



**Assessment of the status of Plant Genetic Resources
for Food and Agriculture (PGRFA) in Lebanon**

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*Optimizing the Use of Plant Genetic Resources for Food and Agriculture for
Adaptation to Climate Change*

**Food and Agriculture Organization of the United Nations
Ministry of Agriculture**

**Joëlle Breidy
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List of Acronyms

ACSAD Arab Center for the Studies of Arid zones and Dry lands
AOAD Arab Organization for Agricultural Development
AUB American University of Beirut
BAU Beirut Arab University
CBD Convention on Biological Diversity
CGIAR Consultative Group on International Agricultural Research
CITES Convention on International Trade of Endangered Species of Fauna and Flora
FAO Food and Agriculture Organization
GDP Gross Domestic Product
GEF Global Environment Facility
GPA Global Plan of Action
HORTIVAR Horticulture Cultivars Performance Database
IBA Important Bird Areas
ICARDA International Center for Agricultural Research in the Dry Area
ITPGRFA International Treaty on Plant Genetic Resources for Food and Agriculture
IUCN International Union for Conservation of Nature
LARI Lebanese Agricultural Research Institute
LU Lebanese University
MAP Medicinal and Aromatic Plants
MoA Ministry of Agriculture
MoE Ministry of Environment
NENA-PGRN Near East and North Africa Plant Genetic Resources Network
NISM National Information Sharing Mechanism
NCRS National Council for Scientific Research
NGO Non-Governmental Organization
PGRFA Plant Genetic Resources for Food and Agriculture
SPA Specially Protected Area
SPAMI Specially Protected Areas of Mediterranean Importance
UNDP United Nations Development Programme
UNEP United Nations Environment Programme
UNESCO United Nations Educational, Scientific and Cultural Organization
USD United States Dollar
USEK University of Holy Spirit Kaslik
USJ University of Saint Joseph

Table of Contents

Foreword.....	4
1. Lebanon General Features.....	5
2. Crop Diversity in Lebanon.....	7
2.1. Diversity of Major Crops.....	7
2.2. Minor and Underused Crops.....	11
2.3. Wild Edible, Aromatic and Medicinal Plants.....	11
3. Farmers' Seed Sources and Seed Exchange.....	12
4. Seeds' System and Policy.....	12
5. Pre-breeding and Breeding Programs.....	13
6. PGRFA Conservation Practices in Lebanon.....	13
6.1 <i>In-situ</i> Conservation.....	13
6.2 <i>Ex-situ</i> Conservation.....	14
7. Institutions Involved in PGRFA Activities.....	15
8. Laws, Decrees and Legislations Related to PGRFA Conservation and Protection	17
8.1. At National Level.....	17
8.2. At Regional and International level.....	17
9. Networks and Information Systems Related to PGRFA.....	18
10. Threats, Erosion and Loss of Plant Genetic Resources in Lebanon.....	19
11. Needs and Gaps.....	20
References.....	22

Foreword

Plant Genetic Resources (PGR) are a heritage of mankind to be preserved, and to be freely available for use, for the benefit of present and future generations. Hammer *et al.* (1999) defines PGR as to include all species, which contribute to peoples' livelihoods by providing food, medicine, shelter, fiber, and energy. They can be reproductive or vegetative propagating material of cultivated varieties (cultivars) in current use and newly developed varieties, farmer's varieties (landraces), wild and weed species, near relatives of cultivated varieties, and special genetic stocks (including elite and current breeders' lines used in agriculture, medicine, and agro-pharmaceutical industries) (Mooney, 1997; Evenson *et al.*, 1998). Plant Genetic Resources are the foundation for sustainable agriculture and global food security; they also are a reservoir of genetic adaptability, which acts as a buffer against harmful environmental changes and economic challenges (Hammer *et al.*, 1999).

This assessment provides an overview of the current situation of PGR in Lebanon. Information gathered in this assessment is largely based on the the second country report of the state of Plant Genetic Resources for Food and Agriculture (PGRFA) in Lebanon. In addition to updated data, it sets a list of recommendations for a better management of PGRFA in the country.

1. Lebanon General Features

Lebanon, a small mountainous country with a total area of 10452 km², is situated east of the Mediterranean Sea. The country is characterized by its diversified topography with four parallel areas running north-south, from west to east, and generating various eco-systems (Fig. 1):

- a flat, narrow coastal strip parallel to the Mediterranean sea;
- the Lebanon Mountains, a chain with mid-range mountains up to 1000 m above sea level and high mountains reaching 3087 m above sea level at Qurnat al Sawda in northern Lebanon;
- the fertile Bekaa Valley at around 900 m above sea level;
- the Anti-Lebanon mountainous chain, which rises to 2800 m and stretches across the eastern border with the Syrian Arab Republic.

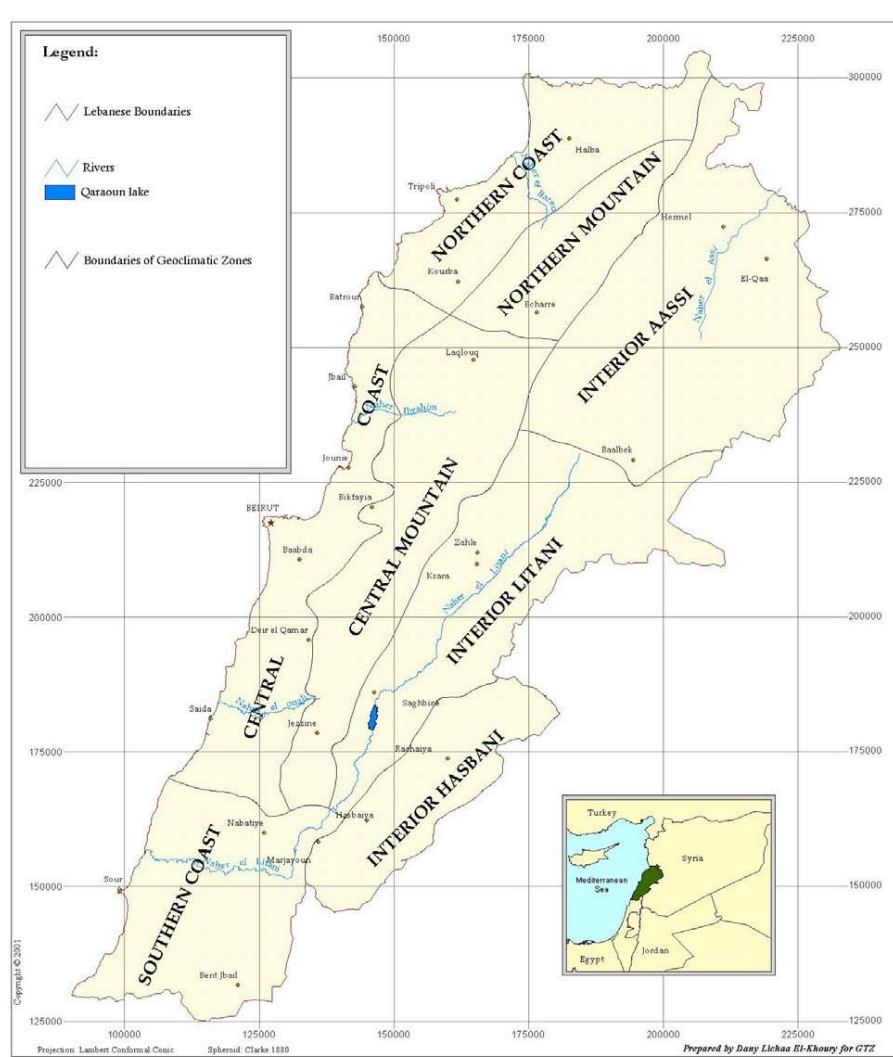


Fig. 1. Geo-climatic zones of Lebanon (Source: National Action Program to Combat Desertification in Lebanon, 2003)

Lebanon is in the heart of the Mediterranean Vavilovian Center, and falls with the Near East Vavilovian center in the pattern of global genetic diversity (Harlan, 1970; 1971). These two Vavilovian centers are of origin for many food crops and belong to the region of West Asia, the cradle of human civilization and including areas where domestication of wild plants may have first occurred (van Zeist and Bakker-Heeres, 1982).

Lebanon hosts a very rich variety of wildlife including many rare and endemic plant species and is home to 1.11% of the world's plant species (Tohme & Tohme, 2007). The Lebanese flora counts about 2,600 species of vascular plants, 8.5% of which are broadly endemic to Lebanon, Syria and Palestine, and 3.5% strictly endemic to Lebanon (92 endemic species) (MOA/UNEP/GEF, 1996). The country notably boasts one of the highest densities of floral diversity in the Mediterranean basin which is one of the most biologically-diverse regions in the world.

The vegetation of Lebanon has an exceptionally high species/area ratio (0.25 species/km²), compared to 0.0044 for Brazil, 0.0021 for Egypt, 0.022 for Jordan, 0.015 for Spain, 0.017 for Syria and 0.011 for Turkey (MOE/UNDP, FNR-CBD, 2009).

Lebanon is located within an area of mega-diversity in terms of important agricultural food crops and pasture species (e.g. wheat, barley, lentils, lathyrus, vetch, medics, clover, almonds, plums, pears, pistachio, onions, garlic).

Moreover, Lebanon is included in the center of diversity for wild relatives of wheat and barley (e.g. *Hordeum spontaneum*, *Triticum urartu*, *T. boeoticum* and *T. dicoccoides*) (Valkoun *et al.* 1998). It is also characterized by its richness in landraces.

Benefits derived from ecosystems are essential to the Lebanese economy. For example, the economic value of forest systems is estimated at USD 131.5 million, with approximately USD 23.5 million/year derived from the harvest of medicinal and aromatic plants from forests, and USD 8.58 million/year derived from the production of 22,000 tons/year of nuts (pine nut, walnut, almond). Other parts of the economy that rely heavily on biodiversity include fishing (with fishermen being among the poorest in Lebanese society), livestock grazing, horticulture, agriculture and ecotourism.

The agricultural arable lands are estimated at 360 000 ha, or 35 % of the country's surface area, but currently, 328 000 ha are cultivated, of which 186 000 ha of annual crops and 142 000 ha permanent crops (MoA, 2010). The main agricultural regions are the Bekaa Valley, accounting for 42 % of the total cultivated area, Akkar Plain (26%), and Marjeyoun Plain (14%). In 1999, the harvested crop area, including both rainfed and irrigated production, consisted of fruit trees (26 %), cereals (22 %), olives (22 %), vegetables (19 %) and industrial crops (11 %). In 2003, the harvested irrigated area was 105 293 ha, half of which (51 %) was in the Bekaa Valley (MoA, 2010). Annual crops represent 77 % of the total harvested irrigated area. The main irrigated crops are cereals (24 %, mainly wheat), potatoes (18 %), citrus (16 %) and vegetables (14 %).

The climate of Lebanon is typically Mediterranean, with heavy rains in the winter, dry and arid conditions in the remaining seasons. The influence of the Mediterranean Sea, the topographic features, and the Syrian Desert in the north create a variety of microclimates within the country. Average annual rainfall is estimated at 823 mm, although this varies from 700 to 1000 mm along the coastal zones, from 1500 to 2000 mm on the high

mountains, decreasing to 400 mm in the eastern parts and to less than 200 mm in the northeast. Precipitation in dry years can be as little as 50 % of the average. Rainfall occurs on 80 to 90 days, mainly between October and April (FAO, 2008).

The total population is 3.58 million (2005), of which around 12 percent is rural.

Agriculture accounts for 6 percent of Lebanon's Gross Domestic Product (GDP) and the service sector for more than two-thirds. The economically active population in agriculture is estimated at 35 000, of which 40 percent is female. The agricultural labor force declined from 25 percent in 1967 to less than 3 percent of the total economically active population in 2005 (FAO, 2008). However, agriculture remains an important source of income in rural areas; most families have agriculture as a part-time activity.

The main agricultural products are citrus fruits, grapes, tomatoes, apples, vegetables, potatoes, olives, tobacco, poultry, sheep and goats. Lebanon is an exporter of fruit and vegetables; it is self-sufficient in poultry but is an importer of wheat and sugar.

According to the last census carried out by the Ministry of Agriculture in 2010, there were 194 829 farm holdings, 87 percent of which had less than 2 ha of cultivated land.

2. Crop diversity in Lebanon

The diversified topography, landscape and ecological zoning of the country lead to a diversified crop production, where more than 80 species for food and agriculture are cultivated (Chalak *et al.*, 2011).

2.1. Diversity of Major Crops

Lebanon produces crops in five major categories: cereals, potato, olive, legumes and vegetables, and fruits. According to the latest data gathered during the preparation of this assessment, we can summarize the percentage of the estimated cultivated area by each of the major crops as follows (Fig. 2): cereals (32 000 ha, representing 10% of the total cultivated area (328 000 ha), potato (18 900 ha, 5.7%), olive (56 800 ha, 17 %), legumes and vegetables (44 500 ha, 14 %), fruits (77 000 ha, 24%), industrial crops (sugar beets, tobacco and others (8 300 ha, 3%) and other crops and trees (11 800 ha, 4%).

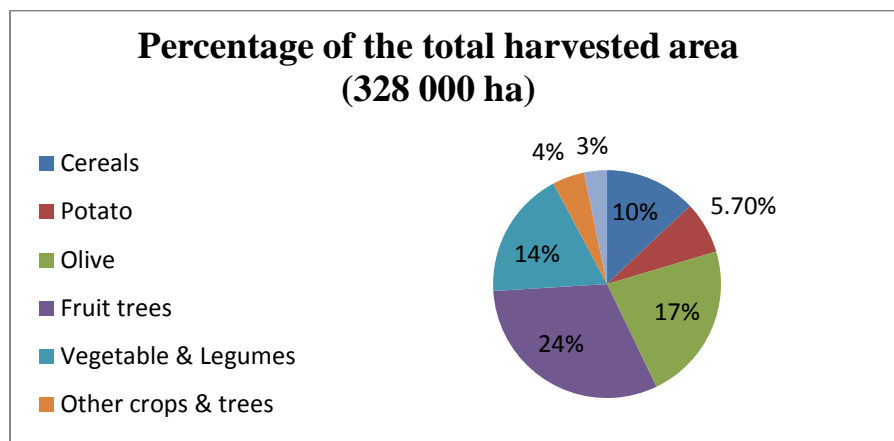


Fig. 2. The percentage of estimated cultivated area for each of the major crops (Ministry of Agriculture, 2010).

Cereals

The most important cereals cultivated in Lebanon are wheat and barley.

According to the Development Plan of Cereals and Legumes in Lebanon settled by the Ministry of Agriculture in 2010, wheat production in Lebanon is estimated at 80 000 tons for a cultivated area of 20 000 ha. Lebanon Wheat Domestic Consumption is estimated at 600 000 Tons, meaning that the local production (mainly durum wheat), is covering almost 13% of the consumption, and the 87% remaining is covered through 520 000 tons imported mainly from Russia, Ukraine, Romania, Kazakhstan, Australia and USA. The State is supporting wheat cultivation as a strategic crop for food security, and to maintain the value of rain fed arable land. Although local durum wheat is only suitable for traditional bread making and local food industry (burghul, freek, kishek, pasta, etc), it remains the only type of wheat cultivated in Lebanon.

Landraces such as Jouri, Bekaii, Salamouni, and Haurani are still used in the main plains (Bekaa and Akkar) by farmers. One variety of bread wheat, Tal Amara 2, released by LARI, and other released varieties of durum wheat, Lahn 2, Lahn 3, Tal Amara 1, Tal Amara 3, Massara, Berdaouni and Ghzayel are widely cultivated.

Barley tolerates poorer soils and lower temperatures better than does wheat. Varieties include with husk and without (naked). Barley is used as a livestock feed, for malt and for preparing foods. The total domestic production in 2013 was reported at 35 000 tons for a cultivated area of 12 000 hectares.

Barley is cultivated in South Lebanon and Northern Bekaa. Landraces such as Roumi and Arabi Aswad are still used, in addition to several improved varieties like Rihan, Assi, Chams and Litani, released through collaborative projects between LARI and ICARDA.

Potato

Potato is considered as the most important field crop in Lebanon. The area harvested in 2009 was estimated at 18 900 ha and had produced 425 000 tons (MOA, 2010).

For French fries, Spunta is still the preferred variety for consumers since many years, while farmers in Akkar plain prefer early varieties such as Synergy and Binella. Agria and Lady Rosetta are the main cultivated variety for chips industry.

Efforts are made to increase the number of cultivated varieties via the introduction of new improved varieties. The production cost in Lebanon is very high and a local seed production system is absent.

Olive

Olives are largely non-irrigated and are grown over 56.800 hectares representing 17 % of the total productive agricultural area. The North Lebanon governorate retains the largest production areas (40%), followed by Nabatiyeh (20%), South Lebanon (18%), Mount Lebanon (17%) and Bekaa (5%). The production in 2009 was estimated at 85 200 tons (MoA, 2010).

Eighty percent of olive production is processed to obtain oil and the remaining twenty percent is used as table olives. Lebanon Olive Oil Production was estimated at 18000 tons for 2013 (Source: United States Department of Agriculture).

Eight local Lebanese olive varieties are widely cultivated, they include: Aayrouni, Abou Chawkeh, Baladi, Soury, Del, Jlot, Kalb el Tair and Teliani. Foreign varieties such as Ascolana, Manzanilla, Picholine and Nabali are promoted, through cuttings by the Lebanese Agricultural Research Institute (LARI). Moreover, LARI is currently introducing new foreign varieties such as Frantoio, Leccino and Pendolino.

An inventory with the characterization of the main Lebanese olive germplasm was published in October 2012 by l'Olio del Libano, an Italian Funded Project, describing the characteristics of the eight above mentioned local olive varieties.

Fruit species

Fruit trees plantation is among principal crops in Lebanon, the area covered by fruit trees is estimated at 77 000 ha (24 % of the total productive agricultural area). Fruit trees cultivation is concentrated in the Bekaa (36%), followed by North Lebanon (25%), South Lebanon (19%), Mount Lebanon (17%) and Nabatiyeh (3%) (MoA, 2010). The most important fruit species grown in Lebanon are citrus, grapes, apples, cherries, apricots, almonds, pears, plums, peaches and banana.

Citrus plantations are estimated at 14 150 ha producing 330 000 tons (MOA, 2010). About 60% of the production is locally consumed, while the remaining 40% is exported to the Arab countries. The Lebanese plantations are constituted of both traditional and improved varieties. The most cultivated varieties of orange are Hamlin, Baladi, Yafawi, Chammouti, Soukari, Mawardi, Valencia, Washington navel, Navelina, Navelate, Tarocco, Lanelate, and New Hall. Those of lemon are Ashouri, Kabbad, Semaani, Saasali, Sabsabi, Eureka, Malti, Meyer, Dona, and Santa Theresa.

Grapes plantations are estimated at 12 025 ha with a production of 108 000 tons (MOA, 2010), of which 40% is exported to the Arab countries. Lebanon grows grapes as an industrial crop for wine making. About 30 local varieties are identified, the most famous of which are Beytameni, Tfayfihiy, Obaideh and Merwah that are used for fresh consumption. Wineries grow French wine varieties such as Cabernet Sauvignon, Merlot and Rhone varieties such as Cinsault, Carignan and Grenache. Currently, grafts are locally produced. About 97 clones have been collected in the country by LARI and their morphological and molecular traits were characterized.

Apples are grown on 11 800 ha, producing about 138 100 tons (MoA, 2010). One local variety, Soukari is grown in Kaa region, while the other cultivated varieties are of the Red Delicious, Golden Delicious, Gala and Low Chill groups.

Cherries are the most cultivated stone fruit in Lebanon. In 2009, 7 510 ha were grown and produced 30 800 tons (MoA, 2010). Plantations are located in high altitude areas (more than 1300 m) and are mainly constituted of traditional varieties such as Teliani (Khamri), Farouni, Soucary, Mkahal (Kaws kozah), Mkahal Aswad, Kalbeltair, Nouwari, Zahr, and Benni,. Fruits are used exclusively for fresh consumption and more than 40% are exported to the Arab countries. This crop is of great interest for the national economy since it is not competing with cherries of neighboring countries and is a luxury fruit. Currently, efforts are made to introduce cultivars and rootstocks.

Apricot is also one of the major fruit crops in the country (5 900 ha, 29 000 tons). Its culture is located mainly in the North of Lebanon and northern Bekaa. Fruits are used for

fresh consumption and in juice and jam industries. Plantations are mainly constituted of traditional varieties such as Ajami, Biadi, Dahabi, and Um Hussein. Modern varieties from Carmingo group were introduced to Lebanon four years ago, among them early and late varieties.

Almond is widely cultivated in the country (6 600 ha, 34 300 tons (MoA, 2010)). Its fruits are mostly used for fresh consumption. Traditional almond varieties are Awja, Halwani libbayn, Firk, Om Omar and Khachabi. These varieties are characterized by early blooming and in certain years may be injured by spring frost, which causes an important decrease in national production. For this reason, new varieties with late blooming period are introduced to Lebanon (Tuono, Texas, Ferragnes, Super Nova).

Pears plantations are estimated at 2 781 ha producing 35 500 tons (MoA, 2010). The Lebanese plantations are constituted of one traditional variety, Miskawi, and many other improved varieties such as Carmen, Coscia, Santa Maria.

Peaches plantations are estimated at 3 200 ha producing 30 500 tons (MoA, 2010). The Local peaches varieties are Chikhany, Aswad Milbis and Aswad Fakch, while the improved grown varieties are of *Prunus persica vulgaris*, *Prunus persica nucipersica*, Clingstone, and flat peaches and Nectarine groups.

Plums plantation is estimated at 1 981 ha producing 23 800 tons (MoA, 2010). The Local plum varieties are Janarek, Abou Riha, Kaysari, Abiad Jabaly, Yazbaki, Abou Maroun and Sariini, while the cultivated improved varieties are Shiro, Black Amber, santa Rosa, Friar, Angelino, Stanley, Reine Claude Verte and President.

Banana is successfully cultivated in South Lebanon (3 325 ha, 96 000 tons (MoA, 2010)) for both local consumption and export to the Arab countries. The local variety denominated Baladi (or Abou Nekta) is the most cultivated one followed by Grande Naine. Fruits are produced in both natural and greenhouse conditions.

Vegetables and Legumes

The main vegetables grown in Lebanon are divided into leafy vegetables such as artichokes (64 ha, 600 tons), cauliflower (1 950 ha, 87 700 tons), cabbage (1 244 ha, 48 900 tons), and lettuce (1 413 ha, 37 400 tons); and fruit-bearing vegetables such as peppers (800 ha, 23 500 tons), cucumbers (3 100 ha, 142 600 tons), eggplants (1 700 ha, 43 000 tons), tomatoes (4 060 ha, 305 300 tons), melons (1 000 ha, 21 500 tons) and watermelons (2 384 ha, 85 600 tons). Common beans (1 420 ha, 14 200 tons) and green faba beans (1 845 ha, 14 800 tons) are also widely cultivated

Potato constituted almost half of the total vegetable cultivation. It is an essential crop important for food security, in terms of consumption and food trade because Lebanon is a net exporter of potato. Tomato is the second most-widely grown vegetable crop, covering 8.8% of the vegetable-cultivated area.

Seeds of all vegetable grown in Lebanon are imported by private seed companies.

2.2. Minor and Underused Crops

Minor crops refer to crops that may be high in value but that are not widely grown.

Underused and neglected crops are domesticated plant species that have been used for centuries for their food, fiber, fodder, oil or medicinal properties, but have been reduced in importance over time. Many fruit trees, vegetables and legumes come under these definitions in Lebanon

Corn has been introduced in the country particularly for feeding livestock and human consumption. Its culture is located in the Bekaa valley but remains limited mainly because of the lack of mechanization and its relatively high irrigation requirements.

Efforts to promote **sunflower** cultures failed due to the lack of oil industry in the country.

Sugar beet has been subsidized by the Government and thus widely cultivated for years. With the suppression of its subsidy in the late nineties, its cultivation area experienced a sudden and sharp decrease from 7 000 ha in 1999 to 55 ha in 2011.

Legumes grown for dry seeds are considered as minor crops, although they constitute a major component of the Lebanese culinary traditions. The most important ones are Chickpeas (1 000 ha, 800 tons) followed by lentils (600 ha, 800 tons) and beans (340 ha, 400 tons). The local variety (Baladi) is used for chickpeas and lentils in addition to released varieties such as Balila and Al Wadi for chickpeas, Rachia, Toula and Talia 2 for lentils.

Many **fruit trees** are neglected and localized in marginal lands or scattered at the periphery of the orchards. This is mainly the case fig, walnut, pomegranate, carob, pistachio, pine, loquat and prickly pear . As for the newly introduced subtropical crops such as avocado and annona, their relative importance is expected to progressively increase in the littoral zone for both local and foreign markets.

2.3. Wild edible, aromatic and medicinal plants

Many plants in Lebanon are collected from the wild to be used as food, spice, condiment or medicine, but they are neglected and almost absent from the priority agenda of the relevant Lebanese Ministries.

The main group of wild plants is the group of edible ones comprising species of *Cichorium*, *Eryngium*, *Gundelia* and *Scorzonera* genera. They are used as salads as well as cooked and snack foods. The second large group is the group of aromatic plants, mainly of the *Lamiaceae* family and they are used as condiments, spices and flavors. The third neglected group is the group of wild fodder plants including species belonging mainly to the *Poaceae* and the *Fabaceae* families.

Wild edible, aromatic and medicinal plants are threatened by the non sustainable harvesting without any consideration for natural regeneration. For this reason, domestication of several species such as *Origanum syriacum*, *Salvia fruticosa*, *Gundelia tournefortii*, *Cichorium* sp., *Malva* sp. and *Capparis spinosa* had taken place. A successful example of wild species domestication is the case of *Origanum syriacum*, which became an interesting crop in many areas of Lebanon mainly in the South and contributed in increasing farmers income and crop diversification.

Recently, efforts to promote the in situ conservation of useful wild species and their sustainable use have been undertaken by few projects that covered species of *Aegilops*, *Allium*, *Centaurea*, *Gundelia*, *Hordeum*, *Lathyrus*, *Lens*, *Malva*, *Medicago*, *Pistacia*,

Prunus, *Pyrus*, *Trifolium*, *Triticum* and *Vicia*. Lately, new markets for “Baladi” (local) products and fairs for diversity rich products are slowly gaining place.

3. Farmers’ seed sources and seed exchange

There is two main sources of farmers’ seeds; informal and formal. The informal source is mainly for traditional varieties, while the formal is for modern and improved varieties.

The informal seed supply is practiced by farmers themselves in conservation of their landraces. These varieties are mainly used for home consumption, but farmers keep some seeds for their own seed stock. The little exchange among farmers of their traditional seeds added to the wide and fast spread of modern high productive varieties is threatening traditional varieties by the risk of extinction through genetic erosion.

The formal seed supply is dominated by the private sector (seeds companies), MoA and LARI for vegetables, fruit trees, cereals and legumes.

Farmers purchase seeds of high-yielding varieties and hybrids of vegetables and corn from seed companies at high prices and couldn't keep seeds to sow next season because most of them are hybrids.

4. Seeds’ system and policy

In 2010, The Ministry of Agriculture adopted a Seed Multiplication Program aiming at procuring to farmers at subsidized prices, treated seeds of improved and released varieties from wheat and barley, and covering the amounts needed to cultivate the harvested area in Lebanon dedicated to these two crops. LARI is the executing agency of this program through its plant breeding and seed multiplication department.

In 2013, The Ministry of Agriculture prepared a National Seed Policy aiming at regulating and developing seed sector in Lebanon, and this by formulating frameworks for the involvement of the private sector in further development of the seed sector for national, regional and international markets, by facilitating access by the qualified seed producers to the new varieties developed by the public research system (LARI) through a highly transparent and competitive procedures, by creating and implementing an efficient internationally - accepted system for variety testing and registration, by rationalizing phyto-sanitary requirements for seed imports, by developing and implementing a regulatory frame-work for seedling production and marketing to ensure access to high-quality and disease-free varieties, by increasing market competition, by promoting agricultural extension to increase farmers’ awareness of the importance of high-quality seed, and finally by developing effective seed certification centre at MoA.

For fruit trees, the production and distribution is predominantly the activity of the private sector (Association Machatel Loubnan). With the efficient efforts of LARI, the ministry developed the production of certified plants of several fruit species such as stone fruits, olive, grapevine and Citrus; also *in vitro* propagation is currently used to produce virus-free root-stocks of stone fruits. In addition, several nurseries have been established in different geographical zones of Lebanon for the local multiplication of major fruit trees such as *Olea europaea*, *Citrus* sp., *Ziziphus jujuba*, *Vitis vinifera*, *Prunus* sp., *Pyrus*

communis, *Actinidia deliciosa* and *Malus communis*. The private sector is also actively involved in the import, multiplication and distribution of the planting materials of new advanced varieties.

5. Pre-breeding and breeding programs

In Lebanon, the characterization and evaluation of plant genetic resources is limited to morphological descriptors and agronomical traits. It has been applied so far to landraces and improved varieties of wheat and barley, fruit trees, field crops and some vegetables. Molecular characterization has only been applied to a limited number of crops.

Few breeding activities had been carried out in Lebanon and were limited to wheat, barley, chickpea and lentil. Six years ago, breeding activities have been stopped, since promising lines (F2) of wheat and barley are sent from ICARDA and ACSAD to be tested for yield at LARI stations, they are subject to selection during 3 years to be later planted on-farm under different agro-climatic conditions and tested for another 5 years. Finally, selected suitable varieties are submitted to registration and are given local names. During the last three years, LARI had registered 4 new released durum wheat varieties and 2 new released bread wheat varieties, in addition to 4 barley varieties.

Regarding fruit species, breeding is restricted to some clonal selection activities that have been recently conducted. Within the framework of RESGEN network (Conservation, characterization, collection and utilization of genetic resources in olive), aiming to conserve and promote local olive cultivars, LARI prepared the passport, the primary characterization and studied some traits of the secondary characterization for 40 Lebanese olive accessions. In addition, LARI studied morphological descriptors and molecular markers for the characterization of local germplasm and improved varieties of some trees (almonds, *Ficus carica* (62 accessions), *Prunus dulcis* (36 accessions), *Prunus persica* (20 accessions) *Vitis vinifera* (48 accessions), *Olea europea* (80 accessions) and *Juniperus* sp.).

An increasing attention is being paid to the wild edible flora which is harvested from its natural habitat and for which domestication attempts are being produced.

6. PGRFA conservation practices in Lebanon

6.1. In-situ conservation

Lebanese laws, decrees, ministerial decisions and resolutions protect most of the nature sites in the country. The sites are classified and protected to a varying degree at the national level, and include nature reserves, protected forests, protected natural sites/landscapes, Hima (local community-based conservation practice). In Lebanon, there are currently 4 Ramsar sites, 5 UNESCO World Heritage Sites, 15 Important Bird Areas (IBAs) (under Birdlife International), 1 Specially Protected Area (SPA) and 2 Specially Protected Areas of Mediterranean Importance (SPAMI).

Large projects related to *in-situ* conservation and sustainable use of biodiversity have been carried out, such as the LARI-UNDP-GEF-Agrobiodiversity project for the Conservation and Sustainable Use of Dryland Agrobiodiversity in the Near East (1999-

2005). This project followed a community-based approach and worked with local communities, farmers and non governmental organizations (NGOs). Focus was given to target crops of global significance for food and agriculture such as wheat, barley and many local fruit trees. Agro-ecological and eco-geographic studies as well as socio-economic, indigenous knowledge, and botanical surveys were conducted in some rural villages. Nurseries and seed-cleaning units have also been established in order to promote in situ conservation (Assi, 2005).

Other projects related to biodiversity conservation and mainstreaming have been initiated, such as the GEF-funded project on “Mainstreaming Biodiversity Management into Medicinal and Aromatic Plants (MAPs) Production Processes in Lebanon” (2009-2013) which aims to integrate conservation objectives into gathering, processing and marketing of globally significant medicinal and aromatic plants.

6.2. *Ex-situ* conservation

Around 1969 accessions from traditional landraces of wheat, barley and forages are conserved at CGIAR/ICARDA gene banks. When another 355 Lebanese accessions of wild and cultivated species are stored in European gene banks.

At the local level, LARI is the only national institution where *ex-situ* conservation is available. In July 2013, LARI's seed bank has been officially launched and assigned as the National Gene Bank of Lebanon. LARI hosts a field gene bank for olive, grapes and stone fruits. More recently LARI seed bank is holding 1380 seed collections representing 950 different wild species stored under long term conditions at LARI seed bank with duplications held at Kew's Millennium Seed Bank of the Royal Botanic Gardens. These collections comprise wild edible, medicinal, aromatic, and endemic species. Among them 87 species are wild relatives of the cultivated crops covered by the Annex 1 of the ITPGRFA (Table 1). In addition, 101 accessions of wheat and barley landraces are also stored at LARI's seed bank and are regularly regenerated every five years.

Table 1. Wild relatives of the cultivated crops covered by the Annex 1 of the ITPGRFA and stored at the national gene bank.

Crop	Species	Accessions number
Beet	<i>Beta vulgaris</i>	1
Brassica complex	<i>Barbarea plantaginea, Biscutella didyma, Brassica cretica, Brassica rapa, Crambe orientalis, Diplotaxis eruroides, Isatis lusitanica, Lepidium sativum, Lepidium spinosum, Raphanus pugioniformis, Raphanus raphanistrum, Raphanus sativus, Sinapis alba, Sinapis arvensis</i>	14
Carrots	<i>Daucus aureus, Daucus broteri, Daucus carota</i>	3
Yams	<i>Dioscorea communis, Dioscorea orientalis</i>	2
Millet	<i>Eleusine indica</i>	1
Pearl Millet	<i>Pennisetum setaceum</i>	1
Solanum	<i>Solanum alatum, Solanum nigrum</i>	2
Sorghum	<i>Sorghum halepense</i>	1
Elymus	<i>Elymus libanoticus, Elymus panormitanus</i>	2

Table 1. Continued

Crop	Species	Accessions number
Forages		
Astragalus	<i>Astragalus cretaceus</i> , <i>A. deinacanthus</i> , <i>A. echinops</i> , <i>A. emarginatus</i> , <i>A. hamosus</i> , <i>A. spinosus</i>	6
Atriplex	<i>Atriplex patula</i> , <i>Atriplex semibaccata</i>	2
Lathyrus	<i>Lathyrus aphaca</i> , <i>L. hierosolymitanus</i>	2
Lotus	<i>Lotus collinus</i> , <i>L. corniculatus</i> , <i>L. tenuis</i>	3
Lupinus	<i>Lupinus digitatus</i>	1
Medicago	<i>Medicago astroites</i> , <i>M. coelesyriaca</i> , <i>M. coronata</i> , <i>M. doliata</i> , <i>M. minima</i> , <i>M. orbicularis</i> , <i>M. polymorpha</i> , <i>M. radiata</i> , <i>M. sativa</i>	9
Melilotus	<i>Melilotus albus</i> , <i>M. indicus</i> , <i>M. italicus</i> , <i>M. sulcatus</i>	4
Salsola	<i>Salsola kali</i>	1
Trifolium	<i>Trifolium angustifolium</i> , <i>T. argutum</i> , <i>T. arvense</i> , <i>T. campestre</i> , <i>T. cherleri</i> , <i>T. clypeatum</i> , <i>T. lappaceum</i> , <i>T. pilulare</i> , <i>T. resupinatum</i> , <i>T. salmoneum</i> , <i>T. spumosum</i> , <i>T. stellatum</i> , <i>T. tomentosum</i> , <i>T. xerocephalum</i>	14
Vicia	<i>Vicia canescens</i> , <i>V. cuspidata</i> , <i>V. palaestina</i> , <i>V. parviflora</i> , <i>V. sativa</i> , <i>V. tenuifolia</i>	6
Poaceae		
Andropogon	<i>Andropogon distachyos</i>	1
Agrostis	<i>Agrostis stolonifera</i>	1
Alopecurus	<i>Alopecurus utriculatus</i>	1
Arrhenatherum	<i>Arrhenatherum palaestinum</i>	1
Dactylis	<i>Dactylis glomerata</i>	1
Festuca	<i>Festuca arundinacea</i>	1
Lolium	<i>Lolium perenne</i>	1
Phalaris	<i>Phalaris aquatica</i> , <i>P. minor</i>	2
Phleum	<i>Phleum graceum</i> , <i>P. pretense</i>	2
Poa	<i>Poa bulbosa</i>	1
Total		87

7. Institutions involved in PGRFA activities

Many public and private institutions, beside several ministries are involved in PGRFA activities in the country, they are the following:

Ministry of Agriculture (MoA): a governmental agency involved in implementing the national Action Plan within the UN Convention on Combating Desertification. It is also involved in protecting and managing forest and its biodiversity, protecting marine life, usage of agrochemicals and their application, animal and plant resources and conserving biodiversity.

Lebanese Agricultural Research Institute (LARI): a governmental organization under the supervision of MoA. LARI is the focal point of the International Treaty on Plant

Genetic Resources for Food and Agriculture and the Commission of PGRFA. LARI has several experimental stations and departments, the most involved in PGRFA activities are the National Seed Bank, The Seed Production Unit, the Plant Breeding Unit, The Seed production Program, the Seed Health and Technology Laboratory and the Plant Biotechnology Department.

Ministry of Environment (MoE): a governmental agency, MoE is the focal point of the Convention on Biological Diversity. Also involved in managing the conservation and sustainable use of biodiversity and natural resources, defining hot spots for biodiversity and identification of threatened animal and plant species, developing appropriate measures to conserve hot spots and important species, raising public environmental awareness, developing and supervising environmental policies and strategies. The MoE currently represents the focal legal entity or National Executing Agency responsible for executing the “Development of a National Biosafety Framework” project and exercising the administrative functions vis-à-vis the CBD secretariat and other parties through the Service of Conservation of Nature.

National Council for Scientific Research (CNRS): a governmental institution having a role in the preparation and updating of the national science policy and programs, offering advice to the government in the fields of science and technology, allocating funds and grants to research development, promoting capacity building and national and international cooperation in the scientific field, conducting research through its four specialized centers (National Center for Geophysics, National Center for Marine Sciences, National Center for Remote Sensing and Lebanese Atomic Energy Commission).

Universities: Several Universities are developing projects and activities related to plant genetic resources such as: American University of Beirut (AUB) through its Nature Conservation Center (IBSAR) which is an academic center that collects, identifies catalogues, creates databases, cultivates, and researches the nutritional, medicinal uses, and applications of endemic species in Lebanon. Other efforts and initiatives are deployed by the Lebanese University (LU), Saint Joseph University (USJ), University of Balamand, Beirut Arab University (BAU) and University of Holy Spirit Kaslik (USEK).

Different International Projects dealing with plant genetic resources: mainly Protected Areas Project (GEF/MOE, 1996-2001), Biodiversity Enabling Activity (GEF; 1997-1998), MedWetCoast Project (UNDP/GEF, 2001-2006), Biodiversity Planning Support Programme (UNDP/GEF; 2001-2002), Conservation and Sustainable Use of Dryland Agrobiodiversity Project (UNDP/GEF/LARI; 1999-2005), Development of the National Biosafety Frameworks (UNEP/GEF/MOE; 2004-2006), and others.

Non-governmental Organizations (NGO's): In Lebanon, there is more than 40 NGO's working on environment protection, understanding and solving agrobiodiversity problems, encouraging on-farm conservation of agrobiodiversity, surveying sustainable use of plant genetic resources, raising public awareness on the importance of agrobiodiversity such as: Association for Forests' Development and Conservation (AFDC) and The Society for Protection of Nature in Lebanon (SPNL).

As to the collaboration with international organization, Lebanon has various cooperative projects with FAO, the International Center for Agricultural Research in the Dry Areas

(ICARDA) and Arab Center for the Studies of Arid zones and Dry lands (ACSAD). For this latest organization, the mission is to face the challenge imposed by the arid and semi-arid environments which are characterized by fragile farming systems through the provision of scientific and applied data and advanced techniques in a way that allows the large-scale implementation of the tasks of the agricultural and social development and the optimum exploitation of the renewable natural resources in the arid areas.

8. Laws, decrees, and legislations related to PGRFA conservation and protection

8.1. At national level

Lebanon has a lot of legislations and regulations indirectly related to PGRFA. These legislations are originally meant to regulate and protect the environment and include the following laws:

Law 256-1994: Framework Convention on Climate Change prepared by the Ministry of Environment, with the objective of promoting in situ conservation of crop wild relatives;

Law 260-1995: Convention on Biological Diversity prepared by the Ministry of Environment with the objective of developing, monitoring, and early warning systems for loss of PGRFA;

Law 469-1995: Convention on combating desertification prepared by the Ministry of Environment with the objective of promoting sustainable agriculture;

Law 444-2002: Protection of the Environment prepared by Ministry of Environment and aiming at the conservation and the sustainable use of biodiversity through the protection of its natural resources.

Within the framework of a UNDP-GEF Top-Up Biodiversity project, the Ministry of Environment with AUB has drafted in 2005 a decree regarding the access and benefit sharing of the genetic resources in Lebanon. This decree will be enacted once approved by the Lebanese council of ministers.

Significant progress has been made recently in terms of PGRFA conservation through the issue in 2012 of two ministerial decisions regulating the wild harvesting of two medicinal and aromatic species (sage and oregano), in accordance with sustainability criteria (time, quantity, method), as well as the terms related to the transport and export of these species. Under this new decision, a permit must be obtained for all sage and oregano collected in Lebanon for commercial purposes.

8.2. At regional and international level

Lebanon has signed several PGRFA agreements and is party of many conventions and protocols related to PGRFA.

Lebanon is Party to the Convention on Biological Diversity Since 15-12-1994 by ratification, to Cartagena Protocol since 05-07-2013 by accession, to the UN Framework Convention on Climate Change (1994), to the UN Convention on Combating Desertification (1995), and to the International Treaty on Plant Genetic Resources for Food and Agriculture (2004). Concerning Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization

(adopted by the Conference of the Parties to the Convention on Biological Diversity in 2010), Lebanon signed it on 01/02/2012 but didn't ratify yet.

To note that as Party to the International Treaty on PGRFA, Lebanon, is committed to provide access to all PGRFA materials listed under Annex I of this Agreement¹, according to the terms set under the Multilateral System of Access and Benefit-Sharing and the Standard Material Transfer Agreement, adopted by the Treaty's Governing Body in 2006. For this reason, LARI as focal point to the ITPGRFA has prepared a national law draft on The Management of Plant Genetic Resources for Food and Agriculture with the assistance of Arab Organization for Agricultural Development (AOAD). This draft notes that the Minister of Agriculture shall be responsible for the implementation of this law while LARI shall be responsible for carrying out its functions.

Lebanon is one of the few countries that have not signed the "Convention on International Trade of Endangered Species of Wild Fauna and Flora" (CITES). This convention is a strong tool for the control over international trade of endangered animal and plant species. Since Lebanon has not ratified CITES, Parties have no obligations towards trade affecting the endangered species of Lebanon.

9. Networks and Information Systems related to PGRFA

Lebanon is a member of The Near East and North Africa Plant Genetic Resources Network (NENA-PGRN) for the sustainable use of plant genetic resources in a regional context. This network with the participation of the institutions representing the countries of NENA Region has developed in November 2011 a draft strategy on the conservation and sustainable use of plant genetic resources in the region.

At the national level, the information systems related to PGRFA active in Lebanon are mainly:

- Horticulture Cultivars Performance Database (HORTIVAR): a FAO's database on performances of horticulture cultivars in relation to agro-ecological conditions, cultivation practices, occurrence of pests and diseases and timing of production. Hortivar is covering six categories of horticultural crops: fruits, vegetables, roots and tubers, ornamentals, mushrooms, herbs and condiments.
- National Information Sharing Mechanism (NISM) on the Implementation of the Global Plan of Action for the Conservation and Sustainable Utilisation of Plant Genetic Resources for Food and Agriculture: A FAO's website featuring a country-driven and flexible process to share information on the implementation of the Global Plan of Action among a wide range of national stakeholders, aiming to improve the efficiency of resource utilization. It includes a list of indicators for monitoring the implementation of GPA at country level, a questionnaire based on such indicators, and a computer application aimed to facilitate and simplify data recording, processing, analysis and sharing of the information addressed by the questionnaire.

10. Threats, Erosion and loss of Plant Genetic Resources in Lebanon

As stated in the second country report on PGRFA, plant genetic resources in Lebanon are facing various threats due to various human activities that may lead progressively to their genetic erosion and loss (Chalak and Sabra, 2007).

The main cause of genetic erosion is the practice of modern intensive farming systems depending on a limited numbers of varieties, and the replacement of local varieties by new improved and more marketable ones.

Other causes include new pests, weeds and diseases, environmental degradation, urbanization, rehabilitation of marginal lands, intensification of agricultural systems, deforestation, over-exploitation, over-harvesting, over-grazing and fires.

The absence of any national rules and legislations encouraging the use of local varieties and traditional species are worsening this situation. In addition, any monitoring system for genetic erosion assessment is absent and thus due to the poor awareness among decision makers about the real dangers of PGRFA loss, and to the lack of skilled personnel, appropriate technology and financial resources (Chalak and Sabra, 2007).

Besides, the displacement of indigenous landraces by new genetically uniform crop cultivars, as well as the habitat conversion and degradation is become a serious factor threatening the PGR in general.

Finally, climate change and drought in particular is gaining more importance in the North East part of Lebanon (LARI, 2013). It may directly or indirectly causes considerable genetic erosion and at times can even drive to a massive destruction of plants (Hammer and Teklu, 2008)

Although National Red Lists for Species in Lebanon do not exist, reports indicate that ninety-six terrestrial floral species, most of which are endemic to Lebanon, are listed as rare or threatened. According to the 2000 IUCN Red List, only *Cedrus libani* is considered an endangered plant species in Lebanon. Specifically, it is denoted “Low risk - near threatened” (MoE, 2010).

Wheat and barley are among the PGR seriously threatened in Lebanon, although they are still considered as important part of Lebanon biodiversity and their importance in the Lebanese agriculture. Many of the Lebanese rural farmers depend on growing their own seeds of wheat and barley in a limited production for family consumption. These farmers live in regions where drought is frequent. Farms of these regions rich by their genetic diversity, landraces and wild species of wheat and barley are the most outstanding for their resistance to biotic and abiotic stresses (especially drought and salt tolerance). Therefore, this diversity is becoming a most valuable source for the sustainable livelihood of the local communities living in those marginal areas.

In order to face these increasing threats, LARI National Seed Bank in collaboration with national and regional collaborative projects, had undertake the initiative to collect and conserve 100 species/accessions including wheat and barley landraces. Additional efforts are needed to enhance further activities related to seeds regeneration and multiplication prior to their use in pre-breeding and breeding programs.

11. Needs and Gaps

As shown from the above, the sustainability of biodiversity and plant genetic resources in Lebanon are seriously threatened by various human activities, market trends and climate change.

With respect to the data analysis presented by the second country report on PGRFA, a set of recommendations are to be urgently considered by the decisions makers in order to promote and to ensure the conservation and the sustainable use of plant genetic resources as a National Priority (Chalak and Sabra, 2007). They are:

- Establishment of a comprehensive national strategy defining the roles and responsibilities of all involved institution in terms of conservation, sustainability and diversification of PGRFA.
- Establishment of a national PGRFA committee responsible of identifying priorities and needs regarding this issue, and of developing a National Program, based on the improvement of institutional capacities in the scientific, research, technical, managerial, and public awareness fields.
- Establishment of a national public PGRFA institution responsible for coordinating all PGRFA activities in the country and to assign to it adequate resources in terms of staff and equipment.
- Development of national laws, legislations and policies for an adequate PGRFA management and exchange, and for the compliance of ratified international treaties and agreements related to plant genetic resources.
- Implementation of appropriate policies and legislations to encourage cultivation of local varieties and traditional landraces in order to diversify the crop production and broaden the crop diversity.
- Assessment of plant genetic resources, *in situ* and *ex situ* conservation, establishment of an appropriate documentation systems to exchange and disseminate information related to PGRFA at the national, regional and international levels or regularly update the NISM database, expansion of plant genetic resources characterization and evaluation of both local and imported varieties and thus by using advanced techniques and by strengthening skills and adopting adequate equipments.
- Enhancement of breeding and seed multiplication programs.
- Support the management of plant genetic resources in a sustainable way in order to face the future challenges of the climate change.
- Amplification and expansion of the national seed bank at LARI, to ensure the sustainability of existing collections, and to establish new collections based on both field and seed gene banks, and ensure cryo-preservation facility.
- Establishment of a legal framework to prioritize the under-utilized crops, local varieties and landraces, to valorize the ethno-botanical heritage and the use of valuable wild plants, and to encourage the domestication of wild edible species and promote their sustainable use.

- Increase the public awareness among key actors of the civil society to better understand the roles and values of PGRFA, and assist small scale farmers in marginal environments to sustainably use PGRFA.

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