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BEST PRACTICES AND TOOLS FOR INCREASING PRODUCTIVITY AND COMPETITIVENESS IN THE PRODUCTION SECTORS: ASSESSMENT OF *ZAATAR* PRODUCTIVITY AND COMPETITIVENESS IN LEBANON

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Preface

This technical report has been prepared by the secretariat of the Economic and Social Commission for Western Asia (ESCWA) as part of its regular programme of work for the 2010-2011 biennium. It draws on field experience accumulated by ESCWA over a number of years, assisting clusters of small farmers in South Lebanon to enhance their productivity and competitiveness through the production of *zaatar*.

ESCWA would like to recognize the contribution of Mr. Jihad Noun in helping to prepare this technical report.

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ABBREVIATIONS

ADR	Association for the Development of Rural Capacities
AFESD	Arab Fund for Economic and Social Development
COLIBAC	*Conseil Libanais d'Accréditation*
DAP	*Deutsches Akkreditierungssystem Prüfwesen*
EFTA	European Free Trade Association
ESCWA	Economic and Social Commission for Western Asia
EU	European Union
FTL	Fair Trade Lebanon
GI	Geographic Indication
Ha	Hectare
IAS	International Accreditation Services, Inc.
IFOAM	International Federation of Organic Agriculture Movements
ILO	International Labour Organization
IPGRI/CWANA	International Plant Genetic Resources Institute, Central and West Asia and North Africa Office
IRI	Industrial Research Institute
ISO	International Standardization Organization
kg	kilogram
LBP	Lebanese pounds
LIBNOR	Lebanese Standards Institution
NL TCs	Lebanese Technical Committees
MOET	Ministry of Economy and Trade
NGO	Non-Governmental Organization
PDO	Protected Denominations of Origin
PGI	Protected Geographical Indications
QUALEB	Quality Lebanon
UKAS	United Kingdom Accreditation Service
UNIDO	United Nations Industrial Development Organization
WHO	World Health Organization

Executive summary

The Arabic term *zaatar* designates a variety of aromatic perennial plants typically harvested from the wild, which generally belong to the *Origanum*, *Thymus* and other genera of the *Lamiaceae* (mint) family. The term *zaatar* is also used to designate the different herb mixes, which in addition to the *zaatar* herb, usually include such other traditional ingredients as grilled sesame seeds, sumac fruits (*Rhus coriaria L.*) and salt. Each country possesses its own *zaatar* mix recipe with specific proportions of ingredients.

Zaatar, whether fresh or dried, is a common item in Mediterranean diets and is witnessing burgeoning consumer demand. As such, its cultivation presents interesting economic opportunities for farmers in selected ESCWA member countries. However, large-scale cultivation and processing of *zaatar* is still very limited in the region. In South Lebanon, interventions by ESCWA and other development agencies demonstrated that *zaatar* cultivation can be pursued as an attractive alternative to subsidized tobacco monoculture and a profitable way to diversify agricultural development and alleviate pressure on wild natural resources.

Opportunities and constraints

Zaatar cultivation presents a number of economic and environmental opportunities for South Lebanon, namely:

(a) Being part of the local Mediterranean ecosystem, *zaatar* adapts easily to the stressful natural environment prevailing in South Lebanon, therefore offering a feasible alternative to the subsidized tobacco monoculture widely available in the area;

(b) *Zaatar* requires low agricultural inputs such as pesticides and fertilizers;

(c) *Zaatar* cultivation is expected to reduce overexploitation of wild *zaatar*, leading to the conservation of its natural biological diversity;

(d) *Zaatar* constitutes an appropriate crop for rural areas that are remote from large cities, since it can be conserved in dried form for up to several months;

(e) *Zaatar* presents important opportunities for income generation and employment creation in rural contexts.

However, a number of constraints may prevent the expansion of *zaatar* production in South Lebanon, namely:

(a) Environmental constraints, the most critical being limited water availability;

(b) Legal and institutional constraints related to small plot sizes, inadequate public assistance programmes, lack of adequate local standards and limited research available about plant selection and improvement;

(c) Financial constraints related to the relatively high initial capital investment needed for large-scale production, fluctuating water pumping costs based on fuel prices and limited farmer access to financing opportunities.

Best practices

Through the implementation and replication of pilot projects involving the cultivation of *zaatar* in South Lebanon, ESCWA has developed a knowledge base of best practices for sustainable *zaatar* production. The following points summarize some of the salient issues to be considered by *zaatar* farmers:

(a) *Zaatar* planting material is better grown in nurseries, rather than uprooting it from wild populations. Direct sowing of *zaatar* seeds in the field is not practical due to small seed size and a relatively long germination period;

(b) Production of seedlings by sowing in nurseries is the simplest and most flexible method, albeit at the expense of genetic heterogeneity. Propagation from cuttings ensures homogeneous genetic material but requires adequate nursery equipment and is restricted to a narrow time window in spring. Micropropagation can also be considered but needs special equipment and knowledge. As such, the selection of the best way of growing *zaatar* planting material depends on existing conditions, taking into consideration the advantages and disadvantages of each method;

(c) Rotation with other crops is needed to avoid depletion of soil nutrients, especially for irrigated *zaatar* production, which allows *zaatar* to be harvested two to three times per year as compared to a single harvest in the case of rain-fed agriculture;

(d) It is important to have well-drained *zaatar* fields through appropriate levelling and land preparation, and avoid lowlands that are close to riverbeds or seashores;

(e) Planting during the autumn season saves more water than planting in the springtime, but exposes seedlings to competition from winter weeds;

(f) Frequent pruning during the first months after planting is important to promote stemming, which is directly linked to increased yield;

(g) Choosing an appropriate irrigation technique and schedule, subject to water availability, is critical for reducing post-planting mortality rates and reaching optimal *zaatar* production in terms of both quality and quantity. Well-calculated scarce watering can allow plants to overcome water stress. While more costly, the installation of a well-designed drip irrigation system is highly recommended for its flexibility and water-use efficiency, and will not affect the essential oils present in the glandular hair of *zaatar* the way that water sprinkling does;

(h) Using the false sowing technique prior to planting, and limiting wet areas around the *zaatar* plants during post-planting watering will help reduce weed germination;

(i) Diseases and pests are scarcely reported on *zaatar* due to its natural repellent characteristics. The adoption of pre-harvest water stress can help cut the cycle of pests which may occasionally appear;

(j) The application of an appropriate fertigation schedule can greatly increase the yield and improve the quality of *zaatar*;

(k) *Zaatar* can be considered as an intercrop in extensively adapted fruit-tree orchards, including olive, grape and fig;

(l) *Zaatar* should be harvested at the appropriate stage, while in full bloom after induction of a three-week water stress and under dry climatic conditions to ensure a final product with good quality;

(m) *Zaatar* needs to be dried soon after harvest to avoid fungal and microorganism development. A shaded, well-ventilated area away from direct sunlight is required for better uniform quality. ESCWA has conceived a pilot drying unit which is light, easily replicable, uses locally available material, and requires no energy input;

(n) Separation of the marketable portion of *zaatar*, mainly the leaves and flowers, after drying, is possible by manual threshing or by beating or scrapping dry stems on wire mesh, a labour-intensive operation. A mechanical thresher conceived by ESCWA is still experimental at the time of the preparation of this study;

(o) Adequate packaging protects *zaatar* from the ingress of moisture and the loss of volatile matter. As for any other product, packaging must comply with national packaging regulations.

Productivity and profitability

Zaatar cultivation, unlike wild *zaatar* harvesting, allows farmers to select the best planting material and control the harvesting period. Irrigation is possible in case rainfall is insufficient, with positive impact on both productivity and profitability. *Zaatar* productivity depends on the variety planted and irrigation practices adopted. The first cut of the season is usually the largest and is usually done in June, while one to two other cuts may be made from late summer to early fall. Yield typically increases over the first three years after planting, growing to around 4.5 tons per hectare, if no limiting factors, mainly related to water, are encountered. Yield is expected to fluctuate from one cut to another within the same year, and also depends on planting density. Generally speaking, for every 100 kg of fresh biomass harvest, almost one quarter, approximately 24.5 kg of dried *zaatar*, can be sold in the market. More research is needed to identify the best *zaatar* ecotypes that maximize both productivity and profitability based on quality.

Zaatar production is a profitable business. Processing of *zaatar* by threshing, grinding and mixing with other ingredients represents value-adding opportunities for farmers and increases *zaatar* profitability. Participants in the projects supported by ESCWA were able to sell dried *zaatar* in bulk at increasingly-higher prices, ranging from LBP6,500/kg in 2007 to LBP9,500/kg in 2009, with prices depending on cleanliness and final quality. Opportunities were also possible for retail sale of ready-to-eat *zaatar* labelled as *baladi* in specialized niche markets for a price as high as LBP25,000/kg.

Productivity and profitability of *zaatar* production may be increased through mechanization. However, given that farmland in South Lebanon tends to be scattered in small parcels, there is reduced potential for large-scale mechanization. Small-scale mechanization such as mechanical threshing is possible, if available equipment is adapted to characteristics of the *zaatar* crop.

Tools for increased competitiveness

As national *zaatar* production increases, competition is also expected to increase. However, new marketing and value-adding opportunities are possible to continue obtaining premium prices for *zaatar* products of high quality.

The adoption of a national quality standard for *zaatar* would help facilitate its national and international trade, encourage high-quality production, and protect consumer interests. While a draft version of the Lebanese *zaatar* standard was provisionally issued in November 2006, laboratory test results of certain *zaatar* samples taken from ESCWA pilot projects demonstrated several flaws in the standard, since a number of these samples turned out to be out of range. Given the diversity of *zaatar* ecotypes, agronomic practices used, and environmental conditions across planting areas, comprehensive sampling is needed to assure full coverage of Lebanese *zaatar* varieties. The development of an essential oil profile is key to determining the specificity of Lebanese *zaatar*. In addition, the availability of standards cannot provide the requested benefits unless appropriate testing and certification services are made available.

Labelling is an important consideration for entry into large supermarkets in the presence of competition. Eco-labels, particularly organic labels, are important for producers to enter niche markets. The production of organic *zaatar* in Lebanon is starting to gain market share, with one private company certifying farmers, processors and traders according to the Lebanese standard for organic farming. Fair trade labelling is also gaining importance in Lebanon, and *zaatar* mixes, labelled Fair Trade, are starting to be more widely available in the market.

The establishment of a *zaatar* geographical indication (GI) will help differentiate the Lebanese or South Lebanon *zaatar* from other types of *zaatar* produced in neighbouring countries, mainly Israel, Jordan, the Syrian Arab Republic and Turkey. Other expected benefits from a Lebanese *zaatar* GI include clustering of small-scale farmers, who would have to collaborate and coordinate in order to benefit from the GI advantage. However, a number of challenges would have to be surpassed before implementing a Lebanese *zaatar* GI, including passing a Lebanese GI law, implementing a quality control system, and creating an appropriate body of specifications in a *cahier des charges*.

Finally, cluster development for large-scale production is expected to increase the competitiveness of *zaatar* cultivation due to reduced infrastructure, operation and maintenance costs. In addition, the production of more homogeneous output enhances consistency and marketability and increases a grower's negotiation position during marketing. However, as group decision-making can be difficult due to lack of group cohesion, signed written agreements with relevant parties can ensure commitment of beneficiaries and availability of resources for the full life-cycle of *zaatar* production.

Next steps

The pilot projects implemented by ESCWA covered *zaatar* cultivation and post-harvest practices, as well as the standard-setting process. Mechanization of certain steps in the production process, such as threshing, to reduce labour costs, was investigated, and steps were taken to enhance the production of complementary goods that could contribute to *zaatar* value or benefit from larger-scale *zaatar* production, namely sumac and honey.

However, further work is still needed to tackle other aspects of *zaatar* production. Therefore, it is proposed that future complementary projects look into additional value-added *zaatar* products such as herbal tea and essential oil extraction, packaging alternatives and in-depth research into suitable *zaatar* varieties with high market value.

Introduction

Zaatar is a popular Mediterranean herb, traditionally harvested from the wild. It is now cultivated in areas throughout the region due to burgeoning consumer demand and increased awareness among small and medium producers of the economic opportunities presented by the aromatic and medicinal plants market. Larger-scale cultivation and processing of *zaatar* can be found in Italy, Spain and Turkey. In south-eastern Mediterranean countries, *zaatar* is a food staple, commonly picked from the wild or grown in backyards for household use. In Lebanon, aggregate consumer preferences and perceptions still view *zaatar* as a wild plant. However, efforts to create sustainable income and employment opportunities in rural and remote areas, particularly following periods of recurring conflict and crisis, has recently led to the pursuit of *zaatar* cultivation as an attractive alternative to subsidized tobacco monoculture and a profitable way to diversify agricultural development in South Lebanon.

The local economy in South Lebanon relies heavily on agriculture and light agro-food production, a sector composed of small-scale producers, offering numerous products. Scale constitutes a major constraint to the competitiveness and market accessibility of these local micro and small enterprises which, in addition, lack the technical and financial means needed to enhance productivity and competitiveness. Lack of income-generation opportunities has led to the exodus of young people from southern villages, which now suffer from demographic disequilibrium.

Furthermore, the political instability that characterized the region during the Israeli occupation had, for decades, isolated the local communities of South Lebanon from other communities in the country. As such, southern farmers have few links with buyers and distributors outside their district, a situation which greatly limits the potential for added value. This chronically-insecure situation, combined with the dependence of these farmers on subsidized tobacco cultivation for the generation of steady income, has led to the neglect of other crops and the lack of agricultural investment initiatives.

In 2004, the United Nations Economic and Social Commission for Western Asia (ESCWA) initiated a collaborative project with the International Labour Organization (ILO) and the United Nations Industrial Development Organization (UNIDO) to conduct an in-depth needs assessment of existing and potential micro and small agro-industries in the areas of South Lebanon that were liberated in May 2000. The purpose of the assessment was to identify one or two products having the greatest potential for income and employment generation based on a set of agreed upon criteria. These criteria examined human resource capacity, income-generation potential in the short-term and long-term, availability and familiarity with production technologies, food safety and conformity assessment requirements, marketing and packaging, investment needs, and the sustainability of the activity from an economic, social and environmental perspective.[1] The assessment concluded that the development of the *zaatar* and honey sectors presented the greatest opportunity for assisting the people of South Lebanon achieve sustainable livelihoods since these products do not require great investment and could effortlessly meet food-safety standards in comparison with other agro-food products such as dairy or meat. In addition, national and international markets are available and accessible.

This technical report thus presents the best practices and tools for increasing the productivity and competitiveness of *zaatar* production based on a series of pilot projects launched in 2005 in South Lebanon as a result of the needs assessment. These pilot projects were implemented by ESCWA with financial support provided by the ILO and the Arab Fund for Economic and Social Development (AFESD). Partnerships were also forged with World Vision International, the Association for the Development of Rural Capacities (ADR) and local municipalities to support the identification of cluster participants, the delivery of training and technical assistance, the installation of equipment, and the establishment of a post-harvest

[1] ESCWA, 2004, *Employment Creation and Income Generation Through the Development of Micro and Small Agro-Industries in South Lebanon: Phase I. Needs Assessment*.

processing facility (see box 1). ESCWA continued to monitor progress and provide technical assistance to the beneficiaries of these pilot projects until 2010.

Box 1. Overview of *zaatar* cultivation pilot projects led by ESCWA in South Lebanon

Zaatar cultivation projects were implemented by ESCWA in the villages of Debel and Ain el-Delb in South Lebanon. Debel is located in the Bint Jbeil district, an area which has limited water resources and farmers' livelihood is highly dependent on agricultural revenues generated through tobacco mono-cropping. The Debel project was launched in 2005 on an area of 1.5 ha with the collaboration of a cluster of 12 farmers including six women. In addition, a nursery for the production of *zaatar* seedlings from seeds and cuttings was established and equipped with an automatic-mist watering system. This nursery succeeded in fulfilling the needs of the project in terms of planting material, in addition to providing a source of income from selling seedlings to other farmers.

Despite the many problems faced in South Lebanon, including the war that destroyed the harvest in 2006, and chronic water shortage, significant agro-economic achievements were reached. The success of this first pilot project encouraged the implementation of another project in the same village in 2008, over an area of 0.85 ha, this time with the participation of a cluster of five farmers, including four women. Other farmers in the area initiated individual cultivation projects of *zaatar* on small parcels near their private homes.

Ain el-Delb is a village located near the coastal city of Saida. In Ain el-Delb, the project approach was extended in 2007 to cultivate *zaatar* as an intercrop in olive orchards. Five beneficiaries were engaged in this project over an area of 0.7 ha of extensive olive orchards.

This report is organized into six sections. It begins by examining *zaatar* and its different varieties and products in chapter I and then proceeds to review the constraints and benefits associated with *zaatar* production in chapter II. Best practices and lessons learned from the pilot projects are elaborated in chapter III, with a focus on production processes associated with the propagation, cultivation and processing of *zaatar*. A productivity and profitability assessment follows with an examination of both fresh and dried *zaatar* outputs in chapter IV. Tools for enhancing *zaatar* competitiveness are proposed in chapter V with a focus on legal instruments and marketing mechanisms for improving the competitiveness of Lebanese *zaatar* products. The report closes in chapter VI with concluding remarks and recommendations based on lessons learned.

I. WHAT IS *ZAATAR*?

The Arabic term "*zaatar*" designates a variety of aromatic perennial and annual plants cultivated or found in the wild, which generally belong to the *Origanum, Thymus* and other genera of the *Lamiaceae*, or mint family. The term *zaatar* is also locally used to designate the different herb mixes, which in addition to the *zaatar* herb usually include such other traditional ingredients as grilled sesame seeds, sesame-seed bran (a by-product of the sesame oil/paste industry), sumac fruit pulp (*Rhus coriaria L.*) and salt. In the eastern Mediterranean region, each country and sub-region possesses its own *zaatar* mix recipe with specific proportions of ingredients. Cumin, chickpeas, corn and wheat are added to *zaatar* in certain villages. Therefore, a specific geographic nomenclature generally accompanies the term *zaatar* to differentiate between recipes, such as Jordanian *zaatar* or Aleppine *zaatar*.

Zaatar is a common item in the Lebanese diet. It is mainly eaten fresh, in salads, or dried and ground in the form of mixes that are combined with olive oil and spread over a pizza-like pastry called *man'ousheh* ("منقوشة" in Arabic). Dried *zaatar* can also be used as seasoning and has become a popular filling to add to French croissants. Known for its therapeutic, camphor-like benefits, dried *zaatar* is sometimes mixed with other herbs to be consumed as herbal tea, despite a taste which is bitter and sharp when compared to other herbs such as marjoram. Essential oils derived from *zaatar* are also reputed to have medicinal properties.

A. *ZAATAR* SPECIES AND VARIETIES

Zaatar species found in Lebanon include mainly *Origanum syriacum*, O*riganum ehrenbergii,* O*riganum libanoticum*, *Thymbra spicata, Thymus syriacus, Coridothymus capitatus, Satureja thymbra* and *Satureja hortensis*.[2] These and other *zaatar* species grow throughout the Eastern Mediterranean region, but mainly in Jordan, Palestine, the Syrian Arab Republic and Turkey. Lebanese *zaatar* products are now exported all year round to the Gulf region and abroad, to service restaurants and the expatriate community. Dried *zaatar* products also enter the Lebanese market from neighbouring countries, but are perceived to be of lesser quality by local consumers. A list of various *zaatar* herbs and their origins is provided in table 1.

TABLE 1. THE DIFFERENT HERB SPECIES COMMONLY CALLED *ZAATAR* IN THE MEDITERRANEAN REGION

Genius	Species	Synonyms	Distribution in Lebanon	Regional distribution
Origanum L.	*O. ehrenbergii*	-	Coastal areas, low and medium mountains	Lebanon (endemic)
	O. bargyli	*O. brevidens* var. *pubescens*	Nonexistent	Syrian Arab Republic (endemic)
	O. libanoticum	*Amaracus libanoticus*	Low and medium mountains, multiple sites	Lebanon (endemic)
	O. syriacum	*Majorana syriaca* (L.); *O. maru*	Mostly spread out, coastal areas, low and medium mountains, multiple sites, Mount Lebanon	Sinai in Egypt (rare), Jordan, Lebanon, Palestine, western Syrian Arab Republic, southern Turkey

[2] *Satureja hortensis* is frequently cultivated as an annual crop and is eaten fresh.

TABLE 1 (*continued*)

Genius	Species	Synonyms	Distribution in Lebanon	Regional distribution
Hybrids	*O.* X *pabotii* (*O. bargyli* X *O. syriacum*)	-	Nonexistent	Syrian Arab Republic
	O. libanoticum X *O. syriacum*	*Majoranamaracus zernyi*, *O. adonidis*, nomen invalidum.	Low and medium mountains	Lebanon (endemic)
	O. X *symeonis*. (*O. laevigatum* X *syriacum*)	-	Nonexistent	Syrian Arab Republic
	O. ehrenbergii X *O. syriacum*	X *O. barbarae*	Coastal areas, low mountains	Lebanon (endemic)
Thymus L.	*T. sipyleus*	*T. squarrosus ; T. serpyllum* L. var. *squarrosus*	Nonexistent	Syrian Arab Republic, Turkey
	T. kotschyanus	*T. serpyllum* var. *kotschyanus*	Nonexistent	Iran, Syrian Arab Republic, Turkey
	T. hirsutus	-	Medium and high mountains	Greece, Lebanon, Syrian Arab Republic, Turkey
	T. decussatus	-	Nonexistent	Sinai (Egypt) Jordan, Syrian Arab Republic
	T. syriacus	*T. lanceolatus* Benth. var. *angustifolius*	Northern Beqaa, Hermon	Iran, Iraq, Jordan, Lebanon, Syrian Arab Republic, Turkey
	T. cilicicus	-	Nonexistent	Syrian Arab Republic, Turkey
	T. alfredae	-	Nonexistent	Syrian Arab Republic (endemic)
Coridothymus	*C. capitatus* L.	*Satureja capitata* L.; *Thymus capitatus* (L.); *Thymbra capitata*	Coastal areas and low mountains	Mediterranean area, Portugal, Syrian Arab Republic
Thymbra L.	*Thymbra spicata* L.	*T. verticillata* L.	Coastal areas, low and medium mountains, Hermon	Greece, Lebanon, Mediterranean area, Palestine, Syrian Arab Republic
Satureja L.	*S. pallaryi*	-	Nonexistent	Syrian Arab Republic (endemic)
	S. cuneifolia	-	Medium mountains	Balkans, Italy, Lebanon, Spain, Syrian Arab Republic, Turkey
	S. thymbra L.	-	Coastal areas, low and medium mountains	Crete, Greece, Lebanon, Palestine, Sardinia, Syrian Arab Republic, Turkey
	S. hortensis L.	-	Only cultivated	Not present in wild form in the region

Source: Compiled by Jihad Noun for ESCWA from different sources, but mainly from Mouterde, P.S., *Nouvelle flore du Liban et de la Syrie*, volume III, 1983.

It should be noted that this report focuses only on varieties of the species O*riganum syriacum* in view of the extensive experience that ESCWA has gathered working with this species of *zaatar* and its wide availability in Lebanon. The two varieties present in Lebanon are *O. syriacum* var. *syriacum*, found mainly in the southern part of the country and *O. syriacum* var. *bevanii*, found mainly in the northern part. Both varieties can be found in the central part of the country and, though both are harvested from the wild, their cultivation was also recently promoted.

B. *ZAATAR* PRODUCTS

There are several marketable products derived from *zaatar*, the main categories being fresh *zaatar*, dried *zaatar* and essential oil. As shown in table 2, each of these categories has its own destination market and use.

TABLE 2. DIFFERENT *ZAATAR* PRODUCTS AND THEIR CORRESPONDING MARKETS

Zaatar product	Used plant part	Final marketable form	Destination market and use
Fresh herb	Tender young leafy shoots	Whole fresh shoots, grouped in bunches	Local fresh produce markets in neighbouring cities, restaurants
Dried herb	Leaves and inflorescences	Ground *zaatar*, pure or mixed with other ingredients	Local and export markets, mills, bakeries (*man'ousheh*)
Essential oil	Leaves and inflorescences	Extracted essential oil or water	Export market for the pharmaceutical, cosmetic and food industry

1. *Fresh zaatar*

Fresh *zaatar* consumed in salads is composed of tender leafy shoots having a length of 10-20 cm. Its taste is sharp and spicy. As a leafy vegetable, fresh *zaatar* is sold in bunches of approximately 200grs each. The main seasons for fresh *zaatar* consumption are autumn and winter. In summer, fresh *zaatar* is difficult to market, especially with the dominance of other leafy vegetables and many other cultivated herbs, for example, purslane, parsley, mint and rocket. In fall and winter, fresh *zaatar* is more acceptable to the consumer, since rainfall increases the fresh biomass and reduces its concentration in essential oils and its taste becomes milder. However, harvest of fresh *zaatar* should stop in early spring, the pre-blooming period, even if the market is still receptive. Otherwise, the yield of dried *zaatar* to be harvested during the following months of June and July, and destined for dried-*zaatar* mix production, would be threatened, as physiologically, the plant would not have time to recover its blooming biomass.

Zaatar seedlings also constitute a marketable fresh product, their importance stemming from the increased trend to cultivate *zaatar* rather than harvest it from the wild. Grown in greenhouses from seeds or cuttings, they ensure the sustainability of *zaatar* production (see section A of chapter III).

2. *Dried zaatar*

Dried marketable *zaatar* is composed of dried leaves and inflorescences. The whole aerial biomass of the *zaatar* plant is harvested, preferably during full-blooming stage, and dried. The dried *zaatar*, including woody stems, may be sold wholesale to companies that further process it by de-leafing, grinding and mixing with other ingredients. Farmers willing to de-leaf and grind the *zaatar* themselves may be able to increase their profits by selling to either wholesale or retail markets at higher prices.

The main harvest for dried *zaatar* production is during June and July. Should another cut be collected later in the summer, it will contain fewer flowers than leaves and would be of lower quality. In case systematic watering is practiced in the field, the induction of a water stress on the plants by stopping irrigation three weeks prior to harvesting increases the concentration of essential oils and reduces the water content in the harvested parts, thus increasing their quality and marketability.

Dried *zaatar* is sold in the Lebanese market in a number of forms:

- As pure ground *zaatar* to be used for seasoning;
- As *zaatar* mix, including for example:

- *Zaatar* for *man'ousheh*: Ground *zaatar* is mixed with proportions of sumac, salt and sesame;
- *Zaatar moughannaj*: Ground *zaatar* is mixed with proportions of *kaak* (crumbs), ground chickpeas and other ingredients. This product is not used in *man'ousheh* but rather as seasoning.

Zaatar for *man'ousheh* is the main marketable form of dried *zaatar*, as the market for *zaatar moughannaj* and *zaatar* for seasoning is of limited size.

3. *Essential oil*

Essential oil is a volatile, aromatic compound extracted from the aerial part of the *zaatar* plant, and is mainly concentrated in the hairy glands on the leaves and flowers, since woody stems have little essential oil content. The extraction can be done directly from freshly-harvested matter or later, after proper drying. However, improper drying may reduce the content of essential oil, which may evaporate if dried at temperatures of more than 35°C. Extraction is done by hydro-distillation or by steam distillation. The yield varies based on genetic and environmental factors. Essential oil content is considered good if it reaches 2-7 per cent of dry matter. Extracted essential oil should be stored away from sunlight in dark bottles and in a cool area.

The essential oil profile of *zaatar*, composed of phenolic compounds, depends on its variety and various production and environmental factors. Not all profiles have the same market value. Consequently, it is important to test and know market needs in order to produce the requested profile and be competitive in the market. Carvacrol and thymol are the two main phenolic, monoterpenic compounds responsible for the unique taste of *zaatar*. They constitute more than 85 per cent of the oil content depending on the variety. For dried *zaatar*, rich in inflorescences, carvacrol is the main constituent, rather than thymol. The concentrations of both compounds in *zaatar* are inversely related: when carvacrol concentration increases, thymol concentration decreases and vice versa. Carvacrol reaches its highest concentration during full blooming. This is an important factor to be taken into consideration when deciding on a harvesting period that will yield *zaatar* of the best quality. Smaller amounts of other secondary compounds, such as cymene and terpinene, can also be found and the complete essential oil profile contains more than 40 different compounds, each one having an impact on taste.

II. CONSTRAINTS AND BENEFITS ASSOCIATED WITH *ZAATAR* PRODUCTION IN SOUTH LEBANON

South Lebanon is characterized by a Mediterranean climate with rainy winters and a dry season that runs from mid-April to mid-October. Rain-fed agriculture dominates South Lebanon, since irrigation water is scarce. For decades, while instability prevailed in the area, the main crop was, and still is, tobacco. Tobacco cultivation is considered as a main household activity, its feasibility stemming from its low-water needs and its suitability to the area's climatic and soil conditions. In addition, it is subsidized and regulated. Over the years it has become a monoculture crop, grown every year on the same plots, due to the limited potential for expanding cultivated areas as a result of population encroachment on arable land. Water scarcity in the region also limits the possibility of rotating it with other more productive and more sustainable crops.

A. CONSTRAINTS TO *ZAATAR* PRODUCTIVITY AND COMPETITIVENESS

1. *Limited water availability*

Despite the fact that *zaatar* thrives in dry environments, its full potential under cultivation cannot be achieved in reasonable time unless a minimum consumption of 2-5 mm of water per day, an equivalent of 20-50 m^3/ha/day, is ensured during its vegetative growth over the summer months.

At present, this amount of water is not available at most potential sites. Therefore, farmers are obliged, in certain areas, to restrict watering to the minimum amount required to keep plants alive, also referred to as survival watering, instead of watering for full capacity growth. This is important, as in certain cases, water is brought by truck, incurring high transportation costs which make delivering the full amount of water for vegetative growth prohibitively expensive.

2. *Legal and institutional constraints*

(a) *Plot size and contracting arrangements*

Land fragmentation is an important impediment to large-scale agricultural production in South Lebanon. Farmers wishing to produce *zaatar* on a large scale need to sign long term agreements with many landowners to ensure that sufficient land will be allocated to *zaatar* cultivation over the life of this perennial crop.

In addition, rental agreements of agricultural land in South Lebanon are typically verbal in nature and have a short duration, usually one year, for tobacco cultivation. Short term contracts, on an annual basis, are not adequate for the production of *zaatar*, which is a perennial crop, lasting for up to eight years. Written agreements would have to reflect this fact if there is any hope to amortize and make a profit on initial investment. Unfortunately, landowners don't like to engage their lands for such a long period. This fact is complicating the arrangements between farmers and landowners.

(b) *Inadequate public assistance programmes*

The production of medicinal and aromatic plants, especially *zaatar*, is not receiving the government attention it deserves, as a result of limited capacity and resources. This fact has also been the leading cause of the non-sustainability of certain development projects executed by local and international NGOs or agencies. This is especially true, as some of these projects were limited in time and fund availability. While certain local partners were occasionally able to continue projects on their own, without Government support, these initiatives are limited.

(c) *Lack of existing quality standards*

An initiative to develop a Lebanese standard for *zaatar* has faced many conceptual and technical problems. In 2006, a set of standards was agreed upon, but these have proved inadequate to Lebanese *zaatar*, both cultivated and wild, though they seem to satisfy *zaatar* importers and traders. These standards need to be revisited to represent the diversity of *zaatar* crops, cultivated and harvested throughout Lebanon or imported (see chapter V of this document for a detailed discussion of the Lebanese *zaatar* standard).

(d) *Inadequate legal context*

Harvesting of wild *zaatar* is regulated in Lebanon, out of concern that rampant harvesting from the wild would destroy species endemic to Lebanon. A Lebanese decree[3] limits harvest to the period extending from the 1st of August to the end of December of each year, on the condition that *zaatar* plants are not removed with their roots. Now that *zaatar* is being cultivated for the local market and for export, a decree should be adopted to liberalize the trade of cultivated *zaatar* and be more restrictive of *zaatar* harvested from the wild, in order to protect the natural habitat and allow for recovery of wild plants. Practically, this could be achieved through an organization similar to the *Régie Libanaise des Tabacs et Tombacs*, which would be responsible for giving licenses to farmers and estimating the production to be traded later, accordingly. For the wild harvest, it could identify harvesters and harvesting mechanisms through a license system and determine the total annual amount of wild *zaatar* allowed, according to available quantities and the number of harvesters for a given area.

(e) *Limited research available about plant selection and improvement*

Scientific research on *zaatar* started relatively recently in Lebanon[4] and little development effort has been exerted to address the wide range of problems hampering the cultivation of *zaatar*. An effective medicinal and aromatic plants research and development programme is particularly needed, in order to identify the various Lebanese *zaatar* chemotypes, including their active essential oil ingredients, which determine the different aromas and tastes of *zaatar*. Increasingly, the importance of *zaatar* production is being recognized and the number of studies and research initiatives are increasing, especially those related to the establishment of standards for industrial production.

3. *Financial constraints*

(a) *Limited access to finance*

Generally speaking, there is a chronic problem of under-investment in the agricultural sector in Lebanon, especially in the South, due to the high risk of instability, which is threatening all development efforts. Farmers are unable to make long-term commitments and investments due to this instability. However, new investment initiatives are being introduced that seem promising. Among these, is the *Kafalat*,[5] which is a Lebanese financial company with a public concern, that guarantees loans provided by banks and/or subsidizes the interest rate charged for various projects, including agricultural projects. Such programmes are important, as the few financial institutions involved in the agricultural sector try to minimize their potential financial losses by setting high interest rates, which have a deterrent effect on farmers, particularly as there are no agricultural insurance companies with which they could share risk. Financial institutions view farming as a risky business because of a number of prevailing conditions, including the following:

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[3] Permission to export *zaatar* and *mariyamiah* (sage). Lebanese decree No. 1/340, 1996.

[4] First domestication research studies were undertaken in 1999 by the International Plant Genetic Resources Institute, Office for Central and West Asia and North Africa (IPGRI/CWANA).

[5] Kafalat, www.kafalat.com.lb.

- Uncertain political climate;
- Poor socio-economic situation of most farmers;
- Poor feasibility studies of projects especially among small farmers;
- Poor access to a credit system by small farmers;
- Doubtful implementation of applicable agricultural standards by farmers.

The *Kafalat* relies on the availability of sound business plans and well-prepared feasibility studies, which have to show the viability of the concerned project before granting loan guarantees. Currently, the *Kafalat's* programmes are not well understood by farmers and there is a lack of proper dissemination of related information by both the *Kafalat* and the banks.

(b) *Cost of initial investment for large-scale production*

As previously mentioned, *zaatar* is a perennial plant, which remains productive for at least five years. As such, the soil requires thorough preparation and maintenance to ensure optimum crop conditions. Investing in drip irrigation infrastructure is required, in order to ensure the efficient use of water, especially as the area is relatively dry. As a result, the initial cost of infrastructure, seedlings and preparation of the soil tends to be high, particularly the first year, thereby making project start-up relatively difficult, especially for small farmers.

B. BENEFITS ASSOCIATED WITH *ZAATAR* PRODUCTION

1. *Natural resource benefits*

(a) *Crop diversification on marginal and degraded land*

Fields in South Lebanon have been planted with tobacco for decades, as it was considered to be the most secure crop for the area, from both agronomic and socio-political viewpoints. This monoculture system lead to nutrient depletion, productivity reduction and an increase of soil-borne diseases and other agricultural problems related to tobacco. The introduction of *zaatar* will prove beneficial as a rotation crop, which should alleviate soil-nutrient depletion by favouring the exploitation of a different soil layer, as a result of the different rooting system and nutrient requirements. Crop rotation will also help break the pest cycle. The introduction of cultivated *zaatar* is, therefore, an important step towards sustainable diversification of agricultural production and preservation of the natural resources of the area.

(b) *Appropriate crop for remote rural areas*

The main marketable product of *zaatar* cultivation, the dried herb used in the food industry, does not require refrigeration and can have a long shelf life if properly stored. As such, *zaatar* is considered an appropriate, high-value product for villages which are remote from large cities and which suffer from power outages. However, only farmers in villages that are close to urban agglomerations can feasibly market fresh *zaatar*, as it needs to be delivered to markets daily.

(c) *Conservation and expansion of the benefits of biological diversity*

To date, wild *zaatar* is the only source of *zaatar* in the market and could be over-exploited, at times, to compensate for swings in revenue. With the introduction of cultivated *zaatar*, farmers will have a more reliable source of income, resulting in the protection of the wild *zaatar* species. The introduction of high-yield and better-adapted genetic material will provide additional agro-economic benefits. This should relieve the pressure on wild *zaatar* species which would then be conserved as a source of genetic material for further improving cultivated *zaatar* varieties.

2. *Income and employment benefits*

Until recently, the only source of income for most farmers in the region was the production of tobacco, which is sold to the *Régie Libanaise des Tabacs et Tombacs*. The *Régie* is a monopoly, which fixes prices at which tobacco will be bought from farmers. The price in 2009 varied from LBP6,000 to 12,000/kg depending on the quality of leaves. One of the advantages of this system for farmers is that, for socio-political reasons, prices are highly subsidized, as they are set by the Lebanese Government at higher levels than prevailing international tobacco prices. The other advantage is that the entire production is sold to only one entity and that farmers are fully paid within a few months of the end of the cropping season. This allows farmers to plan ahead of time, notably regarding the repayment of debts incurred during the production season. As such, the tobacco business is perceived by farmers to be highly advantageous compared to other crops. It should be kept in mind, however, that tobacco subsidy cannot continue indefinitely, making its cultivation unsustainable in the long term.

Zaatar cultivation is, therefore, appropriate for income diversification and the generation of supplementary income for rural households in South Lebanon. Indeed, farmers have some leeway in negotiating the best prices, as *zaatar* products are non-perishable. As such, revenues generated will complement revenues obtained from other farm enterprises, including growing tobacco, and fill the gap in the farmer's budget. Consequently a combination of *zaatar* and tobacco cultivation should greatly improve the livelihood of the rural population by diversifying their sources of revenue.

The development of quality standards and the promotion of biodiversity-conscious conservation measures for wild *zaatar* will support cultivation efforts, in order to meet market demand. This will enhance consumer receptivity to cultivated *zaatar*, while protecting farmers and as such will favour the further expansion of the *zaatar* production chain and attract new investment to the sector.

3. *Building on a traditional knowledge base*

While harvesting and processing wild *zaatar* is a traditional practice, cultivating *zaatar* is a new skill that local communities are acquiring through various capacity-building efforts and technical assistance provided during the implementation of ESCWA-supported projects. Through these projects, producers have the opportunity to learn from experts about the best agricultural practices that respect the environment, preserve natural resources and protect public health, including recommended levels of agricultural inputs such as water and fertilizers. These skills are taught to farmers in the field, preferably using available local resources and expertise so that the knowledge can become better rooted, accepted by stakeholders and later transmitted from generation to generation.

III. BEST *ZAATAR* PRODUCTION PRACTICES

A. SEEDLING PROPAGATION

Zaatar planting material can be obtained in three ways: from cuttings, seeds and tissue culture or micro propagation.

1. *From cuttings*

This method is based on the use of herbal vegetative stems from selected mother plants to produce new plantlets. The herbaceous shoots are cut in portions of one to three nodes, each 3-7 cm in length. Then, the leaves are removed to reduce water transpiration and the bottom of the cuttings are dipped in rooting hormone to promote root initiation (figures 1, 2 and 3), before being planted in a rooting media in trays of 50 to 177 holes.

Figure 1. Left: Filling the trays with substratum
Right: Preparation of cuttings and their planting in trays

Figure 2. Left: Dipping of the cutting bottom in a rooting hormone to promote rooting
Right: Planting of the cuttings in trays

The rooting media should be well aerated and should have good water-retention potential in order to promote rooting. Usually, a mixture of composted organic matter mixed with turf is used. Drainage should be adequate to avoid water-logging and thus, root suffocation. Rooting and plantlet development last for 10 to 12 weeks. During this period, frequent spraying is necessary to provide a high-humidity atmosphere that helps improve rooting success.

Advantage of propagation from cuttings versus seeds:

- The advantage of this method is the production of homogeneous genetic planting material similar to that of the mother plant, through vegetative, asexual propagation.

Disadvantage of propagation from cuttings versus seeds:

- The success of rooting and development is limited to a narrow window in spring;
- Plant development from cuttings is delicate, requiring a properly-timed automatic mist system under a controlled environment.

Figure 3. Left: Development of cutting after a few weeks of planting, with developed roots and stems Right: Plantlet with good root development, ready to be planted in the field

2. *From seeds*

This method of propagation is easier, as it needs less equipment than the previous method. *Zaatar* plants produce a high number of very small seeds, with about 10,000 seeds weighing 1g. Seeds are collected in late summer and conserved in a dry, cold place.

Sowing is done in a specially prepared media in either of the following two ways:

- In polystyrene boxes, filled with the media up to 6-10 cm deep, for easier and safer handling of seedlings (see figure 4), or
- In soil, after preparing the upper layer, or seed bed.

Mixing seeds with sand in a ratio of from 1:2 up to 1:5 parts seeds to sand respectively, is recommended before sowing, due to the relatively small size of the seeds. Consequently, the sown volume is larger, seed handling becomes easier, and sowing precision is improved.

Figure 4. Sowing *zaatar* seeds mixed with sand in polystyrene boxes

The media is made of compost, turf and soil that is free of foreign seeds and pathogens in the following proportions:

- 10-30 per cent compost;
- 30-40 per cent turf;
- 30-40 per cent good quality soil, free of weed seeds and pathogens.

Sowing density ranges from 1 to 5 g of seeds per m². Lower densities are adopted for the production of naked-root seedlings without potting, while higher densities can be adopted when seedlings are to be planted in pots. Seeds are slightly covered with the same media mixture, keeping the depth of the seed in the media at less than 0.5 cm. Seed germination lasts from two to three weeks, depending on the season and the heat inside the nursery. Potting should be done six to eight weeks after sowing, while plant height is around 3-5 cm. Ten to twelve weeks after sowing, seedlings can be delivered, either as naked roots or after potting each plant in individual pots or in trays having 50 to 177 holes. Daily watering is important to prevent seedlings from undergoing water stress.

Figure 5. Left: High-density germinated *zaatar* seedlings in polystyrene boxes destined for potted- seedling production
Right: The process of potting *zaatar* seedlings in trays

Figure 6. *Zaatar* seedlings in potting trays

Advantage of propagation from seeds versus cuttings:

- Flexibility: once mature and properly collected and stored, seeds can be sowed anytime of the year;
- No need for sophisticated equipment.

Disadvantage of propagation from seeds versus cuttings:

- Genetic heterogeneity of the obtained material, since *zaatar* is highly cross-pollinated, mainly by insects.

3. *Through micro propagation*

This biotechnology tool is based on the use of portions of shoot tops to generate planting material *in vitro*. This technique is not yet applied to *zaatar* in Lebanon.

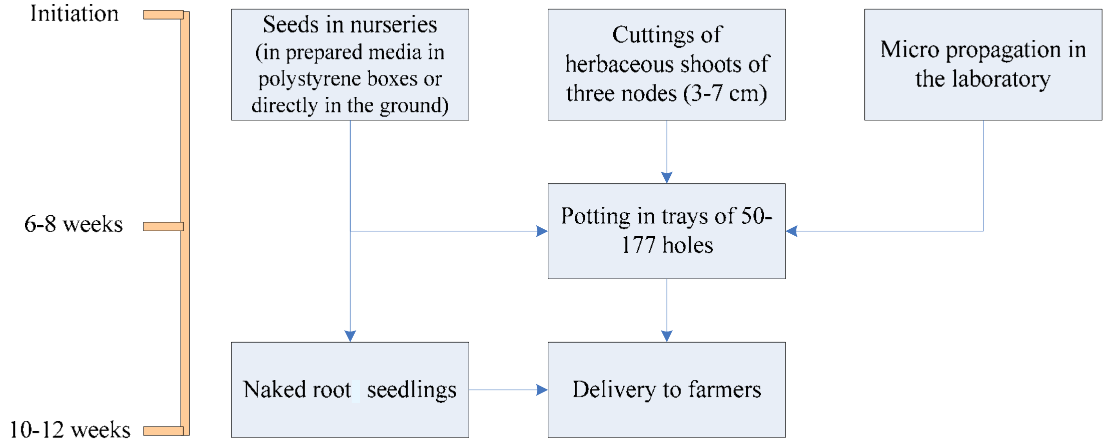
Advantage of micro propagation:

- It allows for the production of virus-free, homogeneous and abundant planting material.

Disadvantage of micro propagation:

- It needs high-cost equipment and adapted technologies. As such, it is not suitable for propagation at the farmer level or in conventional nurseries.

Figure 7. Summary of seedling propagation options



Box 2. Nursery tips

Which seedling technique to choose?

Unequipped farmers produce naked-root seedlings under “do it yourself” low-tunnel nurseries, traditionally conceived in South Lebanon for tobacco-seedling production (see figure 8). Naked-root seedlings are sold at a cheaper price than potted seedlings (LBP125-150 versus LBP250 respectively, in 2008). Meanwhile, professional nurseries use the covered-roots methods in trays, to ensure a high-viability rate. In this case, more substratum and handling is required, which explains why they are sold at a higher price. Naked-root plantlets are at high risk of post-planting mortality in the field, having a low root/stem ratio as a consequence of the uprooting process. For potted plantlets, having an unaffected root/stem ratio, the mortality rate and post-planting stress in the field are very low. Plantlets obtained through the naked-root technique should have their roots in water at all times and be kept in a fresh, shaded environment. They should be pruned to maintain the height of the aerial part at only 5cm, in order to favour the root/stem ratio and reduce transpiration that is fatal at this stage. For optimal results, they should be planted within a few hours after uprooting from the nursery, preferably in the afternoon period. These are serious constraints to be considered in projects involving inexperienced farmers.

Figure 8. Low-density germinated *zaatar* seedlings in a “do-it-yourself,” low-tunnel nursery destined for the production of naked-root seedlings

Box 2 *(continued)*

Which trays to choose?

Tray characteristics affect seedling growth and final quality. The key factor is the hole or alveoli size, or more simply, the number of alveoli per tray which ranges from 50 to 170 holes. The higher the number of alveoli per tray, the lesser the volume of each alveoli. As indicated in table 3, 170-hole trays offer 15-20 cm^3/hole capacity. These trays allow for the propagation of cheaper plants, but with less rooting space and media or substratum for root development, which might affect plant performance.

ESCWA experience showed that the most adequate trays for seedlings growth are the 50-hole trays with 100 cm^3/hole capacity. These trays increase the initial investment for production because they require more substratum and more space in the nursery for plant growth, but they assure better seedlings with better resistance to changes in conditions between the nursery and the field. Therefore, chances of complications in the field are reduced, especially if inexperienced farmers are involved.

TABLE 3. CHARACTERISTICS OF PROPAGATION TRAYS

Number of holes	Hole capacity	Seedling quality	Cost
(High) 170 holes	15-20 cm^3/hole	▪ Low vigour ▪ Less rooting space ▪ Higher post-planting mortality risk	Cheaper seedlings
(Low) 50 holes	100 cm^3/hole	▪ Vigorous ▪ Good rooting space ▪ Good plant performance	More expensive seedlings

It is worth mentioning that whatever the hole size, plantlets should be watered daily or even twice a day during hot periods, transportation and the pre-planting process in order to avoid desiccation and mortality.

Greenhouse versus non-greenhouse seedling production with internal drip irrigation systems

The nursery needs a protected and controlled environment, to allow seed germination and proper seedling development. More specific care and equipment are needed for cuttings. In South Lebanon, unequipped tobacco farmers succeeded in the production of *zaatar* seedlings, using the same system as in tobacco nurseries, in low plastic tunnels. They used the naked-root seedling technique, which is less expensive but carries the risk of delaying post-planting initiation of plantlets in the field for a few weeks, thus increasing the post-planting mortality rate. In contrast, better quality seedlings can be produced by potting in trays in regular greenhouses at equipped nurseries, albeit at a higher cost.

Is direct sowing in the field possible for *zaatar*?

The direct sowing of *zaatar* seeds in the field has not been tried yet in Lebanon. The seeds are of such a small size that they cannot be handled easily in the field and have a slow germination process. Moreover, the lack of seed-coating technology is limiting the use of mechanical seeding. Under the current situation, direct sowing is not encouraged in Lebanon on a commercial scale, before an appropriate seed-production system is developed.

B. CULTIVATION IN THE FIELD

1. *Zaatar life cycle*

Zaatar is a perennial crop with a life cycle ranging from five to eight years. Optimum productivity is reached after the second year in irrigated fields. The aging of *zaatar* plants is characterized by an increase in both plant mortality rate and perennial weed impact in the field, leading to reduced productivity. After such a cycle, soil nutrients are reduced and, as such, it is recommended to rotate *zaatar* with another crop, such as tobacco, which is already well-established in South Lebanon. It should be noted that in rain-fed fields and under limited survival watering, optimum production might be reached after several years, as plant growth rate is reduced. Also, under rain-fed conditions, only one crop per year can be harvested, compared to three to four harvests for watered fields. This should reduce the rate of depletion of soil nutrients and could thus extend the cycle of *zaatar* production to more than ten years. However, it should be noted that the relativelyrecent *zaatar* cultivation experience in South Lebanon is not representative enough to draw conclusions about the overall agro-economic viability of *zaatar* production in the long run.

2. *Site selection*

Zaatar fields should be well-drained. Lowlands or bottomlands that are close to riverbeds or seashores should be avoided. *Zaatar* plants can adapt to most Lebanese soils, especially as they do not need deep soil. Such deep soils of flat clay as are found in the western Bekaa area may cause problems of water-logging during winter, leading to increased plant mortality. However, during summer, particular attention must be given to the frequency of irrigation and fertilization of *zaatar*, particularly in poor shallow soils and in rangelands. *Zaatar* can grow in highly calcareous soils, but yellowing of leaves might appear on certain sensitive plants. Planting *zaatar* on terraces and hillsides is suitable up to an altitude of 1,500 m above sea level. However, the number of potential cuts per year is inversely proportional to the altitude of the field, as a result of the shorter summer period. Slopes exposed to an excess of moisture may cause fungal development during some humid periods of the year. Land exposed to sea spray should be avoided, as *zaatar*'s resistance to salinity is not known. It is also important to avoid polluted sites; including, for example, soils polluted by heavy metals, toxic mud or industrial toxic wastes, or such sites as roadsides which are subject to air pollution, are close to incinerators or generators, or near polluting industries including the production of toxic gases.

Finally, *zaatar* can also be considered as an intercrop, in extensive cultivations or orchards, as a means of ensuring better use of arable land and diversifying production per cultivated area, especially in shallow and poor land, as in the whitish limestone land of South Lebanon's hills (see box 3).

3. *Land preparation*

Land preparation starts with levelling and clearing soil of all such coarse material as stones of more than 1-2 kg, or thick roots. Levelling prevents soil erosion, facilitates drainage in winter and helps the deployment and good functioning of the irrigation system during summer. However, an inclination of 2-3 per cent of the parcel is advised, particularly in flat land, in order to avoid water-logging. After levelling, at least two rounds of ploughing are necessary as part of the land-preparation process. During this operation, the organic matter and any basic fertilizer recommended before planting, such as phospho-potassic fertilizers, are incorporated in the soil.

In flat and low lands, drainage should be properly completed before planting. This could be done during levelling and through the establishment of adequate drainage infrastructure such as canals or pipes in the lowest parts of the field. Peak flow should be taken into consideration since problems will arise in winter during heavy Mediterranean rainfalls (figure 9).

Figure 9. Left: Drainage canalization in the middle, lower part of a *zaatar* field to avoid water-logging Right: Death of *zaatar* plants in the lowest part of a *zaatar* field as a consequence of water-logging

Box 3. Inter-cropping of *zaatar* with olive trees

Zaatar can be introduced successfully into traditional olive, fig, carob, and grape orchards that are extensive and of low density. The disadvantage of intercropping is the possible incompatibility between *zaatar* and the other crop For example, citrus orchards, pome fruits or stone-fruit orchards should be regularly treated with pesticides. Additionally, the final *zaatar* production, as a secondary crop under intercropping conditions, is lower in quantity and in quality than *zaatar* planted alone. However, the overall benefit is higher for both existing crops in the field.

Figure 10. *Zaatar* cultivation as an intercrop in low-density olive orchards

Benefits

Enhanced land-use productivity: This is especially true in certain old orchards where plant density is reduced for many reasons or when the productivity of a given crop is not high. The introduction of *zaatar* as a complement may raise the overall benefit from the land.

Potential collective benefits from irrigation and fertigation: The introduction of watering for *zaatar*, when available, may benefit the other crop, since they are sharing the watered and fertilized soil layers. This allows for the satisfaction of the needs of both crops through the addition of fertilizers in an adapted, integrated manner.

Disadvantages

May reduce plant productivity as compared to intensive cultivation in open land. Since *zaatar* is not growing on the land by itself, it suffers from competition and a shading effect. Consequently, the denser the main crop, the less chance there is to have a successful intercropping system. In extreme cases, *zaatar* planting can be limited to plot boundaries or terrace edges only.

Different crops may have different needs and different schedules. Sometimes, contradictory practices may arise between the main crop and *zaatar*. For example, watering and fertigation should be stopped before harvesting *zaatar* which may be inconvenient in an active-growth period for olives.

4. *Planting season*

Planting is ideally initiated in the months of March and April in order to allow the establishment of seedlings during spring, and later, their full development during the sunny, warm summer period. In order to reduce post-planting mortality and to avoid water stress and plant-growth reduction, plants should be sufficiently irrigated in an adapted frequency. Planting should be done in the late afternoon in order to avoid direct sunlight, especially if naked-root seedlings are used (figure 11).

Figure 11. Planting *zaatar* in the field

Another possible alternative, which allows for water saving, is to plant *zaatar* during the autumn months of September and October. The first handicap of this method, however, is competition between small *zaatar* plants and winter-adapted weeds. The slow initial development of *zaatar* seedlings during the first weeks after planting, associated with the approach of winter frost, will expose *zaatar* plantlets to serious competition from large-leaved winter weeds, characterized by their rapid growth. Examples of potential winter weeds are wild radish, mustard, thistles and grasses. Consequently, weeding the field the following spring will be tedious and time consuming, especially as selective herbicides are not available for all plant families.

5. *Intensive versus non-intensive cultivation*

Zaatar productivity is closely related to the rigorous application of good agricultural practices, concerning weeding, watering, fertilizing and protection from pests. The installation of a drip irrigation system along with a fertigation unit (ventury system, dosing pump or a simple fertigation tank) will accelerate the production cycle if sufficient water is available. During the first months, the number of stems per *zaatar* plant increases and reaches significant yield during the second year of cultivation. Frequent pruning after planting helps to promote stemming (expressed as the number of stems per plant) and is directly linked to an increase in yield.

Figure 12. *Zaatar* plant a few days after cultivation, showing only very few stems

Figure 13. *Zaatar* plants a few weeks after cultivation, showing few stems per plant

Figure 14. First insignificant harvest to promote stemming

Figure 15. *Zaatar* plants a few months after cultivation, showing the stemming effect

6. *Irrigation versus rain-fed alternatives*

Rain-fed cultivation is difficult to launch. It depends on water availability and particularly the availability of survival water, which is crucial during the first summer season after planting. Planting under rain-fed conditions will delay reaching optimum production for several years. Moreover, the number of harvests per season is reduced to one at the end of spring. Harvests may vary in quality and quantity from year to year, depending on climatic conditions. Tools for stabilizing and increasing yield are very limited because there is no fertigation programme and fertilizers cannot be applied during the active growth season. Only basic fertilizers can be applied during the rainy season because of the risk of pollution associated with fertilizer infiltration into the soil, caused by rain.

Scarce watering should be well calculated. If plants are left without water from the beginning of the dry season, they will adapt their aerial biomass and may overcome the whole dry season without severe stress risk. However, if in early summer the plants are watered, they will not be hardened enough and might suffer later, in case of severe water stress, leading to death. This can be explained by the fact that water will be directed by the plant to increase its aerial biomass, namely the leaves, rather than to develop roots. In periods of drought the large leaf area will lose water faster through transpiration. Without water supplement, stress symptoms such as leaf rolling, leaf falling, a greyish aspect or thick hairiness become very common and plant mortality becomes more frequent.

Consequently, if watering is started early in the summer, care should be taken to ensure that enough water is available for watering throughout the whole dry season. Otherwise it would be better not to water early and to conserve available water for use during the second drier period.

C. Weed and pest control

1. *Weeds*

Weeds affect cultivated *zaatar* by competing for sunlight, water and nutrients in the soil and by attracting or hosting a variety of diseases and insects. The irrigation of *zaatar* fields promotes the growth of weeds adapted to irrigation such as fat hen, amaranth and purslane, while perennial weeds such as Bermuda grass, Johnson grass and bindweed, which are associated with unploughed lands, appear later during the production process. As such, appropriate weeding methods should be selected particularly in the early stages of the cultivation process, when *zaatar* plants are most vulnerable.

Zaatar plants grow very slowly in their early stages, even with regular watering and as a result, will be more susceptible to weeds. Later in the development process, the perennial *zaatar* biomass canopy will overgrow the weeds, thereby limiting both their germination and development. There are three ways to overcome the initial impediment:

- Limit wet areas during watering to reduce weed germination around *zaatar* plants during the post-planting establishment phase in the field. This can be achieved through the use of drip irrigation systems which allow for an increase in watering frequency while reducing the amount of water per irrigation;
- Use false sowing, which is a very simple method. Once all the pre-planting preparative steps are finished in the field, the irrigation system is deployed and the land is ready to receive the planting material, the field is significantly watered, without planting. The water will promote the development of weed seeds that are in the upper layers of the soil. Two to three weeks later, the germinated weed seedlings can be destroyed either by chemical weeding or by a very slight, superficial mechanical ploughing. Planting can then be done without ploughing. This practice will reduce the amount of new weed germination after planting;
- For weeds having wide leaves, use manual/mechanical weeding or apply localized herbicide. The use of a mechanical hand-held brush cutter is also possible to clean alleys and border areas in the field. Weeding is labour intensive but can be reduced to a minimum by adopting good watering practices as mentioned above. Selective herbicides for specific grasses such as sethoxydim are being tested and could be applied even after planting, since *zaatar* is a wide- leaved species.

The use of black plastic mulch as a means to reduce weed germination proved unsuccessful. While it prevented weed germination, it also diminished the stemming process of the *zaatar* plants and created a warm and protected environment that encouraged rodent infestation.

2. *Diseases*

Diseases are scarcely reported on *zaatar*. Rust development in certain wet areas in South Lebanon during winter and spring periods has recently been reported. This disease has more serious impact on the marketability of fresh *zaatar*, although it may also affect the quality of dried *zaatar* because of its potential for inducing basal-leaf fall during the pre-blooming stage, therefore reducing the leaf to woody stem ratio in the final harvested biomass.

Mortality due to water-logging is frequent and of serious concern but can be avoided by good drainage and watering practices (figure 16).

Figure 16. Left: Lower part of a *zaatar* field, showing plant mortality due to water-logging during winter
Right: Zooming in on circled area in left picture

3. *Insects and animals*

Zaatar contains phenolic compounds which act as insect repellents. There are, therefore, few incidents of insect attacks reported on the plants. However, mites have been reported in a few cases. During the spring of 2009, a worm was reported eating the flowering buds in a well-watered plot in Debel. Once the pre-harvest water stress was adopted, the cycle of worms was cut. Phenolic compounds found naturally in *zaatar* also act as repellents against herbivorous animals, and very rarely, damage caused by goats or other domestic animals has been reported.

When needed, the use of pesticides should be under the strict recommendations of technical experts. All technical information related to the rate of use, timing and other restrictions should be thoroughly respected.

D. IRRIGATION AND FERTIGATION

Irrigation is essential to reach potential *zaatar* yield in reasonable time. This is a key factor to securing income generation for farmers. In Mediterranean areas, watering becomes a need after the last significant rains at the end of March or early April, as the dry season usually lasts until October or early November. During April and May, water need is estimated to be about 2,000-3,000 m^3/ha/day and may reach 5,000 m^3/ha/day or even more during the peak period from June to August. Water need decreases from September to November, to 2,000-3,000 m³/ha/day. Throughout the season, water need also drops two to three weeks before each cut, in order to induce stress and, therefore, improve *zaatar* quality. Less water is also needed after each cut due to the reduction of the aerial biomass.

1. *Watering modalities*

As previously mentioned, whenever irrigation water is available, it is recommended that irrigated *zaatar* fields be equipped with drip irrigation systems, assuring better flexibility in irrigation management and better water-use efficiency. Watering is usually done frequently but in small amounts during the first post-planting period. Later during the season, frequency is reduced to twice per week. Figures in table 4 illustrate an irrigation programme, expressed in minutes of valve opening.

TABLE 4. DRIP IRRIGATION PROGRAMME THROUGHOUT THE *ZAATAR* LIFE CYCLE

Period of the cycle		Frequency	Irrigation time*	Water amounts*
Year 1	Post planting (2-3 weeks)	Daily	5 min	0.3 litre/plant
	Establishment period (4-6 weeks)	Daily	10-15 min	0.7-1 litre/plant
	Remaining period (peak period)	Twice a week	Up to 30 min	2 litres/plant
Following years	April-May	Twice a week	30-45 min	2-3 litres/plant
	June-August	Twice a week	1h 15 min	5 litres/plant reduced before and after harvesting
	September-October	Twice a week	30-45 min	2-3 litres/plant

* Irrigation time and water amounts are calculated based on drippers having a flow of 4 litres per hour.

It is important to avoid water stress during the period of active growth, especially during the pre-blooming period since it may cause lower leaves to fall, leading to yield reduction, and change in colour to greyish green (see figure 17). To reduce stress impact in case of water shortage, farmers must keep the same frequency of irrigation but could reduce water amounts per irrigation on a regular basis.

In case of water shortage, or if watering is not properly undertaken, it will take more time for *zaatar* plants to reach maximum production. In addition, mortality risk becomes higher after planting.

Finally, irrigation water should not be polluted with heavy metals, pesticide residues, toxic mud, liquid waste or industrial toxic wastes or be saline, for example, due to sea-water intrusion.

Figure 17. Left: Normal *zaatar* field
Right: *Zaatar* field suffering from water stress during blooming period, leading leaves to change in colour to greyish-green and fall

2. *Drip irrigation for improved productivity*

Drip irrigation is the recommended technique for achieving the best use of available water resources (figure 18) and does not affect the concentration of essential oils in the glandular hair of *zaatar*. Sprinkler irrigation washes essential oils away, reducing *zaatar* quality. Moreover, water that remains on leaves after sprinkling may cause fungal attacks. Furrow irrigation requires large amounts of water, is time consuming and has low water use efficiency.

Figure 18. Drip irrigation system for *zaatar* plantation

(a) *Pros and cons*

Drip irrigation has its pros and cons, which are summarized in table 5. On one hand, the drip irrigation system needs substantial initial investment and basic water infrastructure. Therefore, start-up capital should be available at the project-implementation stage. A water-head pump should be acquired in case gravity pressure is insufficient (less than 1 bar). Other equipment needed includes a decantation tank, a filter, a fertigation station, pipes, valves and drippers.

On the other hand, the drip irrigation system lasts for many years, especially if the filtering unit is well maintained to prevent the nozzles, or drippers from clogging. It is also the best system available today for efficient use of water and helps in controlling weed development by reducing the wet area around the plant. Finally, farmers can save on labour costs for watering.

TABLE 5. ADVANTAGES AND DISADVANTAGES OF DRIP IRRIGATION

Advantages	Disadvantages
Lasts for many years if well maintained	High initial investment for basic infrastructure
Increases water-use efficiency	During the fertigation process, only soluble fertilizers can be used, which are more expensive as compared to other forms of fertilizers
Reduces labour costs	
Complements weed control programmes	

(b) *Design alternatives*

The design of a drip irrigation network varies according to topography, shape of the plot, presence of terraces and other factors. The planting distance is typically 50-60 cm between rows and 25-40 cm between plants. It correlates with the adopted distance between drippers, which in turn, varies in relation with the soil type. In clay soils, the water coming out of the dripper is diffused horizontally in the soil, drippers can be distanced further apart and consequently, the largest distance between plants in the same row is applied (40 cm). In contrast, in sandy soil, the flow of water is directly vertical and it is recommended to adopt a distance between drippers of 25 cm. Hence, the farmer is obliged to adopt the same plantation distance of 25 cm in the rows.

It is recommended to adopt the highest plantation densities, of narrower distances between rows and between plants, where the focus of cultivation is on the production of fresh *zaatar*, and water resources are widely available. In areas where water resources are scarce and survival watering is the only possible method, distances between plants can be increased to 40-60 cm and between rows, up to 80 and even 120 cm.

3. *Fertigation for improved productivity*

Good *zaatar* yields depend largely on a good flow of nutrients from the soil to the plant. Depleted nutrients need to be replaced to maintain soil fertility. Contrary to what is commonly thought, if fertilization and irrigation are applied properly, the quality of cultivated *zaatar* can be better than that of wild *zaatar*.

Figure 19. Installation of a fertigation unit including a ventury system and a disk filter

There are no specific data regarding uptake of the main nutrients of local *zaatar* (nitrogen, phosphorus and potassium). However, it can be estimated by comparison with *Origanum vulgare*, a cultivated European *zaatar* species, for which data is available in the literature. As such, the needs per ha are summarized as 250 kg of nitrogen, 150 kg for phosphorus and 200 kg of potassium.

Accordingly, a fertigation programme should be established in irrigated fields, as shown in table 6, based on weekly applications to cover plant needs for the main harvest. The fertigation process should start along with irrigation in early April and continue for roughly 10 weeks. Then, both irrigation and fertigation should be discontinued for the two to three week-period directly before harvest, to induce water stress and allow an increase in dry-matter content and phenolic-compound concentration in the harvested biomass.

TABLE 6. WEEKLY FERTIGATION SCHEDULE FOR IRRIGATED *ZAATAR* CULTIVATION (10 WEEK PROGRAMME)

Fertilizer	Fertilizer quantities (kg/week/ha)
Mono-ammonium phosphate 12-60-0 (12 per cent nitrogen, 60 per cent phosphorus)	17.5
Potassium nitrate 13-0-46 (13 per cent nitrogen, 46 per cent potassium)	45
Ammonium sulfate 21-0-0 (21 per cent nitrogen)	75
Phosphoric acid (85 per cent)	4

After the first harvest, if irrigation water is available, another fertigation programme based mainly on nitrogen can be pursued in order to recover biomass. The intensity of application depends on water availability and production targets for the following harvests for the fresh or dried market.

In rain-fed cultivation, due to the absence of watering, reduced amounts of fertilizers can be added only during rainy season, according to the amounts indicated in table 7.

TABLE 7. FERTILIZATION SCHEDULE FOR RAIN-FED *ZAATAR* CULTIVATION

Timing	Ammonium sulfate 21-0-0 (21 per cent nitrogen) (kg/ha)	Mono-superphosphate 0-16-0 (16 per cent phosphorus) (kg/ha)	Potassium sulfate 0-0-50 (50 per cent potassium) (kg/ha)
Early November (or even before that if significant rains start earlier)	200	250	150
Early February	200	250	150
Mid February	250	-	-
Early March	250	-	-

Annual soil analyses, and if available, complementary leaf analysis, is advisable to monitor soil fertility and to adjust the fertilization programme according to the obtained results, in order to fully control the nutritional status of the crop and avoid over-fertilization, which is costly and leads to health and environmental problems. Inexperienced farmers are advised to seek the help of technical extension staff before proceeding to fertilization.

E. *ZAATAR* HARVESTING AND POST-HARVEST PRACTICES

1. *Harvest of fresh zaatar*

Fresh *zaatar* is harvested using knives or adapted sickles. Bunches of approximately 200 grams are prepared and rushed to market. As fresh *zaatar* has a very short shelf life of less than two days, bunches should be kept in an environment, far from heat and dry wind in order to maintain their freshness. In remote areas such as the villages of South Lebanon, extension of this market is limited, unless refrigerated-transportation vehicles are available. Meanwhile, this product has potential for peri-urban cultivations, such as the Ain el-Delb project near Saida, at low transportation cost.

2. *Harvest of zaatar for the dried-herb market*

Harvesting of *zaatar* designated for the dried-herb market is done with sickles or with pruning shears. Use of the latter is better for the plant and assures better control of the cutting-plant height. Harvesting with sickles is less time consuming but may harm the plants if blades are not well sharpened. Labour cost for harvest of ESCWA projects was around LBP1,000,000 per ha in 2008 and 2009. After analysis of work hours and degree of difficulty, the daily rate for *zaatar* harvesting was estimated at LBP30,000-35,000 per worker, where a full day could be more than eight hours long. Soon after harvest, *zaatar* should be dried in shaded and well aerated areas.

Figure 20. Field under harvest

Figure 21. *Zaatar* plant in full bloom and ready for harvest (showing full height of plant)

Harvesting for the dried-*zaatar* market must be done during the appropriate stage and under proper climatic conditions to ensure a final product with good quality. Rainy, foggy or dusty weather should be avoided. Weeds must be removed and any contamination by sand, soil or other pollutant must be prevented. Harvested material must be properly handled by storing in appropriate, clean bags and aerated containers, far from sources of moisture and direct sunlight.

In this context, farmers practicing animal husbandry along with *zaatar* production are strictly advised to avoid the reuse of bags which have been used at animal farms, unless they are properly washed and cleaned. Otherwise there is a high risk of bacterial contamination of the *zaatar* harvest.

3. *Zaatar drying*

Zaatar needs to be dried soon after harvest in order to reduce its water content and hence reduce fungal and microorganism development and stabilize dried-*zaatar* quality. The product must be dried under a shaded, well-ventilated area away from direct sunlight and from any source of pollution, especially air pollution and animals. If air circulation is good, there is neither a need for artificial ventilation nor for a heat source, since the main harvests are done in summer. The drying process lasts two to three weeks depending on sunlight intensity and relative atmospheric humidity in the concerned area. In Ain el-Delb, a coastal area with higher atmospheric humidity, drying lasted for three weeks during the summer of 2008, while in Debel, an internal area with less atmospheric humidity, it lasted less than two weeks during the same period. The temperature in the drying area must not exceed 30-35°C to avoid essential oil evaporation. *Zaatar* stacks laid for drying must not be more than 25-40 cm high to avoid compression, and branches should be turned over daily to prevent microorganism growth.

Figure 22. Dried *zaatar* ready to be threshed

Once *zaatar* is properly dried, it can be stored, at room temperature, in appropriate clean bags or containers for several months, as long as the storage area is dry and far from heat, sunlight, moisture and polluting agents. Wooden pallets can be used to elevate and separate the *zaatar* from the ground. These should also be distanced from walls to avoid heat or moisture transmission from outside.

Box 4. The drying facility for *zaatar* conceived by ESCWA in South Lebanon

Since *zaatar* needs to be dried in a clean, shaded area away from direct sunlight, and since *zaatar* should be laid in small piles to ensure proper drying, it was not easy to find such free, shaded areas in Debel as empty houses, aerated warehouses or tents, which are large enough to hold the full harvest. Indeed, it was estimated that a drying area of 500 m² is needed for each hectare of cultivated *zaatar* (about 5 per cent).

In order to resolve this issue, ESCWA conceived of a drying unit which is based in full on largely-available agricultural material. The idea was to ensure that interested farmers could replicate the design at a reasonable price. As can be seen in figure 23, the conceived drying facility is composed of an external skeleton of a traditional tunnel greenhouse, which is then covered by mesh that blocks 75 per cent of light while allowing proper ventilation. In contrast, a polyethylene plastic sheet used in a typical greenhouse would induce a greenhouse effect, exposing the *zaatar* to temperatures that widely exceed 50◦C and affect the final *zaatar* quality.

On the inside, the drying area includes four series of drying shelves, each composed of three layers (two upper shelves, plus the floor layer). Three meter-wide alleys, separating each two series of shelves, allow easy access and handling of the material, since *zaatar* needs to be turned over daily during the first days of drying. Each shelf is covered with a wire mesh of 5x5 cm rhombic holes composed of coated galvanized iron. The vertical spacing between shelves is 90-100 cm, so that a 25-40 cm stack of *zaatar* can be laid while leaving 50-75 cm of free space for aeration. *Zaatar* leaves falling through the upper shelves during drying are collected on the floor layer, which is covered with plastic. Once *zaatar* is dry (within 10-15 days), it is collected and can be stored inside a warehouse in a dry environment.

Testing of this experimental design showed a number of pros and cons, which are summarized in table 8.

Box 4 (*continued*)

Figure 23. *Zaatar* drying area conceived by ESCWA
Left: Exterior, showing mesh shade
Right: Interior, showing *zaatar* being dried on shelves and a plastic-covered alley

TABLE 8. PROS AND CONS OF THE LIGHT *ZAATAR*-DRYING CONSTRUCTION

Pros	Cons
▪ Easy to construct at relatively low cost ▪ No need for special handling ▪ No energy cost since naturally-occurring ventilation is present ▪ Can fit a large amount of *zaatar* in a relatively small area	▪ Occasional summer rains can be problematic since there is no hermetic plastic cover to prevent water infiltration ▪ Not adapted for long term storage

4. *Zaatar threshing*

Once the *zaatar* product is sufficiently dry and crisp (weighing 40-50 per cent of its initial weight), the biomass is threshed, either manually or mechanically.

(a) *Manual threshing*

Traditional threshing is still a manual operation and is done in different ways:

- By beating the dried stems with wooden sticks or polyethylene pipes, in order to separate leaves and flowers from the woody part (figure 24). The threshed leaves and flowers are then separated from the stems using a mesh sieve. This method is widely used in Debel projects for large *zaatar* harvests. The yield of this method is around 75-100 kg/working day, and may vary according to the *zaatar* purity sought, the variety and in inverse proportion to atmospheric moisture. Farmers reported that *zaatar* originating from South Lebanon (*O. syriacum* var. *syriacum*) is easier to thresh compared to *zaatar* of Mount Lebanon origin (*O. syriacum* var. *bevanii*), from the Majdel Meoush area in the Shouf;

- By scrapping the stems over a double-layer sieve composed of a top wire mesh of 4 holes per cm^2 approximately and a lower hermetic layer. The threshed leaves and flowers pass through the upper mesh and are collected below (figure 25). This small scale method was tested at the Ain el-Delb project, where harvested amounts are small. The yield of this method is very low compared to the previous one, and is estimated at 4-8 kg per working day. As such, this method is considered costly and labour intensive.

Figure 24. Manual threshing of *zaatar* by beating

Figure 25. Manual threshing of *zaatar* with sieves

(b) *Mechanical threshing*

While mechanical grinders widely exist in the Lebanese market, threshing of dried *zaatar* is not yet mechanized. Through its project, ESCWA piloted a mechanical thresher, composed of three series of plastic brushers for separating leaves and flowers from the woody part, through continuous turning inside a rotating drum, which serves as a stainless steel sieve (see figure 26). Once leaves and flowers have been separated, the woody parts remain inside the drum until they are pushed by the brushers through the bottom of the drum to an external outlet. The flowers and leaves are then collected below the drum, on a conveyor belt and sent to a pneumatic unit, which is based on an adjustable-speed air turbine and allows the separation of the final marketable product from the remaining by-products (wood stalks) into two separate adjacent drawers.

5. *Zaatar grinding*

The threshed, sieved material of leaves and flowers is ground prior to mixing with other ingredients for the final *zaatar* mix. Manual grinding with a traditional stone mortar is not suitable for large quantities. Instead, grinding is done by special electro-mechanical grinders commonly used in different areas in Lebanon. Grinding yield may vary from few kilos per hour to tens of kilos per hour depending on the grinder size. Cooperatives offering grinding services to farmers are available in South Lebanon. They typically charge an average fee of LBP1,000/kg of ground *zaatar*.

6. *Dried zaatar final storage*

Irrespective of format (raw dried, threshed or ground *zaatar*), *zaatar* must be stored under hygienic conditions in a dry place far from sunlight, heat, moisture, and polluting agents, and without access to insects, birds or rodents.

Storage near animal farming activities or in warehouses designated for such agricultural inputs as pesticides, fertilizers, machinery or fuel, should be absolutely avoided, as well as dust-generating zones. Toilets should be separate from the post-harvest and processing areas. In addition, all harvest and post-harvest operations must be registered and specified for traceability concerns. Workers suffering from such contagious illnesses as diarrhoea or skin inflammations, must not have access to post-harvest units, taking into consideration that final *zaatar* cannot be washed and is eaten raw in certain traditional recipes. As such, there are no safety nets against contamination by microorganisms, as is the case when *zaatar* is cooked at high temperatures.

Figure 26. Operational trial of the ESCWA-pilot mechanical *zaatar* thresher

Figure 27. Final marketable *zaatar* product after mechanical threshing during operational trials
Left: Prior to entering the pneumatic unit (including wooden stalks)
Right: Final marketable *zaatar*

7. *Dried zaatar packing*[6]

Dried *zaatar* must be packed in clean and sound containers made of a material which does not affect the product but which protects it from the ingress of moisture and loss of volatile matter. The packaging must also comply with any national legislation relating to food safety and environmental protection.

To access retail markets, the producer has to obtain a registered name. The following particulars need to be marked directly on each container or on a label attached to the container:

- Name of the product and trade name;
- Name and address of the producer or packer, or trademark;
- Code or batch number;
- Net mass;
- Producing country;
- Any other information requested by the purchaser according to related Lebanese standards, such as the year of harvest and date of packing.

[6] Rizk, T., 2009, *Thyme*. Report prepared for ESCWA.

IV. ASSESSING *ZAATAR* PRODUCTIVITY AND PROFITABILITY

A. *ZAATAR* PRODUCTIVITY

1. *Estimated productivity of fresh zaatar*

The fresh *zaatar* referred to in this section is destined for consumption in salads and is typically sold in bunches weighing around 200 grams each and consisting only of tender shoots. As previously mentioned, due to short shelf life, this market cannot be easily targeted by cultivators located in areas remote from large cities without proper transport and storage equipment. However, this market can be profitable for farming activities surrounding the cities, and as such, this section provides an estimation of the productivity of fresh *zaatar*.

Fresh *zaatar* yield depends closely on planting density and vegetative growth in the field. It is estimated that yield starts with two bunches/m^2 during the first year of plantation to reach up to 12 bunches/m^2 during the following years. Harvesting of fresh *zaatar* should be carried out before flowering initiation. Harvested material should be sent directly to the market under a controlled environment (at low temperature and under high atmospheric moisture) in order to preserve freshness and avoid mould development. Prior to reaching the consumer, fresh *zaatar* can only be stored for a couple of days in refrigerators, or its final quality is compromised.

The price of fresh *zaatar* in the Lebanese market ranges from LBP200 to LBP1,000/bunch, depending on season and market proximity. Consequently, sales figures may reach LBP6,000/m^2 based on an average bunch price of LBP500. Given the fluctuation in demand for fresh *zaatar* which is higher in winter compared to summer when other fresh vegetables are present in the market, it is recommended that farmers follow a combined schedule consisting of a harvest during autumn and winter intended for the fresh market, followed by a harvest during spring and summer destined for the dry market.

2. *Estimated productivity of dried zaatar*

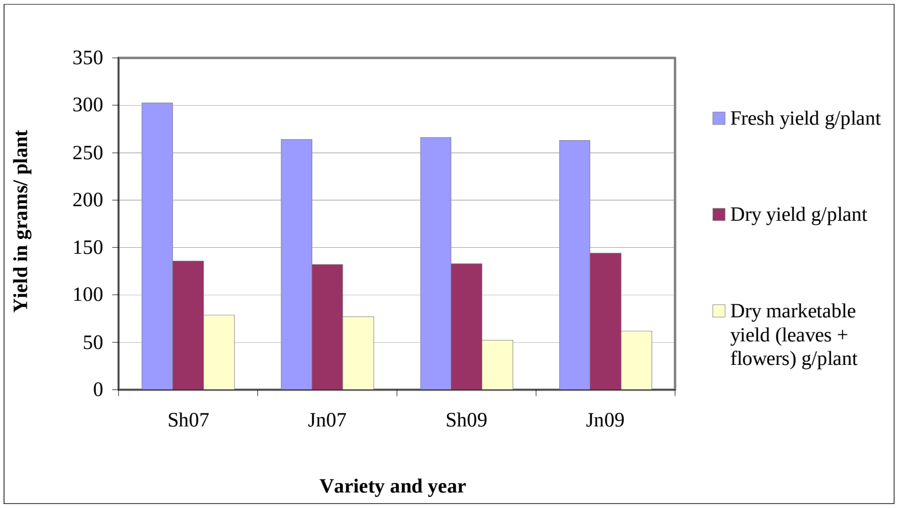
Once *zaatar* is established in the field, after the first year, the annual *zaatar* cycle may comprise more than one cut, depending on irrigation practices. The first cut is the main one and is the highest in terms of inflorescence/leaf ratio. It is also the richest in essential oils having a more interesting profile. The best period for the first cut is between late May and early July depending on watering availability. In irrigated fields, another secondary harvest can be done in midsummer. It is characterized by a lower inflorescence/leaf ratio and an essential oil profile that is less interesting. During late summer to early fall, other cuts can be made for leafy plant material used mainly as fresh salad greens.

(a) *Yield per plant according to cultivated varieties*

Two *zaatar* varieties, the first *O. syriacum* var *bevanii* from the Shouf area (Majdel Meoushe) and the second, *O. syriacum* var *syriacum* from South Lebanon, were grown together in the same field in the Debel projects in South Lebanon. The yield data for the years 2007 and 2009 are shown in figure 28.

The Shouf variety (labeled "Sh" in the graph) tends to give a higher yield of fresh biomass (for both years 2007 and 2009). On the other hand, the dry matter yield is higher for the South Lebanon variety (labelled "Jn" in the graph). The dry matter content at room temperature ranges from 37.8 per cent to 55.4 per cent in weight of the fresh biomass, including flowers, leaves and stems, with an average of 46.5 per cent. The difference between the two origins is around 5 per cent, in favour of the South Lebanon variety. Yield analysis from 2007 and 2009 shows that the marketable product of inflorescences and leaves ranges from 39.6 per cent to 61.3 per cent in weight of the dry yield, with an average of 51.4 per cent. The variety from South Lebanon gives a ratio, higher on average, by 3.3 per cent (2009 yield). Consequently, the final dry yield is higher for the South Lebanon variety compared to the Shouf variety. This explains why after two to three years of experience, farmers in South Lebanon are opting for their own *zaatar* variety. In addition, and as mentioned above, farmers have reported that the South Lebanon variety is easier to thresh and is more appreciated in the local market in the South.

Figure 28. Fresh, dry and marketable yield comparison for *zaatar* varieties) from South Lebanon (Jn versus the Shouf (Sh) for 2007 and 2009



The final marketable product compared to the fresh yield ranges from 20 per cent to 29 per cent with an average of 24.5 per cent. This means that for every 100 kg of fresh biomass harvest, approximately 24.5 kg of dried *zaatar* can be sold in the market (almost one quarter of the harvested fresh biomass).

Finally, it was noticed that the age of the plant in the field had no influence on these ratios. Records from the Ain el-Delb project where the age of the *zaatar* plants was only a few months (plants are not yet well established in the field) gave similar results as for the Debel projects where the plants were 2-3 years old.

(b) *Yield per hectare according to planting density*

The yield per hectare depends not only on the yield per plant but also on the planting density (plant and row spacing), the rate of plant mortality and the degree of homogeneity in the field. Moreover, plant age is a main factor influencing yield. Consequently, the yield per hectare can vary widely, as shown in table 9.

TABLE 9. ESTIMATED *ZAATAR* YIELD (KG/HA) BASED ON PLANT DENSITY

Project	Spacing	Plant density per ha	Estimated yield average (kg/ha)
Debel 1 (men) and Debel 2	60 cm x 40 cm	41 667	2 808
Debel 1 (women, 2005)	120 cm x 25 cm	33 333	2 247
Debel 1 (women, 2007) and Majdel Meouche (individual project)	60 cm x 25 cm or 50 cm x 30 cm	66 667	4 493

Plant density ranges from 33,333 to 66,667/ha, so yield may vary significantly (up to twice the amount). The figures provided in the following sections are based on an average density of 40,000 plants/ha.

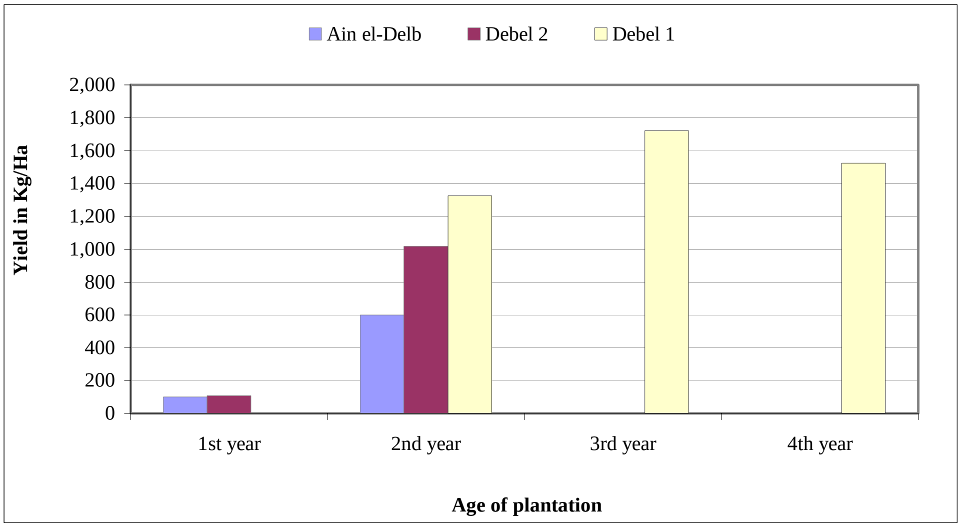
(c) *Yield variation over the years*

Being a perennial plant, the yield of *zaatar* increases during the first two years to reach an optimum that lasts for a few years, before declining again after six to eight years. The dry marketable *zaatar* yield of the first cut in the four to six month period following cultivation is typically about a few tens of kilos per ha. During the same year, in irrigated fields, another harvest is possible if cultivation is done in early spring (March-April). This harvest, while giving an insignificant economic yield, is essential for promoting plant stemming, a factor which encourages yield increase in the following years (the higher the number of stems per plant, the higher the yield per ha).

The second year, the main harvest becomes significant, with more than 1.3 tons per ha for the first cut and a total of 2.5 tons per ha for the first and second cut together. The total yield may reach 5 tons/ha in certain plots over three cuts, especially where no water shortage is reported. Under intercropping conditions with olive trees having a land occupation of 60-70 per cent (Ain el-Delb project), a yield of 0.6 tons per ha was obtained for the first cut.

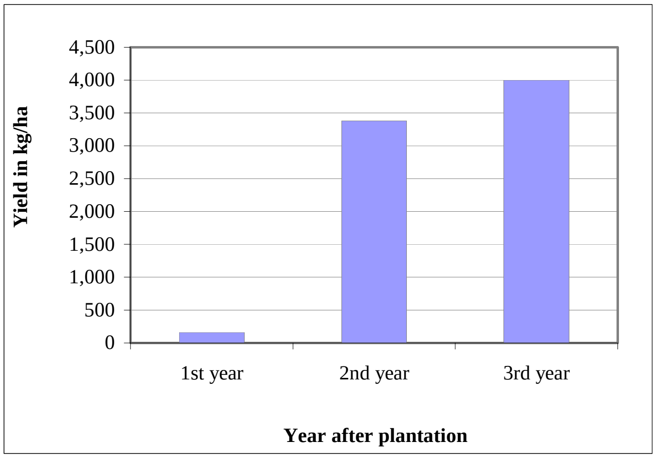
During the third and the fourth years, the yield of the first harvest may exceed 1.5 tons/ha and fluctuate around this level (figure 29). Unfortunately, water shortage and the increase in energy cost associated with water pumping prohibited farmers from performing three cuts during this period.

Figure 29. Change of dry marketable yield of the first main harvest over the first four years of *zaatar* cultivation (different projects)



Consequently, the overall yearly yield may vary greatly, since in some years, three cuts may be performed per season while in other years only one main harvest, or one main plus a secondary meagre harvest, is possible. Water availability is the key factor, playing a major role in this fluctuation, as well as the implementation of an adapted fertigation programme.

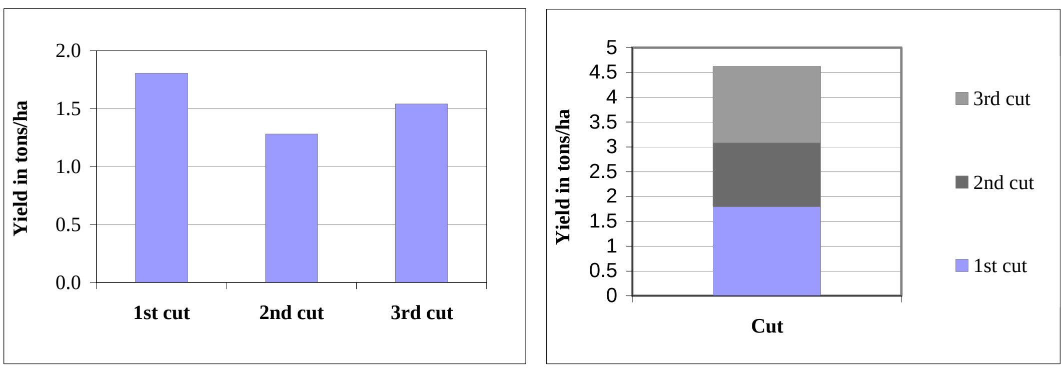
Figure 30. Increase of average total yearly yield over time



(d) *Yield variation across cuts*

As previously mentioned, the number of cuts per year may vary from one (the first cut performed during late spring) to three if proper watering is applied. Under water shortage, the yield is reduced to one or two cuts. Figure 31 shows the average yield of the first, second and third cuts in irrigated fields. The importance of the first main cut as a proportion of the total yield is clear.

Figure 31. Left: Yield change over cuts   Right: Total yearly yield over three cuts



B. *ZAATAR* PROFITABILITY

1. *Selling prices of green zaatar*

Selling prices of green *zaatar* are highly affected by demand fluctuation. They may range from LBP200/bunch up to LBP1,000/bunch. In Ain el-Delb, since the project is close to the city of Saida, farmers tend to profit from such seasonal rises in demand as during the holy month of Ramadan, to market fresh *zaatar* at a wholesale price of LBP500/bunch (in 2008 and 2009).

2. *Selling prices of dried zaatar*

In 2007, selling prices for threshed but not ground *zaatar* were around LBP6,500/kg. During 2008, prices increased to around LBP7,500 – 10,000/kg. In 2009, prices ranged from LBP6,750 to LBP9,500/kg, depending on the cleanliness and the final quality of *zaatar*, being free of weeds, having a good aroma and a high inflorescence/leaf ratio.

TABLE 10. SELLING PRICES OF DRIED *ZAATAR* (LBP/PER KG)

Project	*Zaatar* type	2007	2008	2009
Ain el-Delb	Threshed and ground	-	15 000	15 000
Debel	Threshed	6 500	7 500-10 000	6 750-9 500
	Threshed and ground		13 500-14 000	15 000

When sold in niche retail markets, selling prices of ground *zaatar* may reach LBP20,000/kg. The price of *zaatar* mixes, after the addition of sesame and sumac pulp may increase up to LBP25,000/kg (considered as *baladi* or a traditional home-made product). These prices are high compared to the prices of commercial *zaatar* mixes available in the market, and which typically contain such allowed materiel as sesame, sumac and salt, but may also contain proscribed ingredients such as sesame bran, wheat bran, weeds, colouring agents and citric acid.

C. WILD VERSUS CULTIVATED *ZAATAR*: PROS AND CONS

It is popularly believed that wild *zaatar* is better than the cultivated one as it is "naturally grown". However, wild *zaatar* is highly affected by climatic variations from one year to the next and from one location to the other, leading to heterogeneous quality. With the lack of any control over harvesting from the wild, some of the wild *zaatar* may be collected from polluted areas (near road sides, factories or orchards treated with pesticides). Also, competition for the harvest causes collectors to harvest earlier, usually before the blooming stage. The quality at this stage is low because the collected product has less blooming biomass and therefore less essential-oil content.

Cultivating *zaatar*, however, allows farmers to select the best planting sites, planting material and harvesting period, and provides them with the option to irrigate in case rainfall is insufficient. Consequently, quality and quantity of the final yield are more secured. It is considered by the industry to be a stable crop as the essential oil profile of cultivated *zaatar* could be better stabilized over the years. Table 11 compares wild to cultivated *zaatar*.

D. MAXIMIZING PRODUCTIVITY BY TARGETING SELECTED *ZAATAR* VARIETIES

Many *zaatar* ecotypes exist that lead to a diversity of tastes, yields, and essential oil profiles (essential oil percentage and composition). For the time being, no improved varieties are available for Lebanese *zaatar*. Farmers are looking for plants with good yield, expressed in terms of large biomass, a high number of inflorescences, a high leaf/stem ratio (marketable component) and good adaptation to environmental conditions. Consumers are more concerned with taste, which is related to the amount of essential oil present and the essential oil profile in the final product. Consequently there is mutual interest in having high yield *zaatar* that is also highly rich in interesting essential oils. Practical field biodiversity studies have shown diversity in the profiles and as such, more research is required to select the best material for farmers and convert them to cultivars that maximize both productivity and profitability, with a quality that satisfies market and consumer preferences.

TABLE 11. ADVANTAGES AND DISADVANTAGES OF CULTIVATED VERSUS WILD *ZAATAR*

	Advantages	Disadvantages
Cultivated *zaatar*	• Selection of the best planting material • Choice of the harvesting period • Irrigation in case rainfall is insufficient • Quality and quantity of the yield are secured under good agronomic practices • Essential oil profile is more stable over the years for the industry • Conservation of wild populations	• Common belief that cultivated *Zaatar* is not "naturally grown" • As in every planting activity, farmers may deviate from proper agronomic practices and use chemicals unnecessarily, believing that they are acting in prevention of pests
Wild *zaatar*	• Common belief that wild *zaatar* is healthy and natural.	• Dependence on climatic variations • May be impacted by pollution • Heterogeneous quality over space and time • Reduced quality when harvested before blooming • Overexploitation of wild genetic resources

V. TOOLS FOR ENHANCING *ZAATAR* COMPETITIVENESS

A. SETTING STANDARDS

1. *Purpose*

As with any product, developing national quality standards for *zaatar* is expected to facilitate its national and international trade, encourage high-quality production, improve profitability and competitiveness of local *zaatar* producers and protect consumer interests. By attesting to the required composition and characteristics of Lebanese *zaatar*, the standard is also expected to help overcome misperceptions that consumers may have regarding the difference in chemical constituents between cultivated and wild *zaatar*, and also between the different ingredients of the *zaatar* mixes available in the market.

However, the availability of a standard cannot by itself provide the above-mentioned benefits unless appropriate testing and certification services are available to guarantee the application of the standard. As explained in the following sections, this is not currently the case in Lebanon. In addition, training of local producers is necessary, since food safety and quality standards are currently implemented in a haphazard fashion, depending on farmer awareness. For example, farmers frequently smoke freely inside the *zaatar* threshing or processing areas.

2. *Components of zaatar standard*

Standards characterizing commercial dried *zaatar* products typically include the following components:

- Morphological or physical traits (colour, texture, and size), to verify the absence of strange material, whether of plant origin (woody stalks, altered plant material or weeds) or of non-plant origin (sand, dust, soil, stones or metallic material);
- Chemical traits (ashes, fibres, proteins, lipids, essential oil profiles), to verify the composition, the dietary value and the aromatic richness and profiles. Permissible additives are defined for *zaatar* mixes (salt, sesame and sumac) in addition to materials that should not be added (wheat bran, dry bread or plants other than *zaatar*);
- Microbiological analysis, to verify that the product is free of bacterial contaminants. This is especially needed because during preparation of *zaatar* mixes, the added ingredients could be an additional source of contamination and/or adulteration;
- Toxicological analysis to control the presence of heavy metals, aphlatoxins and other toxic compounds such as pesticide residues and other pollutants.

3. *Zaatar standards in the ESCWA Mediterranean region*

In the eastern Mediterranean region, many countries produce, consume and export *zaatar*, including Jordan, Lebanon, Palestine, Syria and Turkey. Consequently, different countries are developing national *zaatar* standards, which are essentially very close in terms of methodology and interpretation. However, their homogenization or simplification is leading, in certain cases, to a loss of precision, making them unsuited for specific products in a given country. For example in Lebanon, the *zaatar* produced by Lebanese farmers in South Lebanon was found to be out of range according to the Lebanese standard, which is based mainly on traded *zaatar* products which are mostly imported. In addition, certain countries allow additives in the mixed *zaatar*, such as citric acid, that are proscribed by others. The minimum ratio of *zaatar* in the final mixture may also vary widely among countries, from 15 up to 40 per cent. These characteristics should reflect the level of consumption of the product in each country and be stricter in countries with high consumption rates.

Tables 12 and 13 compare the different chemical and toxicological criteria respectively and corresponding thresholds in the eastern Mediterranean countries of ESCWA (in the case of table 12, as compared to the International Organization for Standardization (ISO)). Table 14 compares *zaatar* mix composition according to various standards.

TABLE 12. COMPARISON OF CHEMICAL CRITERIA ADOPTED BY DIFFERENT *ZAATAR* STANDARDS (PURE AND GROUND MIXES) IN THE EASTERN MEDITERRANEAN COUNTRIES OF ESCWA AS COMPARED TO THE INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

<table>
<tr><th>Country</th><th>Concerned species</th><th>Moisture range</th><th>Total ashes</th><th>Acid insoluble ashes</th><th>Crude fibres</th><th>Protein</th><th>Essential oil (ml/100g)</th></tr>
<tr><td>Lebanon</td><td>Origanum syriacum & Thymus vulgaris</td><td rowspan="5">Maximum 12 per cent (10 per cent for mixes only in the Syrian Arab Republic)</td><td rowspan="5">Maximum 9-14 per cent</td><td rowspan="5">Maximum 1-5 per cent</td><td rowspan="3">Maximum 12-30 per cent</td><td>Maximum 9-16 per cent</td><td>Minimum 1-1.8</td></tr>
<tr><td>Syrian Arab Republic</td><td>Thymus vulgaris</td><td>NA</td><td>Traces-5</td></tr>
<tr><td>Jordan</td><td>Thymus vulgaris</td><td>NA</td><td rowspan="3">Minimum 1-1.8</td></tr>
<tr><td>Egypt</td><td>Thymus vulgaris</td><td>NA</td><td>NA</td></tr>
<tr><td>ISO</td><td>Origanum vulgare</td><td>NA</td><td>NA</td></tr>
</table>

Note: NA = Not available.

TABLE 13. COMPARISON OF TOXICOLOGICAL CRITERIA ADOPTED BY DIFFERENT *ZAATAR* STANDARDS IN THE EASTERN MEDITERRANEAN COUNTRIES OF ESCWA

<table>
<tr><th>Country</th><th>Microbiological analysis</th><th>Heavy metals analysis</th><th>Pesticides residues</th><th>Total Aphlatoxins B1, B2, G1, G2 µg/kg</th></tr>
<tr><td>Lebanon</td><td rowspan="3">Definition and details may vary among countries</td><td>Arsenic, Lead, Copper</td><td>According to Lebanese standards</td><td>10</td></tr>
<tr><td>Syrian Arab Republic</td><td>NA</td><td>According to international standards</td><td>15 for all, and <5 for B1</td></tr>
<tr><td>Egypt</td><td>Arsenic, Lead, Mercury</td><td>According to FAO and national standards</td><td>NA</td></tr>
<tr><td>Jordan</td><td>Too general (not specified)</td><td>NA</td><td>According to international standards</td><td>According to international standards</td></tr>
<tr><td>ISO</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td></tr>
</table>

Note: NA = Not available.

TABLE 14. COMPARATIVE TABLE OF *ZAATAR* MIXES ACCORDING TO RELATED STANDARDS

Country	*Zaatar*	Sesame	Sumac	Salt	Citric acid	Permissible additives	Proscribed additives	Impurities of plant origin	Impurities of non plant origin
Egypt	NA	NA	NA	NA	NA	NA	Natural and artificial colorants	NA	NA
Jordan	40 per cent minimum	30 per cent minimum	4 per cent minimum	4 per cent maximum	0 per cent	Anis, cumin, roasted chickpea, fennel, roasted wheat, spices and seasoning, olive oil	Bran, cake, dry bread, straw, hay, any plant leaves other than *zaatar*, natural and artificial flavours except those of spices and seasoning	7 per cent maximum (including strange organic matter such as plant stems and sand)	
Lebanon	15 per cent minimum	NA	NA	NA	Allowed under good processing practices	Any of allowed additives under related standards	Artificial colorants, bulking organic matter	NA	NA
Syrian Arab Republic	15 per cent minimum	NA	10 per cent minimum	NA	2 per cent maximum (and should be mentioned clearly on the label)	*Zaatar* leaves, anis, cumin, sumac flowers, coriander, roasted chickpea, fennel, caraway, sesame. 20 per cent maximum	Bran, cake, dry bread, straw, hay, oilseed by-products, natural and artificial colorants	2 per cent maximum	2 per cent maximum
ISO	NA	NA	NA	NA	NA	NA	NA	3 per cent maximum of broken stalks and other plant parts	3 per cent maximum for semi-processed oregano

Note: NA = Not available.

4. *Legal aspects*

(a) *LIBNOR sub-committee*

The Lebanese Standards Institution (LIBNOR) has established a technical committee for spices and condiments.[7] In 2004, a sub-committee was formed to formulate a Lebanese standard for dried *zaatar* and sumac, which mainly involves the Ministry of Agriculture, private sector producers of spices, and university researchers. ESCWA became involved in the work of this sub-committee in August 2006.

In November 2006, the sub-committee finalized a draft version of the *zaatar* standard, which was not mandatory at that stage.[8]

(b) *Status of the standard development process*

After reviewing the draft, ESCWA found common errors replicated from the regional standards, in addition to gaps in the scientific methodology and the sampling process used in the elaboration of the standard. Accordingly, ESCWA recommended to the sub-committee that further laboratory analysis be undertaken in order to increase data and information available on the composition of *zaatar* and other inputs included in *zaatar* mixes, such as sumac, before modifying the draft standard. In particular, it was recommended that an essential oil profile for *Origanum syriacum* be developed, which would involve the use of gas chromatography/mass spectroscopy techniques. The essential oil profile would:

- Determine precisely the quality of *zaatar* produced;
- Determine the specificity of the local production in view of an eventual establishment of geographical indication related to Lebanese *zaatar*;
- Constitute the basis of a database that will serve the genetic amelioration of the crop and consequently production adjustment, according to characteristics required by different market channels (for example, the characteristics of *zaatar* used in bakeries may be different from those requested by the pharmaceutical industry).

ESCWA conducted a number of laboratory tests on 12 *zaatar* samples of cultivated *O. syriacum* in its final marketable form, taken randomly from implemented pilot projects in addition to other samples from the 2007 and 2008 harvests. Based on the results of these tests, an official request was issued to review the standard. Joint efforts with the Ministry of Agriculture and researchers from the Lebanese University are being deployed to elaborate the characteristics and composition of Lebanese *zaatar* in detail, as a basis for future modifications of the standard, which remains a work in progress.

(c) *Comparison between the results of ESCWA tests and the Lebanese draft standard for zaatar*

The 12 *zaatar* samples taken during harvest in the blooming stage were analyzed in the laboratories of the Industrial Research Institute (IRI), which is the same lab adopted by LIBNOR for the elaboration of the Lebanese standards. The results of the analysis as compared to the Lebanese standard draft are summarized in the following sub-sections.

(d) *Chemical analysis*

With regard to the chemical analysis, results are summarized in table 15. It is possible to conclude that samples taken from ESCWA pilot projects are within the range only for acid insoluble ashes and essential

[7] Committee number NL TC 34/SC 7. See www.libnor.org/Portals/0/List%20of%20NL%20Technical%20committees.pdf.

[8] Standard number 2006:677.

oil. Meanwhile they are 100 per cent out of range for the crude fibre content and 66.7 per cent for protein content. Twenty-five per cent are out of range regarding the moisture content and total ashes.

TABLE 15. SUMMARY OF THE CHEMICAL ANALYSIS OF 12 *ZAATAR* SAMPLES AND COMPARISON WITH THE LEBANESE STANDARD FOR DRIED GROUND *ZAATAR*

	Threshold according to Lebanese standard	Minimum obtained value	Maximum obtained value	Number of out of range samples	Percentage of out of range samples	Observations
Moisture range	12 per cent	9.1 per cent	13.3 per cent	3/12	25 per cent	In non-hermetic bags, this factor is subject to local atmospheric moisture. In Ain el-Delb (coastal area) it is higher than in Debel (interior area)
Total ashes	10 per cent	7.9 per cent	11.5 per cent	3/12	25 per cent	All samples within range
Acid insoluble ashes	1.5 per cent	0.1 per cent	0.9 per cent	0/12	0 per cent	All samples within range
Crude fibres	16 per cent	17.4 per cent	21.2 per cent	12/12	100 per cent	All analyzed samples are out of range
Protein	9 per cent	6.1 per cent	15.0 per cent	8/12	66.7 per cent	Most of the samples are out of range
Essential oil	1 per cent	5.2 per cent	6.5 per cent	0/12	0 per cent	All samples are within range

(e) *Heavy metals analysis*

Results of heavy metals analysis are summarized in table 16. It is observed that the results of all analyzed samples are within the threshold mentioned in the Lebanese standard.

TABLE 16. SUMMARY OF THE HEAVY METALS ANALYSIS OF 12 *ZAATAR* SAMPLES AND COMPARISON WITH THE LEBANESE STANDARD FOR DRY GROUND *ZAATAR*

	Threshold according to Lebanese standard	Minimum obtained value	Maximum obtained value	Number of out of range samples	Percentage of out of range samples	Observations
Arsenic As (mg/kg)	1	<0.1	0.1	0	0 per cent	All samples are within range
Lead Pb (mg/kg)	0.5	<0.1	0.1	0	0 per cent	
Copper Cu (mg/kg)	10	0.2	0.6	0	0 per cent	

(f) *Microbiological analysis*

Results of the microbiological analysis are summarized in table 17. Certain samples are out of range regarding the yeast and mould group and the total coliform microorganisms. These results stress the need for awareness programmes and capacity-building in food safety practices, mainly during post-harvest procedures, especially when farmers are also livestock holders.

TABLE 17. SUMMARY OF THE MICROBIOLOGICAL ANALYSIS OF 12 *ZAATAR* SAMPLES AND COMPARISON WITH THE LEBANESE STANDARD FOR DRIED GROUND *ZAATAR*

	Threshold according to Lebanese standard	Minimum obtained value	Maximum obtained value	Number of out of range samples (Higher than the highest threshold)*	Number of samples within the lowest and the highest thresholds*	Observations
Aphlatoxins (micrograms/Kg)	10	NA	NA	NA	NA	
Total aerobic microorganisms (30°C UFC/g)	10^6-10^7	$1.1x10^2$	$1.7x10^6$	0/12	2/12	All samples within range
Total coliforms (30°C UFC/g)	100-1 000	<10	$2.6x10^4$	5/12	0/12	More than 40 per cent of the samples exceed the upper limit
E. coli (44°C UFC/g)	NA	<10	<10	N/A	NA	-
Faecal coliforms (44°C UFC/g)	1-10	<10	<10	0/12	0/12	All samples within range
Salmonella (37°C et 42°C /25g)	0	0	0	0/12	0/12	All samples within range
Sulfate-reducing anaerobic bacteria (37°C UFC/g)	10-100	<10	$1.0x10^1$	0/12	0/12	All samples within range
Yeast and mould (25°C UGC/g)	10^3-10^4	<10	$2.1x10^4$	2/12	5/12	Two out of 12 samples are above the upper limit and five out of 12 are between the two limits

* In Lebanese microbiological *zaatar* standards, two thresholds are specified, a highest and a lowest, which are interpreted as follows:

- No sample is allowed to exceed the highest threshold;
- Only a limited number of samples is allowed to exceed the lowest threshold (but without exceeding the highest one). Consequently, and in the case of the Lebanese *zaatar* standard, it is permissible to have up to two out of five samples (or 40 per cent of the samples) within the two thresholds.

(j) *Conclusion regarding the result of the comparison*

Since all 12 *zaatar* samples are traceable, with regard to their origin and type of cropping, based on the results, it can be concluded that the Lebanese standard is not applicable to all *zaatar* produced in Lebanon and should be revised accordingly. This is true regarding the chemical analysis, which should be reviewed in order to fit the composition of all Lebanese *zaatar*, since this composition cannot rationally be changed. Meanwhile, farmers themselves should strive to conform to the microbiological standards by improving their food safety practices during the whole production chain.

5. *Institutional aspects*

Acknowledging the importance of access to safe and healthy food, Lebanon, with the support of United Nations organizations (see for example UNIDO's Food Safety project[9]) and other international bodies, has taken several steps to modernize its food safety legislation and strengthen public administrations concerned with standard setting and quality control in the food supply chain.

[9] See: www.unido.org/index.php?id=6385.

In 2004 and as part of an EU-funded programme by the Lebanese Ministry of Economy and Trade (MOET), Quality Lebanon (QUALEB) was launched to establish the *Conseil Libanais d'Accréditation* (COLIBAC) to act as the national accreditation body.[10] However, as of the date of preparation of this publication, COLIBAC has not yet become operational. As a result, all testing and calibration laboratories operating in Lebanon are either not accredited, or have foreign accreditation, which tends to be costly. As part of QUALEB, a number of private-sector testing laboratories are equipped and certain of these laboratories are receiving technical assistance to obtain international accreditation status.

(a) *State of food monitoring and enforcement in Lebanon*

In January 2008, a new EU-funded project was launched under the title "Sustaining Quality". Among the planned outputs of this project is the establishment of a Lebanese Food Safety Authority on the basis of the draft Law on Food Safety.[11]

(b) *State of available testing and certification facilities*

There are currently three Government-affiliated laboratories responsible for food testing:

- Laboratories of IRI which is affiliated with the Ministry of Industry; IRI has the authority to issue certificates of quality or conformity with standards. It is accredited by the *Deutsches Akkreditierungssystem Prüfwesen* (DAP), a German accreditation body, to undertake chemical, physical-chemical and microbiological analysis of food;[12]
- The Central Health Laboratory is affiliated with the Ministry of Public Health and serves such public institutions as ministries and municipalities;
- Laboratories affiliated with the Ministry of Agriculture, including its own central one, in addition to the laboratories of the different stations of the Agricultural Research Institute.

Private sector laboratories are also in operation, notably in renowned universities (for example at the American University of Beirut, Saint-Joseph University and the American University of Science and Technology).

(c) *State of available accreditation facilities*

Numerous international accreditation bodies exist who extend their services to testing laboratories in various testing fields operating in the Middle East region. These bodies basically offer ISO/IEC 17025 accreditation, which specifies general requirements for competence to carry out tests and/or calibrations, including sampling. The cost of obtaining an accreditation by an international body is usually more expensive than that of a national accreditation body, as can be seen in box 5.

B. LABELLING SCHEMES

1. *Current zaatar labelling practices in Lebanon*

Zaatar found in the Lebanese retail market is typically sold in small plastic bags of from 200 grams to one kilogram maximum. As for most other products, the brand and the address of the wholesaler are usually indicated, in addition to the date of production, the date of expiration, and the weight. There are usually no indications of the product origin. Even when "made in Lebanon" is mentioned, it usually refers to mixing and packaging. Certain ingredients could be of foreign origin, such as sumac and sesame, and even sometimes the *zaatar* material itself and as such, traceability is not possible.

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[10] See: www.qualeb.org/.

[11] QUALEB, *Sustaining Quality: Inception Report*.

[12] See: www.iri.org.lb/accreditation.html.

Labelling is an important issue to consider if competition is present and entry to large supermarkets is a target. In this case, indicating ash, moisture, dietetic or dietary values and essential oil content becomes important, in addition to the applied standards and storage temperatures.

Box 5. Cost of international accreditation

Costs associated with obtaining international accreditation tend to be high, as shown in table 18. In particular, costs increase further if a laboratory has multiple fields of testing and multiple branches. In addition, costs incurred by staff travelling to assess the laboratory seeking accreditation are often billable to the laboratory, which tends to make it more expensive. On the other hand, international accreditation presents a key comparative advantage since it facilitates worldwide acceptance, due to the fact that these accreditation bodies are often signatories of Multilateral Mutual Recognition Agreements who mutually recognize each other's accreditation systems as being equivalent to their own.

TABLE 18. FEES INCURRED BY A TESTING LABORATORY FOR OBTAINING INTERNATIONAL ACCREDITATION; EXAMPLES FROM ACCREDITATION BODIES OPERATING IN THE MIDDLE EAST REGION

Accreditation body	Application fee	Assessment fee	Renewal fee (1 year)	Travel cost applicable
International Accreditation Services, Inc. (IAS)[a/]	US$2 550	US$900/day	US$2 000	Yes
United Kingdom Accreditation Service (UKAS)[b/]	₤1 380	₤910/day	₤2 000	Yes
DAP[13]	€700-2 120 depending on number of employees	€1 920-3 070 depending on scale of assessment	€420-1 260 depending on number of employees	Yes

a/ IAS, Fee Schedule for Testing Laboratory Accreditation, 2009.

b/ UKAS, Terms and Conditions of Business.

2. *Eco-labels*

Eco-labels, as applied to crops, certify that the agricultural practices used in producing that crop are environmentally-friendly. In other words, the practices used should be in harmony with nature, support biodiversity and avoid damage to soil health and wild habitats. As such, organic labels are considered a sub-category of eco-labels.

Organic *zaatar* (oregano and thyme) are becoming widely available in international markets. In Lebanon, a number of producers of organic *zaatar* are in operation (for example BioCoop Lubnan, a national organic agriculture cooperative established in 2001 and producing under the registered name *Campagnia*). The Association for Lebanese Organic Agriculture[14] lists at least three producers of organic oregano or other aromatic/medicinal herbs.

LIBNOR has established a technical committee for organic products (NL TC 3005).[15] A draft standard for organic production in four parts[16] is available based on European Council Regulation (EEC) No. 2092/91 of 24 June 1991 (repealed in 2009 by EEC No. 834/2007) and International Federation of Organic

[13] DAP, Fee Regulations for the Initial Accreditation, Extension and Surveillance of Accreditation as well as Reaccreditation of Testing Laboratories, Inspection Bodies and Certification Bodies.

[14] The farmers listed are: Mirna Rizk, Amine Mazeh and Bureau Agricole Ghedrass.

[15] LIBNOR, List of the Lebanese Technical Committees (NL TCs).

[16] The standard is listed as being at stage code 20:00 Part 1: Plants and plant products, livestock and livestock products, food processing and handling and beekeeping. Part 2: Aquaculture. Part 3: Forest Management. Part 4: Accreditation Criteria for Bodies Certifying Organic Production and Processing.

Agriculture Movements norms. A Lebanese private certification company, LibanCert, certifies farmers, processors and traders according to the Lebanese standard for organic farming, but also against European and other organic standards in collaboration with the Swiss body bio.inspecta.[17] At the time of preparation of this study (August 2010), the LibanCert website listed four certified farms that specifically indicated producing *zaatar* or other aromatic/medicinal plants.[18]

3. *Fair trade labels*

Fair trade labels certify that trading arrangements for a crop or product are equitable for disadvantaged farmers. Fair trade enables farmers to market their products directly to outlets and consumers, rather than losing profits to middle-men. Other fair trade principles include adherence to social ideals such as fair labour conditions (for example refusing child labour), environmental sustainability and local community development. In many instances, fair trade-labelled products also flag environmental claims similar to those flagged by eco-labelled products, especially organic ones, and highlight the geographic source of the produce (similarly to geographical indications, see section below).

While popularly associated with the trade of coffee, tea, cocoa, sugar and rice, more herbs and spices carrying the fair trade label are becoming widely available in markets. In particular relation to *zaatar*, one example is the fair trade Sonoran Oregano cultivated by the Seri Indians near the Gulf of California, on the border between the United States and Mexico. This product is being pilot-marketed through a project coordinated by the Centre for Sustainable Environments at Northern Arizona University, and supported by the Overbrook Foundation, a leading contributor to community-based biodiversity conservation in Latin America.[19] Another fair trade *zaatar* example from the region is Palestinian Fair Trade *Zaatar*, marketed internationally by Canaan, a fair trade-certified company.[20]

In Lebanon, an NGO was officially established in 2006 under the name Fair Trade Lebanon (FTL). FTL cooperates closely with Artisanat SEL, a French non-profit association advocating fair trade, to market its products. FTL buys local produce from Lebanese farmer cooperatives at a "fair" price and sells it in local and international markets under the registered name *Terroirs du Liban*. It also provides these cooperatives with the required technical assistance and training that would allow them to raise the quality of their produce to internationally accepted standards. One of the products sold by FTL is labelled "*Zaatar* Mediterranean Blend" which includes oregano (*O. syriacum*), grilled sesame, sumac and salt.

C. Geographical indications

1. *Definition, pros and cons of geographical indications*

Geographical indications (GIs) are defined by the World Trade Organization (WTO)[21] as "indications which identify a good as originating in the territory of a Member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographic origin." Simply put, GIs are the names given to traditional products produced according to traditional methods in a particular geographic area. The name of a particular GI may or may not be geographical (for example Feta cheese (non-geographical), Florida oranges (geographical). Certain countries, notably European countries, differentiate between two denominations, namely Protected Geographical Indications (PGIs) and Protected Denominations of Origin (PDOs).[22] See box 6.

[17] See: www.libancert.com/.

[18] The farmers listed are: *Zaatar* Zawtar, Holy Spirit University, Mirna Rizk and the Lebanese Welfare Association for the Handicapped.

[19] See: www.environment.nau.edu/Seri/index.htm.

[20] See: www.canaanfairtrade.com/products.

[21] WTO, Agreement on Trade-Related Aspects of Intellectual Property Rights. Article 22(1).

[22] A third denomination, Traditional Specialty Guaranteed (TSG), is used to refer to traditional character, either in the composition or means of production, rather than origin. Very few TSGs are registered so far.

Box 6. Protected Geographical Indications and Protected Denominations of Origin

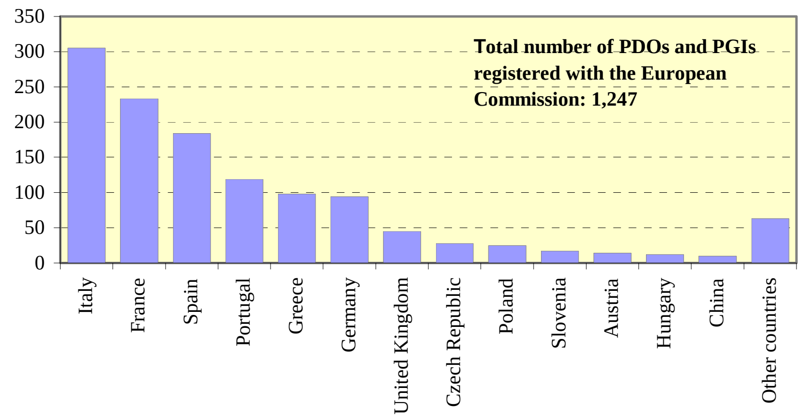
European countries differentiate between what is denominated by PGIs and PDOs. As shown in table 19, both reflect a link between a product and its geographic origin, although the level of linkage denoted by a PDO is stronger than that of a PGI. Other countries, notably Australia, Canada and the United States, have a generalized view of GIs and protect GIs through an integrated legal system which includes trademarks and consumer protection without developing any specific systems and institutions.

TABLE 19. PROTECTED GEOGRAPHICAL INDICATIONS VERSUS PROTECTED DENOMINATIONS OF ORIGIN

GI type	Common characteristics	Differences
PDO	Provides a linkage between a product and its geographic origin	The raw material must come from the geographical area in question and all stages of production must take place in the defined geographical area
PGI	Requires a registration procedure which provides a certain level of protection	No need to prove that the quality, reputation and characteristics of the product are “essentially or exclusively” due to the origin and only one of the three stages of preparation, production or processing must take place in the defined geographical area

Figure 32 shows that as of March 2010, 679 PDOs and 568 PGIs (totalling 1,247) had been registered with the European Commission, with a few (16 in total) belonging to non-European countries (China, Columbia, India, Korea, Thailand and Turkey).

Figure 32. Number of Protected Denominations of Origin and Protected Geographical Indications registered with the European Commission (as of March 2010)



Source: Compiled from DOOR database, http://ec.europa.eu/agriculture/quality/door/list.html.

The number of protected GIs has been growing worldwide, with most of these occurring in developed nations. However, a far greater number of products in developing countries are considered good candidates to become GIs. Therefore, there is still an untapped potential for GIs in the ESCWA member countries, including Lebanon.

Implementing a GI system usually generates important socio-economic benefits, especially in the long-term, although a number of drawbacks have been used as arguments against their spread. Table 20 lists the main advantages and disadvantages of GIs as can be found in the literature.

TABLE 20. POTENTIAL ADVANTAGES AND DISADVANTAGES OF GEOGRAPHICAL INDICATIONS

Potential advantages	Potential disadvantages
▪ Maintaining and enhancing intrinsic product qualities ▪ Developing niche markets ▪ Raising the income of small farmers* ▪ Promoting employment and economic activity (including tourism) in decentralized regions ▪ Preventing unfair international competition ▪ Redistributing the value added in the production chain ▪ Preserving local know-how and natural resources	▪ Non-equitable participation among the producers and enterprises in a GI region ▪ Creating barriers to trade ▪ Unfairly restricting the use of cultural know-how by immigrants to foreign countries ▪ Raising costs for producers which would be passed on to consumers ▪ Administrative and financial burdens on Governments without tangible economic benefits

* In the European Union, the price difference between PDO and PGI products, in comparison to similar products not bearing such designations is on average 10-15 per cent, with some PGI and PDO products having 35-45 per cent higher prices (for example, PDO *Camembert de Normandie* as compared to Camembert cheese and PGI *Turrón de Alicante* as compared to nougat).

2. *Establishment of a geographical indication for South Lebanon Zaatar*

Following developmental projects related to *zaatar* cultivation and production implemented by various local and international NGOs in South Lebanon, it is expected that national *zaatar* production will steadily increase, creating pressure for new marketing and value-adding opportunities to avoid decreasing prices due to increased competition. In addition, the comparative advantages present under South Lebanon production conditions yield high quality *zaatar* and are further incentive for developing a *zaatar* GI.

From another perspective, a project on “the Protection of Lebanese Geographical Indications” is being undertaken by MOET as part of a bilateral technical assistance programme with Switzerland and within the context of the conclusion of the Free Trade Agreement with the European Free Trade Association (EFTA) states.[23] The implementation of this project is expected to lead to a Lebanese law on denominations of origin, which will create the momentum needed to push the *zaatar* GI project forward.

(a) *Expected benefits from a zaatar GI*

The establishment of a *zaatar* GI will probably differentiate the Lebanese or South Lebanon *zaatar* from other types of *zaatar* produced in neighbouring countries, mainly Israel, Jordan, Palestine, Syria and Turkey. Accordingly, the proposed GI will facilitate the marketing of Lebanese or South Lebanon *zaatar*, attract premium prices and increase added value, especially if associated with authentic traditional products of high quality. Consequently, more possibilities for agriculture in the area, leading to additional income generation and employment opportunities will help alleviate the socio-economic situation in South Lebanon.

In addition, the completion of a *zaatar* GI will necessarily favour clustering of numerous small-scale producers, since the propounded Lebanese national law on denominations of origin stipulates that a GI can be registered only if 50 per cent of the producers (or producers representing 50 per cent of total production) apply for the GI. This means that *zaatar* producers inevitably have to collaborate and coordinate their efforts in order to benefit from the GI advantages, a situation which will empower their position vis-à-vis key actors downstream in the value chain.

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[23] The project, which is funded by the Swiss State Secretariat for Economic Affairs, was launched in July 2005. A major output of the project is a national law regulating the implementation of GIs in Lebanon. As part of the project, a list of 41 Lebanese products renowned for their geographic identity was drawn up, one of which is the “*Zaatar* of Litani” (as denominated by the project). Out of this list, three products will be registered to serve as models or pilots for testing the law. See www.economy.gov.lb/MOET/English/Projects/Pages/ProtectionOfGeographicalIndications.aspx.

A positive environmental impact is also expected. As demand for *zaatar* increases, more farmers will be motivated to cultivate it, and wild harvesting, which is a current widespread malpractice, will decrease. As such, various currently-threatened wild *zaatar* populations will be preserved.

(b) *Challenges facing the implementation of a zaatar GI*

In implementing a GI for *zaatar*, two sets of challenges can be foreseen, the first being common to all GIs to be implemented in Lebanon, and the second relating specifically to *zaatar*.

The procedure aiming at protecting a GI always begins at the national level, through the regulation of the country of origin. As a second step, the country applies for protection of a GI internationally, either through the WTO or through bilateral and multilateral agreements.[24]

The Lebanese GI law being developed through the above-mentioned project is expected to become functional soon. However, implementation of this law to any product is expected to face a number of challenges, whether in the selection of the denomination (PDO versus PGI), the establishment of specifications for the *cahier des charges* or the delimitation of the geographical area.

On another front, a GI would have to be maintained through groups of producers, similarly to a collective trademark. Accordingly, a major challenge will relate to implementing a quality control system integrated to the *cahier des charges* that avoids free-rider behaviour, which would harm any GI-protected product.

At the institutional level, certain challenges are also foreseen, since the Lebanese GI law is expected to nominate a new body, dedicated to the protection of GIs, similarly to the European model. While this setup will provide closer follow-up and control of GI implementation, creating a new body, different from the one responsible for trademark protection, may prove administratively complicated and costly.

As indicated, the propounded Lebanese GI law will differentiate between PDOs and PGIs. As such, should *zaatar* be protected as a PDO or a PGI? To answer this question, it should be determined whether the reputation and characteristics of the Lebanese or South Lebanon *zaatar* are "essentially or exclusively" due to its origin. Should Lebanon go for a PGI, which is less restrictive, there are less chances of it being contended by neighbouring countries. However the authenticity of Lebanese *zaatar* may be compromised in the market. Table 21 summarizes the advantages and disadvantages of selecting a PDO or a PGI depending on the product type to be protected.

The question of PDO versus PGI leads to another crucial one: even if, on a local scale, the *Zaatar baladi* of South Lebanon is the most renowned, should the GI be limited to the South Lebanon area or should it include the whole country? Furthermore, what is the impact of the various *zaatar* mix additives, such as sesame and sumac, which are most often imported from abroad?

In addition, different varieties of *Origanum syriacum* grow in Lebanon, namely the *Origanum syriacum* var. *bevanii* and the *Origanum syriacum* var. *syriacum*. The agronomic characteristics, chemical composition and composition of essential oils vary between these varieties. All these parameters need to be deeply considered and assessed in order to build an appropriate *cahier des charges*.

[24] The EU resorts to bilateral and multilateral agreements to protect its GIs internationally, by linking EU market access for developing countries with the protection of European GIs in these countries.

TABLE 21. ADVANTAGES AND LIMITATIONS OF PROTECTED DENOMINATIONS OF ORIGIN AND PROTECTED GEOGRAPHICAL INDICATIONS ACCORDING TO TYPE OF FINAL *ZAATAR* PRODUCT TO BE PROTECTED

GI type	Type of final *zaatar* product	Advantages	Limitations
PDO	Dried ground *zaatar*	Take full advantage of microclimate in South Lebanon, which yields high quality *zaatar*	*Zaatar* cultivated in other areas of Lebanon will not benefit
	Dried ground *zaatar* mixes	Promote cultivation of other *zaatar* mix ingredients, such as sumac	Some of the *zaatar* mix ingredients (mainly sesame) are not grown in Lebanon, and it is not feasible to grow them. Alternatively, the PDO could be specified for *zaatar* (*O. Syriacum*) and sumac, as main ingredients in the *zaatar* mixes (or restrict it to *zaatar* only, allowing imported sumac and sesame to be added)
PGI	Dried ground *zaatar*	Any *zaatar* species could be imported and processed in Lebanon	The authenticity of Lebanese *zaatar* will be compromised in the market. Local *zaatar* production may be affected as profit margins decrease in the face of competition by imported *zaatar*
	Dried ground *zaatar* mixes	Any *zaatar* species could be imported and processed in Lebanon. All complementary *zaatar* mix ingredients could also be imported and added in Lebanon	The authenticity of Lebanese *zaatar* may be compromised in the market. Local production of *zaatar* and sumac may be affected. The approach has no real value since producers of Lebanese *zaatar* mixes use imported ingredients and already have high production costs. Foreign competition will be very high

On another front, it would be hard to achieve a protected *zaatar* GI through the WTO if other neighbouring *zaatar*-producing countries show opposition. A major challenge would be to prove that Lebanese *zaatar* is different, and that its differentiation relates to its geographic origin (such as Lebanese weather, the nature of its soil, local know-how associated with traditional recipes and ingredient modifications).

D. CLUSTER DEVELOPMENT FOR ENHANCED COMPETITIVENESS: WORKING AND MARKETING AS A GROUP

As reported earlier, *zaatar* projects in South Lebanon constitute small-scale, household productions on small, isolated parcels of fertile land with limited water resources and restricted mechanization choices. The farming system in South Lebanon is traditional, based on household activities and fragile, when compared to intensive monoculture practices. These conditions present motives for farmers to work collectively in order to overcome technical problems and enhance their competitiveness.

The implementation of the pilot projects has demonstrated the need to develop common infrastructures, mainly regarding water storage and irrigation networks. In addition, post-harvest and marketing activities, which are crucial for increasing net benefit, are very hard to develop at the individual level on such an extensive scale. This is because product homogeneity, a key factor for successful marketing, cannot be guaranteed unless similar agronomic and pre/post-harvest practices are applied over the various land plots, seasons and years. This is of special importance in case trade names are created or a GI is developed, as it becomes crucial to maintain a certain level of quality in order to preserve the product's reputation, which, if lost, cannot be easily recovered.

Consequently, cluster development is essential for building sustainable *zaatar*-production chains and entails several benefits, including the following:

- Reduce costs of agricultural inputs and mechanization needs;
- Facilitate large-scale production due to reduced infrastructure, operation and maintenance costs;
- Produce more homogeneous output, which enhances marketability;
- Improve negotiation position during marketing and sale.

However, from a practical point of view, clustering faces a number of constraints in South Lebanon and in the ESCWA region as a whole, due to the following reasons:

- Although farmers agree generally to the importance and benefits of clustering, and while the initial enthusiasm of starting a promising new project motivates them to collaborate, the accumulation of small technical and inter-personal problems (related for example to coordination, division of duties, sharing and leadership) during project implementation threatens the solidarity of the group and leads to the appearance of sub-clusters and individualism;

- A prevailing culture of individualism and lack of trust in collective action, nurtured by the failure of previous collaborative projects in the region;

- Divergent interests and priorities among group members, notably those who do not depend on agriculture alone for their livelihood. For example, while certain farmers are interested in developing their know-how and making the project work to develop an alternative source of income generation, others may only be interested in the project as a hobby or for political reasons (to gain importance in the village). Free-rider behaviour is also sometimes observed where group members only want to benefit from the project's common infrastructure, without contributing any effort. Under this cocktail of interests, it is not easy to impose full respect of cooperation rules;

- Intolerance and lack of transparency and accountability within the group. In such an environment, fostering and maintaining group cohesion becomes very time-consuming and group decision-making very difficult to achieve;

- Lack of thorough follow-up with farmers' groups and continuous capacity-building programmes at the national level (for example by the Ministry of Agriculture, Directorate of Cooperatives) is leaving farmers' groups at the mercy of the leading elite inside the group.

- Low educational profile of farmers and a family business style of management within the group, which lead to an unclear sharing of responsibilities, duties and benefits. Indeed, this mode of operation explains the short lifespan of cooperative systems in Lebanon.

Farmers wishing to collaborate can choose one of several legal partnership options available according to the Lebanese code of commerce. Each of these options has its own advantages and constraints, as can be seen in table 20.

TABLE 22. ADVANTAGES AND CONSTRAINTS OF VARIOUS PARTNERSHIP OPTIONS IN LEBANON

Partnership option	Advantages	Constraints
General partnership	None specifically in the case of collective *zaatar* production	• High responsibility of debts • Decision-making is complicated as each member of the board of directors has the right to veto activities

TABLE 22 (*continued*)

Partnership option	Advantages	Constraints
Join stock company	• Sustainability of activities • Additional partners can join relatively easily to increase the capital	• High capital required • Not adapted to farmers' mentality as it is not very common in the agricultural business
Limited liability company	• Limited responsibilities • Limited capital required	None specifically in the case of collective *zaatar* production
Limited partnership by shares and limited partnership	Provides investors and farmers a win-win relationship where investors contribute capital and small-scale producers contribute labour and know-how	• High responsibility of the financed partners (personally and jointly) for liabilities of the company
Cooperatives	• Important fiscal advantages • Acceptance of donations and subsidies • Acceptable concept in the agricultural business	• All members are supported regardless of the quality of their productions • Low motivation of members

VI. RECOMMENDATIONS BASED ON LESSONS LEARNED

The ESCWA-led piloting of *zaatar* cultivation in South Lebanon has generated a wealth of knowledge that this technical report has tried to capture and document. The following paragraphs provide some concluding remarks and recommendations for sustaining and up-scaling the *zaatar* cultivation experience in South Lebanon.

The economic and environmental suitability of the zaatar crop

Zaatar is economically suitable for production in remote rural areas since it is marketed in dry form and has a long shelf life, without need for sophisticated or expensive storage requirements. In addition, *zaatar* processing is a value-added activity which can be traditionally undertaken at a small, even household scale, without need for high technology. As such, it constitutes an income-generation opportunity which can help limit rural exodus. The following actions are recommended for expanding market opportunities for *zaatar* and its by-products and contributing to its added value:

- Promote *zaatar* as a medicinal plant and healthy food which would help establish a niche market;
- Investigate potential benefit from complementarity with other high-value goods, such as *zaatar* honey (honey produced near *zaatar* fields, and characterized by its particular taste);
- Encourage the local cultivation of different ingredients of *zaatar* mixes, such as sumac and sesame, to meet the expected increase in *zaatar* production while ensuring good quality products;
- Develop related value-adding activities (packaging, labelling and GIs) and investigate different *zaatar*-related products (herbal tea, essential oil) in order to enlarge market potential.

From an environmental point of view, *zaatar* is a low-input crop that is adapted to marginal lands and constitutes a suitable alternative to tobacco monoculture. As such, it can contribute to crop diversification, which is a key factor for sustainable agriculture in rural areas, and has a multi-benefit effect both on agro-ecosystems and on income-generation flow. Meanwhile, as water scarcity and land hardness are limiting the choices of alternative crops, medicinal and aromatic plants tolerate water scarcity and represent good candidates. In addition to *zaatar*, it is possible to focus on sumac, sesame, rose, carob, laurel, and other local species which are adapted to the local environment, are part of the local diet and have traditional uses.

Zaatar cultivation instead of harvesting from the wild

In Lebanon, the quantity of wild *zaatar* available per year is limited and cannot, by itself, meet growing market demand. Increasing total *zaatar* production through cultivation should be promoted at the national scale, in order to alleviate pressure on natural resources and preserve biodiversity. In addition, an increase in availability of *zaatar* through cultivation is expected to limit dishonest practices carried out by certain *zaatar* processors, whereby such bulking materials as sesame by-products and wheat bran, or even sawdust and weeds, are added to *zaatar* mixes in order to increase their marketable volume. In a similar line of thinking, encouraging the cultivation of sumac, which is the main complementary ingredient to *zaatar*, is expected to discourage *zaatar* processors from using such low-quality replacement additives as the addition of colouring agents to imitate sumac's reddish colour and of citric acid to replace its acid taste. Such practices must also be discouraged through the development and implementation of national standards that ensure *zaatar* mix authenticity.

In addition, competition for limited quantities of wild *zaatar* encourages harvesters to pick *zaatar* before the recommended full-blooming harvesting stage, frequently before it reaches even the pre-flowering stage, which can have a huge impact on quality and threaten the natural regeneration of wild *zaatar* populations. In addition, harvesters sometimes pick *zaatar* growing in polluted environments (such as near roadsides), which may entail health consequences. In comparison, harvest of cultivated *zaatar* can be scheduled by the farmers, leading to much better quality of the final product, especially when cultivation sites are selected far from polluting agents.

Improving zaatar cultivated material

Genetic and chemical analyses of the various *zaatar* species/varieties are needed in order to better characterize, assess and cluster the inter-specific and intra-specific diversity of the cultivated material. Selecting interesting planting material based on its genetic, chemical and morpho-agronomic profile, will help orient farmers accordingly to cultivars which are best suited to different market types. In particular, the essential oil profile plays an important role in determining the suitability of specific cultivars for use as fresh leafy vegetables, dried herbs, dried *zaatar* mixes, or input for the pharmaceutical and cosmetic industries. Care needs to be taken, however, not to be too selective in order to avoid monoculture.

It is recommended to benefit from biotechnology applications, notably tissue culture, in order to produce certified *zaatar* planting material in large quantities.

Future technology inputs

Water scarcity and the elevated cost of deep-water pumping constitute the main bottlenecks limiting the up-scaling of *zaatar* production to its full potential. It is therefore recommended to develop rainwater harvesting projects in the area, at the community level, as a pre-requisite to the establishment of a collective irrigation network serving farmers. In addition, drip irrigation should be further promoted for its benefits in terms of water-use efficiency and reduction of labour costs associated with watering activities. However, in view of the elevated cost of drip irrigation-system installation, Government and civil society support may be needed at the initial phase to facilitate the acquisition of this technology.

Finally, it is recommended that further research be conducted on the mechanization of some of the production phases of *zaatar*, including adapted technologies for weeding, harvesting and threshing, in order to increase the productivity and competitiveness of *zaatar*, reduce the labour component of production cost and increase net benefit.

Technical assistance programmes

The successful implementation of the *zaatar* pilot projects in South Lebanon was made possible through continuous contact and close coordination with farmers over a relatively long period of more than four years, which allowed the projects to stabilize and overcome the different types of hurdles which farmers are expected to encounter when embarking on a new production. Over time, farmer’s confidence level in the feasibility and profitability of the new crop was built. In contrast, in short term-projects of one year or less, wherein technical assistance is limited to the implementation of training modules and distribution of planting material and infrastructural-irrigation systems, long-term success is threatened; farmers quickly convert back to old practices at the first obstacle, abandoning the material or shifting it to other uses. Consequently, it is recommended that technical assistance programmes planning to develop the cultivation of such perennial species as *zaatar* and sumac, be designed to cover periods of at least three years in order to achieve solid and replicable results on a sustainable basis. During this period, capacity-building programmes, technical assistance and day to day follow-up are essential to ensure success of the initiative.

The success of technical assistance programmes also depends on the ability to promote collaboration mechanisms between farmers and the careful selection of beneficiaries during the preparatory phase in order to avoid parasitic tendencies. The pilot projects have demonstrated the importance of having beneficiaries sign a written agreement among themselves and with the land owner (if different from group members) in order to ensure commitment of beneficiaries and availability of resources for the full six to eight year-life cycle of cultivated *zaatar* and not just for the duration of the project. Indeed, and generally speaking, structuring farmers into clusters with varying degrees of formality, or resorting to cooperatives, is imperative in certain undertakings, whose costs cannot be practically borne by individuals. This is the case, for example, for water-pumping projects using renewable solar or wind energy, rainwater-harvesting projects, or the development of a geographic indication. Innovative yet simple structures of cooperation are needed to counter farmers' tendency for individualism.

Quality standard and geographic indication

Laboratory tests undertaken on *zaatar* samples produced through the ESCWA pilot projects have reflected the inadequacy of the existing Lebanese quality standard for *zaatar*. Therefore, it is recommended to review and modify this standard to take into account the diversity of *zaatar* ecotypes, agronomic practices and environmental conditions across planting areas in Lebanon. This can only be achieved through comprehensive sampling and testing, including the development of an essential oil profile. In addition to standard development, appropriate testing and certification services need to be made available.

The development of a geographic indication (GI) will give prominence to South Lebanon *zaatar* and differentiate it against *zaatar* and *zaatar* mixes of diverse origins, therefore increasing the competitiveness of farmers in the area. Indeed, the climatic conditions in South Lebanon, characterized by long, hot and dry seasons, increase the concentration of essential oils as a secondary metabolism induced by environmental stress, leading to better *zaatar* quality. An adapted GI system for South Lebanon *zaatar* would help certify these qualities and preserve its good reputation.

However, due to the lack of Lebanese experience with GIs, it is essential that an integrated study be conducted that would provide in-depth assessment of the following issues:

- Technical issues: Determine the characteristics of *zaatar*, whether at the level of the crop itself or the mix of herbs, which are "organically" linked to their origin and to the agronomic practices. The establishment of the *cahier des charges* will depend on such a study, especially as *zaatar* cannot yet be considered a widely cultivated crop;
- Strategic GI issues: Define which form of GI is suitable for *zaatar* production in South Lebanon in view of the diversity of species used in *zaatar* mixes in the eastern Mediterranean region, the easy trade of *zaatar* material among the concerned countries (mainly Jordan, Lebanon, the Syrian Arab Republic and Turkey) and taking into consideration that ingredients added to *zaatar* mixes are regularly imported (Sudan for sesame, Turkey for sumac);
- Legal issues: Identify the different legal procedures that have to be followed at the national and international levels, to support preparation of the required documentation and assist in implementing the GI registration procedures;
- Organizational issues: Study the possibilities of forming an organized cluster to apply for a GI, manage its implementation and ensure its sustainability. For optimal results, it is important for the preparation of this study to involve all actors engaged in *zaatar* production, in addition to experts in GI implementation, under the umbrella of the concerned Governmental institutions.

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