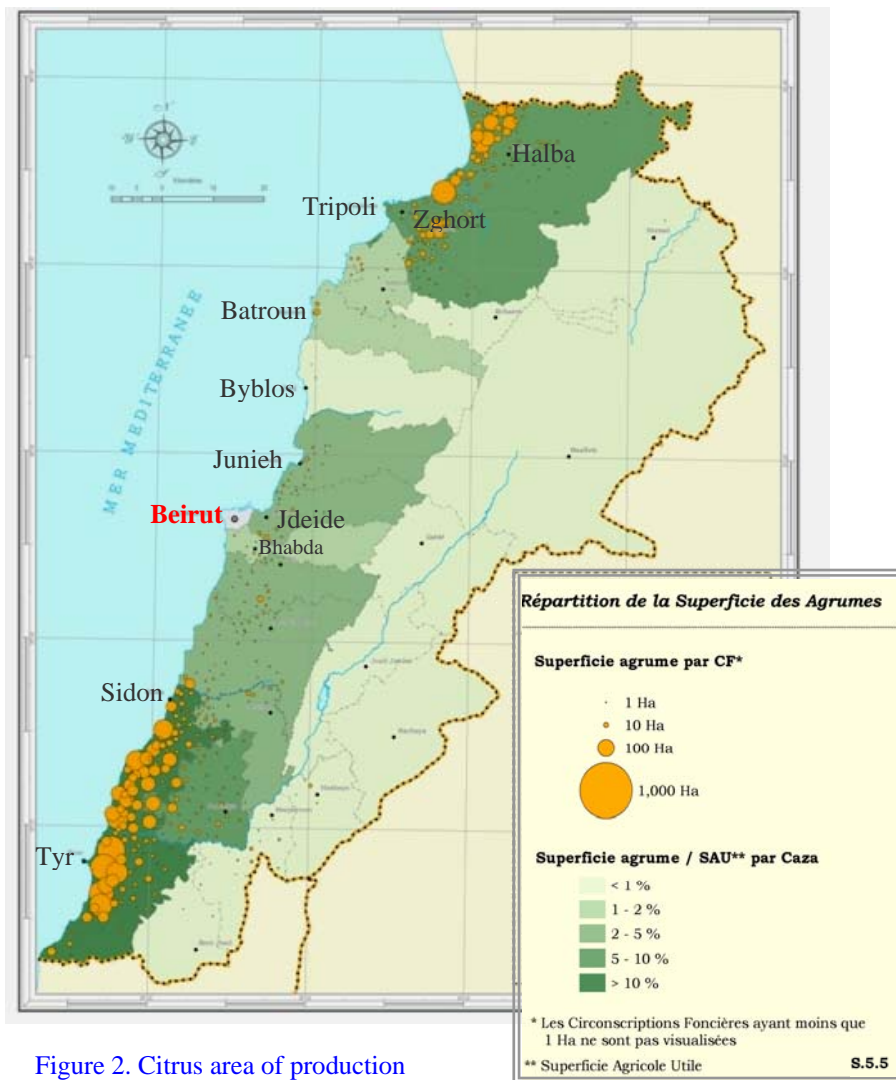


Figure 2. Citrus area of production (Assistance au Ressassement Agricole. FAO. 2004)

Species

Most of citrus varieties in Lebanon are old, they were introduced in the sixties and today they are considered as local varieties. Shamouti is always the most orange variety cultivated (65% of the all orange in Lebanon), followed by Navel Orange and Valencia. Other varieties like Blood Orange and Mawardi Orange, Succari Moghrabi, and Succari Shamouti, Tangelo Minneola are less grown (Table 1). Most of citrus oranges are distributed in the North (Tripoli, Mineh and Zgharta) and in the South between Sidon and Tyr.

Lemon varieties grown in Lebanon are Interdonato, Monachello and Meyer which characterized by their resistance to Mal secco and gummosis diseases. Other varieties can be found in Lebanon with low quantities are Palestine lime, Mexican lime, Lemon Four Season and Femminello. Lemon is mostly cultivated in the Casa of Sidon.

Other important citrus varieties cultivated in Lebanon are Mandarin, Clementine and Tangerine grown mostly in Batroun and few in Sidon (Table 2). The production of Grapefruit and Pomelo is still very low. Kumquat is recently introduced and has proper markets.

Table 1- Most important Orange Varieties in Lebanon

Navel oranges					
Washington Navel	Navel Late	Navelina	Thomson Navel	Lane Late	New Hall
Common Orange					
Jaffa Shamouti	Hamlin	Valencia Late		Valencia Late Olindia	
Blood oranges					
Cara	Washington Sanguine	Ruby	Tarocco	Double Fine	Sanguinelli
Succari oranges					
Succari Moghrabi		Tangelo Minneola		Fortune	

Table 2- Most important Mandarin and Mandarin –like, Grapefruit and others in Lebanon

Mandarin				
Satsuma Owari	Satsuma Mandarin	Temple	Avana	
Clementine				
Nour	Fina	Fedele	Common	Hernandina
Tangerine				
Mediterranean Mandarin		Ortanique Tangor	Commune	
Grapefruit				
Marsh Seedless	Thompson - Pink Marsh	Star Ruby	Red Blush	Ruby red
Pomelo				
shaddock				

Cropping system

Cropping system for citrus production is very old in Lebanon, where trees are planted at a distance of 3 – 6 m. The major rootstock is still the Sour orange because of its resistance to soil diseases. However due to self production of rootstock by the farmer and lack of certified plants, Sour orange showed for a long period, different degrees of resistance to *Phytophthora* and other diseases because the selection of seedling is not made in a proper way. To resolve this problem, a project was established between Lebanon and IAM – Bari to establish a Mother Plot for the production of certified plants.

Other rootstocks also used in Lebanon are Volkameriana, Macrophylla and hybrid rootstocks such *Poncirus trifoliata*, Carrizo citrange, Troyer citrange that were introduced due to their resistance to Tristeza and / or to Gummosis Diseases.

The majority of the orchards are irrigated by furrow. Farmers tend to practice vegetable intercropping especially during the first years of orchard establishment for better land use and income. Some orchards are mixed with banana especially in the South of Lebanon.

Production

Citrus area of production was estimated of about 16.7 thousand hectares in 2007 according to the latest statistic data by the Directorate of Study and Coordination. Production of citrus reached 392 thousand ton in 2007 with a decline in 2006 (374 thousand ton), probably due to the July crisis (Table 3). The most important citrus production is orange with a production of 229 thousand tons in 2007, followed by lemon (114 thousand tons) and mandarin (35 thousand tons) (Table 4).

Table 3 – Production of Citrus between 2005 and 2007

	2005	2006	2007
Productive Area (thousands hectares)	16.5	17.1	16.7
Quantity of production (thousands tons)	392	374	392
Orange	236	231	229
Lemon	113	92	114
Mandarin	31	35	35
Others	12	16	14

Table 4 - Areas and quantity production of citrus between 2005 and 2007.

Citrus crops	2004		2005		2006		2007	
	Area (ha)	Quantity (thousands tones)	Area (ha)	Quantity (thousands tones)	Area (ha)	Quantity (thousands tones)	Area (ha)	Quantity (thousands tones)
Oranges	10,572	234.0	10,244	235.6	10,500	231	10,350	228.7
Mandarin	1,943	39.5	1,750	31.5	1,765	35.3	1,713	34.6
Lemon	3,844	106.5	4,042	113.2	4,200	91.7	4,100	114
Grapefruit	583	15.3	452	11.7	648	16.2	600	15.2

Citrus fruits are mainly considered the most prominent export of agricultural products, reached 155 thousand tons in 2009 for a value of production of 29.2 billion LP. According to customs service, Citrus export recorded an increase of 16.5 % between 2005 and 2009 with a clear decline in 2006 influenced by the July Crises (Table 5 – 6 – 7).

Table 5 – Export Value of Citrus between 2005 and 2009

Citrus Fruits	2005	2006	2007	2008	2009
Quantity of exports (thousand tons)	133	97	162	147	154.9
Value of production (billion L.P)	20.7	15	23.8	24	29.2

Table 6- The quantity of imports and exports of Citrus fruits between 2005 and 2007

	Quantity of exports (tons)			Quantity of imports (tons)		
	05	06	07	05	06	07
Orange	93,508	61,191	116,297	528	1,436	361
Lemon	20,615	16,513	28,020	391	321	365
Others	19,330	19,400	17,677	137	180	141

Table 7- The Value of imports and exports of Citrus fruits between 2005 and 2007

	Exports value (million l.p)			Imports value (million l.p)		
	05	06	07	05	06	07
Orange	14,251	9,233	16,486	424	700	156
Lemon	3,250	2,616	4,427	216	196	315
Others	3,239	3,112	2,885	45	67	65

The main importing countries of Lebanon's oranges were in 2007, the Saudi Arabia (33%) followed by Kuwait (24%) and Syria (19%), the United Arab Emirates (9 % in 2007) and Qatar (6%). These values changed in 2009, where Syria occupied the first class with 24 % of the total exported oranges, followed by Kuwait 21 %, Iraq 18 %, Saudi Arabia 16 %, United Arab Emirates 7% and Qatar 6 % respectively.

Lebanon imports small quantity of citrus, reached 816 tons for a value of 537 billion LP, mainly from Syria with a quantity of 590 tons equivalent to 80 % of the total imported quantity, the other countries are Australia, Brazil, France, Thailand and Spain.

2- Public and Scientific Institutions

The Ministry of Agriculture, Scientific Institutions and Universities are concerned about developing the citrus production in Lebanon (table 8, Figure 3).

Table 8 – Public and Private Institutions working on the development of Citrus production

Institution	Location	Type of activity	Personnel		Facilities
			Number	Qualification	
Public					
Ministry of Agriculture	Beirut	Citrus Committee	1	Agricultural Eng.	Office
		Pesticides legislation	2	Agricultural Eng. Ph Chemistry	Lab
	Nursery and Certified Plants	1	Agricultural Eng.	Nursery	
	Sidon	Plant Protection		Agricultural Eng.	Office
	Tripoli	Plant Protection		Agricultural Eng.	Office
LARI	Tal Amara	Plant Protection	4	1 Ph Virology 3 Agricultural Eng.	Lab (virology / pathology) Lab for rearing <i>Cryptolaemus montrouzieri</i> (under construction)
	Fanar	Plant Protection	1	Agricultural Eng.	Lab (Pest monitoring / Natural enemies) SIT Lab for rearing and release Sterile Male to control <i>Ceratitidis capitata</i> (between 1997 – 2002)
	Abdeh	Plant Protection	1	Agricultural Eng.	Lab for rearing <i>Cryptolaemus montrouzieri</i> (between 1999 – 2003) Pest monitoring
		Mother Plant			Orchard for mother plot
	Kfrarchakhna	Mother Plant	1	Agricultural Eng.	Orchard for mother plot Nursery for certified plants
	Lebaa	Plant Protection	1	Agricultural Eng.	Lab (Pest monitoring)
Tyr	Plant Protection	1	Agricultural Eng.	Lab (Pest monitoring/ Natural enemies)	
	Nursery			Orchard for mother plot	
Private					
American University of Beirut	Beirut	Plant protection Tissue culture			Lab (Pest and diseases) Tissue culture
Chamber of Commerce, Industry & Agriculture	Tripoli Beirut Sidon	Citrus production and postharvest processing			office
Mashatel Lebanon Association		Production of certified plants			Nurseries
Hariri Foundation	Sidon	Citrus packing Production of certified plants			Packing house Nursery



Figure 3. Mapping of Public and Scientific Institutions for Citrus Production

3- Legislation

Citrus Pest and Diseases Quarantine

There is no quarantine control on imported fruits and plants in Lebanon. Nowadays the Ministry of Agriculture is working to organize the quarantine regulations and to prepare the quarantine list for pest and diseases.

Citrus Nurseries

In Lebanon, there are no proper regulations and standards for nurseries. Most of the citrus nurseries are small and unspecialized without any control. Anyone can have his own nursery and sell the material without any quarantine or quality control or certificate of variety true to type.

A CIDAR project was established in 2002 between LARI and CNRS in the collaboration with CIRAD in Montpellier to introduce new varieties and rootstocks from SRA INRA – CIRAD of Corse which are resistance to Tristeza Virus (CTV). 3 new cultivars were planted in LARI in Tyr (Table 9, Figure 4) and grafted on 8 new rootstocks beside the local rootstock the Sour orange.

Table 9- Citrus species introduced through the CIDAR project and cultivated in LARI Tyr

Citrus Rootstock introduced			
Poncirus trifoliata	Flhorag 1	Citrus deliciosa	Volkameriana
Citrumello 4475	Citrus macrophylla	Citrange carizo	Cleopatre
Citrus species introduced			
Citrus limon	Citrus clementina	Citrus orange	
Eureka	Nules	Washington navel	

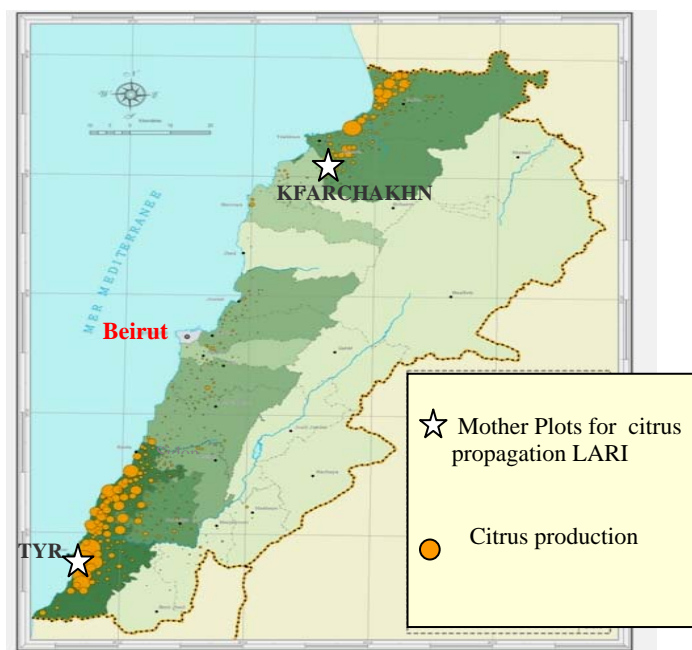


Figure 4. Nursery and Mother Plot for the production of Certified Plant Material for Citrus

Another project for the "**Production and Delivery of Certified Plant Material in Lebanon**" was established between Lebanon and IAM – Bari in 2003 and financed by Italian Cooperation. This project has the priority to provide clean propagating materials to the local nurseries and improve the quality of Lebanese fruit production (Table 10). In this context, new citrus varieties and other fruit trees have been introduced and planted at LARI in order to renew the variety platform of the Lebanese fruit industry and replace the old rootstocks with new ones resistant to viruses and diseases; Citrus Mother Plants were planted only in the LARI station of Kfarchakhna (Figure 4). The adaptation of these varieties to the climate and soil types has been studied also between 2003 - 2007. This project was executed by the Ministry of Agriculture, LARI, and "Mashatel Lebnan Association". Nowadays, those varieties are available at the nurseries of "Mashatel Lebnan Association" the Ministry of Agriculture supervision.

Table 10 – Citrus Varieties for Mother plants grafted on Sour orange and cultivated in LARI – Kfarchakhna in 2006 under "Project for the Production and Delivery of Certified Plant Material in Lebanon"

Oranges							
Navelina VCR	New Hall	Navel Late	Tarocco Nucellare	Lane Late	Valencia Late Olinda	Washington Navel	
Lemon							
Monachello		Femminello Siracusano	Femminello Cerza	Femminello Adamo	Sfusato Amalfitano		
Clementine							
Commune	SRA 63	Spinoso	Clemenules	Hernandina	Rubino	Nour	Fedel
Mandarin		Tangelo		Grape Fruit		Kumquat	
Avana Apirene	Tardivo di Ciaculli	Minneola	Fortune	Marsh Seedles		Kumquat Ovale	

Citrus Plant Certification

"Mashatel Lebnan Association" has the ability of producing certified plant materials to be sold to the farmers.

Pesticides legislation

There are no proper regulations concerning pesticides allowed on citrus to control pest and diseases. However; in 2010 the Ministry of Agriculture generated a list of banned pesticides. In general, all pesticides of High Risk and banned worldwide are not registered in Lebanon.

4- Germplasm collection

Beside the locals varieties, all the varieties introduced to Lebanon under the CIDAR and "Production and Delivery of Certified Plant Material in Lebanon" projects are preserved in the stations of LARI (Abdee, Kfarchakhna, Tal Amara and Tyr) for germplasm collection (Figure 5) .



Figure 5. LARI stations for germplasm collection og citrus varieties

5- Phytosanitary Problems

Pests and diseases were studied and listed by the departments of Plant Protection at LARI and at Faculties of Agriculture of Universities in Lebanon (the Lebanese University, the American University of Beirut, the University of Saint Joseph and the University of Holly Spirit).

Citrus Diseases Problems

Survey conducted on citrus orchards (Table 11), showed that Citrus Tristeza Virus CTV was reported mainly on Washington Navel in the South with low incidence 2.3 % and no decline symptoms were observed in the field. Symptoms of Cachexia and Stubborn were observed in Mandarin and Orange trees with high infestation level of 33% and 10 % respectively, probably they were spread by uncertified plants. Psorose CPsV was observed on Valencia, Shamouti and Washington Navel in old orchards in the north with a frequency of 26 %.

The principal fungal disease reported in Lebanon is the Mal Secco found mainly on Lemon, followed by the gummosis diseases (*Phytophthora citrophthora* and *P. parasitica*) mainly in the South. Other diseases reported with low level are Root Rots (*Fusarium spp*, *Rosellina spp*), leaf spot (*Phyllosticta spp*, *Phoma spp.*), fruit spot and rots (*Alternaria spp*, *Penicillium spp*). Concerning the bacterial diseases, the citrus blast (*Pseudomonas syringae*) was observed with low level maybe because of the unfavorable conditions for the spread of the disease.

Table 11- Citrus Diseases Problems

Pathogens		Diseases		References
Virus and Virus -Like				
CPsV	X	Psorosis	X	Saade, 1996 ; D'Onghia et al, 1998
CTV	X	Tristeza	X	Saade, 1996;
CVEV		Vein enation / Woody gall		
		Concave gum	X	Saade, 1996
		Cristacortis		
		Impietratura		
CEVd	X	Exocortis	X	Saade, 1996
CCaVd	X	Cachexia	X	Saade, 1996
Fungus				
Phytophthora sp	X	Phytophthora gummosis	X	Nienhaus and Saad, 1969
Fusarium sp, Roselina sp		Root rot	X	Nienhaus and Saad, 1969
Phoma tracheiphila		Mal secco	X	Nienhaus and Saad, 1969
Bacteria and Bacteria-like				
Pseudomonas syringae		Blast and Black pit	X	Nienhaus and Saad, 1969
Nematodes				
Tylenchulus semipenetrans	X		X	Nienhaus and Saad, 1969
Phytoplasmas				
Spiroplasma citri		Stubborn	X	Nienhaus and Saad, 1969
		Witches broom		

X = present in the country

Reference: Option Mediterraneennes, Serie B n. 33

Citrus Pests Problems

According to the Lebanese Agricultural Research Institute (LARI) in Fanar (near Beirut), Abdee (north of Lebanon) and Lebaa (south of Lebanon), the Medfly (*Ceratitidis capitata*) is widespread all over the year with 2 peaks; the first is in June and the second is between September and October. Other insects causing serious damages on citrus are the white flies (*Aleurothrixus floccosus*) on Mandarin and (*Paraleyrodes minei*) on Lemon and Orange. Other white flies *Dialeurodes citri* and *D. citrifolii* are less found. Aphids species observed on citrus shoots are *Aphis citricola*, *Aphis gossypii* and *Toxoptera auranti*. The citrus leafminer (*Phyllocnistis citrella*) causes a serious problem in nurseries.

Scales don't cause serious damages. Armored species found on citrus are: *Aonidiella aurantii* and *Lepidosaphes beckii*. Citrus Mealy bugs (*Planococcus citri*) and Cottony Cushion Scale (*Icerya purchase*) are common in the field with low infestation level. New mealy bug species, *Icerya seychellarum* was recently reported in Lebanon by the department of entomology of LARI in Fanar.

Between the mites found on citrus, the Citrus Rust Mite (*Phyllocaptura oleivora*) is the main mite problem on lemon and orange.

Natural enemies, parasitoids and predators, were also studied by LARI and the Lebanese Faculty of Agriculture. On citrus, they are mainly observed on aphids and leaf miner. Due to the excessive use of pesticides in Lebanon, the number of beneficial insects is very low and they are mainly found in organic and abounded orchards.

Actual IPM program for citrus production in Lebanon

LARI is the main research institute that is concerned about conducting studies on citrus production and applying IPM. Departments of Plant Protection, Irrigation, Fruit Trees and laboratories in LARI are well equipped.

An Agriculture Development Project ADP funded by the European Union has recently started in Lebanon. This project executed by LARI is considered the main component of IPM program. The aim of this project is to improve the agriculture sector and the quality of production. SMS alerts are sent to farmers according to










forecast models and monitoring done by LARI staff. Beside, booklets and brochures involves all the good agriculture practices, production techniques, IPM strategies and postharvest techniques were prepared and distributed to the farmers.

In 2010, a citrus committee was established in the Ministry of Agriculture and she involved members from all the public and private institutions listed above in table 8. The main objectives of this committee are to develop a strategy plan to improve the production of citrus and to decrease the use of pesticides. A brochure of IPM program was prepared and it involves all the techniques that farmers must be used to keep the infestation level very low. The committee prepared also a farm record to be distributed to the farmers, this farm record can be used for the traceability.

Ministry of Agriculture has established well equipped laboratories in Kfarchima (near Beirut) to analyze pesticide residues in fresh fruits and the composition of imported pesticides before being registered in the ministry. A laboratory for analyzing pesticide residues is also equipped in LARI.

Despite all the effort done, there is no IPM program applied by the farmers.

Guidelines and strategy to control pests and diseases program on citrus

-  Specify measures to prevent the entry, establishment and spread of quarantine citrus pest/disease
-  Creation and standardization of quarantine measures
-  New legislation rules to organize the propagation of plant material of nurseries
-  Monitoring, survey and inspection of pests in Lebanon
-  Activate the role of Directorate of Agricultural Extension
-  New legislation to control the import and the export of citrus
-  Introduce new rootstocks and new varieties more resistance to diseases
-  Good agriculture practices (good fertilization program, good pruning, irrigation...)
-  Collaboration with national and international organization by providing scientific and technical data and extension material (IAM – Bari)

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