# Sustainable winter oilseed rape





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## Oilseed rape cultivated for edible oils

Oilseed rape (*Brassica napus*) belongs to the cruciferous plant family and in botanical classification to the cabbage family. It is a very old cultivated plant originating in Asia and the Mediterranean area.

Winter oilseed rape – the subject of this brochure – is today the most important oil crop in northern Europe. Its seeds have oil content of 40–45%. Winter oilseed rape is sown in August or /early September. By the following May it is in flower. Within two months the pollinated blooms have developed into pods where the seeds reach maturity. The crop is harvested in July and the seeds are carefully stored before the oil is extracted.

In the second half of the 20th century oilseed rape was the subject of intensive breeding programmes. As a result of decades of selective breeding, 00-rapeseed is now exclusively cultivated and used for nutritional purposes because of its excellent oil composition of unsaturated fatty acids.

The oil of oilseed rape has various food applications, including bottled oils or and margarines where it is valued because it is high in monounsaturates.

# Introduction

These guidelines have been developed under the Unilever Sustainable Agriculture Initiative in cooperation with UFOP[1] Germany to support sustainable management practices for winter oilseed rape (WOSR) production.

Ten indicators of sustainability have been identified:

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

Germany is a major producer of WOSR. Within Unilever and UFOP, the Lead Agriculture Programme team in Germany[2] has worked closely with farmers, organisations and communities to benchmark their agricultural operations against ten 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 further investigation or improvement are indicated. These guidelines are based on a thorough evaluation of existing and potential agronomic practices and associated inputs. They were developed according to the principles of Integrated Farm Management (IFM). Our close relationships with farmers involved in this project, their knowledge base and capacity to innovate, continues to make a major contribution to the project.

These guidelines have been developed in consultation with relevant farmers, scientists and agronomists. Their main purpose is to provide the basis for development and implementation of good practices in consultation with farmers. Additionally, they are intended for use by agricultural development teams and for communication with WOSR processors and suppliers. This document forms the basis for continuous improvement and development of good agricultural practices, including aspects of product safety and quality as well as the environmental impact and sustainability of the entire agricultural production process. Contributions are welcome, and may be sent to:

**sustainable.agriculture@unilever.com**

1 UFOP, Union zur Förderung von Oel- und Proteinpflanzen e.V., is an independent and interprofessional association for the promotion of oil and protein plants in Germany.
2 Professor Olaf Christen and Bernhard Wagner, Institute of Agricultural and Nutritional Sciences, Martin-Luther-University Halle-Wittenberg, Halle, Germany

# Soil health

## Soil is fundamental to agriculture. Sustainable agriculture practices can improve the quality of the soil's ecosystem.

Agricultural practices are governed by both European and national soil protection regulations. Good agricultural practice uses various means to maintain or improve soils. 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 structure, reducing soil loss and increasing nutrient and water use efficiency. It also provides a carbon source for soil micro-organisms and sequesters carbon from the air, playing a critical role in the global carbon balance and mitigating the greenhouse effect. Organic matter levels should be maintained at or improved to meet 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 acidity (pH) and nutrients. Various fauna and biota have a fundamental role in ensuring soil fertility and are consequently excellent indicators of soil health. Soil micro-organisms also contribute to soil health.

### GOOD PRACTICE

#### Rotation and establishment

- WOSR is an excellent preceding crop for cereals such as winter wheat. Short oilseed rape rotations, however, may cause an increase in pests and diseases
- Establishment of WOSR is critical as it is more sensitive to seedbed conditions than cereals. In particular, good early contact between seed and moisture is essential

#### Organic matter

- WOSR helps maintain soil organic matter in arable soils due to its great amount of crop residues. Thus it also helps to comply with legislation for soil protection
- Direct measurements of soil organic matter, however, are difficult due to lack of adequate thresholds and an enormous spatial and temporal variability
- A useful tool to assess the soil organic matter content of agricultural soils and cropping systems is the so-called organic matter balance sheet, which yields the final organic matter balance
- Soil organic matter balances are based on the principle that crops which reduce the soil organic matter content require a higher supply of added organic matter, in contrast to crops which actually supply substantial amounts of organic material, such as WOSR, legumes, fodder crops as well as organic fertilisers (straw, manure or slurry)

#### Soil compaction

- Any potential compaction can be avoided by understanding soil type and moisture conditions, and using appropriate machinery

#### Soil pH, Nutrient status

- For mineral soils, pH should ideally be in the range of 6.5 to 7.0
- Regular soil testing and monitoring crop nutrient requirements helps to establish potassium, phosphorous and nitrogen mineralisation levels

#### Potential areas for improvement

- Farmers are encouraged to create organic matter balances when selecting the crop rotation, and seek opportunities for cover crops and applications of organic manures
- Adjust tyre pressures for all field operations to field conditions. Tracked vehicles, low ground pressure tyres or double tyres can be used on soft soils
- Avoid using heavy machines in fields during rainy periods or on very wet soils
- The fewer the number of in-field machine passes, the less the soil compaction
- Road and field transport should be separated to help prevent lorries entering the field
- Monitor levels of soil fauna (such as earthworms). Reduced organic matter, soil compaction, and inappropriate use of mineral fertilisers and pesticides can all contribute to diminishing soil fauna levels
- WOSR has strong deep roots and provides intensive shading which helps increase soil aggregate stability. It also allows reduced primary cultivations for the following crop where conservation-tilling can be used to prepare the ground, instead of deep ploughing
- Soil structure should be regularly assessed, using 'spade tests' for example
- WOSR is an excellent preceding crop for cereals like winter wheat. A break of two, or better three, years between oilseed rape crops within the rotation is recommended to avoid the increase in pests and diseases that may be caused by short oilseed rape rotations

## Balance of WOSR on a pilot farm

This chart shows how levels were balanced over a five-year period. This is very important for the long-term sustainability of a cropping system and underlines the positive effects of WOSR. The calculation takes into account the contribution of manure to the soil organic carbon as well as the effect of crops and tillage on the balance. Humus unit (hu) is defined as 580kg of carbon and 55kg of nitrogen.

| Year | 2001 | 2002 | 2003 | 2004 | 2005 | Mean |
|---|---|---|---|---|---|---|
| Humus gross need (hu/hectare) | -0,65 | -0,4 | -0,45 | -0,82 | -0,83 | -0,6 |
| Humus accumulation result (hu/hectare) | 0 | 0 | 0 | 0 | 0 | 0 |
| Straw manure (hu/hectare) | 0,72 | 0,54 | 0,5 | 0,84 | 0,81 | 0,66 |
| Humus net demand (hu/hectare) | 0,07 | 0,14 | 0,05 | 0,02 | -0,02 | 0,06 |
| Organic manure total (hu/hectare) | 0 | 0 | 0 | 0 | 0 | 0 |
| Total humus replacement (hu/hectare) | 0,72 | 0,54 | 0,5 | 0,84 | 0,81 | 0,66 |
| **Surplus (hu/hectare)** | **0,07** | **0,14** | **0,05** | **0,02** | **-0,02** | **0,06** |

**The dense canopy of WOSR protects soil from drying out and from damage caused by extreme rainfall and storms. This intense shading improves soil aggregate stability.**

**Conservation tillage – here WOSR stubble is chopped with discs before the following cereal crop, so helping to reduce primary cultivations and preserve soil organic matter (above).**

**Healthy WOSR seedlings in a Schleswig-Holstein field in northern Germany where eight farms contributed to the development of these best practice guidelines. The success of this crop is largely because the seeds had good contact with moisture immediately after drilling (left).**

**This field is showing a very patchy crop, with some areas indicating no crop at all. It is crucial to check soil conditions before drilling – if seeds are drilled into dried out soil with no prospect of immediate rainfall they will not germinate (left).**

# Soil loss

Erosion by wind and water can cause soil to lose its structure and organic matter, 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 choice, wind and the amount of rainfall can all affect the level of soil loss. Erosion removes topsoil and reduces levels of soil organic matter and biological activity, and can contribute to a less favourable environment for plant growth. Nutrients lost through soil erosion are no longer available to support plant growth and can cause nutrient enrichment (eutrophication) of watercourses to the detriment of the aquatic ecosystem. The amount of soil lost in a given rainfall event or over a season is directly related to the amount of exposed soil. Soil cover index (the mean soil cover over the life of the crop including any fallow period before plants start to grow) is a useful indicator of erosion potential.

**GOOD PRACTICE**

- Farmers must comply with EU and national regulations designed to help protect against soil erosion

**Soil erosion**

- WOSR crops cover and protect the soil for a long period during the year from sowing to harvest and its intensive cover can reduce soil erosion
- The root of WOSR in autumn protects against erosion during heavy rains. This enhances soil aeration and water infiltration, and consequently prevents run-off and erosion
- After harvest, a considerable amount of straw remains on the soil surface, which decreases the risk of erosion by wind or water. The use of conservation tillage – minimum cultivation of soil – when planting the following cereal crops means WOSR can contribute to the reduction of erosion throughout the rotation

**Potential areas for improvement**

- Avoid conventional tillage on sloping fields
- Improve conservation tillage systems for WOSR
- Improve spatial cereal straw distribution on the field during and after harvest
- Improve seeding technology for WOSR in conservation tillage systems
- Machine tracks should be parallel to the contour on steeply sloping fields
- If ploughing is necessary, consider setting the plough so that the tractor's wheels are only on the untilled land

**Water-logging on a field headland following severe soil compaction. This in turn can lead to damaging erosion, with loss of topsoil including nutrients and subsequent pollution of watercourses.**

**Compacted tramlines increase the chance of water erosion down a slope. Where possible tramlines should be across the slope of a field (above).**

**A spade test after six months of minimum tillage indicates extremely healthy well structured soil with a high degree of earthworm activity. Earthworms contribute to aeration, nutrient cycling and drainage as well as breaking down organic matter (above).**

# Nutrients

Nutrient inputs are vital for all crops. Fertilisation and crop demand must be in balance.  Nutrients are lost by harvest, leaching, erosion and emissions to air. Sustainable practices can enhance nutrient efficiency and reduce losses.

Agricultural systems depend on the 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. Total nutrient inputs (including soil mineralisation) should be as close as possible to nutrients exported in the harvested product plus that stored in ground vegetation, soil and crop biomass. To achieve this, the nutrient balance (the ratio of nutrient exports to inputs) should be carefully balanced. Phosphorus and potassium are required and would normally be applied as maintenance dressings for the benefit of the whole rotation. Nitrate and phosphate losses through surface run-off and soil erosion, and to groundwater are key parameters for measurement at field level. Nutrient pollution can lead to the eutrophication of inland water bodies and coastal waters, damaging aquatic ecosystems.

**GOOD PRACTICE**

- Farmers must comply with all national and European legislation regarding the use of fertilisers

**Nutrient application and timing**

- With its tap root system WOSR  takes up nutrients from the sub-soil
- In most cases the straw of WOSR remains on the field and supplies the following crop (usually winter wheat) with nutrients
- High yields of WOSR are only possible if the soil pH and levels of magnesium, phosphorus and potassium are within optimum ranges. These should be based on crop uptake and soil testing (see Soil Health)
- Sulphur supplies must be adequate. Deficiency can be a problem, indicated by inter-veinal yellowing of middle/upper leaves or pale yellow flowers. Symptoms in the crop may be too late to treat, but indicate the need to include more sulphur in the rotation
- WOSR responds to organic fertilisation, especially in spring when uptake is greater than in autumn
- Farmers are encouraged to measure soil nitrogen mineralisation in spring and cooperate with the official extension service (if available) or other consulting services. Regular soil tests should be taken (see Soil Health)
- Application equipment should be calibrated regularly

**Potential areas for improvement**

- Adopt a rotation-based approach to nutrient balances
- Avoid nitrate and phosphate leaching at catchment level. Work in partnership with local water companies
- Ensure optimum growing conditions to maximise nutrient efficiency through optimum seedbed preparation and sowing, regular field inspections and weed control
- Record all applications of soil and foliar fertilisers and organic manure to analyse operational improvements
- Use the best available technology for application of fertilisers
- Use dynamic crop models for a better yield forecast as a basis for nitrogen fertiliser recommendations
- Raise awareness of the atmospheric impacts of fertiliser choice. For example, ammonium nitrate emits less ammonia than urea. Organic manures and slurry should be incorporated as soon as possible to minimise ammonia emissions
- Never apply fertilisers in frozen or water run-off conditions

This WOSR crop is suffering from sulphur deficiency, indicated by inter-veinal yellowing of the middle and upper leaves, and the paler colour of the flowers than a healthy crop would exhibit. By now it is too late to remedy this crop, but sulphur applications during the rotation will benefit any subsequent crop of WOSR.

Fertiliser applications should be carefully measured and evenly applied to achieve a uniform crop. The three farmers are collecting fertiliser spread pattern samples. These in turn are placed in a gauge so the farmers can see how uniformly the applicator is spreading the fertiliser.

# Pest management

Integrated Pest Management (IPM) is key to sustainable pest control. Sustainable practices can substitute or help to reduce dependence on pesticides.

Crop protection is one of the most important means of securing high yields, good quality and economic success in agricultural production in general, and in WOSR in particular. IPM is the careful consideration of all available pest control techniques and their subsequent integrated use to improve biological balance. The total amount of pesticides applied per hectare of WOSR can be reduced using IPM.

### GOOD PRACTICE

- The use of pesticides is strictly regulated by national and European legislation and farmers must comply. Pesticide products must be registered and sprayers must comply with technical standards and regulations. Each person using pesticides must have relevant skills and licences

### Pests, diseases and weed control

- An important prerequisite in all IPM control systems is a thorough assessment of incidence and economic impact of weeds, pests and diseases, their lifecycles, and cultural controls
- WOSR competes well with weeds due to its rapid foliar development but the application of herbicides remains unavoidable in most cases. This should be optimised according to the principles of IPM
- WOSR is susceptible to a number of serious fungal diseases including phoma stem canker *(phoma lingam syn. leptosphaeria maculans)* and sclerotinia stem root *(sclerotinia sclerotiorum)* which can dramatically reduce yield and seed quality. Many fungal diseases, such as phoma stem canker or light leafspot, can be controlled by resistant WOSR varieties. The rotation break between oilseed rape crops helps to control sclerotinia and clubroot
- WOSR may suffer from slug or mice attack in autumn, but damage can be reduced by adequate tillage management systems, such as rolling after drilling

### Protection of bees

- The broadcast application of pesticides is strictly limited to special products and application dates because WOSR is important for honey production. Bees are important for pollination and yield
- During bee flying periods, only bee-friendly products are permitted
- Bee-keepers should be notified in advance of intent to spray
- Further information is available at www.ufop.de and www.hgca.com

### Potential areas for improvement

- Enhance understanding of slugs and mice as major pests in conservation tillage systems
- Farmers are encouraged to keep records of all application of pesticides with detailed information on date, field, product, application rate and exact application area
- Use models to forecast the epidemiology of major pests and diseases. Many natural beneficial predators of WOSR pests, particularly around flowering and pod set, can be killed by the indiscriminate use of non-selective insecticides
- Use biological control agents where possible
- During bee flying periods confine spraying to sunrise or sunset (before or after bee activity)

### Intergrating biological control within IPM

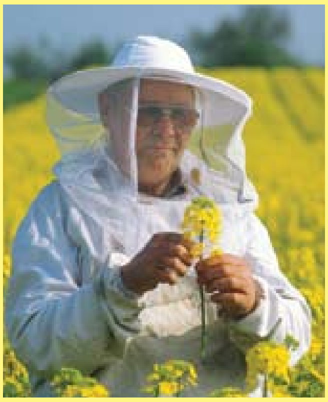
Standard management of pests on WOSR throughout Europe still relies heavily on chemical pesticides. MAnagement STrategies for European Rape (MASTER) pests is an EU partnership project involving six countries (Estonia, Finland, Germany, Poland, Sweden and the UK) that aims to minimise pesticide use by integrating and maximising biological control of six major pests by their natural enemies.

MASTER focuses on indigenous natural enemies, seeking to conserve and enhance the activity of parasitoids and predators in the crop as well as testing the use of mass-reared pathogens. The six major pests are: cabbage stem flea beetle (*Pslliodes chrysocephala*), pollen beetle (*Meligethes aeneus*), cabbage seed weevil (***Ceutorhynchus assimilis***), rape stem weevil (*Ceutorhynchus napi*), cabbage stem weevil (*Ceutorhynchus pallidactylus*), and brassica pod midge (*Dasineura brassicae*). All of these attack the crop successively at various stages of growth and damage different parts of the plant.

Natural enemies of these pests include parasitoids, especially hymenopterous wasps which attack the egg or larva of their host. Key predators are more difficult to assess, and research is focusing on locally abundant beetle populations. The MASTER partners are also investigating the benefits or otherwise of introducing pathogenic organisms including fungi, nematodes, bacteria and protozoa.

Collaborative farm-scale experiments compare standard and biological pest management systems within a cereal rotation over two years. In the Biological Control System, certain husbandry practices (such as soil tillage, plant density, cultivar choice and insecticide input) are modified to conserve parasitoids and predators.

Further information: **www.iacr.bbsrc.ac.uk/pie/master/master.htm**



**A bee-keeper and WOSR honey producer inspecting flowers for pollen quality. Bee-keepers should be informed by growers well in advance of intent to spray (above).**

**A slug feeding on the stems of harvested WOSR. Slugs are best controlled by careful tillage management, including rolling after drilling (top).**

**Protecting bee populations is a priority and only bee-friendly products may be used on WOSR, both to protect the wider environment and also to safeguard honey production.**

**Club root (*Plasmodiophora brassicae*) is a fungal disease that can only be controlled by rotation: the longer the rotation, the greater the chance of it naturally declining. It causes stunted growth and wilting. There are no chemical treatments available (above).**

# Biodiversity

## The diversity of biological systems can be affected by agricultural practices. Sustainable agricultural practices can help improve biodiversity.

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 'semi-natural habitat' include field margins, uncultivated areas, hedges and waterways. These habitats provide a diverse and stable environment for a range of both pests and beneficial species (predators and parasitoids).

The genetic diversity of WOSR – an important component of biodiversity of agricultural systems – is very wide in Europe, because of the large number of different registered varieties. The ongoing process of crop improvement by breeding further increases the diversity of WOSR varieties. The long growing period of WOSR provides habitat and food supply for a wide range of different species.

### GOOD PRACTICE

### Plant and animal species diversity

- Biodiversity levels are affected by field margins, the hedges and walls between fields, as well as the chosen crop
- Hedges or Knicks (a typical feature in the Schleswig-Holstein region of northern Germany) can support a huge number of mammals, birds and insects. They not only increase biodiversity, but also help to prevent wind erosion, and are useful wildlife corridors, connecting other important areas in the landscape such as fallows and small woodlands
- In cereal based cropping systems, WOSR is an important crop for increasing biodiversity, due to its positive effect on honey bees, bumble bees and other insects
- WOSR's dense canopy provides good shelter for ground dwelling insects, animals and larvae. Spiders and beetles are also found in great numbers. Some wildlife species are important predators of crop pests

### Potential areas for improvement

- Create field margins alongside water bodies to increase biodiversity. Consider using buffer and fallow (set-aside) areas
- Enhance awareness of conservation value and potential benefits for farmers (such as pollination and biological pest control) of improving habitat quality
- Support the development of better methods of estimating farm biodiversity levels based on landscape elements (REPRO for example)
- Engage with non-governmental organisations that have 'on-farm' biodiversity expertise and can help farmers identify areas for potential improvement

### Estimating biodiversity levels at farm level

**A direct assessment of biodiversity on the farm level is expensive and time-consuming. The REPRO approach (see page 21) allows farmers to calculate the potential biodiversity based on a number of different and easily available parameters, such as the number of different crops on the farm, field size and variability (see table for details).**

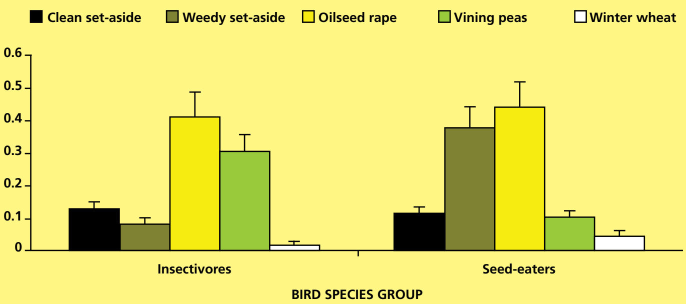
| Level | Data availability | Background |
|---|---|---|
| **Primary landscape structure** | | |
| Proportion of natural landscape (%) | Data is available from National Agriculture Statistics | |
| **Secondary landscape structure** | | |
| Crop diversity index | Farm data and Shannon Weaver index | In total, the different single indicators provide a comprehensive assessment of the potential number of niches on a farm. |
| Proportion of green fallow (%) | Farm data | |
| Pesticide free area (%) | Farm data | |
| Field size and variability | Farm data | |
| Pesticide index | Farm data calculated in REPRO | These indicators give information about the quality of the ecological niches. |
| N-balance (kg/ha) | Farm data calculated in REPRO | |

## Oilseed rape and bird populations

WOSR was included in two studies by the British Trust for Ornithology (BTO) between 2000 and 2005 investigating effects of farming practices on the relationship between crops and birds. The studies focused on the effect on bird abundance and variety of introducing WOSR into a cereal rotation (also containing peas and set-aside) compared with vining peas, cereals and sugar beet. They took place at Unilever's experimental farm at Colworth, UK, and on 19 farms in eastern England.

WOSR was highly effective in attracting birds year-round. At Colworth, replacing just 10% of winter wheat with WOSR increased bird abundance by 80% in midsummer. Both insectivorous (thrushes, wagtails and warblers) and seed-eating species (sparrows, finches and buntings) benefited from the presence of flowering oilseed rape in the summer. Both groups need insects – which the flowering crop attracts in massive abundance – to feed their young (see chart).

SUMMER AVERAGE DENSITIES OF BIRDS USING DIFFERENT FIELD TYPES AT COLWORTH




**A reed bunting, one of many bird species to benefit from the huge variety of summer insects attracted to WOSR flowers.**

**Good farm management considers biodiversity on all scales. The sea of rape and distant woodland dominate the broad landscape. Habitat diversity can be assessed by measuring bird populations - for example, the whitethroat (above), which like other warblers is an insect eater. Field margins at the micro level provide rich biodiversity – the right hand picture shows a colourful and rich borage and coriander mix which attracts beneficial insects.**

# Value chain

## Sustainable WOSR production must be productive, competitive and efficient.

Product value, an important component of the value chain, is determined by the combination of WOSR product quality and yield per hectare. Oilseed rape oil has a very high proportion of monounsaturated fatty acids (65%) and only a small proportion of saturated fatty acids (6%). Oilseed rape oil is a great source of polyunsaturated fatty acids, which contain a high proportion of omega-3 and omega-6 that can help to manage cholesterol levels in the diet.

Yield per hectare should be maintained or improved where possible as a measure of the economic sustainability of WOSR. Seed yields vary widely under European conditions. The maritime regions of northern Germany, Denmark, France and the UK allow for yields above 5 tonnes per hectare, whereas in unfavourable years and under difficult soil conditions yields may not even reach 3 tonnes per hectare.

The use of certified seed in WSOR production is an elementary prerequisite for high yields and good product quality of rape oil and rape meal. Quality of the final oil product includes both tangible aspects (taste, colour and appearance) and perceived quality (consumer convenience, nutritional value, food safety, environmental performance and social responsibility). Consumer sensitivity over pesticide residues makes it essential to conform to Maximum Residue Level (MRL) regulations.

To assess WOSR quality, several aspects should be considered: composition of the product from a nutritional and technical point of view (fatty acids); production process in the field; and optical and sensoric quality (taste).

**GOOD PRACTICE**

### Harvest

- Harvest, cleaning and drying is particularly important for product quality
- Inspect fields carefully before harvest, for example by monitoring maturity
- Ensure that harvesting machinery is well maintained and set up correctly for WOSR
- Note that harvesting efficiency is important in maximising product value
- Time harvesting to ensure uniform maturity

### Storage and drying

- Stores must be cleaned prior to harvest – storage hygiene is critical if a season's yield is not to be lost in contamination
- Consult your processor on the correct moisture content for storage. If drying is necessary, this should be done gently, in terms of heat and physical handling. Excessive heat and rough handling in store can both lead to loss of quality
- Adequate airflow through the seed is very important. The depth of seed to be dried will be less than for cereals, as oilseed rape seeds are far more resistant to airflow
- Maintain routine inspections of the seed during the storage period
- The need for pesticides in store will be reduced if drying is carried out correctly. Applications of pesticides to the stored crop should be avoided as these have great potential for leaving residues, and may lead to rejection by the processor. If pesticides have to be applied in-store, check with the processor first
- Detailed guidance on correct storage and drying practice is available at www.ufop.de and www.hgca.com

### Potential areas for improvement

- Use varieties which show a homogenous ripening and allow for a uniform harvest date
- Allow for detailed traceability
- No direct drying with fuel burners as these can leave partially burnt fuel residues (polycyclic aromatic hydrocarbons) which contaminate the oil

**Farmers assessing harvested WOSR seeds before they are sent to storage before processing. The harvest is the culmination of a year's work, but mistakes in timing at this final stage can ruin everything (top). It is critical to keep a close eye on moisture content at all stages.**

**WOSR maturing healthily, with the seed pods swelling evenly during summer heat. A pod displaying highly desirable even ripening, uniform seeds, which is free from disease or damage (above and right).**

**Field trials testing for quality, yield, and adaptation to specific soil and other conditions. Farmers should keep abreast of new and improved varieties which may help them to reduce inputs and therefore save money (right).**

# 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.

The efficient use of renewable resources should be targeted because the use of non-renewable sources, such as fossil fuels, 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, nitrous oxide emissions and acidification. A lifecycle assessment of WOSR can help to quantify the contribution of agricultural activities to total energy use and emission levels of the total lifecycle, from field to consumer. The biggest indirect energy input in WOSR is related to fertiliser production, while a major component of direct energy use is the cultivation and harvesting operation. These areas can easily be optimised from an energy point of view. Although the physical yields of WOSR are only half those of cereals, the energy output is almost the same due to WOSR's high oil content.

## GOOD PRACTICE

### Energy use in WOSR production

- Use of fossil fuels for power generation (for example, in vehicles) should be minimised and biofuels considered as an alternative
- Mineral or synthetic fertiliser use should be optimised
- Field operations, including transportation, should be reduced where possible

### Potential areas for improvement

- All parameters of energy efficiency are closely correlated with production so it is important to increase yields with constant input

### Energy: Balances and benchmarking with REPRO

An energy balance can be used to calculate how much fossil fuel is used by a cropping system. This can help to optimise fuel use on farms and act as a stimulus for identifying practices or inputs which require less or no fossil fuel.

REPRO uses data available from farms to calculate energy input and output:

- Energy input: The direct and indirect input of fossil fuels into the system, taking into account site-specific parameters such as soil type. It requires more energy to plough heavy clay, for example, than light sandy soil. The energy input of mineral fertilisers also varies according to soil type, composition and amount, as well as the energy required to manufacture specific fertilisers.
- Energy output. The physical calorific value of the products removed from the field after harvest, calculated using the yield and energy content of ingredients.

The table shows an example of energy balancing for a WOSR crop using REPRO. All input and output energy data are noted (in gigajoules per hectare) for a comprehensive calculation of energy indicators. The output/input relation is particularly important, with a higher figure being favourable. In this example, the system produces considerable net energy. The variability between the years is mainly due to differences in yields.

| Year | 2001 | 2002 | 2003 | 2004 | 2005 | Mean |
|---|---|---|---|---|---|---|
| Energy fixation yield (GJ/ha) | 112.9 | 84.6 | 80.7 | 131.3 | 126.3 | 107.2 |
| Input mineral fertilizer (GJ/ha) | 7.8 | 9.5 | 10.1 | 9.1 | 7.3 | 8.7 |
| Seed material (GJ/ha) | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Input plant protection products (GJ/ha) | 1.5 | 1.3 | 1.4 | 2.0 | 5.8 | 2.4 |
| Input fuel (GJ/ha) | 3.7 | 3.8 | 3.7 | 3.7 | 3.3 | 3.6 |
| Input machinery and implements (GJ/ha) | 1.2 | 1.2 | 1.1 | 2.1 | 1.2 | 1.3 |
| Input fossil energy (GJ/ha) | 14.2 | 15.7 | 16.4 | 16.9 | 17.6 | 16.2 |
| Energy-output (GJ/ha) | 112.8 | 84.5 | 80.6 | 131.2 | 126.2 | 107.1 |
| Energy-account (GJ/ha) | 98.7 | 68.8 | 64.2 | 114.4 | 108.5 | 90.9 |
| Energy-intensity (MJ) | 161.6 | 239.6 | 261.5 | 166.6 | 180.0 | 201.9 |
| **Output/input-relations** | **8.0** | **5.4** | **4.9** | **7.8** | **7.2** | **6.6** |


**Every aspect of WOSR production requires energy, from soil preparation to planting, to spraying, harvesting and storage. Fertiliser production also takes high levels of energy. Farmers can optimise their energy use to a great extent through using the REPRO programme (see left) which will take account of local conditions and crop needs.**

# Water

The availability of clean, fresh drinking water is vital for the well-being of society and must be protected. Sustainable practices help to reduce losses and contamination of water supplies from agriculture.

Water quality is essential for healthy natural ecosystems. Water contamination is unacceptable. This includes contamination of ground and drinking water form soil erosion, fertilisers and pesticides. Strict European and national regulations govern the amount of fertiliser used and dates it can be applied. The EU Water Framework Directive is further increasing the protection of waterways, brackwater, seawater and groundwater aquifers.

WOSR is a rain-fed crop in Europe. Its extensive root system and volumes of easily mineralised crop residues impact on the nitrogen turnover in soils in several ways. In autumn, WOSR is one of the crops with the highest nitrogen uptake potential. This substantially reduces the risk of nitrate leaching to groundwater during the winter leaching period. After harvest, WOSR is usually followed by a winter cereal, which only takes up a small amount of nitrogen before winter, thus there is potential for nitrate leaching – depending on soil type and weather conditions. However, those two effects combined, calculated over the entire crop rotations, reveal only an average risk.

**GOOD PRACTICE**

- In some regions it is possible to reduce the risk of post-harvest nitrate leaching by growing catch or break crops which will absorb nitrogen in the roots and leaves. However, in the maritime conditions of northern Europe (with a few exceptions, including Bavaria) the time between the WOSR harvest and the next sowing is too short to be useful for catch or break crops

**Potential areas for improvement**

- Minimise soil tillage operations after harvest to reduce risk of leaching, leaving plant residues to protect the soil surface
- Keep abreast of developments and release of new WOSR varieties with higher nitrogen efficiency. In particular, be aware of any new varieties using less nitrogen and which provide a good harvest and high yield
- Farmers are encouraged to join or create water catchment groups

**A carefully farmed landscape that is managed to protect the pond at the bottom of the slope. Field margins, riparian strips including mature trees do much to prevent the leaching of nutrients into the pond, so minimising the danger of eutrophication.**

**Measuring nitrate leaching losses helps optimise fertiliser management and prevent pollution of local water supplies (left).**

# 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 improve social and human capital. But the prime responsibility remains 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 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 base for the WOSR business. Social and human capital forms the basis for innovation, building confidence and creating trust.

Sustainable agricultural production can help development in rural areas by improving living and working conditions, and creating jobs. WOSR is an important economic crop and can help to maintain or improve farm income.

Farmers from the Schleswig-Holstein region of northern Germany have participated up to now for almost two years in the pilot project on Sustainable Winter Oilseed Rape Production. In the course of the project, the farmers came together several times to get information on the development of the various indicators. This encouraged a discussion among the group about the relevant areas and the best way to reach certain targets. Such a discussion is a core characteristic of the process of sustainable development.

# 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 sourcing locally. The production of WOSR provides a source of income for both farmers and their local communities. This is reflected in the amount of money spent on sourcing goods (including raw materials) and services.

Sustainable WOSR production can form the basis for substantial beekeeping and honey production. The bright and attractive WOSR flowers can also encourage tourism in the surrounding area.

In Germany, for example, tourism is especially increased in areas with WOSR production due to its beauty during the flowering season. In some areas of Schleswig-Holstein the flowering of oilseed rape is celebrated every year as a big cultural and tourist event.



**Tourists in northern Germany flock to see the dazzling oilseed rape fields in flower. Visitors make a substantial contribution to the local economy as well as offering growers an opportunity for dialogue with the public about farming and sustainability.**

**An open day where growers and experts are debating the merits or otherwise of different WOSR varieties in the light of new knowledge (above).**

**A grower workshop and brain storming session. Regular sessions with farmers, suppliers and agricultural researchers help to keep everyone in the picture.**

# The farmer's view

These farmers all took part in the pilot project on Sustainable Winter Oilseed Rape Production at eight farms in the Schleswig-Holstein region of northern Germany, on which these guidelines are based.

**Jochen Moellenhoff is manager on Gut-Koselau farm:**

"I believe we farmers do everything possible to produce high-quality products. Our aim is to produce a 'perfect' commodity in the most natural way. However, not all consumers are convinced about our good intentions, following various food and agricultural scandals in recent years. That's why we must demonstrate publicly, and particularly to the communities where we operate, that our rape production is sustainable. That way we can restore the confidence of our trading partners as well as strengthen our position in the market. It is more important than ever that we use our resources carefully and transparently, with great care of the environment, not just so that we are seen to be doing the right thing but because it benefits the farm and the wider environment in the short and longer term too. We are learning all the time. We must respond to public perceptions, and keep abreast of new techniques and management strategies so that we protect the soil and keep on raising standards."

**Bernard Schwartkop, Krempdorf:**

"Our farm complex at Krempdorf is in the delta of the river Elbe near the North Sea. The historic Elbmarsh farm buildings are considered a cultural landmark, with parts dating from 1690. The soil is a heavy marsh silt which stores water well, and has a high potential yield. Much of the land is below sea level, and has to be artificially drained. We farm intensively but also cost effectively, even though these soils can be a challenge for machinery. What interested me in this WOSR project was the idea that we must continue to preserve our resources – as our ancestors have done, and this can only be achieved by enduring good management based on sustainability. This in turn comes from understanding the consequences of what we do – measuring inputs and outputs, and analysing our systems – and seeking constant improvements. We are already seeing the benefits of our improved management, and we will continue along this road. I see improvements in quality, leading to steady sales, and lasting trade relations. Additionally, we have found new partners who have helped to optimise our production. While we can explain our past, the future is largely unknown, but working with partners with similar ideals seems to be a good way forward."

**Heiner Hartmann has managed the farm at Hohenfelde since 1999:**

"Our farm comprises 110 hectares near the Baltic coast. The soils are sandy loams which formed after the last ice age. At the second branch of the farm, I operate a piggery. Most years, winter oilseed rape takes up about a third of the area of the farm and is therefore a very important crop for us. I advocate conventional agriculture and share the arguments of the other farmers in the Sustainable Winter Oilseed Rape Production project. The project has confirmed the way I manage the farm and the value of assessing sustainability in agricultural production. My main focus is soil protection and secure yields as well as good marketing of the products. A transparent production, which ensures a sustainable production which goes way beyond the legal regulations is important for me, and I would like to communicate this to the consumer. The evaluation of my winter oilseed rape production and the optimisation of the husbandry resulting from it is an important basis for cost-efficient and sustainable production."

# Appendix

## REPRO: a tool for environmental and quality management at field and farm level

The REPRO model has been used by the lead agricultural project team at the Martin-Luther-University Halle-Wittenberg, to help farmers improve the sustainability of their winter oilseed rape crop.

The REPRO model integrates all important energy and material flows at farm and field levels. The evaluation is based on the following input data:

- Climate and soil conditions including GIS data (if available)
- Structure of the farm (crops, crop rotation, animals)
- Husbandry (all input data, working load, dates of application of fertilisers and pesticides)
- Storage details

The data required for the calculation may be taken from electronic field books or the farmer can edit the information. All background data (composition of fodder, fertilisers, energy input, etc.) is available in the model and is used for the calculations.

The result is a virtual farm model which allows you to calculate:

- energy and material flows in the system, soil – plant – animal (N,P,K,C)
- nitrogen losses and nitrogen efficiency
- soil organic matter balances
- erosion risk
- energy intensity and energy efficiency
- environmental risk of pesticide application
- carbon cycle of the farm include source and sink relations

### The analyses include:

- detailed protocols of all field operations and storage (documentations, traceability and cross compliance)
- energy, carbon and material flows
- visualisation of all results
- comparison of current situation with target figures
- optimisation on the field and farm level of all above mentioned parameters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## Further reading:

For further information on Unilever's sustainable agriculture initiative please visit:
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