SUSTAINABLE SPINACH

GOOD AGRICULTURAL PRACTICE GUIDELINES

Unilever

CONTENTS

This document has been discussed with the members of the Unilever Sustainable Agriculture Advisory Board (SAAB). The SAAB is a group of individuals, specialists in agricultural practices or representatives of non-governmental organisations (NGOs), who have expertise in different aspects of sustainability. They have agreed to critically assist Unilever in the evolution of Sustainable Agriculture Indicators and good practices for a range of raw material crops. The contents of this document and the choices made therein are, however, the responsibility of Unilever only.

INTRODUCTION

These guidelines have been developed under the Unilever Sustainable Agriculture Initiative to support sustainable management practices for spinach production.

Ten indicators of sustainability have been identified:

1. **Soil Health**
2. **Soil Loss**
3. **Nutrients**
4. **Pest Management**
5. **Biodiversity**
6. **Product Value**
7. **Energy**
8. **Water**
9. **Social and Human Capital**
10. **Local Economy**

Within Unilever Frozen Foods, Lead Agriculture Programme teams in Germany (Iglo – Reken) and Italy (Sagit – Cisterna di Latina) have worked closely with local farmers, organisations and communities to benchmark their agricultural operations against the indicators of sustainability.
For each indicator specific good agricultural practices are described, which are either already in place or will be implemented in the near future.

In addition, potential areas for improvement are listed, which will require further investigation.

The development of these good agricultural practice guidelines has been based upon a thorough evaluation of potential agronomic practices and associated inputs and follows the principles of Integrated Farm Management (IFM). The guidelines have been produced in consultation with, relevant scientists and specialists, including members of a Unilever Sustainable Agriculture Advisory Board (SAAB).

This guide is primarily intended for use by the agricultural development teams in the processing factories and for communication with other spinach processors and suppliers, but it also provides the basis for development and implementation of good practices in consultation with farmers growing spinach. We value our relationships with the contract farmers, their knowledge base and capacity to innovate, which are all key to a successful development and implementation of the good agricultural practice guidelines.

The guidelines are implemented through local agricultural management systems which contain detailed good agricultural practice standards and procedures aimed at both farmers and company agronomists. This document forms the basis for continuous improvement and development of good agricultural practices, which includes aspects of product safety and quality as well as the environmental impact and sustainability of the entire agricultural production process.

Contributions to the continuous improvement of these good agricultural practice guidelines are welcome, and may be sent to:

sustainable.agriculture@unilever.com

SOIL HEALTH

Soil is fundamental to agriculture. A rich soil ecosystem improves performance of crops and livestock. Sustainable agriculture practices can improve the quality of the soil's ecosystem.

Soil health has been defined as: 'the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation'. **Soil organic matter** is important for maintaining soil health and soil structure, reducing soil loss and increasing nutrient and water use efficiency. It also provides a carbon (energy) source for soil micro-organisms and sequesters carbon from the air playing a critical role in the global carbon balance and the greenhouse effect. Organic matter levels should be maintained at, or improved to, a satisfactory equilibrium level for the particular soil type. The organic matter will derive from organic manures and compost, and incorporation of crop residues and/or cover crops in the rotation. Long term deterioration in soil structure and fertility may result from **soil compaction**, particularly under mechanisation, from changes in **soil pH** and **soil nutrient status**, or from build-up of **salinity**, a possible side effect of irrigation. In addition, a variety of soil fauna species, such as earthworms, carabid beetles and soil micro-organisms are good indicators of soil health. For example, earthworms are important in maintaining soil structure, aeration, nutrient cycling, drainage and by breaking down organic matter for incorporation into the soil profile.

Healthy soil is a prime requirement in sustainable spinach production. Regular tests on different spinach fields indicate levels of soil organic matter and nutrient status as well as soil pH and salinity levels. Spade tests are also used to indicate soil compaction levels.

GOOD PRACTICE

Organic Matter

Conduct regular soil tests for organic matter

Compensate organic matter losses throughout the rotation through:

– Encouraging the use of organic fertilisers (manure, compost) at the appropriate time in the rotation, with management practices aimed at minimising nitrogen leaching losses to watercourses

– Leaving crop residues on the field

– Discouraging straw burning and promote straw chopping to be incorporated into soil

– Encouraging improved crop rotation strategies & green manuring through introduction of cover crops before and/or following the spinach crop

Promote appropriate soil cultivation techniques to conserve soil health, build organic matter and reduce tillage-induced losses to the atmosphere

Soil Compaction

Stipulate regular visual, qualitative soil structure assessments (i.e. 'spade test') through training seminars for farmers aimed at alleviating soil compaction

Avoid soil compaction through:

– Minimising the number of in-field machine passes

– Using wide machinery where possible to reduce the impact of a single operation

– Adjusting tyre pressures for all field operations to field conditions through use of tracked vehicles or low ground pressure tyres

– Separating road and field transport to prevent lorries from entering the field

Soil pH, Nutrient Status and Salinity

Spinach requires a pH between 6 and 8 for good growth

Encourage soil testing to determine:

– Macro- (nitrogen, phosphorus, potassium and magnesium) and micro-nutrient (copper, boron, etc.) status

– Optimum fertilisation rate

– Need for application of lime to shift pH to (soil type specific) optimum value

– Need for adjustment of nitrogen top-dressing

– Need for split nitrogen applications – maintenance (seed-bed) and top dressing (growth)

Where salinity is a problem, regularly monitor the following important variables related to irrigation:

– Water table level

– Total rainfall, irrigation and evapotransporation to ensure a net downward movement of water over the full year

– Quality of irrigation water to avoid situations of high sodium build-up, which might adversely affect crop growth

POTENTIAL AREAS FOR IMPROVEMENT

Introduce a strategy to compensate organic matter losses from spinach cropping during the contract year through:

– Considering use of certified composts

– Optimising soil nutrient as well as organic matter flows and status by prescribing certain rotations (i.e. cereals; leave chopped straw)

Research to establish the correlation between organic matter and other soil health parameters (i.e. earthworm biomass), and between organic matter and yield, for local soils and conditions

Optimise management and recycling of factory organic waste to achieve a 'closed carbon cycle'

Identification of fields susceptible to soil compaction using risk assessment methods

Further optimise soil conservation activities to alleviate soil compaction

Review current crop management strategy with the aim to further minimise the number of machinery passes on the fields

Adjustment of harvest transport system i.e. through use of tracked wheels

Consider soil and moisture specific maximum loads (under development) to prevent irreversible (sub-soil) damage, especially in wet conditions

Further understand the impact of crop rotations on soil organic matter dynamics and soil compaction

Critically review fertilisers and their potential for heavy metal pollution of the soil

The specific development of wide anti-compaction tracks on harvesting equipment has done much to minimise the effect of heavy machinery on spinach fields (top). Separating field and road transport (above) also helps to minimise the impact on fields - the high tyre pressures necessary for road use are damaging to soil fertility.

SOIL LOSS

Erosion by wind and water can lead to soil losing its structure and organic matter, so reducing the main asset of the agricultural system. Sustainable practices can reduce soil erosion.

Soil erosion is a natural process, but agricultural activity, soil type, slope, crop, wind strength and amount of rainfall can all affect the amount of soil lost. Erosion removes topsoil, reduces levels of soil organic matter, and contributes to the breakdown of soil structure, creating a less favourable environment for plant growth. In soils that have restrictions to root growth, erosion decreases rooting depth, which decreases the amount of water, air, and nutrients available to plants. Erosion removes surface soil, which often has the highest biological activity and greatest amount of soil organic matter. This causes a loss in nutrients which once removed are no longer available to support plant growth onsite, but can cause nutrient rich (eutrophic) water to the detriment of the aquatic eco-system.

The topography in the spinach growing areas is mostly flat, with some areas situated on mild slopes. The soil types in these areas show low to medium susceptibility to water and wind erosion. There is a relationship between the relative amount of exposed soil and the soil lost in a given rainfall event or over a season. **Soil cover index** (the mean soil cover over the life of the crop including any fallow period before plants start to grow) is therefore an extremely useful indicator of erosion potential.

Farmers make the best use of sloping fields, such as this one in Münsterland, Germany, by contour tillage and drilling. Working across the slope significantly reduces soil loss. Wildflower strips at strategic points in the middle of fields and along the margins also help to prevent gully and sheet erosion. Not only are these strips of benefit to native wildlife, but they add to the visual appeal of a landscape which is popular for recreation and tourism.

GOOD PRACTICE

Soil Erosion

Avoid sloping fields – where not possible till and sow across the slope

Divide field through introduction of buffer strips (i.e. grass) to reduce slope length

Ensure good soil surface structure and satisfactory levels of soil organic matter depending on soil type to increase soil infiltration capacity and stability

Soil Cover Index

Extend soil cover period prior to and following the spinach crop by:

– Growing winter cover crops

– Protecting the surface by leaving crop residues (i.e. stubble) from preceding crop as cover, increasing water infiltration rates and improving aggregate stability

– Ensuring fast spinach canopy development for early crop cover

POTENTIAL AREAS FOR IMPROVEMENT

Analyse the soil cover index in the crop rotation as an important driver in the land selection process for growing spinach

Review available soil erosion risk assessment methodologies and screen on the basis of scientific robustness, practicality and flexibility of use

Carry out soil erosion risk assessments based on soil type, slope, rainfall figures and irrigation activities to identify scope of the problem

Investigate the practicality of introducing measures such as forage crops in rotation or as permanent cover, growing winter cover crops, protecting the surface with crop residue, increasing water infiltration rates and improving aggregate stability

Create higher awareness of how to identify soil erosion and its causes (i.e. poor structure, bare soils, long slopes) with the farming community

Salad and cabbage (top) and tomatoes (above) rotation crops in Italy. There are several ways of managing crop rotation, and when farmers decide on a particular strategy they take into account how many days per year a field will be protected by the crop canopy.

NUTRIENTS

Crops need a balance of nutrients. Some, such as nitrogen, can be created locally. Others must be imported. Nutrients are lost through cropping, erosion and emissions to air. Sustainable practices can enhance locally produced nutrients and reduce losses.

Nutrient inputs are vital for most agricultural systems. Rock weathering and nitrogen fixation by legumes and free-living bacteria rarely provide enough to compensate fully for the amounts of nutrients removed with crops, even in mixed farming systems.

As a consequence, agricultural systems depend on use of fertilisers on most soils. Sustainable farming systems should maximise the nutrients that are recycled within the system and thereby minimise the quantities of imported nutrients that are necessary. Ideally, total nutrient inputs (including soil mineralisation) should be similar to nutrients exported in the harvested product plus that stored in ground vegetation, soil and spinach biomass. To achieve this, the **ratio of nutrient exports to inputs** should be carefully balanced, and the **nutrient efficiency** of the crop should be optimised.

Loss of nitrate and phosphate by surface run-off and to ground water, and phosphate loss through soil erosion, as a result of excessive inputs of inorganic fertilisers, animal manure or sewage, must be avoided.

A workshop in Latina, Italy (above), with farmers and other stakeholders plus members of the Unilever Sustainable Agriculture Advisory Board (SAAB). Andrea Granier (top), factory agricultural manager of Sagit's frozen foods factory in Cisterna, near Latina, is explaining new research into plant nutrition.

GOOD PRACTICE

Nutrient Inputs

Select and apply nitrogen, potassium and phosphorous based on the following criteria:

– Carry out soil tests before application

– Determine nitrogen, potassium and phosphorus levels available in the soil to be compared to optimum target values based on soil type and timing of application

– Choose suitable fertiliser according to the physical and chemical characteristics of soil

Ratio of Exports to Inputs (Nutrient Balance) and Nutrient Efficiency

In the case of nitrogen applications, analyse the soil for level of available nitrogen before planting and during crop growth. Where appropriate, split the total amount of nitrogen by applying at various stages throughout the cropping cycle based on the needs of the growing crop

Irrigate spinach, where appropriate, which improves the nutrient uptake efficiency

Ensure optimum growing conditions (i.e. optimum seedbed preparation and sowing, regular field inspections, weed control) to maximise nutrient efficiency

Sow a cover crop (e.g. fodder radish) after spinach to take up excess nutrients

Loss of Nitrate and Phosphate by Surface Run Off, Soil Erosion and to Ground Water

Apply nutrients according to optimum target values

Avoid water surplus due to irrational/poor irrigation practices

Avoid applying fertilisers adjacent to watercourses

Stimulate the introduction and planting of cover crops after spinach

Following spinach, recommend the cultivation of a crop that is highly dependent on nitrogen (i.e. cereals, tomatoes), climatic conditions permitting

Harvest as much of the crop canopy as possible and avoid canopies that are rejected due to poor quality

Synchronise factory-harvest and sowing schedules to avoid excess produce that cannot be processed

POTENTIAL AREAS FOR IMPROVEMENT

Make better use of farmers' and other expert knowledge on the mineralisation potential of fields in adjusting nitrogen application rates

Develop simple tools to estimate the mineralisation potential

Consider the environmental impact of selecting different types of fertiliser

Optimise rotations. i.e. by using crop models

Optimise the production of spinach (e.g. cut when smaller, plant spacing) to avoid high amounts of harvest residues

Alternative methods for nutrient analysis are being investigated

Regular water table tests for nitrate or pesticide leaching are carried out through pipes 2m deep. Here a fieldsman is taking samples to monitor the water quality beneath a spinach field.

When pesticides are applied to crops or livestock, a small but significant proportion can escape to water and air, or accumulate in foods, affecting ecosystems and human health. Sustainable practices can substitute natural controls for some pesticides, reducing dependence on synthetic substances.

Pheremone traps in Italy (top) and Germany (above) provide effective control of insect pests and are an important decision tool for the application of IPM. These and other cultural or physical control practices ensure the minimisation of the use of synthetic crop protection.

Integrated Pest Management (IPM) is key to sustainable pest control. The objective is to adopt cultural, biological, mechanical, physical or other less-hazardous strategies to minimise the use of pesticides (including fungicides, herbicides and insecticides). IPM is therefore the careful consideration of all these available pest control techniques and their subsequent integrated use to improve biological balance. This should discourage the development of pest populations whilst keeping pesticide use and other interventions to economic levels, and will also minimise risks to health and the environment.

The total amount of pesticides applied per hectare in spinach indicates a reduction as a result of IPM, but this does not take into account the hazard potential of the products used. The environmental impacts of approved pesticides for use in spinach are based on extensive toxicological, biochemical and ecological studies. In addition, a pesticide profiling system has been developed that enables a preferred list of pesticides to be drawn up on the basis of efficacy in spinach, human and environmental hazard, residue risk and consumer perception. The aim is for downward trends in the mean pesticide profile scores as older products are gradually replaced with less harmful ones, when practical and economical alternatives are available.

THOMAS KLUG

Treated seeds (above) are used to avoid the use of leaf pesticides which then only need to be applied under the very rare circumstances of extreme contamination.

The caterpillars (left) of *Autographa gamma* (the silver Y moth), the main insect pests in German spinach crops, are a most unwelcome ingredient in the finished product. A research programme uses pheromone traps to monitor populations of adult *A.gamma* males to determine the correlations between the number of trapped male moths against the number of counted caterpillars in a given area, with the aim of developing a precise forecasting tool. With such a tool it might be easier to time bio-insecticide applications to coincide with the emergence of the caterpillars.

GOOD PRACTICE

Arthropod Pests and Fungal Diseases

Field manuals must include detailed methodologies for management of the pests and diseases in the area with emphasis on cultural controls

Key elements of the IPM system in spinach include:

– Consideration of all possible pests and whether any control is necessary or justifiable

– Disease tolerant and resistant crop varieties should be used where possible

– Use of routine cultural and physical controls (such as destruction of breeding sites and maintaining good ground cover)

– Development of census systems for the main pests, founded on knowledge of life cycles and natural enemies

– Regular monitoring, either by field scouting or the use of pheromone traps should be used for key insect pests to allow informed decision making

– Where cultural control is not possible, pesticide application decisions must be made on the basis of economic justification and action thresholds for pests, which are likely to impact on yield or quality

– Establishment of action (damage) thresholds for the main pests, based on economic damage levels

– Avoid preventative use of pesticides where possible, with the exception of seed treatments

– If pesticide use is necessary, selectivity is important to reduce eco-balance disruption and ensure operator safety

– Seed treatments are used to avoid the need for foliar pesticides, which should only be used in exceptional circumstances

Weed Control

Prepare seed bed as early as possible in order to germinate the weeds and then selectively remove problems weeds before drilling

Remove weeds (i.e. through mowing or cutting) before they set seed

Use mechanical and/or manual weed control when economically viable

In case of control of tenacious weeds (e.g. *Veronica* spp. and *Cuscuta* spp.), rotational control (during other crops in the rotation) should be considered

Product choice should be made on the basis of weed species, timing, soil type, weather conditions, crop health and previous application history

Practice spot spraying with accurate targeting of the weeds

Post-emergence herbicides should be applied only occasionally, as early as possible after drilling

Pesticide Use

Issue a list of permitted pesticides

– based on their efficacy and hazard (human and environmental) profile in relation to the field and weather conditions in which they are to be used (soil type, drainage, leaching potential, rainfall etc.)

– to be reviewed on an annual basis to include any newly registered products or new information relating to older products

– pesticides used are restricted to those on the permitted list

Accurate records must be kept of pesticide use (including date, field, crop, amount, and pesticide/product name)

Pesticide should be selected from the permitted list with regard to their efficacy and hazard (human and environmental) profile in relation to the field and weather conditions in which they are to be used (soil type, drainage, leaching potential, rainfall etc.). Company agronomists and farm managers must be able to justify the use of each pesticide

Ensure pesticide harvest intervals (time between application and harvest) are strictly adhered to – failure to do so will lead to crop rejection

Spray applications must comply with the statutory conditions of use on the label

Ensure safety measures are followed with respect to pesticide handling and use, including appropriate storage, mixing, cleaning and waste handling facilities and the correct use of appropriate personal protective equipment (PPE)

Label nozzle recommendations in relation to spray quality should be followed. Consider using low drift spray equipment wherever possible

All applications must be made by a suitably qualified operator

Spray equipment used should be well maintained and accurately calibrated

Consider the protection of appropriate buffer zones around water bodies, habitats of particular wildlife importance and buildings, especially dwellings and places of work, schools, etc

POTENTIAL AREAS FOR IMPROVEMENT

Promote research on biological control agents (predators, parasites, bio-fungicides, pheromones etc.) as IPM tools. Where research findings are encouraging, incorporate their systems into management practices and evaluate their effectiveness and consequences for pest management and the wider environment

Develop and test mechanical means of weed control as an alternative to herbicides

Improve Low Dosing System (LDS) technique based on split applications.

Investigate the use of insecticide seed treatments to replace post-emergence insecticides

Fine-tuning, testing and further development of IPM strategies for certain pests

Create better awareness of the effects of farmyard pesticide losses (filling and cleaning of sprayer, disposal of empty packages), even if amounts are small

Promote the registration of new active ingredients for spinach to replace old ones

Thomas Klug, a research scientist with the University of Hanover, counting pitfall traps in a spinach field to gather information about beneficial wildlife, especially carabids and spiders. The information will be helpful in indicating how wildlife populations are affected by different plant protection strategies.

NEW DEVELOPMENTS IN BIOLOGICAL CATERPILLAR CONTROL

Iglo has commissioned a three-year research programme with the University of Hanover to find new methods of biological controls to combat pests and diseases. An area of this research with promising preliminary results concerns moth pests.

One way of overcoming moth pest species, particularly *Autographa gamma* (silver Y moth), without using insecticide applications is being researched using the egg parasitoids of the genus *Trichogramma*. Egg parasitoids are already successfully used against other moth pest species in maize crops.

The females of the tiny (1mm) hymenopteran species lay their eggs into the eggs of the target moth pest. Their offspring develop inside the host eggs, eventually killing their host, and thus prevent the development of any pest caterpillars. Researchers are currently trying to find suitable strains of these parasitoids to target the eggs of spinach moth pests, especially *A.gamma*.

One approach has been developed by the company AMW-Nützlinge GmbH. Their 'Tricho-balls™' are filled with parasitized eggs of a mass-rearing host of the Trichogrammatid species. The balls are placed on trial spinach fields where the tiny Trichogrammatids eventually emerge from their host eggs. The females instinctively search the spinach plants to find the eggs of the target pest (*A.gamma*) in order to lay their own eggs, which in turn will kill the target pest. In this way no caterpillar infestation occurs, and no insecticides are needed to achieve a clean crop. Research is on-going throughout 2003.

ALL IMAGES THOMAS KLUG

Setting traps to catch *Autographa gamma* (the silver Y moth). Male moths are seduced into a sex pheromone funnel-trap (left). But scientists are also researching techniques which prevent the eggs of *A. gamma* from hatching in the first place. A Tricho-ball™ (top) is filled with thousands of parasitized eggs of the mass-rearing host of *Trichogramma* egg parasitoids. When these eggs hatch the females (above) immediately seek the eggs of *A. gamma* as an ideal host for their own eggs, with the result that the eggs of *A. gamma* never have a chance to develop, hatch or lay eggs which would turn into spinach-eating caterpillars.

BIODIVERSITY

The diversity of biological systems (biodiversity) can be improved or reduced by agricultural practices. Sustainable agricultural practices can help improve biodiversity – eg by 'greening the middle' of fields as well as 'greening the edge'.

Certain plant and animal species, which form a natural part of the arable ecosystem, are important indicators of the health of that ecosystem and of changes occurring within it. These indicators show the total impact of a range of factors in that environment.
It is important to understand what flora and fauna species are present, at what densities and how management practices might affect these species, especially in relation to **whole farm habitat quality and management**. The areas on a farm managed as 'natural' habitat include field margins, uncultivated areas, hedges and waterways. These habitats provide a diverse and stable environment to a range of both beneficial (i.e. predators and parasitoids) and pest species.

In Germany and Italy, spinach contributes to the rotational diversity of most farms. However, most spinach fields are of relatively low habitat value with flora and fauna consisting of ubiquitous species also found in other intensive arable crops.

A single strip of native wildflowers alongside spinach fields or even in the middle of them not only improves habitat quality for wildlife but helps provide a buffer zone to nearby water courses. It also dramatically enhances the appearance of farmland as an integral part of the landscape.

GOOD PRACTICE

Plant and Animal Species Diversity

Create and improve suitable areas for wildlife habitat:

– Enhance farmers' awareness of valuable elements (i.e. conservation) and potential benefits (i.e. pollination, biological pest control) of improving habitat quality

– Undertake baseline studies of habitat types and landscape elements on the farm, including recommendations on how to maintain and improve valuable elements

– Ensure that riparian strips are maintained and dominated by native species. Link wildlife habitats wherever possible through corridors and riparian strips

– Encourage the conservation and planting of native trees in the growing areas without affecting other agricultural activities

– Enhance the farm environment for locally important, rare or endangered species by providing appropriate habitats and adopting the right cultural practices, including avoiding pesticide damage to beneficial flora and fauna

– Consider creating suitable biodiversity habitat as permanent features in areas of low productivity

Adhere to Integrated Pest Management principles

Always use buffer zones alongside water bodies to prevent pollution

Minimise losses of nutrients to the environment

POTENTIAL AREAS FOR IMPROVEMENT

Work with local initiatives to encourage biodiversity

Adopt conservation measures for rare or endangered species that use farmland as a habitat

Encourage biodiversity census activities and identify 'keystone species' in the spinach growing areas

Clearly establish the economics of cultivation of marginal areas (steep slopes, shallow soils, low pH areas and poorly drained land) and convert non-profitable areas to wildlife conservation zones

Define the management of these marginal areas in order to enhance the presence of beneficial flora and fauna, whilst avoiding negative effects on the cultivated area

Promote research on the establishment and management of permanent grass and wildflower margins and communicate results to farmer network

Further develop margin management strategies for flowering herb mixtures (margin strips, set aside areas) to control weed invasion and propagation

Investigate the introduction and value of environmental audits for the whole farm to be completed by all farmers in which targets for improvement are agreed

Develop awareness and consensus on the biodiversity issue within the farmer community through introduction of social learning tools

Certain species in any particular habitat provide valuable information on the health of the environment. In Italian spinach growing areas biodiversity is studied through the presence of amphibian species living in the canals around the fields. Birds, like barn-owls (above), will also be monitored because they are considered a biological indicator of environmental health. In Germany recommendations are made with the aim of achieving a diverse landscape that can support a wide variety of species. Wildlife corridors are especially encouraged.

PRODUCT VALUE

Product value is a measure of the desired outputs of an agricultural system. Sustainable practices should at least maintain or strive to improve product value.

Sustainable spinach production must be productive, competitive and efficient. Product value is determined by the combination of spinach **yield per hectare** and **product quality**.

Quality of the final product includes both tangible (taste, colour, appearance etc.) and perceived quality of the final product. The latter refers to consumer concerns about food safety, environmental performance and social responsibility, which must be satisfied. This is related to measures such as the number of consumer complaints, which are directly linked to the number of contaminants in the final product.

Yield per hectare is used as a measure of the economic sustainability of spinach, since yield should be maintained or improved where possible. Yield also has a direct impact on other sustainability indicators when expressed per tonne of finished product.

A healthy spinach plant (above) before it was harvested (below) and transported to the factory for processing. Taste, colour and appearance are one aspect of consumer expectations. Increasingly consumers also want to be convinced that their food is produced in a sustainable way.

GOOD PRACTICE

Product Quality

Use Hazard Analysis and Critical Control Points (HACCP) system in spinach processing to select and manage fields in order to avoid any contamination of the product including:

– Pre-processing product control (factory) on pesticide residues, nitrate levels, foreign bodies, leaf-stem ratio, and yellow leaves based on clear raw material specifications

– Additional testing for microbiological contaminants and heavy metals

– Stipulate use of fast decay active ingredients and stay within the recommended harvest interval – 100% of crop monitored for pesticide residue before harvest

– Reject produce and/or stop harvesting if spinach does not meet standards

– No use of organic fertilisers on spinach crop due to hygiene

Set targets for pesticide residues below legal Maximum Residue Levels (MRLs) with the aim to achieve zero detectable pesticide residue in the final product in the long-term

Optimise transportation times and container filling

Yield per Hectare

Select growing areas based on suitability for growing spinach to ensure high yield per hectare combined with reduced input levels

Select growers for their ability to produce good yields and high quality crops, and support the 'growers group' approach in this process

Provide good up-to-date technical advice to enable growers to get the best from the crop

Harvesting efficiency is important in maximising product value

POTENTIAL AREAS FOR IMPROVEMENT

Develop automatic detection and cleaning systems for foreign body detection on harvesting machines

Develop a system to produce high quality 'second cut' leaf spinach from each field to improve yield per hectare

Evaluate the use of nitrate content in the finished product as an additional parameter

One of the main advantages of frozen vegetables compared to fresh produce is that nutritional and quality characteristics can be fixed at the moment of freezing and kept in this state for several months.

ENERGY

Although energy from sunlight is essential for growth, the energy balance of agricultural systems depends on additional energy, from non-renewable sources to power machinery. Sustainable practices can improve the balance of energy, ensuring there is more coming out than going in.

In spinach production the greatest amount of direct energy consumption is in the harvesting operation, an area where there is still much work to do to find ways of reducing dependence on non-renewable resources. Harvesters are continually being customised by Unilever technicians to make improvements. Here customised harvesters are being worked in Germany (top) and Italy (above).

The **efficient use of renewable resources** should be targeted since the use of non-renewable sources, such as fossil fuel, is not sustainable in the long term. Energy use is a measure of resource consumption and is related to environmental impacts such as **greenhouse gas emissions** and acidification.

A Life Cycle Assessment (LCA) of spinach quantifies the contribution of agricultural activities to total energy used and emission levels of the total life cycle – from 'field to fork'. The dominant indirect energy input in spinach is related to fertiliser production, while a major component of direct energy use is the harvesting operation. The energy balance is a key measure relating metabolisable energy with energy inputs to produce the crop. Agriculture also generates waste. The 'farm waste ratio' looks at the amount of waste used, recycled and/or disposed of safely in relation to total farm waste.

GOOD PRACTICE

Efficiency and the Use of Renewable Resources

Minimise use of fossil fuel for power generation i.e.:

– Optimise field operations

– Careful selection of equipment

– Ensuring good maintenance practices

Minimise the input of synthetic fertilisers

Investigate and test alternative practices for re-use, recycling and/or safe disposal of waste incurred as a result of growing spinach

Review practicality of best current waste re-use, recycling and disposal technologies available

Greenhouse Gas Emissions

Optimise nitrogen balance (nitrogen input minus output) to reduce nitrous oxide losses

Ensure sufficiently aerated soil to minimise denitrification through application of a soil compaction strategy and using small-dose irrigation

Minimise tillage intensity and depth to maintain and/or improve level of soil organic carbon

Optimise fossil fuel consumption during field operations through:

– reduction of tillage depth, choice of machinery and driving technique

– regular monitoring of soil moisture levels – to inform/adjust irrigation strategy

POTENTIAL AREAS FOR IMPROVEMENT

Further work on more detailed energy audits to review the baseline

Investigate energy requirements in relation to harvest strategies and energy efficiency of harvesters

Long-term strategy for use of plant oil for fuel and lubrication of tractors

Develop the potential for generation of renewable energy sources, including the bio-gas initiative which has been initiated to use factory organic wastes for energy production, and, where practical, develop hydro-electricity or wind-power schemes

Investigate alternative practices for recycling and waste disposal, especially for plastic

Review fertiliser application scheme to reduce gaseous losses

Instigate co-operation with fertiliser manufacturers to promote use of renewable energy sources and create a list of 'preferred fertiliser suppliers'

The exploitation of various types of renewable energy sources throughout the life cycle of spinach production is an important area for further research and development in the future.

WATER

Irrigation and other practices can lead to pollution of ground and surface water with pesticides, nutrients or soil. Sustainable practices target inputs and reduce losses.

All aspects of 'water' are important in that water itself is a critical renewable resource for all agricultural production. Responsible use and management of water (i.e. irrigation) supplies is fundamental to the sustainability of not only agriculture, but also human health and social development. Water plays an important role in the environment's ability to 'self-purify'. The quantity of water used for **irrigation** is a useful direct measure to assess water consumption. Irrigation is indispensable in spinach production due to the shallow root system of spinach plants. Irrigation volume and scheduling need to be controlled carefully even in rain-fed areas. When water is a scarce resource, **water harvesting** is important in securing the **sustainability of water supply**.

The notably pure water of the river flowing through Ninfa near Latina (above) creates a unique oasis of flora and fauna which is well known in Italy. The water then runs on through the canals of Latina's spinach growing areas. In Münsterland (left) regular, controlled irrigation of fields is necessary for the production of healthy spinach.

GOOD PRACTICE

Irrigation

Ensure the amount of water applied does not exceed the remaining water capacity of soils at the moisture level triggering irrigation

Regular maintenance of the irrigation equipment

Ensure that refuelling and lubrication operations for pumping equipment do not pollute watercourses

Where necessary, monitor the quality of irrigation water. Water harvested from agricultural or industrial areas may have effects on soil nutrient retention and release equilibrium, and there may also be toxicity effects from pollutants

Keep irrigation records of water usage and timing, and measure water consumption

Irrigation should preferably be done at night wherever practical and dry or windy days should be avoided

Where appropriate, support farmers' irrigation knowledge and practices with a modelling system to assist in optimising the use of irrigation water

Water Harvesting and the Sustainability of Water Supply

Ensure water-harvesting operations are not at the expense of other users downstream

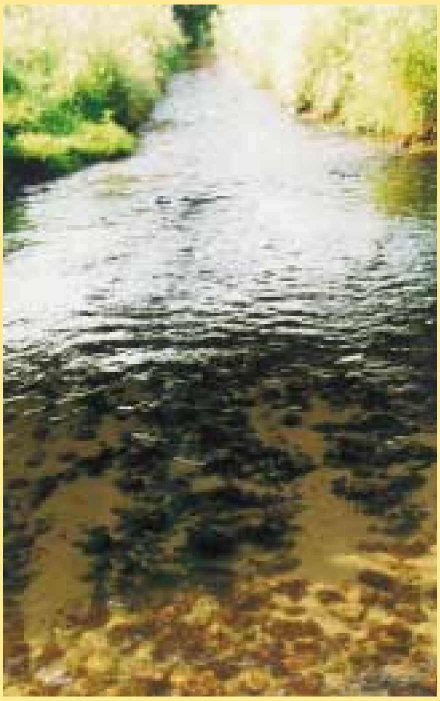
Maintain in-field dams and water catchment areas (i.e. reservoirs)

Choose appropriate water harvesting method. Water may be stored:

– In the soil profile (deep soils with high organic matter have particularly high capacities to store water)

– By the local geological structure providing that storage systems are fully replenished every year during the rainy season

– In small dams or reservoirs which do not fundamentally alter catchment characteristics



POTENTIAL AREAS FOR IMPROVEMENT

Regular checks on irrigation scheduling performance on spinach farms and, if possible, use the pilot project farms as a benchmark

Base land selection for spinach growing on area where the need for irrigation is reduced

Testing irrigation water quality (above left) for nitrate and salinity content is an important tool for improving agricultural practices in southern Italy. The water quality of streams in Germany (above) is also regularly tested as part of the farmers' good practices improvement programme.

SOCIAL AND HUMAN CAPITAL

The challenge of using natural resources sustainably is fundamentally a social one, requiring collective action, the sharing of new knowledge and continuous innovation. Sustainable practices can improve social and human capital. The prime responsibility should remain with the local community.

Good **relationships** with the workforce, local community, suppliers, customers and government are vital for the long-term sustainability of any business. These relationships reflect the degree of trust within and between social units (individuals and/or groups) and are often referred to as **social capital**.

Human capital entails the capacity of people to earn and sustain a livelihood (including health, nutrition, education and training). Well-trained, knowledgeable, and responsible farmers now and in future form the most important asset for the spinach business. Social and human capital forms the basis for innovation, building confidence and creating trust.

Two second-generation Iglo spinach farmers, Thomas Föing and Bernhard Icking-Haselhoff, both of whom are members of the Iglo pilot project, discuss the workings of a new mechanical hoeing machine with Iglo horticulturalist Hansjörg Komnik. Very regular contact is part of the successful working relationship Iglo enjoys with its suppliers, and helps to produce continuous improvements.

GOOD PRACTICE

Relationships (social capital)

Continue to build trust and confidence between the company and the farmers through:

– Use of long term contracts which offer financial security to growers

– Striving to be a good customer, citizen and supplier – pay and supply on time and at the agreed price

– Company agronomists (fieldsmen) ensuring close contact between the factory and the individual farmers

– Stimulate and provide assistance to farmers to group together to obtain bulk discounts for inputs such as fertiliser or equipment. Farmer groups will also find it easier than individuals to gather and share information on subsidies, tax and agronomic benefits

Stimulate farmers' participation in the Sustainable Agriculture initiative; and make joint decisions with the farmers' organisations whenever possible, such as discussing good practice guidelines

Provide further structure and facilities for farmer participation through:

– Negotiation of prices and contract conditions between a farmer' group representative (i.e. board of farmers' organisation) and the company

– Providing farmers with the ability to secure their production sites based on a profitable and mutually beneficial relationship with the operating company

– Establishing communication links through periodical farmer meetings and factory/research site visits

Link with other stakeholders by:

– Maintaining good relationships with local government and others in the local community

– Develop links with schools and school programmes to educate through visits, talks, and literature

– Facilitate interaction between consumers and producers

Human capital

Provide educational/training opportunities for farmer and other interested groups in key aspects of sustainable spinach production

Ideas boards are a valuable outcome of workshops for farmers and other stakeholders in the supply chain. Regular meetings between those in the supply chain are part of good working relationships, and lead to a culture of continuous improvements in all areas.

POTENTIAL AREAS FOR IMPROVEMENT

Continue to develop useful and appropriate parameters for social and human capital

Development of a 'Farmers' Forum' with representation from all growing areas to enable and stimulate grower empowerment in decision making about the sustainability of the spinach business

Farmer groups may consider, and be supported in, developing partnerships with government to address commonly shared threats and opportunities, and to support public services

Stimulate and improve relationships between farmers and consumers, and between farmers and local communities

LOCAL ECONOMY

Sourcing agricultural inputs locally helps sustain businesses, livelihoods and communities. Sustainable practices maximise use of local resources to increase efficiency.

Rural communities are dependent on sustainable local agriculture. Farming and other businesses can help build and sustain these communities by buying and **resourcing locally**. The production of spinach provides farmers with an additional income source, and it also provides work and income to the local community. This is reflected by the amount of money spent to source goods (including raw materials) and services.

GOOD PRACTICE

Local resourcing

- Use local suppliers wherever practical (based on availability, reliability and cost)
- Use local farmers as much as possible (based on reliability and consistency in performance – yield and quality of spinach crop)

POTENTIAL AREAS FOR IMPROVEMENT

- Continue to develop useful and appropriate measurements for local economy
- Consider working with local communities to develop businesses that reduce the need to import goods and services (for the farm) from further afield

Farmers, fieldsmen and harvester drivers together in a Latina field (above). Spinach is also grown in the Foggia region in the dry weather between December and February. Foggia plays an important role in the entire Sagit spinach supply chain as it is the only area in Italy where it is possible to grow spinach during winter. The winter spinach crop makes a key contribution to the health of Foggia's economy.

Iglo opens its doors to visitors (left). More than 100 farmers supply the factory in Reken, north-west Germany. Iglo offers a guided tour of selected farms, fields and the factory – including a special spinach tasting session. In an additional package arranged in cooperation with the local tourist board and hotels and restaurants people can enjoy a weekend including a guided cycle tour and cooking course.

THE FARMERS' VIEW

Amedeo Subiaco and his son Graziano, have been supplying spinach to Sagit for only two years. Amedeo says: "We feel proud to work for Sagit. Within our farming community those who have the opportunity of working for Sagit belong to a select group which puts us among the best. A significant part of our family income is now from spinach which is why we enthusiastically decided to apply the new practices and support the project locally".

Piero Pozzi (left) and Sagit fieldsman Santino Ponzani (right), two farmers who supply Sagit with spinach. Santino recently replaced Piero as Sagit fieldsman. Piero says: "To be both fieldsman and farmer puts me in a favourable position to communicate the new concept of sustainability in an effective way. I can easily transfer the findings of the pilot farms trials to my colleagues. I already see the positive effects of regular and consistent communication in Santino".

Thomas Föing from Borken (seen left with fieldsman Hansjörg Komnik and colleagues Bernhard Icking-Haselhoff and Bernherd Droste) is one of the five Iglo pilot farmers. He works 60ha of arable land with his father and one employee. Besides spinach, herbs and other vegetables for Iglo, the arable rotation includes cereals, maize, potatoes and sugar beet. Thomas is aware of the area's long agricultural tradition and believes that sustainability is key to successful farming. "To us farmers, sustainable agriculture means securing our existence. This is why we want to work with nature, not against it", he says.

Bernhard Droste from Reken and his father before him have supplied spinach and fine herbs to Iglo since the early 1960s. Besides extensive woodlands, Bernhard's farm encompasses 56ha of arable and grassland which supports a dairy herd. Like Thomas Föing, he is committed to sustainable farming practices, and takes up the challenge when it comes to experimenting with new practices or implementing improved techniques.

"This sustainability programme gives us the opportunity to underpin our experience with hard facts and numbers. That also helps us to understand our production systems better and to further optimise our practices," Bernard says.

GLOSSARY OF TERMS

Biodiversity – There are two aspects to biodiversity: the first is the diversity of wild floral and faunal species on and around a spinach field and up to landscape scale. The second is the genetic diversity in the spinach crop grown on a world scale

Carbon sequestration – The process by which atmospheric carbon dioxide is converted to organic carbon by vegetation or soil micro-organisms

Greenhouse effect – The rise in global temperature caused by certain gases in the atmosphere (e.g. carbon dioxide) trapping energy from the sun

Integrated Farm Management (IFM) – A whole farm policy encompassing crop and animal husbandry, which provides the basis for efficient and profitable production which is economically viable and environmentally responsible. IFM integrates beneficial natural processes into modern farming practices using advanced technology. It aims to minimise environmental risks while conserving, enhancing and recreating that which is of environmental importance

Integrated Pest Management (IPM) – A sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimises economic, health and environmental risks

Pesticide – A chemical used to control invertebrates such as insects, mites, slugs and snails, nematodes etc., weeds, plant diseases and vertebrate pests

Soil organic carbon – The carbon content as a proportion of organic matter in the soil; % organic carbon x 1.7 indicates the % of total organic matter.

CREDITS

PROJECT PARTNERS: GERMANY

Iglo Contract Farmers' organisation
Chamber of Agriculture Westfalen-Lippe (Agriculture Extention Service)
University of Hannover, Institute for Vegetable and Fruit Science and Institute for Plant Diseases and Plant Protection
University of Applied Sciences Fachhochschule Südwestfalen
Biodiversity Research Station Zwillbrock
Trifolio (biological pest control products)
TerrAquat (soil, water, and nutrient consultancy)
ccgis (GIS consultant and programming)
County Borken Local Government
IGZ (research institute for plant growth and mildew epidemiology modelling)
Regional Water Supply company RWW

PROJECT PARTNERS: ITALY

Growers' trade unions and organisations: ColDiretti, ConfAgricoltura, CIA
Local Water Consortium
Growers' suppliers: Ricci Agricoltura and Agriprogress
Universities and Research Institutes: University of Perugia, University of Piacenza, University of Ancona, ISNP (Plant Nutrition Institute), ISMA (Experimental Institute for the Agricultural Machinery), ISPaVe (Plant Pathology Institute),
FiBL Switzerland (Forschungsinstitut für biologischen Landbau)
Key pea (and other vegetable) suppliers: EQT Sweden, Marollo
Local Government institutions: Lazio County
Specialised media: Informatore Agrario

Text
Andrea Granier
Thomas Klug
Jos van Oostrum
Volker Schick
Christof Walter

Editorial consultant
Juliet Walker

Design
Red Letter Design, London

Photographs

Printing
Scanplus, London

FURTHER READING

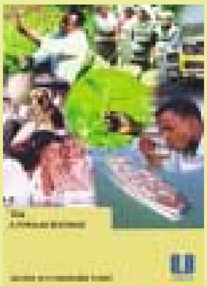
UNILEVER SUSTAINABILITY INITIATIVES

Growing for the Future II
Unilever and Sustainable Agriculture (2002)

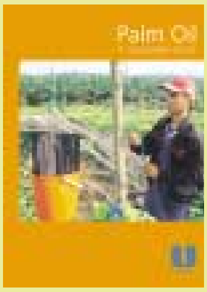
Fishing for the Future
Unilever's Sustainable Fisheries Initiative (2002)

Our Everyday Needs
Unilever's Water Care Initiative (2001)

UNILEVER SUSTAINABLE AGRICULTURE INITIATIVES

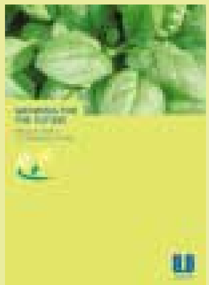


Tea – A Popular Beverage
Journey to a Sustainable Future (2002)



Palm Oil
A Sustainable Future (2001)

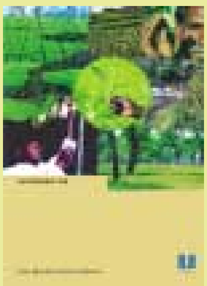
In Pursuit of the Sustainable Pea
Forum for the Future in collaboration with Birds Eye (2002)



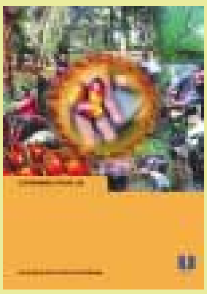
***Growing for the Future**
Spinach: For A Sustainable Future (2003)

• Growing for the Future
Tomatoes: For A Sustainable Future (2003)

GOOD AGRICULTURAL PRACTICE GUIDELINES



Sustainable Tea
Good Agricultural Practice Guidelines (2002)



Sustainable Palm Oil
Good Agricultural Practice Guidelines (2003)

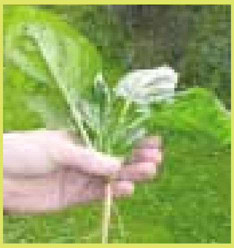
***Sustainable Vining Peas**
Good Agricultural Practice Guidelines (2003)

***Sustainable Spinach**
Good Agricultural Practice Guidelines (2003)

• Sustainable Tomatoes
Good Agricultural Practice Guidelines (2003)

Copies of these publications and further background on Unilever and sustainability, the environment and social responsibility can be obtained from **www.unilever.com** (click link for environment & society) or can be requested by email on **sustainable.agriculture@unilever.com**. For specific information on the Unilever Sustainable Agriculture Initiative visit **www.growingforthefuture.com**.

*Available in English, German and Italian •Available in Portuguese (2004)



"Unilever is committed to making continuous improvements in the management of our environmental impact and to the longer-term goal of developing a sustainable business. Unilever will work in partnership with others to promote environmental care, increase understanding of environmental issues and disseminate good practice."

Antony Burgmans and Niall FitzGerald, Chairmen of Unilever.

Unilever

sustainable.agriculture@unilever.com

www.unilever.com

SSG/RLD/SP/1000/0703