

ESTABLISHING THE CULTIVATION AND PROCESSING OF PLANTS FOR THE PRODUCTION OF SPECIALITY CHEMICALS AND THEIR ASSOCIATED MARKETING. SOME UNITED KINGDOM EXPERIENCE.

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INTRODUCTION

I have been asked by the organising committee to talk to you about some of the practical problems, which anyone embarking on the production of speciality chemicals has to face. The UK is behind such countries as France, Italy and Germany in the production of these compounds from plants. But now a realisation of the potential has resulted in a number of ventures being initiated and I would like to talk to you of some of the problems that two of these have encountered and the lessons to be learnt.

THE PROJECTS

The two ventures are very different but surprisingly have many issues in common. The first consists of a 4 year development programme in Eastern England involving 42 farmer members under the aegis of Anglia Industrial Crops Group Ltd. The programme is financed partly through Gorham and Bateson who are responsible for the overall management of the project and the commercialisation of the crops with support from UK Ministry of Agriculture, EU structural funds and UK local government bodies. It is a market development led initiative, which seeks to produce products from plant species on a trial basis to match end user specifications and price. Once this achieved then production of that product and crop goes in to commercial production. The programme began in 1996 with 28 crop species and now has 15 with potential for commercial production. Commercial production of the first of these started in 1998.

The second of these is rather different. It is based in the Highlands of Scotland with the aim of reintroducing traditionally used plants indigenous to the Highlands for the pharmaceutical, cosmetic and chemical industries. As one would expect, there is a strong developmental element involved. From a long list of 22 plants, 8 have been selected in the short term for development. The raw material will be sourced from crofters, farmers and landowners. In the short term supplies will come from wild harvested material, with the introduction of cultivation as a medium term objective. Products from these species will be produced from processing locally by Highland Natural Products Ltd, the company set up to carry out the venture.

ISSUES

Four areas of activity can be identified where anyone setting up ventures such as these is likely to come across issues, which will have to be solved and these are discussed below.

MARKET DEVELOPMENT

The sector is characterised by weak linkages between the primary providers of the raw material and the ultimate end users, unlike the commodity sector where there is an established chain through agricultural merchants and brokers to the end user. So one of the first problems is what to market and who to market to. The options are to sell dried material or to process further to produce intermediary products such as oils, extracts or fractions. The nearer you are to the end user, the higher the margins. However the risks are greater as is the problem of identifying individual end users and persuading them to take your product.

Various initiatives such as IENICA and the EU Framework Programmes have helped to bring the two sides together but it is still difficult to develop a marketing strategy for the products of each crop species.

This leads to a related problem, that of identifying demand in order to plan the scale of operation geared to the proportion of the market you hope to acquire. Other than global information on for instance, the market for pharmaceuticals, there is little published information on the likely demand for individual ingredients such as taxol. End users are paranoiac about giving information on their raw material requirements and I have had the experience of being physically barred from entering a German company's premises. The situation is slowly improving as end users realise that if they require quality material from traceable sources then they have to meet their producers half way. However, it is still often a question of calculating demand from indirect sources and what one can glean from cooperating end users.

The third issue in this area is the need to determine the specifications of end users so that one has a target to meet. This is usually achieved by a contribution from end users and the provision of samples for end users to comment on. This latter activity is the one that usually opens doors and from which a response is obtained.

CROP PRODUCTION

This is the area where some of the major problems arise.

Cultivation Systems

The first concerns the selection of a cultivation system for a specific crop. Most of these are minor crops such as valerian, *Valeriana officinalis* or plantain, *Plantago major* so that there is little publicly funded work on them in the UK. Sources of information have to be obtained from published information in countries with similar environments. In some

cases as in the Highlands most of the species such as meadowsweet, *Philipendula ulmaria* they are not currently cultivated. When planning, yields and costs of production have to

be based on extrapolation and tested over one or two years. This uncertainty affects ones ability to accurately plan and to price the end product when asked to by an end user.

Improved Planting Material

In parallel with this, is access to improved planting material. For many of these crops sources outside the UK are used. This needs research. There are specialist seed companies for instance in Germany but many good varieties have and are being developed in research institutes in such countries as Poland or Hungary and it is time consuming to identify these. In the UK there are importers of for instance, herb seed but often the sources are not clear and there is a danger of buying the same seed of the same origin from two different importers. A further complication is, that information of the levels of the active ingredient are not always available on a particular variety. The sourcing of high value seeds we have found is a key factor both in achieving high yields where we have found, differences up to as much as a 50% increase between varieties, but also from the quality point of view.

Organic vs Chemical Control

This is becoming more of an issue. The options are no chemicals, low chemical useage or a conventional system. In some sectors such as essential oils, the demand for organic oils is high for the aromatherapy market and premiums can be obtained. In addition, some end users are routinely monitoring pesticide levels and this is important in pharmaceuticals. As well as the market aspect, we have had to take into account other aspects such as the state of knowledge of the cultivation of a species and off label approvals, which I will mention shortly. An organic system implies hand work, mechanical weed control or mulches or a mix and implies often a higher cost of production. We have also found that farmers are not used to these systems in the UK as food crop production is now based on the use of chemicals and farmers do not have the experience or the equipment for organic production.

Off Label Approvals

This brings me to the question of chemical approval. In the UK most of these types of crops are minor and there has been little work done by agro chemical companies on the useage of their products on such crops. I understand that the cost of obtaining approval for a crop is of the order of EU 83,000. In general, Continental Europe has more experience of this area but it is difficult to find out how growers in Europe are dealing with pest and weed control on a particular crop.

Harvesting

The parts of the crops that we are harvesting include leaves, berries, flowers and roots and even petals. There is no currently available machinery designed specifically for these

crops on the market in UK. Ventures will perhaps modify an existing harvester such as a leaf stripper or bean harvester or in extreme cases, incur the expense

of having one designed specifically. The cost and efficiency of harvesting is often a key factor deciding the profitability of a crop.

PROCESSING

Unless one is selling fresh material some form of processing is required even if it is only drying. We have had to deal with 3 main issues in this area.

Technology Selection

Before the recent boom in the requirement by end users for ingredients of plant origin, the conventional technology was based on steam distillation for the production of essential oils and water and alcohol for the production of extracts. Now there are new technologies such as those based on CO₂ which provide a more efficient process with less adverse affect on the product. However these new methods can be more capital intensive and produce a different product from a crop to what is currently produced and which the market is used to. For other crops such as dyes there is little currently available.

Therefore, the selection of appropriate technology has required an evaluation of:

- market acceptability of the product
- technology available
- availability of finance
- potential of integrating different technologies in a venture to use common components

Developing Processing Techniques

Once one has set up a processing facility one has to learn how to produce a product from it and practical problems must be sold such as:

- How to achieve an end product. In the Highlands we have been trying to obtain an essential oil from Meadowsweet with to date not much success.
- There is a problem in cleaning the unit after the distillation of some species such as *Anthemis nobilis*, Roman Chamomile which is costly and time consuming

- With certain crops such as *Larix europaea*, larch, yield increases of oil can be obtained if the material is pre treated. This experience can only be gained from practice
- What is the optimum time for distillation for a particular species. This varies by species

This practical experience can only be learnt the hard way or by accessing it via someone with such expertise if available.

Access to Expertise and Training

With the exception of herb dryers none of this type of equipment is available off the shelf and it is necessary to have each unit individually designed and the material sourced, construction supervised and commissioned. There is also the need for access to this type of expertise on a trouble shooting basis as problems always seem to arise and systems require modification. This process of modification may continue as the processing system is refined in the light of experience.

As part of this process a training scheme is usually required.

QUALITY CONTROL

Included in this section are a number of issues.

Development of Systems

The first is the need to develop quality control systems. These must take into account:

- processing procedures used
- production techniques used for the raw material
- needs of the end users
- where relevant national, and European pharmacopaea.
- analytical procedures

Of particular relevance, is whether there are specifications relating to the levels of active compounds in a particular ingredient and where relevant, the proportions between them. For instance, for hypericum, a level of 0.08% of hypericin is the mean that end users look for. For peppermint oil the key compounds should be in the following proportions:

Menthol	In the upper 30 percentile
Menthofuran	Upper limit of 5 percent
Menthone	In the range of 15 to 20 percent
Cineole to limone ratio	4:1

This requires access to analytical equipment capable of providing GCMS and HPLC. This raises the issue of whether one has one's own or whether one contracts out with the corresponding loss of flexibility and speed of response.

As an aside, this supposes that one knows what to analyse for. In the case of some of the species in the Highlands, no analysis has been done for, such as pine bark in the form that it is available, or for birch sap. This lack of information restricts the efficiency of marketing and to identify the major compounds is a complicated and costly exercise.

Finally, to set up a quality control system, it is likely that one would have to have outside assistance to undertake this

Health and Safety

Health and safety procedures will vary by country and according to the process involved. In the UK, Government health and safety officials are usually not too familiar with this type of processing which can result in overkill.

Again, for the operators, a training programme is required.

Monitoring

The above two elements require some form of monitoring. This in turn means that someone has to be allocated the responsibility for both the recording and also any analysis and reviews of the systems.

National and EU Legislation

This aspect has been left to the last but legislation influences every aspect of this type of venture and it can be a minefield to the uninitiated. This is because much of the current relevant legislation concerns the pharmaceutical sector and the understanding of it requires a steep learning curve if you are not familiar with the sector.

In addition, there are changes in the legislation occurring with the objective of tightening up on the use of plants and the associated claims made for their use. It is not appropriate to go into all the different legislation, which currently exists and is being proposed but it does make a difference if you are going to grow a species for processing to produce an ingredient for the pharmaceutical sector as opposed to one for the food industry. The claims that you make for an ingredient are also relevant.

The relevance of legislation has to be taken into account as early as the planning stage as it affects costs and influences the targeting of the market sectors.

CONCLUSIONS

In our experience, when developing these types of ventures, even when one species is involved, there is little information readily available and considerable time must be allowed for research and accessing data on a first hand basis. Once the venture is up and running it must be expected that modifications, to the crop range, processing and marketing will be required.

EU programmes have done much to help these ventures to get off the ground and it may be that without compromising commercial confidences some of the experiences gained could be made available.

As an example we have identified two possible areas.

Access to Improved Planting Material

As mentioned earlier, there is a problem of identifying improved planting material of many species as they originate from specialist plant breeders, research institutes and universities often in countries unfamiliar with EU and US such as Poland and Hungary. There is scope for increasing the awareness of new varieties of specialist industrial crops from these and other sources.

Harvesting Equipment

It is likely that there exists throughout Europe, the answer to many of the problems of harvesting leaves, berries, roots and petals and it is equally likely that great effort and costs are currently being devoted to individual efforts to solve these problems. Sharing of this type of information should not compromise the commercial confidentiality of individual ventures but save greatly on time and costs.

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