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ALTERNATIVE CROPS, WITH SPECIAL REFERENCE TO MEDICINAL AND AROMATIC PLANTS, FOR A COMPETITIVE MALTESE AGRICULTURE

Introduction

The exploitation of alternative crops is a complex issue. In this context, the cultivation of medicinal and aromatic plants, as alternative crops, shall be discussed. Medicinal and aromatic plants link the fields of agriculture and health. As a matter of fact, up to a few years ago, one looked at these plants in this way. Today, there is an array of products that have different degrees of medicinal and food implications. Although within the European Union, there are directives and regulations for medicinals, food and even cosmetics, different countries have a different perspective regarding these three areas.

The main highlights of the following article are:
1. the situation of the fruit and vegetable production on the Maltese Islands,
2. the importance of the herbs in the agricultural and industrial sectors, and
3. the commercial exploitation of herbs as alternative crops.
Analysis of Imports and Local Production of Agricultural Products

A quantitative survey was undertaken, to determine the demands of fruit and vegetables in Malta. This involved the analysis of data obtained from imports (PQS, 2006) and local production of fruit and vegetables (Pilkalija, 2006) between the year 2000 and 2005. The analysis was carried out for four categories of fruit (citrus, stone, exotic and others), three categories of vegetables (fresh vegetables, tubers, processed vegetables) and herbs.

As observed from the statistics over the six-year period (figure 1), fruit were mostly imported while the vegetables

![Figure 1: Imports/Local totals for Fruit, Vegetables and Herbs](image-url)
predominated in local production. It is worth noting that the quantities of imported fruit and local vegetables approximately mirrored each other on a yearly basis.

The most popular category within the imported fruit group (figure 2), was that of apples, bananas, pears and grapes for pressing (with average imports of 17361.80 tonnes/year, 62.96% within the fruit group). As regards the local vegetables grown, cabbages, carrots, cauliflower, lettuce, marrows, and tomatoes constituted the main

Figure 2: Analysis of Various Categories of Imported and Locally - Grown Crops
bulk within the group (with an average entry of 19423.23 tonnes/year, 63.25 % within the vegetable group). The tuber category includes both the locally sold and the exported Spring crop potato (9742.305 tonnes/year). Despite all this massive data, when it comes to herbs, one would observe that the average import was 24.32 tonnes/year and the average local production was 476.98 tonnes/year. From the last figures, it was observed that the locally produced herbs outweighed those imported and the local producer is already growing these herbs on a small scale.

3 Herbs: The Local Perspective and Potential Uses

3.1 The Local Perspective
In Malta, herbs are exclusively grown for culinary purposes. From statistical data (figure 3), the most commonly cultivated herbs include parsley (63 %), mixed herbs (21 %), basil (7 %) and fennel (6 %) (Pitkalija, 2006).

These have been rarely exploited for other purposes, except for chamomile and olive leaves harvested for the production of tea bags and the use of prickly-pear for the production of a stress-fighting extract.

Although the Maltese Archipelago has a restricted environment due to its small size, the diversity in biological species is vast. There are about 1264 vascular plant species, including casual or naturalized aliens. The bioclimatic conditions of Malta are also found in coastal regions of other Mediterranean countries (Haslam et al., 1977). In fact, about 66% of the flora of Malta is common to other Mediterranean regions while the other 34% of the flora is adapted to cold European and sub-tropical conditions. Out of these, 458 species possess medicinal
Figure 3: The locally - cultivated herbs
(average for 2000-2005)

- Basil 7%
- Others 3%
- Fennel 6%
- Mixed Herbs 21%
- Parsley 63%

Figure 4: Local Traditional Uses of Medicinal and Aromatic Plants

- GastroIntestinal 24%
- CardioVascular 14%
- Nervous System 15%
- Dermatological 13%
- Antimicrobial 4%
- Others* 30%

*Others: plants used in other conditions whose contribution is < 4%
virtues (Attard 2004) and have been used in traditional medicine (Lanfranco 1993; Lanfranco 1975) for several ailments (figure 4). These medicinal and aromatic herbs are sparsely distributed throughout the country.

3.2 Potential Applications

Herbs may have several important applications other than culinary in the strict sense. In fact, added-value crops and their products may be found in the following categories:

1. Traditional Foods/Crops, those crops that have been abandoned with the introduction of modern and perhaps more vigorous varieties;
2. Functional Foods, those crops that may provide a health benefit beyond basic nutrition;
3. Nutraceuticals, crop derivatives enclosed within a pharmaceutical dosage form;

Taking the tomato crop as the classical example,

- Old tomatoes varieties fall within the traditional crop category,
- A tomato variety with a high lycopene content (which is a chemopreventive) falls under the functional foods group
- an encapsulated lycopene extract, derived from tomato, is a nutraceutical.
- an encapsulated tomato extract is a medicinal although this category suites more non-edible plants.
Reasons for cultivating alternative crops

According to the Common Agricultural Policy, producers within the European Union are obliged to set aside a portion of their agricultural land in return for the subsidies they receive on their main crop/s. However, this fallow land can be used to grow other crops that are not intended for food purposes. Crops used as raw materials for medicinal and cosmetic products are in a particular permitted category. This opens the possibility for cheap raw materials for plant-based products (Grant, 1997). Despite this opportunity, there are certain elements that are counterproductive in such a subsidised agricultural system. These may include administrative difficulties from the paying agencies, and the misuse and abuse from the producer's side, amongst others. This will hinder the good will of the dedicated producers.

The use of fallow land for the cultivation of herbs that require minimal care and maintenance will enhance the producers to build their trust in this new crop or crops, which might eventually lead to the replacement of some established crops.

Commercial exploitation of added-value crops

In most cases, the alternative crops, in discussion, do not reach the market in the crude state, but should be processed to give an added-value finished product. Therefore, the producer and industry must work hand in hand to accomplish this. The end user is the consumer. This makes the cycle complete with the supply and demand factors linked together by industry (figure 5). If one of the components is affected, the whole system will collapse.
Collaboration and communication can be achieved by direct discussions between members of the three parties. The weakest link in the cycle is the processing component. In fact, in the past the farmers' co-operatives failed in the processing of agricultural products and wine-making (Walker, 2004).

There are several factors that affect the commercial exploitation of herbs, all of which are particular to each individual herb in question. These include (a) production of alternative crops (technical feasibility) (b) industrial processing (economic feasibility) (c) marketing and the consumer (market potential) (d) role of collaborative research

5.1 Production of Alternative Crops (Technical Feasibility)
This factor greatly depends on the agronomic factors including both biotic and abiotic components, which
may lead to the success or failure of production. The first question that will surely come to mind is, whether the crop can be grown on a field scale or not. This is the most important hurdle which determines whether the crop may be considered as an alternative or not. If we are considering here, an established wild medicinal plant, the factors that affect its growth and vigour should be considered when this is being domesticated.

Several studies should be performed at this stage to determine whether the medicinal value is retained, enhanced or deteriorated with domestication. For example in the case of borage, plant spacing affects the seed yield but not the fixed oil content (Coleiro, 1994). Sage is more quickly propagated by cuttings rather than seeds and shading is preferred over a sunny position (Azzopardi, 1994). For lavender and spearmint, the type and quantity of fertiliser affects the composition of the essential oil (Caruana, 1996; Barbara, 1996). These are a few examples of some plants studied locally.

However a problem may arise due to producer resistance to growing a new crop. In general, in almost all countries, growers are somewhat reluctant to risk their main crop, which is rendering a living, for a new alternative crop. On the other hand, if the grower succeeds in growing the alternative crop or crops, then he would be very keen to know what returns he would get, should there be a surplus in production. Therefore for new crops, there should be a contract between the grower/s and industry. Moreover, a kind of association or cooperative should be in function to lease between the two parties and hence avoid surpluses or insufficient quantities of crop.

The production cost is greatly influenced by the yield of the crop which is indeed inversely related to the unit cost. Since the initial phase is the cultivation of the crop,
this will particularly affect the producer. The producer will surely grow the most profitable crops on the most suitable piece of land at his disposition. Therefore, even though an alternative crop tends to grow better or gives a better yield on this soil type, as established by its technical feasibility, it is more profitable to grow the alternative crop in less 'advantageous' areas. After all, with the right conditions at hand, wild-type species may not necessarily require strict care when domesticated.

Another important point is the government involvement when it comes to subsidies on crops. If there is a subsidy exclusively on the main stream crops, then alternative crops will be side-lined and their production ceases. However, if there are incentives and subsidies on the production and commercialisation of new alternative crops, then agricultural economy will rise, keeping in mind that from such crops, even the industry will benefit.

At this point the producer will decide on the fate of the new crop, whether to exploit its commercial potential or not. However, once the crop's performance has been established, economic evaluation is the next step in line.

5.2 Industrial Processing (Economic Feasibility)
There are two important factors that mainly affect the economic feasibility of a crop: the price of the end-product, and the cost of industrial production from field to consumer (finished end-product). Economic feasibility is merely the balance between these two factors. However, a new product on the market will have a high initial intrinsic value to the consumer, that is, the price of the end-product will surely outweigh the production costs. With time, if there are competing products for this new alternative crop, or if an already market-established crop
is being cultivated, then the price of the end-product is governed by the price of the competing products.

For example, if we have a natural cream for chilblains prepared from nettle (Lanfranco, 1993), there are merely few natural alternatives with the same effect, so initially the consumer will be willing to pay a price that might be higher than that for the commercial conventional creams used for chilblains. However, if there are competing natural products on the market, the price of the chilblain cream has to be reviewed. Another product that would qualify under this situation would be the flavonoids in the caper plant (Spiteri, 1998), to be prepared as a topical formulation for varicose veins. On the other hand, we find several natural and alternative insect repellent sprays on the market, mainly based on citronella oil and derivatives. A Maltese medicinal plant with significant insect repellent properties is the pennyroyal which has over 90% of the insect repellent component (pulegone) (Tanti, 1994). The price of pennyroyal oil or formulated spray has to be adjusted according to the competing sprays, just from the start. Another example is in the field of functional foods. Added-value tomatoes contain a high concentration of lycopene, a well-known chemopreventive. The consideration of a local variety with such potential has to be thoroughly evaluated as regards the product costs, as compared to already established high lycopene-containing tomato varieties.

As a result of these pros and cons, there might be a resistance of industrial processors to new crops. A processor, having an already-established industrial plant, will find it difficult to change the already established processing conditions to suit the processing of a new crop product. This is more so when the processor has to invest in new equipment for a product that still needs to be
tested. This is not the case, in Malta, as there are relatively few companies that process crop products, even more with the medicinal and cosmetic fields.

At this point, the problems in technical and economic feasibility measures, are overcome with the selection of the appropriate instruments. However, the next question will be: Will the product reach the market?

Marketing and the Consumer (Market Potential)

Market Size
The size of the market will determine whether the crop production and processing will be feasible or not. Considering the local consumer population, the market size becomes the bottle neck for the commercialisation of processed products from alternative crops (figure 6). In fact, the demand will greatly influence the supply of product. Even though the crop is potentially able to make a running profit, these limitations will stifle the whole commercialisation process. This means that in the case of

Figure 6: Market Size: The Local Consumer Population

Local Consumer Population

Negative Feedback

Producer
Malta, markets beyond the local one should be exploited for sustainability.

Therefore an international market should be looked at in the long run. Recently, there have been interests from Central Europe in the revival and introduction of Greek-Arabic medicine into the European market. Due to our exclusive geographical and political position, Malta forms part of the European Union and part of the Magreb Region. Besides, Malta has a history of North African and Southern European occupations, which suggests the brewing of a multicultural civilisation, eventually leading to our uniqueness in this respect. This gives us the opportunity to re-discover our cultural roots, including the use of medicinal and aromatic plants, and apply the commercial implications of these in the context of the modern world. So effectively, one may take medicinal plants, used in the past and formulate them into a suitable medicinal or cosmetic product.

Considering Council Directive 2004/24/EC, the bibliographical or expert evidence to the effect that the medicinal product requires medicinal use of at least 30 years preceding date of application, including at least 15 years within the Community. Although all this is out of the agricultural context, this is the strong evidence where locally, the cultivation of such crops would be an advantage. In spite of these opportunities, the challenges may imposed by countries that have a similar historical background.

The Cost of the Product
Although this factor would be already considered at an earlier stage during economic feasibility studies, this will emerge again if the market is exploited from a wider perspective, i.e., beyond the national perspective.
In fact, the cost of the products vis-à-vis the **competing products** on the markets and the **product quality** are part and parcel of the absolute cost of the product. **Product stability** is another problem in question, especially if the growth cycle of a crop is very long. As a result, annual herbs are preferred over perennial herbs for two main reasons: primarily to practice crop rotation once the plant is harvested and to obtain an immediate significant yield of crop without waiting for years (in case of trees).

**Rate of Market Penetration**

A factor that limits market penetration is perhaps a balance between **supply and demand**.

For example, from the supply point of view, the multiplication of germplasm to obtain sufficient yields for propagation, may be a limiting factor. In most instances, a crop can multiply within the five to tenfold range, therefore sufficient seed stocks will probably be achieved within five to seven years. However, this problem may be overcome by selecting plants with a high seed turnover within a single crop, the use of micropropagation techniques and the use of alternative propagation methods (e.g. cuttings - sage, bulb division - squill, etc.).

However, the problem arises in predicting the supply of crop by the end of the cycle. This is called **supply uncertainty**. Although a crop might give a high yield, supply uncertainty will be possible if at the same time the crop might be also prone to production failure.

On the other hand from the demand point of view, this depends on advertising and **consumer awareness**. In fact, market penetration from this end, might be difficult if the consumer is unaware of the new product or if there is **consumer resistance**. The product is passed on from the processor to consumer, via the distributor. Here is
another form of low market penetration, when there is 
distributor resistance, usually arising from the fear that 
the product will not reach the sales expectations. Apart 
from this, distributors of already-established competing 
products, tend to take counteractions to this by increasing 
public awareness strategies to beat the new entrant.

Role of Collaborative Research
The three points discussed above lead to the success or 
failure of a crop or crop product to reach the market. 
However, all this has been based on the knowledge and 
predictions. In fact, research and education are the key 
success to the commercial exploitation of alternative 
crops. There are three research areas considered: technical 
(agronomic) research, industrial research and marketing 
research (figure 7). Although the production of a crop 
product goes from production to processing to marketing, 
the three research instruments, mentioned, should be 
applied in the reverse order. This means that first the

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**Figure 7: Role of Collaborative Research**

![Diagram showing the roles of collaborative research in a circular flow: Marketing Research, Production, Industrial Research, and Technical Research]

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61
market should be studied to determine which products are demanded by the consumer, the economic feasibility comes next and finally the technical feasibility.

Currently, the Institute of Agriculture (University of Malta) is involved in a number of projects related to alternative crops with a special reference to medicinal and aromatic plants. Since basic knowledge on these local plants is lacking, the Institute has embarked on a project, in collaboration with the Department of Anatomy (Faculty of Medicine and Surgery) to determine the potential pharmacological activity of a wide range of plants. This project is funded by the National RTDI. Another project developed between the Institute and the Ministry for Rural Affairs and the Environment, involves the cultivation of a number of medicinal plants to conserve the endangered species through *ex situ* and *in vitro* propagation and to stimulate the interest of the local producers in order to cultivate these medicinal plants as alternative crops. Another project, still in its preliminary phase, is the collaboration between the Institute and industrial processors, willing to embark on the processing and finalization of alternative crop-derived products, especially with medicinal and cosmetic values. This is not limited to local processors but also processors from EU member states.

Apart from research projects, the Institute has the responsibility of educating the producer, processor, consumer and persons involved in this sector. In fact, the Institute offers a wide range of courses related to the use and exploitation of medicinal and aromatic plants as alternative crops.
Conclusions

In the absence of government assistance, it is likely that only new crops with potentially new uses will be developed. It would seem sensible therefore for the government to fund extensive research on new crops up to the point where it is possible for them to make money, and at that point allowing the private sector to take over. The government would also help the farming community by providing the necessary assistance to grow these alternative crops. It is only through these means that a range of alternative crops are likely to be produced.

The realisation of this sector relies solely in the hands of those who are willing to set things going and collaborate. As a matter of fact, as mentioned earlier, the establishment of a cooperative for alternative crops, would be a good start. Although it is easier said than done, no alternative crop will manage to make it to the market unless the three major components, of the 'fate cycle' mentioned (figure 5), are managed on the same level.

References
DIRECTIVE 2004/24/EC, amending, as regards traditional herbal medicinal products, Directive 2001/83/EC on the Community code relating to medicinal products for human use. Article 16c.1(c)  


