



Assured Produce

Crop Specific Protocol

HERBS (CULINARY)

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Preface

This crop specific protocol has been written to complement and avoid duplicating the generic principles of the scheme and appendices.

It is advisable to read the Assured Produce Generic Crop Protocol Standards and the Assured Produce Generic Protocol Guidance Notes (referred to in this document as the Generic Standards and Generic Guidance Notes) first before reading this crop specific protocol.

This protocol is designed to stimulate thought in the mind of the reader.

This crop specific protocol contains crop specific parameters and guidance, where applicable, for the requirements stated in the Generic Standards.

All statements in this protocol containing the words "**must**" (in bold type) will be verified during the Assured Produce assessment and their compliance will form a part of the certification/approval decision. The score required for these "**must**" control points can be found on the final page of this document and in the checklists produced by Assured Produce licensed certification bodies.

Disclaimer and trade mark acknowledgement

Although every effort has been made to ensure accuracy, Assured Produce does not accept any responsibility for errors and omissions.

Trade names are only used in this protocol where use of that specific product is essential. All such products are annotated[®] and all trademark rights are hereby acknowledged.

Notes:

There may be other withdrawals or revocations. Products containing substances which have been revoked are shown on the PSD website (<http://www.pesticides.gov.uk>). Growers should check with their advisers, manufacturers, the Assured Produce website 'Newsflashes', the PSD website (www.pesticides.gov.uk)

Growers should comply with the 'Use up by' dates for all pesticide products. Growers should also be aware of and comply with changes on new product labels.

There may be changes for the following reasons:

- At re-registration stage after Annex 1 listing there may be: reductions of dose rates; changes in timings and/or number of applications for some products.

In the following Appendices products and use by dates are only listed for SOLAs, and in some cases new product MAPP numbers may not be available yet.

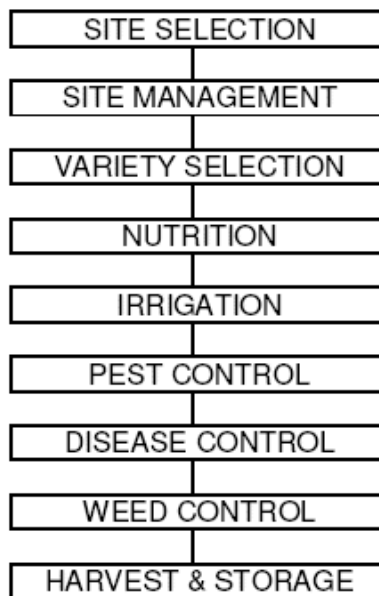
For pesticides on-label, only active substances are shown.

Any new standards have been prefixed in the text with **(NEW)**

1 General introduction

Following a systematic approach will help growers to identify and manage the risks involved in crop production. This protocol is based on a typical crop production process. Using a flowchart approach, food safety, Health & Safety, environmental and quality hazards are identified. Appropriate controls may then be established to minimise risk. Food safety and Health & Safety issues always take precedence over quality and environmental controls.

The flow chart is structured as shown below. Note that the sectional layout of both this protocol and other crop specific protocols follow the same structure.



The contents of each crop specific protocol are reviewed annually by informed farmers and growers, food technologists, scientists, the relevant fresh produce association, processors and agronomic consultants. Updated editions are issued prior to the cropping season.

The review process considers both new developments and all relevant technology which have emerged throughout the course of the previous year and which have been found to be both workable by the grower and beneficial to the environment. As one aim of the Scheme is to transfer such information and technologies to growers, attention is drawn to those features of specific relevance to ICM by using *italic* script. In order that growers may be confident that they are working to a current document, each protocol is dated and numbered.

2 Planning and records

See Generic Standards and/or Generic Guidance Notes.

Appropriate use of plant protection products

In planning a Herb growing season it is necessary to carefully consider plant protection measures as these specialist crops have few approved chemical options and the procedures are made more intricate with the large number of species covered within the category.

General legal and regulatory aspects of approved plant protection product use have been highlighted in the Generic Guidance Notes. As Herbs form a specialist crop group, there are very few "on label" approvals. With the end of the Long Term Extrapolation arrangements, in 2006, and the consequent loss of products there was a major overhaul in current approvals for UK herbs. Since 2007 approvals of Plant Protection Products for UK herbs have essentially derived from Specific off-Label Approvals (SOLAs). All of these have approval expiry dates subject to various conditions in the SOLA. However, revocation notices can be issued at any time by PSD for any current approval available for UK herbs. It is therefore necessary for grower of Herbs to check the current status of any approved product prior to spray application.

Several types of Specific off-label approval (SOLA) issued by PSD, apply to UK Herbs:

1. SOLAs for a specified field of use, such as outdoor Herbs only, or protected herbs only or crops grown under covers. Conditions of use, particularly rates of product application, frequency of treatments and pre-harvest intervals often vary.
2. Certain SOLAs have a defined 'expiry' date by which time satisfactory residue data need to have been generated to extend the approved use. The final expiry or revocation date is generally some time after the data submission deadline.
3. SOLAs for one or a few specified Herbs only for a particular product which does not currently stipulate further residue data to support continuation of the approval. Examples could include products suitable and approved for chives only or weed spot treatments to parsley, mint and tarragon with various pre-harvest intervals. Since September 2008 SOLAs of this type may be restricted to certain Herbs as a result of differential MRLs set across herb commodities.
4. SOLAs may also be granted by mutual recognition. This approach extends the use of products approved for use on Herbs in other parts of the EU to UK grown crops. Currently, however, few SOLAs for UK grown Herbs have been granted by this means.
5. SOLAs for herbs may be granted as extensions of use of existing SOLAs for other crops. These SOLAs are sometimes abbreviated as EOLAs.

The range of herb species acknowledged by PSD is under review and many SOLAs for herbs contain a wide range of species. Each selected SOLA should be checked that it is appropriate for the intended herb crop and its herb products before further consideration of use of that SOLA. The following Herbs are designated as 'leafy Herbs' in the basic list: Angelica, Balm, Basil, Bay, Borage, Burnet (salad), Caraway, Chamomile, Chervil, Chives, Clary, Coriander, Dill, Fennel, Fenugreek, Feverfew, Hyssop, Land Cress, Lovage, Marjoram, Marigold, Mint, Nasturtium, Nettle, Oregano, Parsley, Rocket, Rosemary, Rue, Sage, Savory, Sorrel, Tarragon, Thyme, Verbena (lemon), Woodruff.

In most recent herb SOLAs other 'leafy Herb' species may be included. The additional species include: Agastache spp., Catnip, Curry Plant, Dragonhead, Edible Pansy, horehound, Lavender, Lavandin, Origanum heracleoticum, Plantain, Spike Lavender, St Johns Wort, Violet, and Yarrow.

In certain cases a crop could be classified into more than one commodity group eg rocket. Different approval rules apply to such crops according to the end product use e.g. rocket may be offered for sale as a herb or as a baby leaf crop.

Since 2004 the PSD arrangements for Herbs have been in a transition phase whilst a scheme more in harmony with the EU is established. Ultimately this will result in a SOLA system where active ingredients will be more closely linked with permitted residue levels. Growers should be vigilant in seeking out these changes in approval regulations and ensuring that they comply with, and hold, current approval documentation.

Each year a number of SOLAs may be approved or revoked for various reasons. When new SOLAs for Herbs are released by PSD these can be quickly distributed e.g. via HDC to growers that have expressed an

interest in the crop group. It is important to regularly review SOLA lists as amendments have often been issued by PSD that overrule existing SOLAs. These can include alterations resulting from change in approval holder or as a result of active ingredient review or requirements for supporting data. Careful note should be taken of any specified restrictions such as outdoor or protected cultivation only, approved application method, etc. given on the 'Notice of approval' document.

An off-label approval does not necessarily imply that the product is safe to all the listed Herbs. It is for each grower to assess the selectivity of these products on the Herbs of particular interest to them. However, it should be borne in mind that it is the legal responsibility of the grower to have a current copy of the approved product label or SOLA notice, or SOLA amendment notice, relevant to any proposed approved use on UK herb crops.

Some further aspects, relevant to ICM principles, must be followed when using pesticides:

- use only clean water to ensure effective pesticide reaction and to avoid introducing microbial contamination on to the sprayed crop plants.
- pest and weed monitoring, before and after control measures, enables objective assessment of whether a pesticide application is justified or whether other appropriate control options can be used in future.
- pesticide application records must be completed whenever an application is deemed necessary, giving attention using the minimum effective dose that minimises the number of follow up treatments.

Any harvested herb crop must not contain pesticide residues exceeding the permitted maximum residue level (MRL). Similarly, when container grown Herbs leave the nursery, or are offered for sale, they must not contain pesticide residues exceeding the permitted MRL. Lists of MRLs for Herbs are published and current lists should be sought through grower organisations, HMSO or PSD (see Appendix A in the Generic Guidance Notes). Extensive lists of UK MRLs were set for Herbs and these have been increased with the setting of EC/UK MRLs for many active ingredients that previously had no set legal levels. Under EC Directive 396/2005 herb species were divided into Commodity groups for residue purposes and growers must be familiar with these categories as any one sub group of herbs may be allocated different MRLs for any particular approval. The various herb categories were published in EC 178/2006 and are summarized in Appendix 11.

EC Directive 396/2005 is expected to harmonise MRLs across the EU and the directive has several annexes that will affect herb growers. MRLs set in Annex II of the directive are definitive and are not expected to alter. Some active ingredients of currently approved products for use on UK herbs are set at the limit of determination. Annex III lists MRLs for active ingredients that have not been finalized; these include several new commodity groups of herbs and MRLs may be changed in their transition to Annex II. Annex IV lists substances for which MRLs are not required. Any substance not listed in Annex II, III or IV is subject to a default setting of 0.01mg/kg in Regulation 396/2005. It is therefore a necessity for herb growers to become familiar with the MRL settings for active ingredients under consideration within their crop protection management plans before they are implemented into practice. Further details are available on the PSD website (see also Appendix 10).

Herb growers must abide by the pre-harvest interval stipulated for each plant protection product approval. This will reduce the risk from exceeding the permitted MRL. It is therefore necessary to record the pre-harvest interval for each spray application.

Before using any plant protection product you must consider whether the use of such agents is necessary and suitable for the particular Herb. If so you should determine carefully the most benign appropriate agents for the encountered problem. Several sources of information should be monitored, for example weekly pest forecast bulletins provided by the HDC are frequently relevant to herbs. Due consideration should also be given to alternating control agents where appropriate to reduce the risk of target resistance building up. FRAG-UK strategies, appropriate for herbs, against resistance to fungicides are available via the PSD website and via <http://frag.csl.gov.uk>. Similarly, strategies to

minimise insect and weed resistance should be sought e.g. via the PSD website where useful matrices of insects and their resistance can be found.

Where approved plant protection products are to be selected for use on Herbs then:

- the optimal chemical inputs must be used to maximise plant health and product quality ie minimal effective dose with due attention to the mode of action of the agents used .
- chemical options must be appropriate in relation to the tolerance of the herb species being treated.

*All records relating to pesticide use **must be** retained up to date in the farm/nursery office. Ensure that only appropriately trained personnel handle pesticides and follow the necessary legal requirements for safe practice in all operations including: storage, dispensing, transport, application, cleanliness, and disposal of pesticides as well as retaining all the necessary recorded details of pesticide related operations (see also Appendices A-G in the Generic Guidance Notes).*

3 Site selection

3.1 Site history

3.1.1 Site and pre-production assessments

For an ICM system to operate successfully it is necessary to regularly review and ensure that the growing environment is suitable, safe and sustainable for the Herbs of interest. As different herb species thrive under different environmental conditions some key features that need to be considered are listed in Appendix 9. (For detail on the range of species covered as Herbs in this protocol see Section 5.) The factors that require assessment before starting to grow Herbs are outlined in the following paragraphs in Section 3.1. *Layouts showing environmentally sensitive areas of the production unit should be prepared and retained in the farm/nursery office. Plans for future enhancement of the farm/nursery environment should also be evident.*

i) Potential pollution problems

Pollution problems can arise from a number of primary sources. These sources may be categorised into those under the grower's direct control, those under adjacent or connected operational control and "force majeure" (those resulting from abnormal conditions eg. extreme weather or other natural disasters). Reasonable consideration of each of these categories is required with greatest attention given to those under the direct control of the grower. Some general examples are given in the table below to encourage self-assessment of the potential problems.

The risks from pollution should all be evaluated before embarking on a fresh herb or container herb operation and the production unit should be developed to minimise and control an effective approach to pollution factors. This approach should also be reviewed on a regular basis to evaluate any changes e.g. water quality is of increasing concern in food production systems (see also Section 7).

Problem	Source
Water contamination viz. mains water, streams, rivers, ponds, reservoirs, direct ground water contamination	Sources of water contamination pesticides, fuel and oil, fertilizers, other chemicals e.g. cleaning compounds, waste products (organic and inorganic)
Air contamination	burning, smoke, motorised vehicles
Noise contamination	vehicles, tractor noise
Substrate contamination	heavy metals (e.g. cadmium, zinc, lead), crop or chemical residues

An action plan should be in place in case of a contamination incident and should include contacts for medical,

environmental and water related incidents.

ii) Energy conservation measures

Energy conservation is a very important part of a sustainable approach to herb production. Various factors should be identified and reviewed to minimise energy loss eg. energy-efficient growing structures. The number of operations should be minimised to reduce the number of passes in preparing the ground for crops; particularly with respect to reducing fossil fuel usage. *Such measures can readily be achieved by careful assessment, monitoring and planning of cropping programmes .*

Maximise the recycling of equipment and consumables particularly plastic and polythene materials such as propagation containers, crop covers and packaging containers. Encourage careful handling of harvesting bins to prolong their useful life and develop a structured approach to collection, cleaning and reuse of recyclable products. With careful handling, module trays (usually polypropylene or polystyrene) may be recycled several times on site after sterilising with a suitable environmentally benign biocide.

Reuse water economically by careful maintenance of equipment and time applications to conserve stocks.

Growers may find it helpful to undertake an energy conservation audit.

ii) Environmental sensitivity

Such sensitivities may well interact with pollution control and energy conservation. *Prior to growing leafy Herbs the impact that a new or changing operation may have on the environment should be assessed.* Changes could arise from the need to make some alterations to the existing land eg. structural changes such as glasshouses could alter local environmental conditions affecting wildlife and neighbouring properties.

Other environmental sensitivities may arise from herb-growing operations. These could include altering habitats or watercourses with cultivation-related activities, and the application of chemicals. Take the opportunity to consider non-chemical pest control options, e.g. the use of pheromone lures and sticky traps; particularly in protected growing environments. Check and *use less hazardous spray options wherever possible and keep non-essential people away from spray operations. Attention should be given to selecting suitable weather conditions for applying sprays and a note kept of conditions before, during and after spraying chemicals. Attention should also be given to avoiding sprays harmful to bees especially when Herbs are flowering.* The storage site for waste or of recycling products could also be an environmentally sensitive issue.

A number of opportunities should be identified where a positive influence could be exerted eg. stimulation of wildlife habitat and appropriate ecological diversity by generating wider field boundaries, specific wildlife areas, introduction of native plants to unused areas, formation of plant screens around eyesores and planting windbreaks in large open areas of ground.

iv) Pest, weed and disease potential

A soil check should be made prior to crop planting to establish whether any troublesome pests reside in the proposed ground. Typical examples that may require control before planting Herbs include ants, cutworms, carrot fly, caterpillars, slugs, snails, wireworms, and weevils.

The endemic weed population should also be assessed very carefully prior to cultivation to establish whether adequate control measures are available to sustain herb production. Techniques that reduce herbicide use during crop growth should be sought to ensure that the crop has minimal weed competition at the early stage of crop growth. By enabling the crop to cover bare ground rapidly this will reduce the germination of weed by blocking out the light reaching soil level. *This result could be obtained by various means including careful ground preparation, delaying sowing with false seedbed preparation and by judicious use of residual herbicides before crop growth.* This is equally important for long term as well as short term herb crops, as perennial weeds are generally more difficult to control than annual weeds.

Techniques should be sought to ensure breaks in the life cycle of any potentially serious diseases eg. some soil-borne fungi may require several years break between host crops (eg. white rot of chives), others may require a change in soil moisture regime. Weed species in hedgerows or surrounding areas may also provide fungal inoculum. Weeds in contact with the Herb can attract pests such as whitefly, aphids.

For a sustainable approach to pest, weed and disease control, ICM techniques rely on using a number of tools that reduce the potential of resistance to build up to any one tool or controlling agent. This requires careful consideration in herb production where certain subjects may grow in the same location for a number of years e.g. perennial Chives, Mint, Rosemary, Sage or Thyme. It also needs careful planning prior to short term sown umbelliferous Herb crops including Coriander, Dill and Parsley which are vulnerable to many common pest, weed and disease pathogens. The encouragement of beneficial insects by enhancing suitable habitats around the farm/nursery should be another element in reducing potential problems from pests. These considerations should be documented so that the ICM logic inherent in the decisions reached can be apparent for future reference. A risk assessment plus management plan should also be followed with regard to microbial contamination as fresh and frozen Herbs are classified as High Risk (see Section 14 and Generic Protocol Section 14).

Where continuous Herb production is planned within protected cultivation regimes particular attention should be given to prevent the carryover of potential pests or diseases from one season, batch or crop to the next. Several options should be considered. Can any crop debris be removed? Has all weed been removed? Can any non-cropped areas be cleaned up? Have moisture, light and aeration levels been ameliorated to be optimal for healthy crop regeneration? Numerous biological control agents have become available for protected cultivation environments (see Appendix 8).

3.2 Crop rotation

This is an important principle in ICM to maintain and improve soil fertility, to reduce the risk from pest, weed and disease build-up and to manage the environment with sympathy to wildlife and landscape. This is made more demanding for the herb grower as many of the short term Herbs are from the Apiaceae / Umbelliferae family which share several common growing problems. Where possible rotation between labiate and umbelliferous crops should be practised. Alternatively the integration of leaf Herbs into a wider cropping programme is beneficial. For container and pot grown Herbs, alternating crop areas around the nursery may be practised to reduce the risk of the build up of pathogenic inoculum that may be associated with continuous production of related Herbs in the same areas. To help the grower evaluate possible rotation options by using successive herb crops from different families, the plant families of common leafy Herbs are given in the following table.

Typical Culinary Herbs	Plant Family
Chives	Alliaceae
Tarragon	Asteraceae
Basil, Mint, Oregano, Rosemary, Sage, Thyme	Lamiaceae (Labiatae)
Sorrel	Polygonaceae
Chervil, Coriander, Dill, Fennel, Parsley	Umbelliferae / Apiaceae

4 Site management

4.1 Soil mapping

See Generic Standards and/or Generic Guidance Notes.

4.2 Soil management

Soils and other growing media/substrates

Herb species react differently to soil conditions. In general, the pH tolerance is wide ranging although greatest yield for most Herbs is achieved on soils between pH 6-7. Another criterion is drainage, as few leafy Herbs thrive in poorly drained soils. Most leafy Herbs require free draining soils that do not become waterlogged in winter. Chives, mint and sorrel will grow well in wet but well-aerated soils. Rosemary, tarragon, sage and oregano will fail if the soil remains waterlogged in winter.

During the active growing season Herbs react in different ways to fluctuations in soil moisture eg. Coriander, Basil and Chives bolt readily to form flowers given rapid loss of soil moisture in hot weather. Other Herbs, e.g. Rosemary and Sage, have generally indifferent reactions to summer soil moisture levels although their leaf yield will decline. A ranking of common leaf Herbs based on their tolerance to water stress is given in Section 7.

Short season sown herb crops generally thrive better in warm soils. Consequently larger yields would be expected from short season herb crops sown from April to early August in the UK unless the crop is given some initial protection (see Section 4.6). Further guidance on the length of growing season in different parts of the UK may be obtained from indices provided by the Meteorological Office.

It is also necessary to select growing media that fulfil the requirements of Herbs in terms of texture, structure, nutritional values etc. *The maintenance of soil as a healthy growing medium requires a holistic approach involving the control of disease and pest inoculum as well as attention to soil structure, water cleanliness and nutritional balance .*

With Herbs it is important to take note of leaf colour and vigour, as well as other indicators of general plant health, to assist in future decisions regarding suitable cropping or possible necessary ameliorations to the substrate. Given the short cropping season for a number of Herbs in the UK, attention may need to be given to soil care over winter months e.g. by ensuring that some form of soil cover crop is grown. Timely operations should reduce weed infestation and deterioration of soil and should aim to build up soil fertility and organic matter.

4.2.1 Soil substrate policy

Ground preparation

As many of the short season Herbs require warm growing conditions, basic ground preparation should ideally be undertaken in late autumn before winter rains saturate the ground making early spring cultivations very difficult. The final tilth can be quickly prepared in the spring.

Deep cultivation and incorporation of green manure is advocated to retain soil structure. The soil should be given minimal rotovation to maintain biological components, moisture and soil structure but a fine even tilth is required in the uppermost layer as a seed bed. As seeded Herbs generally have short life before harvest, a uniform seedbed is essential for even placement and seedling establishment. Most umbelliferous herb seeds need to be sown just under the soil surface with access to adequate moisture. A decision may have been reached to incorporate a pre-drilling herbicide or insecticide treatment at this stage.

For transplanted, perennial Herbs the tilth need not be so fine as for direct seeded crops, however, for ideal crop growth and effective application of crop treatments soil preparation would need to be even.

For systems that use other substrates, the growing media should be protected from the weather and wind-dispersed weed seed. In protected structures all surfaces should thoroughly cleaned and dried of any potential source of pathogenic inoculum at appropriate intervals before re-stocking.

4.3 Soil fumigation

See Generic Standards and/or Generic Guidance Notes.

4.4 Substrates

See Generic Standards and/or Generic Guidance Notes.

4.5 Sowing and planting

4.5.1 Sowing

This is a critical operation in achieving maximum establishment and good crop vigour. Attention should have already been given to soil preparation, fertiliser placement and seed quality. Some Herbs should be sown at or just below the soil surface eg. Marjoram, Basil, others require dark conditions for germination and should be sown around 1- 3 cm below the surface eg. Coriander, Chervil, Dill and Parsley. The sowing depth generally relates to seed size.

Most Herbs should not be sown at soil temperatures below 10°C or establishment will be uneven. Other Herbs require higher soil temperatures for successful establishment eg. Basil and Dill. Although seeds of these crops may chit at lower temperatures seedling establishment will be impaired and fungal diseases may develop. Some guideline sowing rates are given in Section 5 but they will vary according to chosen cultural system.

4.5.2 Transplanting

A number of considerations need to be made prior to transplanting propagules into a permanent position. Healthy, weed free propagules need to be selected with strong but not choked root system. The propagules also need to be easily and rapidly removed from their propagation trays and should have been well watered prior to transplanting. The transplant beds should also have adequate tilth and moisture to accept the propagules and be of sufficient depth to enable the transplants to be efficiently inserted into their growing positions. Generally Herbs are transplanted in early spring or autumn so they establish well before inclement conditions ensue.

Various techniques can be employed for transplanting depending on the scale or sophistication. The method used should enable transplants to enter the desired field positions, calculated to suit each particular crop, with minimal disturbance to the propagule or growing medium. Some guidelines plant densities are given in Section 5, although these will vary enormously in field production systems. Avoid transplanting in windy cold or drought periods unless there is suitable plant protection. Transplant production in containers occurs throughout most of the year although often designed for most tender subjects to be sold during late spring and summer.

Fertiliser may be introduced during soil preparation by band or broadcast placement. Care should be taken to avoid excess application or applying when the plants are stressed.

Regular applications of water may be necessary in the first month after transplanting to minimise plant losses. Thereafter, the transplants should be well established and further watering should relate to a) rate of growth required and b) resource availability. Regular watering of container grown Herbs will be required until the plants leave the nursery. Plants should be adequately watered at the point of despatch. In all these water decisions best practice guidance should be followed to ensure that water usage is efficient and monitored effectively to avoid wastage (for example by following the Defra Irrigation Best Practice Manual 2007).

4.5.3 Module sowing and vegetative propagation

Much production for container grown Herbs starts in plastic module trays of individual cells. The trays are filled

by hand or machine with fine textured, usually fairly low nutrient substrate, which may contain small granule controlled release fertilizers. Sowing may be done by hand or machine and germination may be assisted by the use of germination chambers and heated beds.

For cultivars produced via cuttings, it is important to propagate healthy material from well-maintained true-to-type stock. Commonly used techniques include: mist and fog units, closed case propagation, micropropagation, heated beds and sun tunnels and cold frames.

Growth rate of the young plants can be controlled via manipulation of nutrition, temperature, water and light. The health of young plants should be monitored to produce vigorous cell-grown units suitable for transplanting by hand, potting machine or robot. The plug size used should be appropriate for the intended container volume.

4.6 Growing systems

Many Herbs thrive in warm sunny locations; some are constrained by day length or night temperatures. Whilst this protocol covers Herbs as a group Appendix 9 does contain a few environmental features that can influence the growth of some common Herbs. The growing system that is appropriate for certain Herbs may not suit others. The following table summarises various systems used for growing Herbs in the UK.

Herb growing systems

System	Crop examples
Open field	Parsley, Coriander, Dill, Chervil, Chives, Sorrel, Mint, Tarragon
Bed system	most Herbs
Mulched beds	perennial Herbs (Thyme, Oregano, Rosemary)
Crop covers	high quality Herbs and extended season
Protective structures with soil substrate	high value Herbs and tender Herbs (Basil)
Protective structures with other substrates	high value Herbs; including container grown Herbs for garden centres and Herbs grown in pots or punnets for other retail outlets

4.6.1 Open field

This system is probably the most extensive available to the herb grower. Bulk crops grown for quality may be suited this system, allowing Herbs to be grown with equipment of limited sophistication. Lower yield per unit area would generally be expected from this system, in any one year, compared with more intensive systems.

4.6.2 Field bed systems

Bed systems allow field equipment to pass overhead without damaging the crop. This approach requires careful preparation and accuracy in sowing, spraying and harvesting. With the commensurate reduction in damage, a higher quality leaf can be harvested.

Attention should be given to wheel marks to minimise soil damage, undulation and compaction thus enable bed harvesting to proceed evenly

4.6.3 Protected soil and other substrates

A large number of ground cover options are available for specific herbs from biodegradable mulch, polythene covers through woven covers to complete structural protection. Essentially a basic polythene or similar mulch can suit the open field or bed production of perennial leaf Herbs; biodegradable mulches are well suited for seed sown herbs. These systems can effectively minimise herbicide use provided the ground is free of perennial weeds. Rain splash, and therefore fungi propagated by soil splash, is also reduced providing higher quality leaf

growth and reduced fungicide application. Soils covered over winter in this way can however retain too much moisture for certain Herbs eg. Sage and Rosemary.

Woven covers (such as fleeces) may be used either throughout crop life or for certain periods for assisting early or late growth. Covers of this form can reduce rain splash and wind effects but their greatest benefit is in moderating temperature fluctuations; Fleeces reduce night time temperature fall and daytime maxima relative to uncovered crops.

Various forms of protective structures may be used to produce cleaner leaf Herbs. These could include cloches, temporary tunnels of fixed polythene or glasshouses. With increased capitalisation, protected cultivation from mulching to glasshouse gives greater environmental control resulting in improved crop quality and extended growing seasons. Protected crop environments often permit a wider range of non-chemical crop husbandry techniques to be adopted, particularly with respect to biological agents and physical barriers against pathogens, weeds and pests. *A glass and plastics inventory should be maintained with a satisfactory system of disposing of all breakages and "spent" polythene products.*

Particularly in protected structures, substrates other than soil have been successfully used to grow Herbs. These include inert and liquid media complemented by varying degrees of supplementary heat and light. For most container grown Herbs peat-based substrates are generally used. A shift to peat-free substrates based on wood/bark, coir products etc., will continue as their costs, availability, reliability and consistency permit. As each peat substitute requires different management regimes then such changes need to be carefully considered.

4.6.4 Review crop records

Growers **must** review the sustainability of their herb growing systems annually . This entails a determination of whether improvements have resulted from their crop production managements. From records retained to conform with APS protocols it should be possible to determine a number of key points in sustainable herb production. For example:

i) Yields

Are yields sustained or improved from the same identifiable growing areas. Is the quality of herb product retained or improving? Have inputs declined in attaining acceptable levels of sustainable herb production? Do trends indicate an optimal crop life for perennial herbs?

ii) Environment

Have more benign crop protection measures been successfully adopted? Has their reliance on pesticide materials declined? Are there any gaps in your approved herb crop protection options that could be addressed?

iii) Review Herbs and protocol guidelines

Are you growing appropriate herb crops for your local conditions? Given the wide array of herb species and growing systems, are the protocol guidelines sufficiently specific for your herb production system? Herb growers **must** take action towards ensuring that: improved benign crop production and crop protection measures are being pursued by industry or government representatives **and** : that gaps in technology are being addressed. Growers are expected to participate in a technical herb growers meeting each year or if not, to have contacted a relevant herb industry representative, such as the BHTA Technical chairman, with suggestions or comments on benign crop protection methods.

The principle here is that herb growers need to accrue some direct benefits in economically sustainable production via improved productivity and/or reduced cost inputs for the grower and protocol to remain viable with UK grown Herbs.

5 Variety selection

Herb species

For the purpose of this protocol the species covered as Herbs are those listed in the current PSD crop hierarchy as Herbs. They include the groups mentioned in Section 3.1 **Appropriate Pesticide Use**. Other species may be recognised as Herbs and principles in this protocol may apply to them. However as they are not currently acknowledged by PSD they could not be treated with pesticides under present UK approvals.

Cultivars

Although some Herbs have received substantial attention from certain plant breeders, (eg. in Eastern Europe), the choice of cultivars suitable for commercial UK production is currently very limited. A few new cultivars do however occasionally appear specifically selected for flavour (see following table).

A choice of Parsley cultivars is available in various curled and flat leaf forms (see the table below). Coriander has a few cultivars for leaf production but none seem ideal for the variable UK conditions. There is a choice of Dill cultivars but only one is commonly grown for leaf production. Two types of Chervil may be obtained but there is little difference in performance between them. A wide range of Basils may be bought, some may have fusarium resistance; the actual choice will however often be determined by customer specifications.

Mints and Tarragon for culinary purposes should always be grown from vegetative propagules. Although seed forms are available they are generally less highly regarded. Only the French form of the Tarragon is acceptable for certain culinary uses.

Standard cultivars of Rosemary, Sage, Oregano, Marjoram, Thyme and Sorrel may be grown from either seed or vegetative propagules.

It is in the best interest of the grower to make observations on disease and pest tolerance to assist the selection of cultivars for future use.

Many common leaf Herbs have closely related species that satisfy albeit smaller specialised culinary markets. Some of these more minor species are listed, together with cultivars of common Herb species, in the table below.

Common species	Cultivar example	Related species
Basil (sweet)	Genova, Genovese, Lettuce Leaf	purple Basil, bush Basil
Chervil	Curled Leaf, Plain Leaf	
Chives	Grolau, Hylau, Fine Leaved, Medium Leaved	Garlic
Coriander	Alfie, Filtro, Leisure, Santo, Slobolt	Parsley
Dill	Bouquet, Dukat, Vierling	Fennel
Parsley (curled)	Bravour, Darki, Decora, Garland, Moss Curled	Parsley (flat)
Rocket	Astro, CN SROC 2503	
Tarragon (French)		Tarragon (Russian)
Spearmint	Moroccan Italian	Peppermint

Pot herb production typically includes a wider range of species and cultivars. Often 50-300+ variants may be stocked and can include variegated and coloured forms with frequent additions of new variants.

Plant populations

Final plant density will vary according to the desired end use, method of cultivation and harvest. A number of leaf Herbs are typically grown by direct seeding viz. Chervil, Coriander, Dill, Parsley. Others should only be grown from vegetative propagules eg. Spearmint, French Tarragon. A third group may be grown by either method eg. Basil, Chives, Marjoram, Oregano and Thyme; economic parameters or local conditions will be the determining factors. Some guideline plant densities expressed as kg seed/ha or transplanted plants per hectare are given in the table below. Sowing rates in containers should be optimised according to cultivar, container size and time of year, to give a suitable balanced plant at the time of sale.

Plants grown in containers should be optimally spaced during the growing period.

Crop	Guideline Plant Density (per ha)	
	kg seed	transplants
Basil	4 - 10	-
Chives	10 - 30	-
Dill	8 - 14	-
Marjoram	6 - 8	-
Mint	-	25000+
Oregano	-	70000+
Parsley	3 - 7	-
Rosemary	-	19000+
Sage	-	25000+
Tarragon	-	41000+
Thyme	8	70000+

6 Nutrition

Whilst numerous studies on herb crop nutrition have been undertaken in various parts of the world, few have been established on UK soils. Soil responses in the UK may well differ to those in other countries and care should be exercised to establish herb crop needs. *Thought should be given to supplying a balanced nutrition for rapid crop establishment with strong root growth and early accumulation of green leaf tissue.*

Care should also be exercised with the fertilisation of leaf Herbs grown for harvesting by sequential "cuts" in order to replace the off take with appropriate nutrients.

Some examples of basic fertiliser requirements for common leafy Herbs are given in Appendix 1. It is hoped that ongoing development work will refine the typical nutritional requirements for UK-grown leaf Herbs.

Ensure that organic fertilizers used on Culinary Herbs comply with current acceptable microbiological levels. *Occasional nutrient and fertiliser analyses may become increasingly necessary to confirm safe and appropriate use.* The inclusion of suitable slow or controlled release fertilizers in the substrate will assist to increase healthy shelf life of container grown Herbs.

7 Irrigation

As the annual variation in soil moisture within UK is wide, provision should generally be made for irrigating high value leaf Herbs. The form of irrigation will be determined by growing system as well as herb species (see Section 3.3). As leaf product is required from these crops it is essential to avoid flowering during the planned production period. Some Herbs such as coriander will bolt even if the seed or seedling is exposed to moisture stress, therefore, it is imperative that adequate soil moisture is available pre-sowing and throughout the leaf growth period. Generally overhead irrigation systems are appropriate for short-term Herbs although consideration has to be given to the possible problems arising from soil splash and microbial contamination. For longer-term crops, drip or soak-hose systems are possibly more appropriate provided the installation costs could be justified. For container grown Herbs overhead irrigation is regularly practised; these

may also be served by capillary beds or hand lances. The design of overhead watering systems should combine sprinklers or nozzles of suitable design to apply the appropriate volumes and spray patterns for the container size(s) to be watered.

Good water supply and management is imperative to sustainable economic herb production in the UK. Consideration should be given to the efficient use of water for both container and field grown Herbs. In particular, timing of irrigation with respect to stage of plant growth, weather and time of day. Also container and field herb growers should strive to use appropriate droplet size for minimal water wastage via evaporation or run-off.

With increasing concerns on responsible use of water quantity and quality herb growers should consult current best practice manuals for example the Defra Irrigation Best Practice 2007.

Identify the source and distribution of water used and be aware of its relative potential as a source of pathogens. Growers should consider practices to protect the quality of water used for irrigation, such as protecting wells and pump areas from uncontrolled livestock or wildlife access, covering irrigation storage tanks, flushing water systems as necessary to avoid problems associated with stagnation. Ensure that water sources used on Culinary Herbs comply with current acceptable microbiological levels. Occasional water analyses may become increasingly necessary to confirm safe water use. To minimise plant stress and disease plus optimise yield output regular monitoring of soil moisture status is essential adding only sufficient irrigation necessary to achieve a healthy yield.

The relative water stress tolerance of common Herbs is given in the table below.

Coriander	least tolerant	
Basil		
Chives		
Mint		
Sorrel		
Parsley		
Chervil		
Dill		
Rocket		
Thyme		
Tarragon		
Oregano		
Marjoram		
Sage		
Rosemary		most tolerant

8 Crop protection

8.1 The basic approach to crop protection

See Generic Standards and/or Generic Guidance Notes and Pest, weed and disease potential in Section 3.1 of this protocol.

8.2 Plant protection product choice

See Generic Standards and/or Generic Guidance Notes and Appropriate Pesticide Use in Section 3.1 of this protocol.

Approved uses not included on the product label

For most UK herb approvals product labels do not include all of the approved uses and growers and advisers

wishing to check the approval notice of a particular product should note that this information is available from www.pesticides.gov.uk/psd_databases.asp

A search on the database for a product name should yield a results page. A click on the product name should link to a summary of the approval information. At the bottom of the summary are links to available notices which will give the statutory conditions of use including all the Herb species covered by specific approvals..

In the case of products with older approval an electronic approval may not be available. In these cases growers should contact the PSD Information Services Branch for details of the approved conditions of use.

Contact details are: p.s.d.information@psd.defra.gsi.gov.uk tel. 01904 455 775

8.3 Advice on the use of pesticides

See Generic Standards and/or Generic Guidance Notes.

8.4 Application of pesticides

See Generic Standards and/or Generic Guidance Notes.

8.5 Records of application

See Generic Standards and/or Generic Guidance Notes.

8.6 Protective clothing/equipment

See Generic Standards and/or Generic Guidance Notes.

8.7 Pesticide storage

See Generic Standards and/or Generic Guidance Notes.

8.8 Empty pesticide containers

See Generic Standards and/or Generic Guidance Notes.

8.9 Pesticide residues in fresh produce

See Generic Standards and/or Generic Guidance Notes.

See Generic Protocol Guidance Notes 8.9 for further background and generic advice.

Assured produce is aware that a key area in the production of fresh produce which requires continued attention by growers and their advisers is that of keeping pesticide residues to a minimum. This issue is not just one of meeting the MRL trading standard but ensuring that any individual or multi residues are kept as low as possible below this level.

At this stage data from Herbs are being evaluated to examine for any trends in residue response. A number of non-standard sources of residue accumulation may arise with Herbs. For example, these could include: variable reactions according to different species within the group, multiple harvests from the same crop, and differing harvest intervals according to time of year. The effects of these variables need to be established before generalised statements can be made in relation to specific Herb and active ingredient in approved plant protection products. However it is clear at this time that a number of actions can be undertaken by Herb

growers to minimise the risk of any residue accumulation.

The key targets are -

- **optimising late applications of fungicides and insecticides to the edible part of the crop.**
- **optimising the use of post harvest treatments.**
- **ensuring minimum harvest intervals are followed.**
- **ensuring that application equipment is applying products correctly.**

See Appendix 10 for further guidelines in relation to Herbs.

8.10 Early stages of herb management

8.10.1 Crop covers

Early stages of growing Herbs in containers usually take place under protection, possibly with heating, water and supplementary lighting supplied as required according to season.

Whether from seed or vegetative propagation, the use of crop covers may be considered appropriate particularly in spring or autumn for a variety of reasons. Technology in this area is still developing and thought needs to be given to various options, eg. fleece versus polythene covers, thickness of cover, timing and length of time covered.

The reasons for covering crops are to moderate climatic conditions, by reducing wind effects and temperature fluctuation to provide a suitable environment for even growth. If inappropriately placed, however, crop covers encourage humidity that stimulates disease and pest development rather than crop growth. There are also a number of herb crops and growing systems that do not readily lend themselves to covering, eg. fleecing spiky Herbs requires great ingenuity.

Finally, the disposal of crop covers needs to be considered carefully prior to their installation. Some covers may be used for several successive crops. Inclement weather or continual use results in the need for "disposal areas" where material can be discretely stored until recycling, burying or off-site removal is organised. In any event crop covers should not be left in the field beyond their useful life.

8.10.2 Pre-emergence weed, disease and pest control

*Given good ground preparation and a weed-free site there may be no need for weed control pre-crop emergence but at certain times of the year, especially when herbs are likely to germinate quickly, weed seeds germinate prolifically particularly after soil disturbance and stimulation from light. Perennial weeds that were not fully controlled during ground preparation may well re-grow prior to crop emergence. In these circumstances applications of pre-emergence herbicides may be considered. A list of approved pre-emergence herbicides is given in Appendix 4. Care **must** be taken to follow label instructions or 'Notice of Approval' documents and assess any potential residue issues prior to choosing any of these approved products.*

Problems can also arise for seedlings from insect or fungal attack and may require chemical action. Attention should also be given to determining the threshold level of identified pest or weed, or disease (see Section 8.11), by regular systematic crop survey reports. These reports should provide the basis for determining the appropriate control option where further action is deemed necessary. Concerted effort should be given to ensuring the selection of an appropriate efficacious product that it is applicable to

the herb species concerned and ensuring the conditions at application allow its use eg. adherence to pre-harvest interval or following crop constraints.

The growing media for "windowsill" Herbs should be protected from contamination with weed seed. Herbicides are only appropriate for non-cropped areas and standing beds in container grown herb production. Beds where pots are stood down can also be kept clear of weeds by use of gravel or woven ground cover fabrics.

8.10.3 Disease control

The most common pathogenic fungi at the seedling stage of common herbs include *Rhizoctonia* spp, *Phytophthora* spp and *Pythium* spp. The most obvious symptoms are brown discolouration at stem bases, collapse of the seedling stalk and gaps in the crop from fallen seedlings. Specialist attention is generally required to determine the exact causal organism and confirmation may be necessary before choosing an appropriate treatment. These disease organisms proliferate in wet soils and most commonly attack Herbs when the soil temperature is cool and sub-optimal for good growth.

8.10.4 Pest control

A number of soil-borne pests can affect herb seedlings. Cutworms are a common problem particularly in crops following grass. Slugs and snails can also be troublesome particularly near hedgerows or in covered areas where winter temperatures have been warmer than in the open (see Sections 3.1 (pest, weed and disease potential), 4.6 and 8.11.3).

8.10.5 Irrigation

Adequate water supply is critical at early stages of growth. The consequences of too much or too little water have been discussed earlier. *To minimise imbalance of water supply attention needs to be directed at avoiding water leaks and ensuring an uninhibited, even supply through clean filters and nozzles especially if supplementary water is applied.*

8.11 Late stages of herb management

*Regular observations **must** be kept on herb crops as their life is often short and blemishes have to be kept to a minimum. Control of weeds, diseases, pests, water and nutrition is critical to producing high quality produce. Regular systematic crop surveys must continue through the life of the crop to aid appropriate and timely control measures. It is however vital to correctly identify the pest before deciding on control measures (see HDC Herb 'Crop Walker Guide'); by way of example some aphid species are resistant to common aphicides. On the other hand lacewings will generally eat all common species of aphid. Skilled monitoring of the early signs of pest and disease problems will aid the choice of appropriate cultural, biological and chemical controls.*

As container growing systems may have a wide range of plant species and cultivars at various growth stages and in close proximity, great care is needed in the correct identification and control of pests and diseases. If chemical pesticide action is deemed necessary great care **must** be taken to avoid drift onto adjacent blocks of plants.

8.11.1 Weed control

A number of weed species may occur in herb crops. Their influence is often made greater as several Herbs and weeds belong to the same weed plant families eg. Umbelliferae. Furthermore if these weeds remain unchecked then flushes of different problematic weeds will occur at later stages during the growing season, eg. chickweed may be significant in cool spring conditions but fathen is most serious in late summer. *Strategies need to be formulated to minimise these problems, because post-crop emergence the options are very*

limited viz. hand weeding, inter row cultivations, a limited choice of herbicides or spot spraying/weed wiping.

Great care need to be exercised in the selection of herbicides; the general considerations have been highlighted in Section 3.1 (appropriate pesticide use). In particular, care over the pre-harvest interval is necessary especially when approved products of different formulations with similar active ingredients have different pre-harvest intervals. Field pegs showing the safe harvest dates **must** be clearly displayed following spray applications where several blocks of the same Herb species are in close proximity.

Ensure that areas around protected structures are kept free from weed species that could provide a source of wind-blown seed. Timely hand weeding may be required if weeds develop in container Herbs.

8.11.2 Disease control

Currently approved fungicides are listed in Appendix 3 and 6 . *However other control strategies should also be implemented wherever possible including crop rotation, destroying diseased crop debris, substrate cleanliness and environmental control particularly with regard to moisture and air movement.*

As a number of leafy Herbs are not endemic to the UK ideal conditions for growth do not always occur, hence, stress-related disease and disorders can readily arise, particularly when extension of crop life is sought into the cool springs or autumns. Intensive monoculture also often leads to conditions conducive to rapid disease spread and actions to minimise these should be considered. With protected cropping, it is possible to try to minimise disease pressure by strict hygiene and manipulation of the environment. Temperature, humidity, light, water and ventilation may be altered by manual or computer control. Extra care needs to be taken in polythene structures to maintain good ventilation during autumn and winter periods when conditions are more conducive to fungal rather than herb growth. Whenever humidity and condensation levels may be high forced air ventilation may be beneficial in herb disease control.

Examples of common herb diseases have been published by the HDC as identification cards and, in 2008, the herb-specific 'Crop Walkers Guide'. Growers should become familiar with these identities for ease of determining appropriate treatment. Details of best practice for disease control in protected herbs are available on the HDC website; much of the information is also relevant to outdoor Herbs. The main diseases and disorders of Herbs are briefly described below:

Disease types

The common seedling diseases are covered in Section 8.10.3.

- i) Wet soil and cool temperatures lead to the rapid spread of 'damping off' pathogens that move rapidly through soil moisture and attack weak or young growing plants (see Section 8.10.3).
- ii) Foliar diseases can be split into those that occur in humid or dry conditions. The former group includes leaf spots, leaf blights and grey mould; the latter includes powdery mildew, rusts, and vascular wilts.
- iii) Under stressed conditions (see Section 7) secondary pathogens produce symptoms that cannot readily be associated with any specific primary agent eg. Oregano, which in winter months can succumb to a complex of secondary pathogens including *Cladosporium*, *Alternaria*. Secondary pathogens may not respond to specific fungicide treatments.

Root and stem diseases

There are common vascular wilts that arrest the water pathways within the plant. Typical examples are *Fusarium* and *Verticillium* spp. *Verticillium* can arise in Mint following another perennial herb. *Fusarium* spp. have been found in Basil. *Sclerotinia* spp. also attacks stem bases. In each of these diseases soil

sterilisation and break crops provide the only long-term control solution.

***Septoria* spp .**

Symptoms arise as leaf spots most commonly in Parsley although they have been recorded in a number of other leafy Herbs including Coriander (where they can also arise from a different form of leaf spot species *Ramularia coriandri*).

***Botrytis* spp .**

Commonly *Botrytis cinerea* is the causal organism and it can readily attack cut Herbs under humid conditions. A wide range of leafy Herbs suffers from this organism including woody labiates (Sage, Rosemary) and it is particularly common on delicate Herbs (including Dill and Basil) especially after harvest or injury cuts.

***Erysiphe*spp. and *Oidium* spp.**

These powdery mildews can be widespread in dry hot weather, particularly following a period of high relative humidity; these mildews affect a wide range of leaf Herbs including Parsley, Dill, Oregano, and Sage.

***Puccinia*spp.**

Various species of rust fungi attack leaf Herbs. They have been recorded on Mints, Tarragon, Chives, Marjoram and Thyme. Control should be aimed at breaking the life cycle, as these pathogens can survive all year-round without a secondary host. No single treatment is likely to control rust. They provide an excellent example of the need for integrated management techniques.

Sclerotium cepa

White rot of chives has tended to be localised to particular parts of the UK. Where outbreaks have occurred the consequences have been serious and require long term crop breaks to reduce the inoculum to an acceptable level.

Viruses and Bacteria

Coriander has been recorded with bacterial blight and it can also succumb to bacterial wilt. Parsley can suffer from bacterial crown and leaf rots. Various viruses (eg. carrot motley dwarf virus and celery mosaic virus) can distort umbelliferous leaf Herbs. Mint can display symptoms of cucumber mosaic virus transmitted by aphids. Vector control, eg. using an aphicide, or traps, may therefore be essential to reduce virus attacks.

Physiological disorders

Symptoms of waterlogged conditions are generally first seen as purple or red colouring on leaf tips and margins, followed by either yellowing of the leaf blade or a spread of the red colouration. This can be a serious problem especially where herb crops are grown for the garnish market and when crops are approaching the boundaries of their growing season.

Symptoms of nutrient deficiencies are complex often involving more than one nutrient. For general leaf discolouration in herb crops, specialist advice for recognition and rectification should be sought.

8.11.3 Pest control

A wide range of pest problems can arise in leafy herb crops. These could range from microscopic organisms to rabbits, hares, birds and deer. *Each problem needs to be tackled on its own merit. The first priority is to assess the level of threat to crop quality and yield. Monitoring severity of attack is therefore crucial*

and observers skilled in identifying causal organisms should regularly inspect herb crops and record developments. Various pest-forecasting systems are available and these should be sought where appropriate. Also helpful pest and predator/parasitoid identification cards have been published by the Horticultural Development Council (see Appendix A of the Generic Guidance Notes). Examples of some biological control agents for some common herb pests are given in Appendix 8.

It would not be practical to list all potential pests of herb crops but the HDC has published identification cards for some of the common pests of Herbs and, in 2008, the herb-specific 'Crop Walkers Guide'. Growers should become familiar with these identities for ease of determining appropriate treatment Details of best practice for pest control in protected herbs are available on the HDC website; much of the information is also relevant to outdoor Herbs.

Soil related pests

Possibly the most obvious soil-borne pests are cutworms and wireworms which were present in the preceding crop. They often manifest themselves by attacking quite large growing plants by gnawing at the root or stem base until the aerial parts collapse. Gaps are then readily visible in the crop. These pests should normally have been observed prior to cultivation and some treatment applied. At a late stage effective treatment is difficult and crop loss will occur although there may be some control options (see Appendix 4).

Sciarid fly, leatherjackets, vine weevil, swift moth can all cause damage to herb plant roots in containers. Ground beetles and other predators can help control some of these pests.

Foliage related pests

Problematic pests again vary with the season and growing environment. More pests overwinter in warmer protected structures than in open fields. Slugs and snails, thrips, leafhoppers, whitefly and some caterpillars may be troublesome at any time of the year in protected crops. Biological agents specific for some of these pests are listed in Appendix 8. Flea beetles and aphids may also become a problem much earlier in the season than on unprotected crops, however, control measures are easier to administer.

As exposed herb crops can succumb to pests from neighbouring areas (eg. aphids, flea beetles, caterpillars, weevils) careful assessment, involving insect traps and pest forecasts, will help determine the levels of infection and whether any action should be taken. Biological or natural agents and traps may be highly effective in closed environments.

8.11.4 Irrigation

Water supply is particularly critical, as most UK grown leafy Herbs are short-term crops. Interrupted or uneven water supply will have a disproportionate deleterious effect on leaf growth (see also Section 7).

9 Harvesting and storage

Product traceability is a common customer requirement. Random pesticide residue tests may be undertaken, so each unit or section of production should be coded and be readily identifiable. A current farm layout must be available at all times showing each unit or section by status. Any batching system should be continued from sowing through harvest into packing and despatch operations.

The crop harvest operations will differ with end-customer specifications, its life span and expected number of cuts, flowering influences on crop growth and post-harvest handling requirements eg. customer specifications may demand that harvested Chives are all brought to the post-harvest handling area as unblemished green leaves lying flat and parallel.

9.1 Hygiene

See Generic Standards and/or Generic Guidance Notes.

9.2 Post-harvest treatments

See Generic Standards and/or Generic Guidance Notes.

9.3 Post-harvest washing

See Generic Standards and/or Generic Guidance Notes.

9.4 Growth stage at harvest or point of sale

Generally, leaf development is the main criterion that determines the correct stage to harvest or despatch. The crop plants should be true to type, free of pests and disease, of good colour, weed free, optimum size and turgid. Container Herbs should be correctly labelled where appropriate, free of weeds, moss and liverworts, as well as be healthy products free from pests and diseases.

It is not possible in this document to specify all the variations that may determine the desired product format, however, some common considerations ensure that the desired stage is not passed before harvest eg. Coriander leaves can change within days from a rosette to a highly divided leaf ("carrot leaf") with an accompanying change in flavour that may negate the marketable value of the crop. With other crops the petiole or internodal length may become longer than desired if the correct growth stage is not correctly identified at harvest.

The most frequent problem is a change from vegetative to flower development. This will occur at certain defined times of the year or in response to stress factors. Most leaf Herbs have a known flowering period that is more or less constant year after year but to avoid unnecessary losses, observation and crop planning may require proactive steps to be taken. By growing susceptible Herbs simultaneously in more than one environment minimises the risk of loss from flowering influences. The selection of cultivars with different flowering periods can assist continuity of supply. Crop planning should take account of the application of pesticides in relation to time required for the crop to reach to the required harvest stage of growth.

Generally, fresh Herbs should be harvested early in the day after any dew has evaporated but when crop turgidity is at its greatest. The shelf life of Herbs is greatly affected by harvest time within the day. Problems are worse following water stress in hot sunny weather.

9.5 Harvest method and frequency

Any consideration of the wide array of harvesting techniques and technologies available is beyond the scope of this protocol where the objective is to highlight principles of good ICM practice. One basic principle is to ensure cleanliness of equipment during the harvest and transport stages. In particular, as ready-to-eat Herbs are often categorized as having a high potential microbial risk *control of equipment to prevent soil contact with harvested herb product is essential* and this may require the implementation of physical barriers such as sacrificial ground crates, *as well as controls on the cleanliness and accountability of cutting implements. Do not use damaged or contaminated harvesting equipment. Minimise contamination by transporting cut Herbs in cool, clean, covered vehicles.*

Although most leaf Herbs lend themselves to multiple cuts at certain stages in the year, this may not suit customer specifications as physical and/or flavour characteristics may alter as the crop plant develops. In these cases, single cut sequential crop production maybe more desirable.

Perennial leaf Herbs tend to develop slower than the annual seeded Herbs and are often more suitable to multiple cuts with similar product specifications (see Section 9.3).

*Harvest frequency **must** also conform to the pre-harvest interval for any necessary pesticide application made to the crop. Quality often varies and generally deteriorates with the number of cuts harvested. As the crop continues to develop any pest, disease or weed presence results in an increased risk of crop blemishes. Regular monitoring determines the cut-off threshold of economic crop life.*

Some Herbs tolerate harvesting to ground level (eg. Mints, Oregano and Chives) whilst Rosemary, Sage and Thyme will not.

Windowsill and container herb plants of appropriate size and quality should be selected for sale.

Therefore careful planning and training is required with harvesting procedures and to ensure that crop sustainability is attained. By diligent attention to post-harvest procedures a great deal of pest, weed or disease control can be incorporated simultaneously.

9.6 Multiple cuts

When herb crops are maintained for more than one cut it is often prudent to apply certain maintenance treatments immediately after cutting eg. Plant health measures to protect the crop against invasion from weed, pest or disease whilst at a vulnerable stage following the cutting procedure. It may also be opportune to replace some of the lost nutrients as a broadcast top-dressing fertiliser application as liquid or granular feed subject to the crop's future requirements (see Section 4.2 and Appendix 1).

9.7 Cooling

As mentioned earlier leaf herb crops should, whenever possible, be harvested early in the day. This requires that the harvested crop is taken to a cool store area at the earliest opportunity otherwise the harvest material heats up rapidly as the air space around the leaves reduces in the harvesting bin.

Most cut Herbs require an ambient storage temperature of 0-4°C in a high humidity environment. Once stabilised at these temperatures cut Herbs may be processed further. Optimum post harvest temperatures for the maximum shelf life of windowsill Herbs should be between 6°C to 10°C and they should be well watered before despatch.

If herb crops are not cooled sufficiently under the correct conditions then a number of different reactions can occur. Some Herbs display yellow discolouration of leaves eg. Chervil and Dill; or exude fluids which will rot the plant tissue eg. Chives.

Some leaf Herbs will not tolerate cooling to low temperatures ie. the thermophilic species such as Basil. Others may have been growing rapidly in protected conditions or cut in hot conditions and chilling will then damage them if cooling is too rapid or too severe. The most common expression of chilling damage is blackened leaves or leaf tips.

Conditions in the cool store should be regularly measured and recorded.

10 Pollution control and waste management

See Generic Standards and/or Generic Guidance Notes.

11 Energy efficiency

See Generic Standards and/or Generic Guidance Notes.

12 Health and safety

See Generic Standards and/or Generic Guidance Notes.

13 Conservation

See Generic Standards and/or Generic Guidance Notes.

14 Microbial Food Safety

(NEW)

See Generic Protocol Guidance Notes 14 for further background and generic advice.

A key area in the production of fresh produce which requires continued attention by growers and their advisers is that of keeping microbial risk to a minimum in Herbs. The FAO/WHO Report (2008) 'Microbiological Hazards in Fresh Fruits and Vegetables' classified Herbs amongst leafy green vegetables in the category of highest priority in terms of fresh produce safety. The leafy green vegetables were identified as being of highest concern from a microbiological safety perspective particularly as they maybe consumed raw and therefore carry potential microbial pathogens. The FAO/WHO report listed the following micro organisms of concern which could be introduced at the primary production level of the commodity group including Herbs: *Escherichia coli*, *Salmonella enterica*, *Campylobacter*, *Shigella spp.* HepatitisA virus, Noroviruses, *Cyclospora cayatenensis*, *Cryptosporidium*, *Yersinia pseudotuberculosis*, *Listeria monocytogenes*.

Whilst many Herbs are generally considered to accumulate antimicrobial compounds in their natural environments human pathogenic microbes on the outer leaf surface may not trigger any reaction from Herbs. It is therefore good practice to minimise the risk of Herb contamination from human pathogenic microbes. Many measures can be followed (see Generic guidance notes) to assess the risks and formulate an active plan to minimise microbial entry into the Herb production system. As microbiological levels are highly variable even within a location and over time it is important to ensure regular monitoring systems operate to minimise routes of microbial entry and contamination including control on: site history, water, and animals, clean equipment and human contact with harvest leaves. Attention should also be directed towards minimising water contact with product leaves particularly near harvest. Where possible and practical drip or similar irrigation applications directed in the substrate should be considered. Irrigation equipment should be maintained clean and a microbiologically low risk water source used. One specific Herb highlighted in the FAO/WHO report was Basil. It is a commodity which cannot be stored at the low temperatures recommended to minimize microbial growth and multiplication; temperatures which many other Herbs tolerate. It is imperative therefore to reduce the risk of the microbes of concern from contacting Herb crops.

To lessen the risk of the pathogenic microbes entering the Herbs at harvest or despatch start-up checks should ensure that:

1. Harvest and product handling staff are fit: with no gastroenteridal problems within the preceding 48h. They are trained in food hygiene and prepared for Herb product handling, wearing gloves and hair cover,
2. Knives, mechanical harvesters and handling equipment are all clean and sanitized.
3. The Herb leaf material is not wet.
4. The Herb products can reach cool temperatures soon after harvest
5. Storage crates, product containers and transport vehicles are clean and sanitized.
6. Herb chillers or cool rooms are clean and functional at 0-4°C (except for Basil)

Appendix 1 Typical fertilizer application rates (kg/ha)

Crop	N	P ₂ O ₅	K ₂ O	N (After Cut)
Basil	100	125	125	75
Chives	125	250	125	75
Dill	75 + 75	125	125	75
Marjoram	180	180	180	180
Mint	90	60 - 125	125 - 180	80
Oregano	180	125	125	180
Parsley	60	30 - 90	50 – 125	125
Rosemary	125	125	125	60
Sage	125	30 - 90	90 - 180	60
Tarragon	250	100	120	250
Thyme	125	125	125	60

Notes:

Fertiliser requirement will vary enormously with soil status, crop life and quality desired.

Appendix 2 Insecticides currently approved (December 2008) for use on Herbs in outdoor cultivation

Active Ingredient	Product Features	Approval Type ⁽²⁾	Expiry Date	Pre-harvest Interval ⁽¹⁾	UK/EC MRL ⁽⁶⁾ (mg/kg)	Some Environmental Sensitivities	Buffer Zone Restriction	Current Applicable LERAP(s) ⁽³⁾	Hazard Rating
Acetamiprid ⁽²⁾	Neo nicotenoid Parsley only	EOLA	12/2014	7 days	0.01* 5 ⁽⁷⁾	Aquatic areas	yes	B	harmful
<i>Bacillus thuringiensis var. kurstaki</i> ⁽²⁾	bacteria	SOLA	12/2013	none set	none set	aquatic areas	none stated	none stated	none stated
cypermethrin ⁽²⁾	pyrethroid	SOLA	11/2011	see SOLA	2.0	bees, aquatic areas, fish	yes	A	Harmful Irritant
deltamethrin ⁽²⁾	pyrethroid	SOLA	12/2013	see SOLA	0.5	bees, aquatic areas, fish	yes	A	Harmful Irritant
diflubenzuron ⁽²⁾	contact and stomach acting	SOLA	12/2013	7 days	0.2	fish, aquatic areas	yes	B	none stated
lambda cyhalothrin ⁽²⁾	pyrethroid	EOLA	06/2011	3 days	1.0	fish, aquatic areas	yes	A	Harmful Irritant
nicotine ⁽²⁾	agonist	SOLA	06/2010	2 days	(none set) 0.01	bees, birds, animals, aquatic areas, fish	None stated	None stated	Toxic
pirimicarb ⁽²⁾	carbamate anticholinesterase	SOLA	12/2013	3 days	5	fish, aquatic areas	none stated	none stated	Harmful
pymetrozine ⁽²⁾	azomethine insecticide	EOLA	10/2011	7 days	1	fish, bees, aquatic areas	none stated	none stated	none stated
pyrethrins	pyrethrin insecticide	Full	12/2013	Not specified	1	bees, aquatic areas	yes	none stated	none stated
spinosad ⁽²⁾	agonist	EOLA	1/2017	3 days	10	aquatic areas	none stated	B	none stated
tefluthrin ⁽²⁾	pyrethroid seed treatment	SOLA	12/2013	see label	0.05	fish, aquatic areas	none stated	none stated	Irritant

Notes:

* indicates MRL set at limit of determination (LOD)

⁽¹⁾ or latest time of application

⁽²⁾ SOLA - refers to Specific Off label Approval.

⁽³⁾ LERAP relates to certain products with the shown active ingredients.

⁽⁶⁾ These ECMRLs were set in 2008 (see Section 3.1 Appropriate Pesticide Use) and apply throughout the EU. These MRLs apply to all leafy herbs unless specified differently.

⁽⁷⁾ MRL applies to parsley only; all other herbs at LOD

Not all products containing these active ingredients may be currently approved for use on all leafy Herbs. As recommendations are revised regularly, read a current label and the SOLA 'Notice of Approval' document before use.

Appendix 3 Fungicides currently approved (December 2008) for use on Herbs in outdoor cultivation

Active Ingredient	Product Features	Approval Type ⁽²⁾	Expiry Date	Pre-harvest Interval ⁽¹⁾	UK/EC MRL ⁽⁶⁾ (mg/kg)	Some Environmental Sensitivities	Buffer Zone Restriction	Current Applicable LERAP(s) ⁽³⁾	Hazard Rating
azoxystrobin ⁽²⁾	systemic & protectant strobilurin	EOLA	12/2011	14 days	3.0	aquatic areas, fish	none stated	B	none stated
boscalid+ pyraclostrobin ⁽²⁾	Strobilurin	EOLA	9/2013	14days (Apr-Oct)	10+2.0	aquatic areas	none stated	B	Harmful Irritant
copper oxychloride ⁽²⁾	Inorganic protectant Not approved for all herbs	SOLA	12/2013	14days	20 (50) ⁽⁸⁾	aquatic areas fish	none stated	none stated	Harmful
cymoxanil+ fludioxonil+ metalaxyl-M ⁽²⁾	Translaminal, systemic, Phenylamide mixture	SOLA	03/2012	21 days	0.05*, 1, 2	aquatic areas, birds, wildlife	none stated	none stated	Harmful
dimethomorph+ mancozeb ⁽²⁾	Cinnamic acid+ Dithiocarbamate	SOLA	09/2011	21 days	1 +5.0	aquatic areas, fish	none stated	B	Irritant
fenhexamid ⁽²⁾	protectant	EOLA ⁽²⁾	05/2011	3 days	30	aquatic areas fish	none stated	none stated	none stated
fosetyl aluminium ⁽²⁾	phosphonic acid.	SOLA	12/2013	14 days & 7 days ⁽⁵⁾	75	aquatic areas	none stated	none stated	none stated
Iprodione ⁽²⁾	Dicarboximide	EOLA	12/2013	7 days	10.0	aquatic areas	none stated	B	Irritant
Mancozeb ⁽²⁾	Dithiocarbamate	SOLA	12/2013	14 days	5.0	aquatic areas, fish	none stated	none stated	Irritant

Notes:

*indicates MRL set at limit of determination

⁽¹⁾ or latest time of application

⁽²⁾ SOLA - refers to Specific Off label Approval; EOLA-refers to Extension Off Label Approval.

⁽³⁾ Note LERAP relates to certain products with the shown active ingredients.

⁽⁵⁾ The type of formulation can affect the harvest interval, which is therefore specific to the approved product. The brackets () indicate a varying condition of use - see the product label and 'Notice of Approval' document for details.

⁽⁶⁾ These ECMRLs were set in 2008 (see Section3.1 Appropriate Pesticide Use) and apply throughout the EU. These MRLs apply to all leafy herbs unless specified differently

⁽⁷⁾MRL applies to chives only; all other herbs at LOD

⁽⁸⁾ applies to celery leaf group (coriander, dill, etc) although no current approval for this group of herbs

⁽⁹⁾No MRL applies as active substance listed in Annex IV of Regulation 396/2005

Not all products containing these active ingredients may be currently approved for use on all leafy Herbs. As recommendations are revised regularly, read a current label and the SOLA 'Notice of Approval' document before use.

These may alter with new regulations expected in 2008 (see Section3.1 Appropriate Pesticide Use)

Appendix 3 Fungicides currently approved (December 2008) for use on Herbs in outdoor cultivation (Cont'd)

Active Ingredient	Product Features	Approval Type ⁽²⁾	Expiry Date	Pre-harvest Interval ⁽¹⁾	UK/EC MRL ⁽⁶⁾ (mg/kg)	Some Environmental Sensitivities	Buffer Zone Restriction	Current Applicable LERAP(s) ⁽³⁾	Hazard Rating
Metalaxyl-M ⁽²⁾	Systemic phenylamide	EOLA	09/2012	14 days ⁽⁵⁾	2	aquatic areas, fish	none stated	none stated	Harmful irritant
Metalaxyl-M+ Mancozeb ⁽²⁾	Systemic & protectant	SOLA	12/2013	14 days ⁽⁵⁾	2, 5	aquatic areas, fish	none stated	none stated	Harmful irritant
Potassium bicarbonate	inorganic protectant	Commodity substance	12/2013	none stated	none set ⁽⁹⁾	aquatic areas, fish	none stated	none stated	none stated
prochloraz ⁽²⁾	protectant & eradicator conazole	SOLA	12/2013	21 days	5.0	aquatic areas, fish	none stated	none stated	none stated
propamocarb hydrochloride ⁽²⁾	translocated protectant	SOLA	12/2013	See SOLA	30	aquatic areas	none stated	none stated	none stated
tebuconazole ⁽²⁾	Conazole Chives only	SOLA	12/2013	14 days	0.05*, 0.5 ⁽⁷⁾	aquatic areas, fish	none stated	B	Harmful
Thiram ⁽²⁾	protectant	SOLA	12/2013	14 days	0.1*	aquatic areas, fish	none stated	none stated	Harmful Irritant

Notes:

*indicates MRL set at limit of determination

⁽¹⁾ or latest time of application

⁽²⁾ SOLA - refers to Specific Off label Approval; EOLA-refers to Extension Off Label Approval.

⁽³⁾ Note LERAP relates to certain products with the shown active ingredients.

⁽⁵⁾ The type of formulation can affect the harvest interval, which is therefore specific to the approved product. The brackets () indicate a varying condition of use - see the product label and 'Notice of Approval' document for details.

⁽⁶⁾ These ECMRLs were set in 2008 (see Section 3.1 Appropriate Pesticide Use) and apply throughout the EU. These MRLs apply to all leafy herbs unless specified differently

⁽⁷⁾ RL applies to chives only; all other herbs at LOD

⁽⁸⁾ applies to celery leaf group (coriander, dill, etc) although no current approval for this group of herbs

⁽⁹⁾ No MRL applies as active substance listed in Annex IV of Regulation 396/2005

Not all products containing these active ingredients may be currently approved for use on all leafy Herbs. As recommendations are revised regularly, read a current label and the SOLA 'Notice of Approval' document before use.

These may alter with new regulations expected in 2008 (see Section 3.1 Appropriate Pesticide Use)

Appendix 3 Fungicides currently approved (December 2008) for use on Herbs in outdoor cultivation (Cont'd)

Active Ingredient	Product Features	Approval Type ⁽²⁾	Expiry Date	Pre-harvest Interval ⁽¹⁾	UK/EC MRL ⁽⁶⁾ (mg/kg)	Some Environmental Sensitivities	Buffer Zone Restriction	Current Applicable LERAP(s) ⁽³⁾	Hazard Rating
Metalaxyl-M ⁽²⁾	Systemic phenylamide	EOLA	09/2012	14 days ⁽⁵⁾	2	aquatic areas, fish	none stated	none stated	Harmful irritant
Metalaxyl-M+ Mancozeb ⁽²⁾	Systemic & protectant	SOLA	12/2013	14 days ⁽⁵⁾	2, 5	aquatic areas, fish	none stated	none stated	Harmful irritant
Potassium bicarbonate	inorganic protectant	Commodity substance	12/2013	none stated	none set ⁽⁹⁾	aquatic areas, fish	none stated	none stated	none stated
prochloraz ⁽²⁾	protectant & eradicant conazole	SOLA	12/2013	21 days	5.0	aquatic areas, fish	none stated	none stated	none stated
propamocarb hydrochloride ⁽²⁾	translocated protectant	SOLA	12/2013	See SOLA	30	aquatic areas	none stated	none stated	none stated
tebuconazole ⁽²⁾	Conazole Chives only	SOLA	12/2013	14 days	0.05*, 0.5 ⁽⁷⁾	aquatic areas, fish	none stated	B	Harmful
Thiram ⁽²⁾	protectant	SOLA	12/2013	14 days	0.1*	aquatic areas, fish	none stated	none stated	Harmful Irritant

Notes:

*indicates MRL set at limit of determination

(1) or latest time of application

(2) SOLA - refers to Specific Off label Approval; EOLA-refers to Extension Off Label Approval.

(3) Note LERAP relates to certain products with the shown active ingredients.

(5) The type of formulation can affect the harvest interval, which is therefore specific to the approved product. The brackets () indicate a varying condition of use - see the product label and 'Notice of Approval' document for details.

(6) These ECMRLs were set in 2008 (see Section 3.1 Appropriate Pesticide Use) and apply throughout the EU. These MRLs apply to all leafy herbs unless specified differently

(7) MRL applies to chives only; all other herbs at LOD

(8) applies to celery leaf group (coriander, dill, etc) although no current approval for this group of herbs

(9) No MRL applies as active substance listed in Annex IV of Regulation 396/2005

Not all products containing these active ingredients may be currently approved for use on all leafy Herbs. As recommendations are revised regularly, read a current label and the SOLA 'Notice of Approval' document before use.

These may alter with new regulations expected in 2008 (see Section 3.1 Appropriate Pesticide Use)

Appendix 4 Herbicides currently approved (December 2008) for use on Herbs in outdoor cultivation

Active Ingredient	Product Features	Approval Type ⁽²⁾	Expiry Date	Pre-harvest Interval ⁽¹⁾	UK/EC MRL ⁽⁶⁾ (mg/kg)	Some Environmental Sensitivities	Buffer Zone Restriction	Current Applicable LERAP(s) ⁽³⁾	Hazard Rating
asulam ⁽²⁾	translocated carbamate (for certain herbs only)	SOLA for weed spot	12/2013	See SOLA	0.5	none stated	none stated	none stated	none stated
asulam ⁽²⁾	Translocated carbamate	SOLA	02/2011	See SOLA	0.5	none stated	none stated	none stated	none stated
chloridazon ⁽²⁾	residual pyridazinone	SOLA	12/2013	pre-emergence	0.5	fish, aquatic areas	none stated	none stated	harmful
chloridazon+quimmerac ⁽²⁾	residual pyridazinone	SOLA	12/2013	pre-emergence	0.5+ 0.5	fish, aquatic areas	none stated	none stated	harmful
chlorpropham ⁽²⁾	residual carbamate	SOLA	07/2010	pre-emergence	0.05*	fish, aquatic areas	none stated	none stated	harmful
chlorthal-dimethyl ⁽²⁾	residual benzoic acid	SOLA	12/2013	pre-emergence	5	aquatic areas	none stated	none stated	none stated
clopyralid ⁽²⁾	translocated picoline	SOLA	12/2013	6 weeks	3	livestock	none stated	none stated	none stated
diquat ⁽²⁾	contact bipyridyl	SOLA	12/2011	1 week	0.05*	livestock	none stated	none stated	Harmful
ioxynil ⁽²⁾	contact HBN chives only	SOLA	12/2013	2 weeks	0.05*	bees, fish, aquatic areas	none stated	none stated	Harmful
Lenacil ⁽²⁾	residual uracil	SOLA	12/2013	none stated	0.1*	Bees, fish, aquatic areas	none stated	none stated	Irritant
linuron ⁽²⁾	residual urea	SOLA	12/2008	see SOLA	1.0	fish, aquatic areas	yes	B	Irritant
metamitron ⁽²⁾	residual triazinone	SOLA	12/2013	6 weeks	0.1*	aquatic areas	none stated	none stated	none stated

Notes:

* indicates MRL set at limit of determination

⁽¹⁾ or latest time of application⁽²⁾ SOLA - refers to Specific Off label Approval.⁽³⁾ LERAP relates to certain products with the shown active ingredients.⁽⁶⁾ These ECMRLs were set in 2008 (see Section 3.1 Appropriate Pesticide Use) and apply throughout the EU. These MRLs apply to all leafy herbs unless specified differently

Not all products containing these active ingredients may be currently approved for use on all leafy Herbs. As recommendations are revised regularly, read a current label and the SOLA 'Notice of Approval' document before use.

Appendix 4 Herbicides currently approved (December 2008) for use on Herbs in outdoor cultivation (Cont'd)

Active Ingredient	Product Features	Approval Type ⁽²⁾	Expiry Date	Pre-harvest Interval ⁽¹⁾	UK/EC MRL ⁽⁶⁾ (mg/kg)	Some Environmental Sensitivities	Buffer Zone Restriction	Current Applicable LERAP(s) ⁽³⁾	Hazard Rating
pendimethalin ⁽²⁾	residual dinitroaniline	EOLA	12/2013	see SOLA	0.05*	Bees, fish, aquatic areas	none stated	B	none stated
phenmedipham ⁽²⁾	contact carbamate	SOLA	10/2009	21 days	7	fish, aquatic areas	none stated	none stated	Harmful Irritant
propachlor ⁽²⁾	residual amide	SOLA	03/2010	6 weeks	0.1	aquatic areas	none stated	none stated	Irritant
propachlor + chloridazon ⁽²⁾	residual amide	SOLA	12/2013	12 weeks	0.1 & 0.5	fish, aquatic areas	none stated	none stated	Irritant
propaquizafop ⁽²⁾	phenoxy alkanonic acid	SOLA	12/2013	3 weeks	0.2	fish, aquatic areas	none stated	none stated	Irritant
propyzamide ⁽²⁾	residual amide	EOLA	03/2014	See SOLA	1	aquatic areas	none stated	none stated	none stated
prosulfocarb ⁽²⁾	thiocarbamate	SOLA	12/2013	Pre-emergence	0.05*	aquatic areas	none stated	B	irritant

Notes:

* indicates MRL set at limit of determination

⁽¹⁾ or latest time of application

⁽²⁾ SOLA - refers to Specific Off label Approval.

⁽³⁾ LERAP relates to certain products with the shown active ingredients.

⁽⁶⁾ These ECMRLs were set in 2008 (see Section 3.1 Appropriate Pesticide Use) and apply throughout the EU. These MRLs apply to all leafy herbs unless specified differently

Not all products containing these active ingredients may be currently approved for use on all leafy Herbs. As recommendations are revised regularly, read a current label and the SOLA 'Notice of Approval' document before use.

Appendix 5 Insecticides currently approved (December 2008) for use on Herbs in protected cultivation

Active Ingredient	Product Features	Approval Type ⁽²⁾	Expiry Date	Pre-harvest Interval ⁽¹⁾	UK/EC MRL ⁽⁶⁾ (mg/kg)	Some Environmental Sensitivities	Buffer Zone Restriction	Current Applicable LERAP(s) ⁽³⁾	Hazard Rating
Abamectin ⁽²⁾	avermectin	SOLA	12/2013	14 days	1.0	Aquatic areas, bees	None stated	None stated	Harmful
Acetamiprid ⁽²⁾	Neonicotinoid Parsley only	EOLA	12/2014	3 days	0.01* 5 ⁽⁷⁾	Aquatic organisms & areas	yes	B	Harmful
<i>Bacillus thuringiensis var kurstaki</i> ⁽²⁾	bacteria	SOLA	12/2013	none stated	none set ⁽⁹⁾	aquatic areas	none stated	none stated	none stated
cypermethrin ⁽²⁾	pyrethroid	SOLA	11/2011	none stated	2.0	bees, fish, aquatic areas	none stated	A	harmful irritant
deltamethrin ⁽²⁾	pyrethroid	SOLA	12/2013	7 days	0.5	bees, aquatic areas, fish	none stated	A	harmful irritant
dimethoate ⁽²⁾	organophosphate	SOLA	12/2013	before 7 lvs	0.02*	fish, aquatic areas	yes	A	harmful
fatty acids ⁽²⁾	soap concentrate	SOLA	12/2013	none stated	none set ⁽⁹⁾	fish, aquatic areas	none stated	B	none stated
lambda cyhalothrin & pirimicarb ⁽²⁾	pyrethroid & carbamate	SOLA	01/2012	3 days	1, 5	fish, aquatic areas	yes	A	Harmful Irritant

Notes:

* indicates MRL set at the limit of analytical determination

⁽¹⁾ or latest time of application

⁽²⁾ SOLA - refers to Specific Off label Approval.

⁽³⁾ LERAP relates to certain products with the shown active ingredients.

⁽⁶⁾ These EC MRLs were set in 2008 (see Section 3.1 Appropriate Pesticide Use) and apply throughout the EU. These MRLs apply to all leafy herbs unless specified differently

⁽⁷⁾ MRL applies to parsley only; all other herbs at LOD

⁽⁹⁾ No MRL applies as active substance listed in Annex IV of Regulation 396/2005

Not all products containing these active ingredients may be currently approved for use on all leafy Herbs. As recommendations are revised regularly, read a current label and the SOLA 'Notice of Approval' document before use.

Appendix 5 Insecticides currently approved (December 2008) for use on Herbs in protected cultivation (Cont'd)

Active Ingredient	Product Features	Approval Type ⁽²⁾	Expiry Date	Pre-harvest Interval ⁽¹⁾	UK/ECMRL ⁽⁶⁾ (mg/kg)	Some Environmental Sensitivities	Buffer Zone Restriction	Current Applicable LERAP(s) ⁽³⁾	Hazard Rating
methiocarb ⁽²⁾	Stomach acting carbamate	SOLA	09/2009	10 days	1	birds, animals, aquatic areas, fish	none stated	none stated	Harmful
nicotine ⁽²⁾	alkaloid, agonist	SOLA	12/2013	2 days	none set (0.01)	bees, birds, animals, aquatic areas, fish	none stated	none stated	Toxic
pirimicarb ⁽²⁾	carbamate anticholinesterase	SOLA	12/2013	see SOLA	5	fish, aquatic areas	none stated	none stated	Harmful
pymetrozine ⁽²⁾	azomethine insecticide	EOLA	10/2011	14 days	1	fish, bees, aquatic areas	none stated	none stated	none stated
pyrethrins	pyrethrin insecticide	Full	12/2013	Not specified	1	bees, aquatic areas	yes	none stated	none stated
spinosad ⁽²⁾	agonist	EOLA	1/2017	3 days	10	aquatic organisms	none stated	B	none stated
thiacloprid ⁽²⁾	cloronicotinyl	SOLA	12/2014	14 days	3	aquatic areas	none stated	none stated	none stated
<i>Verticillium lecanii</i> ⁽²⁾	fungal parasite	SOLA	12/2013	None stated	none set	aquatic areas	none stated	none stated	none stated

Notes:

⁽¹⁾ or latest time of application

⁽²⁾ SOLA - refers to Specific Off label Approval.

⁽³⁾ LERAP relates to certain products with the shown active ingredients.

⁽⁶⁾ These ECMRLs were set in 2008 (see Section 3.1 Appropriate Pesticide Use) and apply throughout the EU. These MRLs apply to all leafy herbs unless specified differently

Not all products containing these active ingredients may be currently approved for use on all leafy Herbs. As recommendations are revised regularly, read a current label and the SOLA 'Notice of Approval' document before use.

Appendix 6 Fungicides currently approved (December 2008) for use on Herbs in protected cultivation

Active Ingredient	Product Features	Approval Type ⁽²⁾	Expiry Date	Pre-harvest Interval ⁽¹⁾	UK/EC MRL ⁽⁶⁾ (mg/kg)	Some Environmental Sensitivities	Buffer Zone Restriction	Current Applicable LERAP(s) ⁽³⁾	Hazard Rating
azoxystrobin ⁽²⁾	systemic and protectant strobilurin	EOLA	12/2011	28 days (Nov-Apr) 14 days (May-Oct)	3	aquatic areas, fish	none stated	B	None stated
boscalid+pyra clostrobilin ⁽²⁾	Strobilurin	EOLA	9/2013	14days (Apr-Oct)	10+2.0	aquatic areas	none stated	B none stated	Harmful Irritant
copper oxychloride ⁽²⁾	Inorganic protectant Not approved for all herbs	SOLA	12/2013	14days	20 (50) ⁽⁸⁾	aquatic areas fish	none stated	none stated	Harmful
fenhexamid ⁽²⁾	protectant	EOLA ⁽²⁾	05/2011	3days	30	aquatic areas fish	none stated	none stated	None stated
fosetyl aluminium ⁽²⁾	phosphonic acid	SOLA	12/2013	See SOLA	75	aquatic areas	none stated	none stated	None stated

Notes:

* indicates MRL set at limit of determination

(1) or latest time of application

(2) SOLA - refers to Specific Off label Approval; EOLA-refers to Extension Off Label Approval.

(3) LERAP relates to certain products with the shown active ingredients.

(4) The type of formulation can affect the harvest interval, which is therefore specific to the approved product. The brackets () indicate a varying condition of use - see the product label or 'notice of approval' document for details.

(6) These EC MRLs were set in 2008 (see Section 3.1 Appropriate Pesticide Use) and apply throughout the EU. These MRLs apply to all leafy herbs unless specified differently

(8) applies to celery leaf group (coriander, dill, etc) although no current approval for this group of herbs

Not all products containing these active ingredients may be currently approved for use on all leafy Herbs. As recommendations are revised regularly, read a current label and the SOLA 'Notice of Approval' document before use.

Appendix 6 Fungicides currently approved (December 2008) for use in Herbs in protected cultivation (Cont'd)

Active Ingredient	Product Features	Approval Type ⁽²⁾	Expiry Date	Pre-harvest Interval ⁽¹⁾	UK/EC MRL ⁽⁶⁾ (mg/kg)	Some Environmental Sensitivities	Buffer Zone Restriction	Current Applicable LERAP(s) ⁽³⁾	Hazard Rating
iprodione ⁽²⁾	dicarboximide	EOLA	12/2013	14days	10.0	aquatic organisms	none stated	B	Irritant
Mancozeb ⁽²⁾	dithiocarbamate	SOLA	12/2013	21 days	5.0	aquatic areas, fish	none stated	none stated	irritant
Metaxyl-M ⁽²⁾	systemic phenylamide	EOLA	12/2013	14 days ⁽⁵⁾	2	aquatic areas, fish	none stated	none stated	irritant
Metaxyl-M+ Mancozeb ⁽²⁾	Systemic & protectant inorganic	SOLA	12/2013	21days ⁽⁵⁾	2,5.0	aquatic areas, fish	none stated	none stated	harmful irritant
Potassium bicarbonate ⁽²⁾	protectant	Commodity substance	12/2013	none stated	none set ⁽⁹⁾	fish	none stated	none stated	none stated
prochloraz ⁽²⁾	conazole	SOLA	12/2013	21 days	5.0	aquatic areas, fish	none stated	none stated	none stated
propamocarb hydrochloride ⁽²⁾	translocated protectant	SOLA	12/2013	See SOLA	30	aquatic areas	none stated	none stated	none stated
pyrimethanil ⁽²⁾	amlinopyrimidine	SOLA	12/2013	14 days	3	aquatic areas, fish	none stated	none stated	none stated
sulphur ⁽²⁾	inorganic protectant	SOLA	12/2013	none stated	50	aquatic areas, fish	none stated	none stated	none stated
thiram ⁽²⁾	dithiocarbamate	SOLA	12/2013	21 days	0.1*	aquatic areas, fish	none stated	none stated	Harmful Irritant

Notes:

* indicates MRL set at limit of determination

- (1) or latest time of application
(2) SOLA - refers to Specific Off label Approval.
(3) note LERAP relates to certain products with the shown active ingredients.
(4) The type of formulation can affect the harvest interval, which is therefore specific to the approved product. The brackets () indicate a varying condition of use - see the product label or 'notice of approval' document for details.
(6) These EC MRLs were set in 2008 (see Section 3.1 Appropriate Pesticide Use) and apply throughout the EU. These MRLs apply to all leafy herbs unless specified differently
(9) No MRL applies as active substance listed in Annex IV of Regulation 396/2005

Not all products containing these active ingredients may be currently approved for use on all leafy Herbs. As recommendations are revised regularly, read a current label and the SOLA 'Notice of Approval' document before use.

Appendix 7 Herbicides currently approved (December 2008) for use on Herbs in protected cultivation

Active Ingredient	Product Features	Approval Type (2)	Expiry Date	Pre-harvest Interval ⁽¹⁾	UK/EC MRL ⁽⁶⁾ (mg/kg)	Some Environmental Sensitivities	Buffer Zone Restriction	Current Applicable LERAP ⁽⁵⁾ (3)	Hazard Rating
asulam (2)	translocated carbamate (for certain herbs only)	SOLA for weed spot	12/2013	See SOLA	0.5	none stated	none stated	none stated	none stated
(cestrimide +) chlorpropham (2)	residual carbamate	SOLA	7/2010	pre-sow	0.05*	fish, aquatic areas	none stated	none stated	harmful irritant
ioxynil (2)	contact HBN Chives only	SOLA	12/2013	2 weeks	0.05*	bees, fish, aquatic areas	none stated	none stated	harmful
propyzamide (2)	residual amide	EOLA	03/2014	See SOLA	1.0	fish, aquatic areas	none stated	none stated	none stated

Notes:

*indicates MRL set at limit of determination

- (1) or latest time of application
(2) SOLA - refers to Specific Off label Approval.
(3) note LERAP relates to certain products with the shown active ingredients.
(4) The type of formulation can affect the harvest interval, which is therefore specific to the approved product. The brackets () indicate a varying condition of use - see the product label or 'notice of approval' document for details.

(6) These EC MRLs were set in 2008 (see Section 3.1 Appropriate Pesticide Use) and apply throughout the EU. These MRLs apply to all leafy herbs unless specified differently

Not all products containing these active ingredients may be currently approved for use on all leafy Herbs. As recommendations are revised regularly, read a current label and the SOLA 'Notice of Approval' document before use.

Appendix 8 Possible biological control agents for some major pests of container grown Herbs under protection (December 2008)

Pests	Predators	Parasitoids & Nematodes	Bacteria & Fungi
Aphids	<i>Adalia bipunctata</i> (ladybird) <i>Aphidoletes aphidimyza</i> (midge) <i>Chrysoperla carnea</i> (lacewing) <i>Episyrphus balteatus</i> (hoverfly)	<i>Aphidius colemani</i> & <i>A. ervi</i> (wasp) <i>Aphelinus abdominalis</i> (wasp)	<i>Verticillium lecanii</i> (fungus)
Caterpillars / Moths		<i>Trichogramma brassicae</i> (wasp that attacks moth eggs) <i>Steinernema carpocapsae</i> (nematode)	<i>Bacillus thuringiensis</i> (bacteria)
Leafhoppers		<i>Anagrus atomus</i> (wasp that attacks leafhopper eggs)	
Leaf miners		<i>Dacnusa sibirica</i> & <i>Diglyphis isaea</i> (wasps which attack larvae) <i>Steinernema feltiae</i> (nematode)	
Mealybugs	<i>Cryptolaemus montrouzieri</i> (ladybird)	<i>Leptomastix</i> spp. (wasp)	
Soft scale insects		<i>Metaphycus helvolus</i> (wasp)	
Sciarid flies	<i>Hypoaspis aculeifer</i> (mite) <i>Hypoaspis miles</i> (mite) <i>Atheta coriaria</i> (beetle)	<i>Steinernema feltiae</i> (nematode)	
Shore flies	<i>Atheta coriaria</i> (beetle)		
Slugs & snails		<i>Phasmarhabditis hermaphrodita</i> (nematode)	
Spider mites	<i>Phytoseiulus persimilis</i> (mite) <i>Feltiella acarisuga</i> (midge) <i>Strethorus punctillum</i> (ladybird) <i>Amblyseius californicus</i> (mite)		
Thrips	<i>Amblyseius cucumeris</i> (mite) <i>Amblyseius swirskii</i> (mite) <i>Orius</i> spp. (bug) <i>Hypoaspis aculeifer</i> / <i>H.miles</i> (mite)	<i>Steinernema feltiae</i> (nematode)	<i>Verticillium lecanii</i> (fungus)
Vine weevils		<i>Heterorhabditis</i> spp. (nematode) <i>Steinernema carpocapsae</i> (nematode) & <i>S.krausei</i> (nematode)	
Whiteflies	<i>Amblyseius swirskii</i> (mite)	<i>Encarsia formosa</i> (wasp) <i>Eretmocerus eremicus</i> (wasp)	<i>Verticillium lecanii</i> (fungus)

Pheromone traps are useful to monitor for some insect pests e.g. Tortrix moths, Silver Y Moth, Tomato Moth.

As a number of these organisms require specific conditions for optimal activity, growers should seek a programme to suit their particular circumstances. Ensure that this is done with technical support from the supplier or an independent IPM consultant.

Some insecticides / acaricides approved for use on protected herbs are safe to use with most biological control agents. Current examples include: Aphox[®], Chess WP[®], Dipel DF[®], Phantom[®], Mycotal[®], Vertalec[®].

Eradicoat[®], Majestik[®] and Savona[®] are safe for use in biological control programmes once the spray residue has dried. (Eradicoat[®] and Majestik[®] act by physical means only, so are not subject to the pesticide regulations, thus may be used on any crop at grower's own risk.)

Fungicide examples safe to use with biological control agents include: Amistar[®], Proplant[®], Rovral WG[®].

Other approved pesticides may be compatible with biological control agents within an IPM programme. Full details of pesticide compatibility with biological agents should be sought from suppliers or an independent IPM consultant.

Appendix 9 Some environmental features suitable for certain Herbs commonly grown in the UK

Herb	Habitat	Temperature (°C day)	Temperature (°C night)	Daylength (hours)	Flowering Peak	Soil pH range	Climate for leaf product	Ground preparation
Basil	Semishade if hot	25 - 35	>15	12h	Summer	4.5 - 8.0	Hot with ample soil moisture	Fine seed bed
Chives	Sun, semishade if hot	15 - 25	>1	>10h	May	5.0 - 8.0	Warm, half shade	Fine seed bed if direct sown; free of grass
Coriander	sun	10 - 30	>5	neutral	June	5.0 - 8.0	Even temp., no moisture stress	Firm seed bed
Dill	sun	15 - 25	>5	neutral	June	5.0 - 8.0	Low humidity, warmth and sunshine	Firm seed bed
Mint	Sun, semishade if hot	15 - 25	>5	>10h	June	4.5 - 7.5	Warm, sunny	No perennial weeds
Parsley	Sun	15 - 25	>5	neutral	May	5.0 - 8.0	Cool to warm	Firm seed bed
Rosemary	Sun	15 - 30	>1	Neutral	April (&Sep)	5.0 - 8.5	Dry and sunny	Firm seed bed
Tarragon	Sun	>10	>5	>10h	July	5.0 - 7.5	Dry with ample moisture for regrowth	No perennial weeds
Thyme	sun	15 - 30	>1	neutral	May	4.5--8.0	Dry and sunny	Firm seed bed ; no perennial weeds

Appendix 10 Guidelines for minimising pesticide residues in U.K. Herbs

These guidelines have been produced after consultation between crop stakeholders and the Assured Produce crop author. They will be developed over the coming seasons as knowledge on minimising residues develops. Growers should consult with their crop protection adviser to ensure other best practices are not compromised before considering these guidelines. For a number of reasons covered in this protocol it is desirable to plan crop protection programmes with consideration for minimal pesticide residues in Herbs. A number of points should be addressed to reduce the risk of residues being detectable. A typical six-point plan is presented below:

1. Evaluate whether non-chemical options are available and appropriate for the anticipated herb problem without compromising efficacy or resistance management. Examine weed history and P&D forecasting systems appropriate to the Herbs.
2. Generate a crop protection management plan that involves efficacious approved products having active ingredients that rarely display residues in the herb species at harvest. Consult available databases (e.g. Rapport or BHTA according to your membership and specific needs) for further details if necessary.
3. Check herb species reaction / sensitivity to residue accumulation for any of your proposed uses and whether the subjects are outdoor or protected Herbs.
4. Integrate the information into a programme that involves complementary low residue, efficacious, approved products.
5. Examine and implement ways of increasing pre-harvest interval following application. Also examine and implement options for reducing dose rate where this may be possible without compromising efficacy or crop safety.
6. Have regard for the weather, time of day and impact on crop stress, environment, rates of biological and chemical breakdown, in your proposed approach; particularly as many herbs may be grown all year round, albeit at different growth rates according to season.

Notes.

1. Herb species do not necessarily carry common MRLs for the same active substance. Within EC 396/2005 some Herb species groups have different MRLs set for some substances in Annexes II, IIIa & IIIb . Such differential MRLs e.g. acetamiprid may result in certain Herbs having workable MRLs whilst others may be at the limit of detection and be unworkable or not permitted within approved products.
2. Certain SOLAs currently have different dose rates and harvest intervals according to herb species and perceived residue risk e.g recent approvals containing propyzamide.

Appendix 11 Basic table of herb grouping for EC396/2005 MRL Annex I.

EC Code	Group	Lead individual	Examples also include
200000	Vegetables	General	All herbs if not listed in lower categories
250000	LeafVeg +Fresh herbs	General	All herbs if not listed in lower categories
256000	Herbs	General	All herbs if no individual listing
256010	Herbs	Chervil	none
256020	Herbs	Chives	none
256030	Herbs	Celery leaves	Angelica, Caraway leaves, Coriander leaves, Dill leaves, Fennel leaves, Lovage, Sweet Cicely, other Apiaceae
256040	Herbs	Parsley	none
256050	Herbs	Sage	winter savory, summer savory
256060	Herbs	Rosemary	none
256070	Herbs	Thyme	marjoram, oregano
256080	Herbs	Basil	balm leaves, mint, peppermint
256090	Herbs	Bay	none
256100	Herbs	Tarragon	Hyssop
256990	Herbs	Other	All herbs not accounted for above

Appendix 12 Crop Specific Questions: (December 2008)**CS.38 HERBS (CULINARY)**

- CS.38.1 If you consider the use of chemical control is necessary for a crop protection problem, you must be able to demonstrate that you select appropriate pesticides in relation to specific pest problem and take account of individual Herb: tolerance, residue issues and pre-harvest interval.
Protocol reference: Section 2 & 8.10.2
- CS.38.2 If you use chemical pesticides, you must be able to show evidence of minimal effective dose and due attention to the mode of action of the agents used, avoid risk of drift on to adjacent Herb blocks and use labels to indicate first permitted harvest date.
- Protocol reference: Section 2, 8.11.1 & 9.5
- CS.38.3 If you use chemical pesticides you must be able to demonstrate an understanding of current MRLs that apply to the various Herb categories
- Protocol reference: Section 2
- CS.38.4 You must be able to show that the sustainability of your Herb production system has been enhanced with greater environmental care (e.g. measures of minimal but effective chemical use, more environmentally benign management).
- Protocol reference: Section 4.6.4
- CS.38.5 You must be able to demonstrate you take action to ensure improved benign Herb crop production measures are being pursued by industry or government representatives (e.g. either by attendance at technical meetings or correspondence with industry representatives) and take action to address any gaps in your Herb crop protection measures
- Protocol reference: Section 4.6.4.iii
- CS.38.6 You must be able to show that you regularly and systematically survey Herb crops to determine timely control crop protection measures
- Protocol reference: Section 8.11