











# SUSTAINABLE TOMATOES

GOOD AGRICULTURAL  
PRACTICE GUIDELINES



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Note: 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

This guide has been developed under the Unilever Sustainable Agriculture Initiative to support sustainable management practices for the production of processing tomatoes.



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**

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). These 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 management teams of Unilever tomato processing operations and for communication with other tomato processors and tomato product suppliers. A complementary guide for agronomists and farmers growing tomatoes should be developed for each individual region in close consultation with the farming community.

We value our relationships with growers, their knowledge base and capacity to innovate, which are all key to a successful development and implementation of the

good agricultural practice guidelines. These guidelines are supported by other documents relating to the management system which cover the full tomato life cycle from detailed agronomy aimed at tomato processors, company agronomists and growers, to the finished product. This document forms the basis for continuous improvement and development of good agricultural practices. These include 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 guidelines are welcome and may be sent to:

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# 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. 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 manures and compost, and incorporation of crop residues and/or cover crops in the **crop rotation**. Long term deterioration in soil structure and fertility may result from **soil compaction**, particularly under mechanisation. Deterioration in soil fertility may result from changes in soil structure, **soil pH** and soil nutrient status, or from build-up of **salinity**, a possible side effect of irrigation.

Various **soil fauna species** are excellent indicators of soil health. Earthworms are important in maintaining soil structure, aeration, nutrient cycling, drainage and in breaking down organic matter for incorporation into the soil profile. Earthworms also stimulate microbial activity, mix and aggregate soil, increase infiltration rates and water-holding capacities. Carabid beetles are intra- and supra-soil dwellers and are important predators of insect pests. Soil micro-organisms (bacteria, fungi, protozoa) are also important in the context of soil health as indicators of the innate fertility of the soil and its suitability for growing tomatoes.



Checking the earthworm population (top and above right). Large earthworm populations help to maintain soil structure and aeration, nutrient cycling and drainage, as well as breaking down organic matter. Other local fauna species, such as carabid beetles, are useful indicators too.

Monitoring the moisture content (right), and levels of soil compaction (left) also indicates the health and resilience of the soil. In Australia tomato growers face not only persistent drought but salinity (above left) as water tables rise due to changes in catchment water balance.

## GOOD PRACTICE

### Soil Type

- Avoid light, sandy and heavy clay soils
- Promote appropriate tillage procedures to encourage root growth when severely restricted

### Organic Matter (OM)

- Conduct regular field soil testing for organic matter – every four years as a minimum
- Advise growers to improve or compensate organic matter losses in 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
  - Incorporating previous crop residue (e.g. tomato trash, cereal straw) into soil and promote practices to incorporate residues into the soil profile
  - Encouraging improved crop rotation strategies and green manuring through introduction of cover crops before and/or following the tomato crop
- Promote appropriate soil cultivation techniques to conserve soil health, build organic matter and reduce tillage-induced gaseous losses to the atmosphere

### Crop Rotation

- For an optimal crop rotation, the following points need to be considered:
  - Selection of crops that provide an economic return
  - Consideration of all crop management factors. For example, one crop may provide a lower direct return per unit of area than the alternate crop, but may also lower management costs for the alternate crop (e.g. by reducing weed pressure, and thus avoiding tillage and/or application of herbicides), with an overall net increase in profit
  - Keep tillage intensive crops in the rotation to a minimum

- Avoid planting other solanaceous crops such as potato, peppers and eggplant in a rotation with tomatoes
- The need for crop-specific equipment

### Soil pH

- Tomatoes require a pH between 5.0 and 6.5 for good sustainable growth:
  - If soils are too acidic (pH below 5) advise on using good quality liming material where available. Recommended rates should be obtained from local research or extension services
- Dissuade growers from planting tomato crops on fields with pH above 7.5 as this significantly increases mineral deficiencies (such as zinc)

### Soil Compaction

- Stipulate regular visual, qualitative soil structure assessments through training seminars for growers to alleviate soil compaction. Field compaction checks can be made using a simple penetrometer or solid metal probe
- Avoid soil compaction through:
  - Minimising the number of in-field machine passes and using wide machinery where possible to minimise the impact of a single operation
  - Ensuring vehicle traffic and tillage operations are conducted when the soil is at appropriate moisture content. Avoid traffic when the field is too moist
  - Ensuring land is adequately drained
  - Using sub-soiling or deep ripping in appropriate conditions where compaction appears to be a problem
  - Using tracked vehicles or low ground pressure tyres. Adjust tyre pressures for all field operations to suit field conditions
  - Advise on reducing longer-term degradation by providing well-formed, well-drained and stable tracks and roads (grass or tarmac)

### Soil Fauna

- Earthworm activity (presence and numbers) should be monitored as an indicator of soil health

- Regular soil testing for presence of soil borne diseases (i.e. root-knot nematode) combined with advice on corrective measures when necessary
- Retain crop residues in the field
- Where available, use organic fertilisers and soil improvers
- Use pest action thresholds to reduce number of pesticide sprays
- Avoid the use of broad-spectrum insecticides and soil fumigants wherever possible
- Use cultural methods of pest and weed control wherever possible

### Salinity

- Regularly monitor irrigation water quality for sodium, magnesium and chloride levels
- Monitor ground water table depth and quality in situations where rising ground water tables have the potential to move salt from depth into the crop root zone of the soil
- Minimise losses of water below the crop root zone where ground water tables are rising and have the potential to increase soil salinity

### POTENTIAL AREAS FOR IMPROVEMENT

- Support growers to establish appropriate and viable crop rotations
- Review current field cultivation strategies with the aim of reducing further the number of machinery passes
- Further research on:
  - The correlation between organic carbon levels and other soil quality parameters like microbial activity and earthworm biomass, and between OM and yield for local soils and conditions
  - The influence of vegetation cover, biomass return, pesticide and fertiliser use on soil health
  - The perceived link between retaining tomato vines in the field after harvest and subsequent soil borne diseases and pests

# SOIL LOSS



Erosion by wind and water can lead to the loss of valuable top soil, thereby reducing the main asset of the agricultural system. Sustainable practices can reduce soil erosion.



Soils form over very long periods of time as a result of weathering, reworking and reorganisation of the upper layers of the earth's crust. Soil erosion is a natural process, but agricultural activity, soil type, slope, crop, wind and amount or intensity of rainfall can all affect the amount of soil lost. Erosion removes topsoil, reduces levels of soil organic matter and nutrients, 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 depths, which in turn decreases the amount of water, air, and nutrients available to plant roots. Erosion removes surface soil, which often has the highest biological activity and greatest amount of soil organic matter. It also results in loss of nutrients which once removed are no longer available to support plant growth on site. Soil removed by water erosion often ends up in streams and rivers, which may also be detrimental to the health of aquatic ecosystems.

Soil erosion in tomato growing areas – consisting of both **water erosion** and **wind erosion** – is a factor not only on light soils on sloping land but also on some land previously classified in 'low risk' erosion categories. There is a linear relationship between the relative amount of exposed soil and the soil lost during rainfall or over a season. **Soil cover index** (the average 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.

**Soil loss during mechanical harvesting operations** not only removes fertile soil, but also presents a problem during processing and is an undesirable waste stream for tomato factories. **Minimum tillage systems** can, where appropriate, contribute to erosion prevention.



The effective prevention of soil loss depends on careful attention to the particular characteristics of a field, or areas within a field. Two examples here from Brazil: the sloping ground has been terraced to help avoid erosion (top). A 'minimum tillage' approach (above) where only the surface layers of soil are prepared for planting the following crop, is an important contribution in helping to stem soil erosion by wind and rain. Additionally, a reduced number of machine passes over a field is also helpful in preventing the loss of fertile topsoil.

## GOOD PRACTICE

### Water Erosion

- Avoid cultivating steeply sloping fields
- On sloping fields follow contours with operations for soil preparation where possible
- Encourage construction of contour banks to arrest run-off

### Wind Erosion

- Light soils are more vulnerable to wind erosion and should be permanently covered or left rough after ploughing wherever possible
- Tree shelter belts and field margins should be constructed to protect highly vulnerable fields

### Soil Loss During Harvesting

- Advise growers on proper tomato bed preparation, cultivation during the season and harvest techniques to minimise soil removal

### Soil Cover

- Keep the soil covered as long as possible using an economically viable crop rotation
- Develop management systems to achieve a greater crop cover as early as possible in the life of the crop
- Avoid dusty pathways through control of soil moisture levels

### Minimum Tillage Systems

- Promote minimum tillage systems in appropriate conditions to help prevent erosion and to preserve soil structure
- Use suitable mulches if available

## POTENTIAL AREAS FOR IMPROVEMENT

- Increase awareness with the farming community of how to identify soil erosion and its causes (i.e. poor structure, bare soils, long slopes)
- Further work on soil erosion risk based on soil type, slope, rainfall sequence, and irrigation activities to identify scope of any field problem, and possible links with soil compaction risks
- Review cultural practices with growers to reduce soil erosion and amounts of soil delivered to the processing plant
- Investigate the effect of current nitrogen and phosphorous fertilisation practices on minimum tillage systems
- Identify potential for practices to increase soil cover (and therefore reduce water erosion) including:
  - forage crops in the rotation or as permanent cover
  - winter cover crops
  - protecting the surface with crop residue
  - improving aggregate stability



An example of bad soil erosion on sloping land (top) as a result of poor management. Leaving the soil bare in this way encourages loss of topsoil, including nutrients and water.

In Australia most tomato farms are on relatively flat landscapes so erosion from run-off surface water is minimal, although dust storms (middle) can be equally devastating to soil quality. The best way to counter wind erosion is by planting cover crops, or on heavier soils the ground can be left rough after ploughing. Shelter belts of trees are also beneficial.

Keeping fields covered with other crops throughout the rotation – in this case (above) corn in California – is crucial in helping to prevent soil loss. Cover crops which grow quickly and have extensive root systems are the best way of binding the soil between tomato crops.

# 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 by crops, even in mixed farming systems. Consequently, 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 if the soil fertility status is close to optimum (around 90% of maximum yield). However if current soil fertility is low, potential crop yield may also be limited. Nutrient input will need to be greater than nutrient export in order to build soil fertility and optimise crop yields. If soil fertility is significantly greater than optimum, nutrient input can be reduced or eliminated for a period of time, in effect mining the soil resource until soil fertility falls closer to optimum levels, at which time nutrient inputs may need to be increased. The **ratio of nutrient exports to inputs (nutrient balance)** should be carefully balanced according to factors such as current soil fertility. Macro-nutrients – including nitrogen, phosphorous and potassium – are required for tomato production and would normally be applied as both maintenance dressings for the benefit of the whole rotation, and specific targeted applications to stimulate root development, crop growth, yield and quality. Micro-nutrients are required only in small amounts, but are essential for healthy crop growth. Deficiencies can lead to retarded growth, disease symptoms and quality defects. High



NETAFIM

concentrations of certain elements in the soil may cause phytotoxic effects.

**Nitrate and phosphate losses by surface run-off, soil erosion and to ground water** must be avoided.

Phosphate pollution can lead to the eutrophication of inland water bodies. Nitrate pollution causes off-shore eutrophication and impacts on ground water systems used for human and livestock consumption (nitrate toxicity).

If inputs can be maintained at a level close to exports, losses to water should not be a severe problem.

Providing a judicious balance of nutrients and water to tomato fields can be achieved by state-of-the-art drip irrigation systems. Nitrogen, phosphorous and potassium are the principle inputs that are mixed with water. This system is often referred to as 'fertigation'. The aim is to maintain levels of inputs equivalent to levels of exports in the crop, and so prevent losses to water both locally and in the wider catchment.

## GOOD PRACTICE

### Nutrient Inputs

- Select and apply nitrogen, phosphorous and potassium based on these criteria:
  - Carry out soil tests before application to determine nitrogen, phosphorous and potassium levels and compare these levels to officially documented, optimum target values based on soil type and timing of application
  - Choose fertiliser according to previous cropping, rainfall, and soil physical and chemical characteristics
  - When selecting a fertiliser consider the principles of 'CRAFT': Choice of product, Rate of Application, Application method, Frequency and Timing of applications
- Growers need to take advice from local research centres or soil test laboratories on optimal micro-nutrient balances
- Ensure fertiliser application equipment is regularly calibrated and maintained
- All applications of soil and foliar fertilisers and organic manure should be recorded and justified to field staff

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

- In the case of nitrogen applications, analyse the soil (0 to 20cm and 20 to 60cm) for level of available mineral nitrogen before planting and during crop growth. Wherever possible, split the total amount of required nitrogen by applying at various stages in the cropping cycle based on crop needs
- Irrigate tomatoes, wherever possible soon after fertiliser applications, to improve the nutrient uptake efficiency – drip irrigation provides a window for direct application of fertiliser (fertigation)
- Ensure optimum growing conditions (i.e. optimum seedbed preparation and sowing, regular field inspections, weed control) to maximise nutrient efficiency
- Sow a cover crop after tomatoes to take up any residual nutrients



Fertilising a field using the minimum tillage system (above). The five principles of 'CRAFT' are helpful in selecting an appropriate fertiliser: Choice of product, Rate of Application, Application method – e.g. the 'banding' method (left), Frequency and Timing of applications. Local research centres and soil test laboratories are often the best source of advice on appropriate nutrients. Regular soil testing is part of a sustainable fertiliser management strategy.

### Loss of Nitrate and Phosphate by Surface Run-off, Soil Erosion and to Ground Water

- Growers should especially be aware of areas and soil types that are particularly sensitive to nitrate leaching. Split applications are essential in these cases
- Minimise surface water run-off by applying fertiliser when heavy rains are less likely
- Apply nutrients according to optimum soil and plant tissue target values
- Avoid water surplus or water-logged soil profiles due to inefficient irrigation
- Avoid applying fertilisers adjacent to watercourses by leaving a 3-4m buffer
- Encourage the introduction and planting of cover crops after tomatoes
- Take immediate corrective action where there is excessive water weed or algal growth in standing or slow moving water, an indication of nutrient over use. Cereal barley straw/stubble is an effective treatment for nutrient-

enriched surface water

- Following tomatoes, recommend a crop (cereals) that is highly dependent on nitrogen, climatic conditions permitting, to absorb surplus residual nutrients

### POTENTIAL AREAS FOR IMPROVEMENT

- Encourage the grower to establish nutrient budgets considering nutrient inputs and losses, soil reserves, and exported nutrients. Nutrient budgets will assist in fine-tuning fertiliser rates and methods of application
- Support establishment of permanent monitoring sites and encourage growers to take up soil testing as part of their fertiliser management strategy
- Evaluate renewable and organic fertiliser options
- Evaluate leaching losses under existing tomato rotation systems as a tool to improve 'CRAFT' and water use efficiencies

# PEST MANAGEMENT



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.

**Integrated Pest Management (IPM)** is key to sustainable pest and disease control. IPM is a system of maintaining pest populations below an economically damaging level. It is a management approach rather than an eradication programme, using many control techniques integrated into a multi-pronged approach. It does not rely on a single control method - for example chemicals. Other control methods used may be physical, mechanical, cultural, managerial, genetic, quarantine, exclusion and biological.

IPM programmes are designed to reduce the negative effect of pest control in terms of both financial and environmental costs. A well-developed programme does not rely on pesticides as the first line of defence against pest pressure, and if pesticides are required they are used rationally.

Measuring and reviewing the total amount of pesticides applied per hectare in tomatoes can indicate a reduction as a result of an IPM strategy, but this measure does not take into account the hazard potential of the products used.

A pesticide profiling system has been developed to enable a preferred list of pesticides to be drawn up on the basis of efficacy in tomatoes, human and environmental hazard, residue risk and consumer perception, and to ensure consumer confidence in the tomato brands. In practice this is a mandatory list, as products not appearing on the list are not permitted for use on tomatoes by the processor or government agencies. The aim is to demonstrate a downward trend in the mean pesticide profile scores as higher risk products are gradually substituted by less harmful ones.



## GOOD PRACTICE

### Integrated Pest Management (IPM)

- Field manuals must include detailed methodologies for management of the pests and diseases in each production area with emphasis on cultural controls
- Essential elements of the IPM system in tomatoes include:
  - Consideration of all possible pests and whether any control is necessary or justifiable
  - Selection of disease tolerant, resistant and more vigorous tomato varieties
  - Use of routine cultural and physical controls such as rotational aspects, manual weeding, catch crops, etc
  - Life history, natural enemies, action thresholds and appropriate monitoring systems should be established for all the key pests on the basis of economic damage levels and taking into account natural controls
  - Make available a compendium or digital manual to all growers to ensure adequate knowledge and pest and disease recognition through field scouting
  - Where cultural or physical 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
  - Regular monitoring, either by field walking or the use of pheromone traps should be used for key insect pests to allow informed decision making
  - No prophylactic use of pesticides where possible – move away from the preventative use of pesticides, with the exception of seed-dressings
  - If pesticide use is necessary, use a target-specific product which is environmentally benign to reduce eco-balance disruption and ensure the highest operator safety
  - Broad-spectrum insecticides should only be used where there is no selective alternative and when economically justifiable



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

### Weed Control

Weed pressure is high in tomato fields with high fertility requirements and many closely related weed species

- Prepare the seed bed as early as possible to germinate the weeds and then selectively remove them mechanically before drilling
- Use mechanical and/or manual weed control when economically viable
- Spot spraying should be practiced if possible to ensure proper targeting of weeds
- Where contaminant weeds are present, rousing (selective, manual removal) should be considered as first option for control
- Herbicide choice should be made on the basis of weed species, timing, soil type, weather conditions, crop health and previous application history
- If vigorous varieties are being grown and weed pressure is low, consider using reduced rates of certain herbicides
- To achieve sustainable weed control and reduce the risk of developing herbicide resistance, a planned programme of rotating active ingredients from different chemical groups should be introduced



Tomato crops must be checked throughout the growing season for early signs of pests and diseases (opposite).

By far the most pernicious weeds in all tomato growing areas are the nightshades, (black nightshade, top). A single plant can produce up to 30,000 seeds which lie dormant for several years, awaiting ideal conditions. So far there is no efficient herbicide, and crop rotation is the best weapon. Unchecked, nightshades can cause yield reductions of up to 50%.

Fruitworm (middle) completes its larval development inside the fruit. Feeding results in a messy, watery internal cavity filled with cast skins and faeces, and yield losses of up to 30%.

The Colpam predictive system (above) for fungal diseases detects early and late blight proliferation risks, based on a leaf wetness and temperature matrix. The system offers an accurate way to enhance fungicide action and manage its use.

# PEST MANAGEMENT CONTINUED

## Pesticide Use

- Issue a list of permitted pesticides recommended by the processor and formally reviewed by appropriate governmental and non-governmental organisations:
  - 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
  - excluding compounds which erode consumer confidence in the tomato brands
  - aimed at leaving no residue in the final product and complying with international MRL (Maximum Residue Level) legislation
  - pesticides used are restricted to those on the permitted list
- Accurate records must be kept of pesticide use, including any legislative requirements
- Pesticides 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

- Ensure highest attention to operator safety through:
  - Regular training and retraining
  - Provision of appropriate protective clothing
  - Making personal washing facilities available and stipulate all clothing and equipment must be appropriately washed/cleaned after use
  - Routine health checks for operators and appropriate measures for first aid and incidents associated with product use
  - Pesticide purchase should be recommended from suppliers who will take back empty containers for proper disposal
- 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
- 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.
- Spray equipment used should be well maintained and regularly calibrated. Records should be kept of procedures and equipment calibrated

## POTENTIAL AREAS FOR IMPROVEMENT

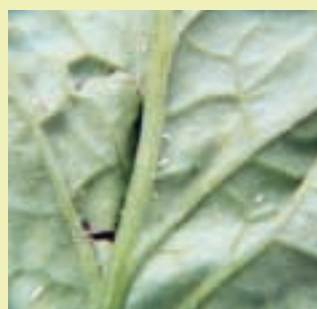
- Review current pesticide use, using the pesticide profiling method – assess the risks of use, substituting where possible with the lowest risk (non-chemical IPM compliant) control measure
- Promote research on bio-control agents (predators, parasites, bio-fungicides, etc.) as IPM tools. Where research findings are encouraging, incorporate their systems into management practices and evaluate their effectiveness and consequences for pest management and the wider environment

- Research alternative products such as semio-chemicals (behaviour disrupters), natural chemicals, which might provide economically justifiable alternatives to synthetic pesticides
- Investigate and test use of precision farming tools as part of a decision support system
- Research into better ways to assess pesticide risk for use in profiling system
- Reduce rates or number of pesticides applications and use low drift nozzles
- Investigate weed-mapping techniques to target herbicides more efficiently
- Research where in rotation best weed control might be obtained
- Define weed tolerance levels to allow selective weeding
- Investigate the potential of mechanical weeding as an option for weed control, to replace and/or complement the use of pre- and post-emergence herbicides
- Use Low Dosing System (LDS) – split pesticide applications to increase effectiveness
- Use Metered Dosing Systems (MDS) – new spray application technologies enabling pesticides to be metered and mixed at point of application
- Create better awareness of the risks and impacts of farmyard pesticide losses (filling and cleaning of sprayer, disposal of empty containers and packaging), even where amounts are small
- Provide guidelines and support to growers on minimising water pollution associated with storage, filling and cleaning spray equipment

## CASE STUDY: USING SORGHUM AS A WHITEFLY SHIELD CROP

Whitefly *Bemisa tabaci* and Silverleaf whitefly *B. argentifolli* are sap-sucking pests which can transmit disease and cause tomato fruits to drop. They migrate in huge populations from other crops such as soybean, melons and cotton and attach themselves to the underside of leaves. Here they feed voraciously, causing the leaves to yellow and curl. The honeydew they excrete becomes mouldy, giving the leaves a shiny or blackened appearance. In humid areas especially they also transmit geminiviruses such as the devastating tomato yellow leaf curl. All tomato varieties are susceptible to whitefly damage.

One solution to the whitefly problem which is working well in Brazil is to plant swathes of sorghum alongside field margins, the areas of a field that are usually infected first. Sorghum grows faster than tomatoes and provides an ideal habitat for whitefly. Swarms of insects descend on the taller plants, ignoring the nearby tomato plants that are developing more slowly closer to the ground. Sorghum is also extremely attractive to a wide variety of native wildlife, including parrots and other birds.



Sorghum (above) planted alongside field margins (far left) entices whiteflies away from tomato plants. Regular monitoring for eggs (left) is essential to prevent damage and transmitted diseases, such as geminivirus (below).

# BIODIVERSITY



The diversity of biological systems can be improved or reduced by agriculture. Sustainable agricultural practices can improve biodiversity both within cultivated fields as well as in adjacent uncultivated habitat.



The word biodiversity simply means 'variety of life.' By definition, biodiversity includes all life forms.

The development of agriculture has caused significant changes in the native flora and fauna in most agricultural areas. Current farming practices can also have a positive or negative impact on biodiversity. There is wide acceptance that human activity (including farming) should not cause any further loss of biodiversity; and should enhance biodiversity where possible.

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 which 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. Such habitats provide a diverse and stable environment for both beneficial (i.e. predators and parasitoids) and pest species. Conservation and enhancement of bio-diversity is important, particularly for farm operations located in areas of high habitat value.



At the level of **crop genetic diversity**, the long-term sustainability of crop production is strongly dependent on the maintenance of a wide genetic base from which future progenies, varieties or clones could be developed.

## GOOD PRACTICE

### Crop Genetic Diversity

- Support the use of diverse tomato varieties e.g. no mono-culture of identical hybrids

### Whole Farm Habitat Quality and Management

- Conduct a farm biodiversity reconnaissance assessment to identify the presence, magnitude and health of any existing flora and fauna on the farm or in the vicinity
- Enhance the farm environment for locally important, rare or endangered species by providing appropriate habitats and adopting proactive cultural practices, including avoiding pesticide damage to beneficial flora and fauna
- Consider creating suitable biodiversity habitat as permanent features in areas of low productivity
- Carry out a full environmental impact assessment before any extension of the tomato growing area into previously non-agricultural, natural habitats
- Encourage the conservation and re-establishment of native forests and trees planting in areas that have been converted from forest. Emphasis should be on planting of native species in a manner that mimics the natural forest mosaics (species composition similar to undisturbed local ecosystems). Native tree species can be planted more widely through estates and farms without affecting the other agricultural activities. Riparian zones, roadsides and field margins can provide other useful areas for conservation without direct impacts on viable farm land areas
- Ensure that field margins and buffer zones are maintained and dominated by native species
- Link wildlife habitats wherever possible through corridors and field margins.
- Adhere to Integrated Pest Management principles
- Prevent the spray of chemicals into or next to waterbodies and consider using



buffer zones even where it is not a statutory requirement

- Minimise losses of nutrients to the environment by ensuring principles of CRAFT are applied and by maximising irrigation water use efficiencies

### POTENTIAL AREAS FOR IMPROVEMENT

- Undertake baseline studies of habitat types and landscape elements to implement biodiversity enhancement plans
- Identify opportunities to participate and link with regional conservation strategies
- Work with local initiatives:
  - to adopt conservation measures for local rare or endangered species
  - to learn about and to encourage biodiversity, co-operate with research programmes that assess and document biodiversity on the farm and surrounding area
- Help to define the management of marginal areas to enhance beneficial flora and fauna, avoiding negative effects on the cultivated area
- Encourage widespread biodiversity monitoring
- Enhance growers' awareness of potential benefits of improved habitat



Preserving the native environment in and around farms encourages biodiversity. The photographs opposite taken on a tomato farm in Brazil indicate the immense variety that can thrive even in small areas - including the emu.

In drought-stricken Australia swampy areas (top) are best left as they are. It is not worth growing crops in such pockets, and there are many benefits from encouraging native wildlife. Additionally, swampy areas are important in water table management.

Great efforts are being made on tomato farms in California (above) to encourage biodiversity where little existed before. One project in conjunction with a local high school involves restoring a field recycling pond with the aim of encouraging native flora and fauna.

# PRODUCT VALUE



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



Sustainable tomato production must be productive, competitive and efficient. Product value is determined by the combination of tomato **yield per hectare** and **product quality**, minimising costs and waste, and adding value wherever possible.

Yield per hectare is used as a measure of the economic sustainability of tomatoes, since yield should be maintained or improved where possible. Yield also provides an important measure of impact for other sustainability indicators when expressed as per tonne of finished product.

Quality of the final product includes both tangible (taste, colour, appearance, etc.) and perceived quality of the final product. Good tangible quality tomatoes which meet processors' standards not only add value for the grower and the processor, but also avoid fruit losses during harvest, transport, handling and processing. Consequently environmental impact is diminished. Perceived quality refers to consumer concerns about food safety, environmental performance and social responsibility, which must be satisfied.



## GOOD PRACTICE

### Yield per Hectare

- Select growing areas based on suitability for growing tomatoes 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



### Product Quality

- Use only pesticides on the permitted or preferred list. Pre-harvest intervals must be strictly followed
- Pre-processing product control on pesticide residues should be carried out and targets set for pesticide residues below legal Maximum Residue Levels (MRLs), with the aim of achieving zero detectable residues in the final product in the long term



## POTENTIAL AREAS FOR IMPROVEMENT

- Development of a HACCP plan incorporating Critical Control Point tools for fruit production, harvest, transport and sample procedure to ensure full traceability from seed to finished product
- Ensure growers follow processor's internal Quality Procedures for fruit in addition to the Good Practice guidelines as the main reference for farm to factory quality control.

Yield per hectare and product quality are the measure of product value. Attention to detail is the key, from preparing the soil to planting and monitoring growth. Sampling the crop in the field (above) before and during harvesting (opposite) is all part of tight quality control.

Sampling continues in the factory (top) to establish Brix - the soluble solids content, and

MOT - material other than tomatoes. Green tomatoes and fruits that are damaged, diseased or mouldy are deducted from the total weight to establish the net weight. If certain thresholds are exceeded truck loads can be refused.

An evaporator (right) is part of primary processing in the making of intermediate products including tomato paste and dice.



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 and contribute to efficient energy use.



This Colpam device is used to predict fungal diseases, so that growers can target and minimise their use of chemicals. It is solar powered, which is a practical, self-sustaining solution to equipment that is permanently installed on fields far from the main sources of energy.

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.

Through the burning of fossil fuels, organic matter, releasing CO<sub>2</sub>, nitrous oxide (N<sub>2</sub>O) and methane (NH<sub>4</sub>) into the atmosphere, humans have induced the greenhouse effect known as 'global warming'. Arable and horticulture farms can have an impact on the greenhouse effect; however through the use of good agricultural practices the impact can be significantly reduced.

A Life Cycle Assessment (LCA) of tomatoes 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 tomatoes relates to synthetic fertiliser and pesticide manufacture, while a major component of direct energy use on the farm relates to irrigation, cultivation and harvesting.

The on-farm energy balance is a key measure relating metabolisable energy with energy inputs to produce the crop. Farms generate a range of waste streams, from field crop trash, input packaging and handling (fertiliser and chemicals), irrigation equipment, workshop and machinery wastes. The 'farm waste ratio' looks at the amount of waste used, recycled and/or disposed of safely in relation to total volumes of farm waste generated.



Large fields (left) enable farmers to use very wide machinery, so minimising the number of passes needed through a field which not only helps in preventing soil compaction but saves energy too. In California (above) wind farms supplement systems which generate energy by conventional methods.

## GOOD PRACTICE

### Efficiency and the Use of Renewable Resources

- Minimise use of fossil fuel for power generation i.e.
  - Optimise field operations, including transportation from field to factory
  - Careful selection of equipment
  - Ensure proper and timely maintenance
  - Meter all power outlets to minimise power misuse/wastage.
- Minimise the input of synthetic fertilisers and consider alternative organic and renewable fertiliser technologies
- Investigate and test alternative practices for reducing, re-using, recycling and/or safe disposal of waste incurred in tomato growing
- Review practicality of best current waste re-use, recycling and disposal technologies available

### Reducing Greenhouse Gas Emissions

- Optimise nitrogen balance (nitrogen input minus output) to reduce nitrous oxide losses and consider split nitrogen applications to match crop demand

- Ensure sufficiently aerated soil and minimise periods of water logging to reduce denitrification through application of a soil compaction alleviation strategy
- Use irrigation scheduling techniques such as soil moisture sensors and manual field soil moisture assessments to improve timing and placement of irrigation
- Improve irrigation system water use efficiency through the use of drip systems (converting from less efficient furrow systems)
- Minimise tillage intensity and depth to maintain and/or improve level of soil organic carbon levels
- Avoid burning stubble and trash through improved tillage practices and incorporation techniques
- Optimise fossil fuel consumption during field operations through reduction of tillage timing and depth and choice of machinery
- Consider establishing biodiversity conservation areas (areas of native vegetation) to improve the farm CO<sub>2</sub> balance and offset farm CO<sub>2</sub> emissions

### POTENTIAL AREAS FOR IMPROVEMENT

- Further work on more detailed energy audits – including machinery efficiency, work rate and fuel use per hectare – to review the baseline
- Investigate energy requirements in relation to harvest strategies and energy efficiency of harvesters
- Investigate alternative practices for recycling and waste disposal, especially plastics
- Review possible use of alternative energy sources such as bio-fuels
- Long-term strategy for use of plant oil for fuel and lubrication of tractors
- Develop the potential for generation of renewable energy sources, including bio-gas from factory organic wastes and, where practical, develop hydro-electricity or wind-power schemes
- Review fertiliser application scheme to reduce gaseous losses, in particular identifying renewable nitrogen sources. Research slow release nitrogen technology. Nitrification inhibitors also need attention

# WATER



Irrigation is indispensable in tomato production. Poor and inefficient practices can lead to pollution of ground and surface water with pesticides and nutrients, and may cause soil erosion. Sustainable practices target inputs and reduce losses.



All aspects of water management 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 tomato production and in the climatic conditions under which the crop is grown. Irrigation volume and scheduling need to be controlled carefully even in rain-fed areas. When water is a scarce resource, securing **the sustainability of water supply** is important. Adequate water storage and quality are highly important. Healthy and sustainable production can only be maintained if adequate precautions are taken to avoid open space, ground and irrigation water from being polluted in any way. The irrigation practices that are the most appropriate for tomato production vary considerably with the geographical and climatic conditions of different regions; the most common types are furrow, drip and centre pivot.



Two methods of irrigation. A traditional pivot system (left) which irrigates the whole field, and carries with it, in the high humidity of Brazil, a high risk of disease proliferation. Increasingly farmers are turning to drip systems (above) which target the roots of the tomato plant very directly, so saving water and chemicals as well as money. Drip is expensive to install, but can soon pay for itself through dramatically improved productivity as well as savings of inputs.

## GOOD PRACTICE

### Irrigation

- Ensure the amount of water applied does not exceed the water holding capacity of soils
- Regularly maintain irrigation equipment and systems to minimise water wastage via leaks
- Ensure that refuelling and lubrication operations for pumping equipment do not pollute watercourses
- Monitor the quality of irrigation water applied. 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 (flow metres)
- Where practical advance the use of drip irrigation rather than furrow or pivot irrigation for economy of water use, disease reduction and subsequent yield improvement
- Pay attention to design and layout of drip irrigation systems, inclusively flushing endpoints and advise growers on improvements if necessary. Drip irrigation systems are designed and tested to achieve a maximum flow variation of +/- 5% and +/-10% variation in pressure and a distribution uniformity of >90%
- Backflow prevention devices must be in place for all fertiliser injection facilities regardless of whether inject occurs on suction or discharge side of the pump or in-field injection into submains
- Use objective methods for determining when and how much water to apply are used. These methods include: soil moisture sensors, tensiometers, weather stations (evapotranspiration models) and manual field deep soil probe assessments
- Where appropriate, support growers' knowledge and practices on irrigation with available modelling systems



### Sustainability of Water Supply

- Maintain in-field dams and water reservoirs. Consider the environmental impacts of water harvesting on downstream ecosystems
- To minimise contamination of water supplies use dedicated water tanks for filling and cleaning spray equipment. Spray out tank washings on the crop and clean down equipment in an area of least risk to the environment and water supplies.
- To avoid unintentional pollution to public open waters and to store recycled water the laying-out of tail water ponds should be encouraged



NETAFIM

### POTENTIAL AREAS FOR IMPROVEMENT

- Promote wider use of irrigation scheduling techniques
- Regular checks on irrigation system and scheduling performance on tomato farms and, if possible, use the pilot farms to demonstrate a benchmark
- Support enhanced water management systems based on drip irrigation
- Evaluate drip irrigation system distribution uniformities

A water channel in the far west of the Peloponnese in Greece (top). Water supplies are excellent here, with numerous channels draining from a large dam and artificial lake.

In Brazil (middle) numerous natural lakes offer a plentiful source of water for irrigation as required. The maintenance of in-field dams and reservoirs is part of sustainable water management.

A state-of-the-art gravel filtering system (above) which is used for the primary filtration of water taken from reservoirs, dams, open canals and rivers.

## 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, NGOs and authorities 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 growers now and in future form the most important asset for the tomato business. Social and human capital forms the basis for innovation, building confidence and creating trust.

Australian farmers, agronomists, scientists, NGOs, local authority and community leaders with other stakeholders taking part in the Little Wallenjoe field day in Victoria. All of them are involved in the sustainable tomato production project. Regular meetings help promote sustainable farming methods and the sharing of innovative techniques.

## GOOD PRACTICE

### Relationships (Social Capital)

- Continue to build trust and confidence between the company and the growers 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 ensure close contact between the factory and the individual growers
- Discuss and develop advanced farming methods that support environmental improvement
- Provide further structure and facilities for grower participation through:
  - Negotiation of prices and contract conditions between grower organisations and the company
  - Giving growers the ability to secure their production sites based on a profitable and mutually beneficial relationship with the operating company
  - Establishing communication links through periodical grower meetings and factory/research site visits
- Link with other stakeholders by:
  - Maintaining good relationships with authorities and others in the local community
  - Facilitate interaction between consumers and growers
  - Invite local communities to the farms and the factory
- Share good citizenship with groups caring for the environment
- Strive to avoid noise, smell or spray drift

### Human capital

- Provide training opportunities for growers and other interested groups in key aspects of sustainable tomato production

## POTENTIAL AREAS FOR IMPROVEMENT

- Stimulate growers' participation in the Sustainable Agriculture Initiative; and make joint decisions with the growers' organisations whenever possible, such as discussing good practice guidelines
- Continue to develop useful and appropriate parameters for social and human capital
- Further work on interactions and relationships requiring socio-economic auditing
- Enable and stimulate grower empowerment in decision making about the sustainability of the tomato business
- Grower groups may consider, and be supported in, developing partnerships with the authorities to address commonly shared threats and opportunities, and to support public services
- Stimulate and improve relationships between growers and consumers, and between growers and local communities



The 2003 annual Unilever Sustainable Agriculture workshop was held in Brazil. Here workshop participants, as well as farmers, (top) are visiting one of the sustainable tomato project farms in the Goiânia region.

Truck drivers (above) are the essential link between tomato growers and the factory. The processors rely on them for safe and precisely timed delivery of the crop, and their ability to arrive on schedule is critical in safeguarding fruit quality and the smooth running of the factories.

# 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 tomatoes provides growers with an important 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.

Furthermore, a **grower's margin** from tomato production should be high enough to ensure proportional coverage of grower's non-crop related expenses and sustained tomato production, relative to accepted economic and social standards.

## GOOD PRACTICE

### Local Resourcing

- Use local suppliers wherever practical (based on availability, reliability and cost).
- Use local growers as much as possible (based on reliability and consistency in

performance – yield and quality of tomato crop)

- Promote the employment of local workforce on the farms
- Assess the relative share of turnover spent locally and enhance where possible.

### Grower's Margin

- Yields, production cost breakdown and grower's margin should be monitored and evaluated annually

### POTENTIAL AREAS FOR IMPROVEMENT

- Continue to improve yields and reduce costs on the farms in the context of promoting good agricultural practices
- Consider working with local communities to develop businesses that reduce the need to import goods and services (for the farm) from further afield

Hand harvesting (above left) sustains a very large section of the community in Brazil in areas where UBF sources processing tomatoes. Goiânia (top) is the main city in the Cerrado and the centre for agricultural development in this large region. Approximately 525,000 tonnes of tomatoes are processed by UBF annually in Brazil.

In Australia (middle) the Tatura tomato processing factory is vital to the economy of the small agricultural town of Tatura in Victoria. UBF in Australia processes some 50,000 tonnes of tomatoes annually.

In California's central valleys (above) the excellent infrastructure is one reason for UBF's efficient processing of some 650,000 tonnes of tomatoes annually. California is the world's main growing area of processing tomatoes and the crop is therefore vital to the economy.

## THE FARMERS' VIEW



Frank Muller (right) of Joe Muller & Sons, here with UBF fieldsman Rudy Lucero (middle) and UBF director, field operations Randy Rickert (left), in the Sacramento Valley, California. Frank comments: "Unilever Bestfoods (UBF) is the first buyer we have worked with to recognise the value of sustainable agriculture. We recently signed a three-year term contract for processing tomatoes with UBF. This contract offers our farming operation significant economic sustainability, with time rather than price the most important component. Until this contract was signed, the cost of production was the major focus of economic sustainability. Now a secure flow of income can also be a part of the sustainability index. The contract has allowed us to turn a philosophy into a valuable marketing tool.

The term commitment has given us the motivation to be more aggressive and innovative in researching and adopting new production practices.

"Interestingly, our conversations with UBF representatives have evolved from price and tonnage negotiations to discussions about cover crops, water return systems, crop rotation and other production practices that provide benefits to multiple parties in this community. We appreciate the opportunity to be aligned with a company that is an innovator in the sustainability movement. We look forward to the day when the marketplace recognises the true value of UBF's efforts."



Carlos Alves de Leles farms with his brother Marco in Itaberaí near Goiânia, Goiás in Brazil. He explains: "We began working with UBF in 2002. Growing tomatoes requires more effort than other crops but we find it a good business. Profitability depends on field

performance with price driven by the contract you have with UBF. We achieve some 100-110 tons/ha, while the average yield in Goiânia is 80 tons/ha.

"We have two irrigation systems, the traditional sprinkler (pivot, seen here) and drip irrigation. We have found significant advantages with drip, including savings on water and pesticides use as well as higher yields. Careful management is essential, and we are still learning how to optimise the system. We use technology such as tensiometers, disease monitoring systems (Colpam), and soil analysis. Pest management on the drip area is vital, with white fly and geminivirus the main challenges. We also want to preserve the natural forest and encourage biodiversity. We have registered one area of natural forest already, and plan a second, to be linked by a wildlife corridor, which will enhance the whole locality."

Sergio, Glenn and Allan Rorato farm at Jerilderie, New South Wales. Sergio says: "My brother Lou and I came to Australia in the 1960s, and our operations include cultivating processing tomatoes, other mixed crops and a food processing plant. We were one of the first to furrow-irrigate crops such as tomatoes and onions in this region, and my sons Glenn and Allan are some of the first to trial precision farming technology in the tomato processing industry." Glenn adds, "We went from taking virtually no soil tests to conducting over 190 tests in 2002/3. The information we have learned from the UBF sustainable approach has helped us to reduce our fertiliser requirements by over 30% so far. Yields are up too."

# 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 tomato field and up to landscape scale. The second is the genetic diversity in the tomato crop grown on a world scale

**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

**Low Dosing Systems (LDS)** – Low dosing systems are an emerging new approach used to apply fungicides in particular where the label rates are split into 2 or 3 applications in order to improve the efficacy of the applied pesticide.

**Metered Dosing Systems (MDS)** – These systems involve modifying existing spray application equipment to carry water and pesticides, thereby only having

the mixing of pesticides prior to application to target crops. Advantages of these systems include improved efficiency and efficacy, reduced OH&S risks associated with chemical handling and mixing, reduced environmental impacts due to the elimination of the need to wash chemical tanks and vats, reduced chemical compatibility issues in tanks as chemicals are stored in manufacturers containers prior to direct field application.

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

## CREDITS

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# FURTHER READING

## UNILEVER SUSTAINABILITY INITIATIVES



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



**Fishing for the Future II**  
Unilever's Fish Sustainability Initiative (FSI) (2003)



**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)

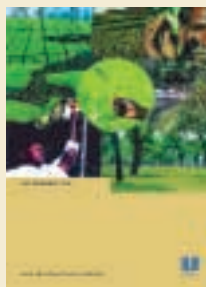


**\*Growing for the Future Spinach**  
For A Sustainable Future (2003)

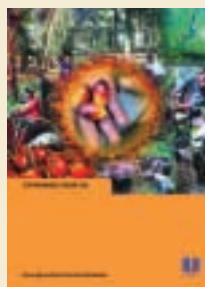


**\*Growing for the Future Tomatoes**  
For A Sustainable Future (2003)

## 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)

If you wish to read more about our sustainable agriculture programme, please look at the Unilever website at [www.unilever.com/environmentandsociety/sustainability](http://www.unilever.com/environmentandsociety/sustainability)  
Specific documents, protocols, brochures, etc. can be found at [www.growingforthefuture.com](http://www.growingforthefuture.com) or email us at [sustainable.agriculture@unilever.com](mailto:sustainable.agriculture@unilever.com)

For information on the Sustainable Agriculture Initiative (SAI) - a platform created by the food industry to support the development of and communicate worldwide about sustainable agriculture – visit [www.saipatform.org](http://www.saipatform.org)



\*Available in English, German and Italian • Available in English and Portuguese



“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.