# The Maltese Code of Good Agricultural Practice

**Background**

The following Code of Good Agricultural Practice (COGAP) has been developed to deal not solely with the Nitrate Directive but constitutes an exhaustive compilation of all good practices pertinent not only to the Nitrates Directive and the Malta Action Programme but also to all the other Directives, prevailing National Legislation, Good Farming Practices as well as a number of potential practices under a voluntary basis.

Malta's COGAP has been elaborated to provide long-term sustainable directives to farmers not only to produce from an environmentally friendly point of view, but also on a cost-effective basis. Following the recommendations of the code should be advantageous both for the farmers and for the environment.

The code contains recommendations concerning all aspects of agricultural production, namely:
Animal husbandry
Manure handling
Fertilization practice
Irrigation practice
Plant protection.

Malta has transposed EU Directives as the Nitrate Directive, Water Framework Directive and others into national legislation. In the transposition of the Nitrate Directive Malta implemented an action programme with measures that are specified in annex II and III of the Nitrate Directive. As explained below these measures or codes are mandatory for farmers and constitute part of the Code of Good Agricultural Practice.

A table that indicates and summarises which of the codes are obligatory and mandatory for farmers and which of the codes are voluntary, has been accordingly formulated. It divides the different codes into four sections in the table as described hereunder :
1st Section – Codes that are obligatory for all farmers because they form part of the Nitrate Directive, more specifically of the Malta Action Programme for Nitrate Directive (Nd);
2nd Section – Codes that are obligatory for all farmers because they form part of other Directives (Od);

3rd Section – Codes that are obligatory for farmers entering into any Agri-environment commitment and/or are in receipt of compensatory allowances in Less favoured Areas, since they form part of the Good Farming Practices (Gf);
4th Section – Codes that are voluntary for farmers (Vc).

As a further reference, near each code, within the text, a two letter code has been included to refer to the categorisation of that particular code within the four sections mentioned above.

**Division of Codes within the following categories:**

| Category | Two letter Code | Code Numbers which fall within these divisions |
|---|---|---|
| Obligatory Codes part of the Nitrate Directive | Nd | 4/21/24/29/32/33/35/41/44/45/46/ 48/49/50/51/52/53/54 |
| Obligatory Codes part of other Directives | Od | 2/3/5/6/7/9/13/15/20/22/23/26/27/28/30/31/34/47 |
| Codes which are part of Good Farming | Gf | 10/19/56/76/86/87/89/91/92/93/94/95/96/97/100 |
| Voluntary Codes | Vc | 1/8/11/12/14/16/17/18/25/36/37/38/39/40/42/43/55/57/58/59 /60/61/62/63/64/65/66/67/68/69/70/71/72/73/74/75/77/78/79 /80/81/82/83/84/85/88/90/98/99 |

The Code of Good Agricultural Practice was elaborated within the Twinning Light Project MT 2001/IB/AGRI/01/TL funded by the EU in 2003. It was drafted by a team of experts from the Agricultural Services and Rural Development Division in Malta, experts from the Federal Agricultural Research Centre (FAL), the Federal Biological Research Centre (BBA), both in Braunschweig and the Federal Ministry of Consumer Protection, Food and Agriculture, Germany.

The recommendations in this Code have been drafted according to current scientific knowledge and technical agricultural standards. This code shall be revised and modified at regular intervals in close cooperation with the people concerned so as to be based on the latest scientific and technical knowledge plus experiences together with socio-economic developments.

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# 1 The Situation of Agriculture and the Environment in Malta

## *1.1 The Maltese Islands*

### 1.1.1 Location and Area

The Maltese Islands have a total area of 316 square kilometres and are located in the centre of the Mediterranean Sea, approximately 100 km south of Sicily. The archipelago consists of three main islands, namely Malta, the largest, (about 245 km², population of about 350,000), Gozo, the second largest, (67 km², population of about 30,000), and Comino, which was only inhabited by three people in 2003.

### 1.1.2 Climate

The climate of the Maltese archipelago is typically Mediterranean, with dry, hot summers and mild rainy winters.

For the past century, the mean monthly temperature registered for the summer season was 35°C, while the lowest recorded was 11°C in the winter months of January and February. The hottest month in the Maltese Islands is July, with the average highest temperature of 36°C. Temperatures during the past century never reached the freezing point, and snow is practically unknown. The average temperature for the past century has tended to increase. The highest precipitation occurs in November, December, January and February. However, rainfall in the Maltese Islands is unpredictable. Some winter months may produce abundant rain in one year and little or no rain in another.

The Maltese Islands are heavily influenced by the strength and frequency of winds. The most common of these are the north-westerly and north-easterly winds. The north-easterly wind usually blows straight into the mouth of the Grand Harbour and Marsamxett, where it can restrict shipping operations. The south-westerly wind blows from the Sahara Desert, bringing with it hot air currents and sometimes ‘red rain’. Humidity tends to be high in Malta, averaging between 65 per cent and 80 per cent.

### 1.1.3 Geology, geomorphology and hydrogeology

The Maltese Islands are almost entirely made up of sedimentary rock deposited in a marine environment during the Oligo-Miocene period. These limestones and clays form a series of stratigraphic layers of varying composition and hardness. In a few localised places, these are unconformably overlain by sparse Quaternary terrestrial and raised beach deposits, most of which are of high palaeontological importance.

The geomorphology of the Maltese Islands is largely determined by tectonism, drainage, doline features, drowned valleys and drowned doline structures. The five main rock layers making up the Maltese Islands have an undulating tilt towards the northeast, thus producing two types of coastline, a gently sloping rocky coast on the north-eastern side and a steep cliff-dominated coastline on the south-western and western side of the Islands. Superimposed on this general dip are the effects of faulting and differential erosion.

Faulting, especially that brought about by the Great Fault system, resulted in the formation of broad valleys that slope gradually to sea level forming relatively broad sandy bays. The second factor that influences geomorphological patterns, especially near the coast, is erosion. Due to the structural properties of the various rock layers, these do not erode uniformly under the action of wind, waves and rain.

The islands' natural water resources depend entirely on rainwater percolating through the porous limestone rock and accumulating in aquifers from where it either seeps out, or is pumped by man. The largest aquifer is the main sea-level aquifer that consists of a Ghyben-Herzburg lens of freshwater floating on denser saline water in limestone rock at sea level. The other aquifers of importance are the perched aquifers, which consist of rainwater trapped in the permeable Upper Coralline Limestone due to the underlying layer of Blue Clay that acts as an aquiclude. Water seepage from the perched aquifers occurs wherever the Upper Coralline Limestone/Blue Clay interface is exposed, giving rise to high level springs which drain into watercourses (*widien*). The renewable groundwater potential of the Maltese Islands is estimated at 40 $mm^3$/yr. An estimated 20 $mm^3$/yr are extracted from potable water production sources (13 pumping stations and 160 boreholes) and about 5,113 registered private wells.

Structurally, Malta tilts gently to the east giving rise to a topography that is high along the western shores and gently slopes down to sea level along the eastern shores. The surface drainage lines cross the entire width of the island from their source close to the western shore before reaching the sea on the east. This favourable topography, combined with good water storage capacity of the soil, excellent infiltration characteristics and effective runoff interception by numerous dams and cisterns, gives the surface water maximum time to seep into the ground and minimises runoff losses to the sea. The total surface water resources are estimated at 0.5 $mm^3$/yr. The total dam capacity of a large number of small dams constructed across the drainage lines is estimated to be 154,000 $m^3$.

The water availability in the Maltese Islands is determined by climate and catchment characteristics. Rainfall is the only natural source of water. The seasonal distribution of rainfall defines a wet period (October to March with 70-85% of the total annual precipitation) and a dry period (April to September).  The average annual precipitation is circa 530 mm. However, rainfall is highly variable from year to year.  Only a small percentage (6%) of this rainfall is lost directly to the sea as surface runoff. The rest of the water percolates through the ground where it is partly retained by the soil. Most of this water (70-80 % of total rainfall; Cilia and Schembri, 1992) is in turn lost to the atmosphere via evapo-transpiration.

The remaining water percolates deeper into the ground until it reaches the aquifers as recharge water. It is estimated that almost half of this recharge water is in turn lost to the sea by natural subsurface discharge at various points along our coastline.

### 1.1.4 Soils

Maltese soils are characterised by:

- their close similarity to the parent rock material;
- their relatively young age;
- the general lack of soil horizon differentiation;
- the influence of human activity and disturbance of soil.

## *1.2 Agriculture*

Agriculture's share in the GDP for Malta has been declining in view of the relatively high rates of total GDP growth since the 1980s, and presently stands at 2.5%. The development of agriculture in Malta is constrained by the natural and geographical characteristics of the islands. The major constraints facing agricultural activity are the opportunity cost of land, the scarcity of water resources and the high labour costs.

Two factors hampering the development of agricultural and specifically horticultural output are water shortage and land fragmentation. Land fragmentation is caused mainly by the laws of inheritance under which the land is constantly sub-divided until it is no longer feasible to work it profitably. For the most part, the fields are composed of terraces. The shape and size of the individual plots often makes cultivation difficult and the use of heavier agricultural machinery more complicated. Land in Malta is owned 2/3 by the state and 1/3 by the private sector. Growers are thus reluctant to make long-term investments due to the risk of not continuing to hold tenure on their land.

In 2000, the total agricultural land area in the Maltese Islands was established at 10,738 ha, representing a decrease of 396 ha when compared to 1991. This decline continues to accentuate the trend of loss of agricultural land established over the past 50 years. The amount of dry land decreased from 9003 ha to 8240ha, however, the irrigated land area increased by 367 ha over the same ten-year period. The agricultural land in the Maltese Islands is categorized into:

- **Irrigated land** (*raba' saqwi*): land which depends on a source of irrigation water, other than rain, during the entire agricultural calendar;
- **Dry land** (*raba' baghli*): land which depends solely on rain for irrigation of crops;
- **Unutilised/garigue land** (*raba' moghxa*): land that is registered as agricultural land but is considered to be unproductive, or marginally suitable for agriculture, due to a number of limitations.

87% of the agricultural parcels are less than one ha in area, and 99.7% of the parcels are less than 5 ha.

The total number of registered tenants of agricultural land in 2000 was 11,400; of these, 974 were full-time farmers, and 10,426 were part-timers (NSO, 2001a).

42.6 % of land tenants are over 60 years old, and another 46.7 % are aged between 40 and 60. Compared to the situation in 1990, when 33.6 % of the tenants were below the age of 40 (SoE 1998), the present statistics show that only 10.7 % of tenants are below the age of 40.

Potatoes are by far the major agricultural crop (excluding fodder crops), followed by tomatoes, onions, melons (including watermelons), broad beans and cauliflower (including broccoli).  Cultivation of *Solanaceae* (potatoes and tomatoes) exceeds that of all the other vegetables combined. 69% of the total area of the Maltese Islands that is used for the cultivation of vegetables and other crops (excluding fruits and fodder) is dry agricultural land, whilst only 31 % is irrigated land.

The cultivation of fruit is dominated by grapevines, followed by peaches and related stone fruits; carobs, citrus fruits and apples/pears are next in importance. 91 % of the land area occupied by fruit trees is located on the island of Malta, whilst only 9 % is on Gozo.

Many of the types of trees cultivated have a high rate of water consumption, a particularly unfortunate characteristic in the relatively semi-arid Maltese environment. In this regard, field observations suggest that fruit orchards are relatively concentrated within specific valleys with abundant natural water supplies.

Cereals account for 73 % of the total fodder crop on the island of Malta, as opposed to 49 % in Gozo, whilst the respective figures for legumes are 26 % (Malta) and 49 % (Gozo).

During the past fifty years, Maltese agriculture has moved away from traditional practices towards intensive systems relying more on the use of fertilisers and agro-chemicals.  Between 1956 and 2001, the total agricultural land declined from 20,433 ha to 10,713 ha, however, during the same period, irrigated land as a percentage of total agricultural land increased from 4 % to 11 %. According to recent statistics, approximately 12% of the arable land (1143 ha) in the Maltese islands is irrigated. The greater part of this irrigated land area is located in the northern and western regions of Malta, where shallow groundwater is readily available from the perched aquifers.

Beyond 2001, the extent of irrigated land is projected to increase substantially, following the completion of three new sewage treatment plants.  The implementation of the Sewerage

Master Plan, and the construction of two new sewage treatment plants in Malta and one in Gozo will generate sufficient treated sewage effluent for the irrigation of a total of about 2090 ha of agricultural land. This means that if the decline in agricultural land were to be stopped, in 2010, the irrigated area would represent about 34% of the arable land in the Maltese Islands.

The most widespread sources of irrigation water are the large number of boreholes that abstract water from the mean-sea level aquifers. A number of fresh water springs are tapped for irrigation. In some areas, the water emerges from man-made galleries excavated at the Upper Coralline Limestone-Blue Clay interface. These galleries are gradually and slowly replenished by natural spring water from the perched aquifer and periodically emptied into a cistern or reservoir. The deep wells (*spejjer*) also harvest water from the perched aquifers by pumping. Throughout the centuries, several farmers have built or dug small reservoirs in the rock to collect rainwater that is primarily used as a source of supplemental irrigation. Recently, several reservoirs with capacities ranging between 100 $m^3$ to 2,000 $m^3$ were constructed for irrigation development, some with financial assistance from the government. Some of the water harvesting and water catchment structures are privately owned, however, in most cases, the source of water is shared and administered in traditional farmer managed irrigation systems since both the land and water rights are inherited with the lease.

In the past 20 years, the use of treated sewage effluent has enabled further expansion of irrigated land. In 1983 the Sant Antnin Sewage Treatment Plant (SASTP) was built in the south eastern region of Malta [13]. The plant was originally designed with a capacity of 12,000 $m^3$/day, and subsequently upgraded to 17,000 $m^3$/day in 1998. The treated sewage effluent used for irrigation is pumped to five reservoirs situated on high ground having a total capacity of 11,840 $m^3$. The water flows to the fields by gravity in open channels built on the rubble walls that separate the land parcels. The construction of two new sewage treatment plants in Malta and one in Gozo is estimated to augment the availability of treated sewage effluent by a total of 26.7 $Mm^3$/yr.

According to the census of cattle farms carried out by NSO in 2000, there are 260 dairy and beef cattle units in Malta and Gozo. Most of the farms (about 55%) are not specialised and are engaged in both milk and beef production. The cattle herd was established at 20,326 heads. The breeding stock totalled 11,989 heads of which 9,306 were milking cows. There are 174 pig farms in the Maltese Islands of which 138 are production units, 18 are fatteners, 16 farms are engaged in both activities, and another two farms are involved in other activities. The pig stock amounted to 80,074 heads.

In Malta there are approximately 1,100 breeders of sheep and goats with a total herd of 7,492 sheep and 3,328 goats (A. Atanasio, Department of Veterinary Services, personal communication). Most of these are small farms concentrated in rural areas and operated as a small cottage industry. The number of poultry animals is estimated at 5,500,000, the number of rabbits at 2,400,000 and the number of horses at approximately 600 (Jackson, 2001).

## 1.3 *Environmental impacts of agriculture*

The major issues associated with the environmental impacts of agricultural activity are related to competition for land resources, displacement of natural biotic communities, and the release of chemical pollutants into the environment.

The quantity of inorganic nitrogen fertiliser fluctuates from year to year. The maximum consumption of nitrogen on an annual basis was reached in 1998, when an average of 147 kg N/ha were used. Since the data refers to import statistics rather than actual consumption, the indication is that stocks are replenished regularly through imports. The import statistics do not include the land application of nitrogen through organic manures. In terms of phosphorus fertilisers, the importation is relatively stable at about a mean of 13kgP/ha/year. The consumption of pesticides has also remained relatively constant in the past three years, however, when compared to 1998, the importation seems to have dropped by more than 50 %.

The most important environmental implication of livestock farming is the generation of animal waste, and its disposal in such a manner as to prevent contamination of the freshwater aquifers, drinking water supplies, bathing water, air and soil. If managed properly, animal waste can become an important nutrient resource with economic value.

Analysis of the density of animal farms in Malta (Jackson, 2001) suggests that the largest concentration of cattle and swine production units are located within the water catchment areas overlying aquifers with the highest nitrate levels. The temporary storage of manure on bare soils and leaking cesspits on the farms are thought to be the major point sources of nitrogen pollution (Mangion, 2001). A study on the quality of irrigation water in Malta (Farrugia, 2000) has also demonstrated that higher nitrate levels in the perched and mean sea level aquifers are associated with irrigation sources from sites in the vicinity of a noticeable source of pollution. On a national basis, the livestock density for the Maltese Islands can be estimated by taking into account the total agricultural land under forage cultivation. According to these estimates, the livestock density is 4.85 LU/ha.

The rate of groundwater abstraction exceeds the maximum potential extraction rate for sustainable production, and is the main cause of groundwater depletion and seawater intrusion. Many of the high level springs used to flow all year round, albeit with a much reduced flow in the dry period, however, most have now been tapped by farmers for irrigation. Accurate statistics on the exploitation of the aquifers (perched and mean sea level) by the agricultural sector are not available. This is mainly due to the fact that private groundwater abstraction (both for agriculture and industrial purposes) is not metered. As of July 2001, there were a total of 5,113 private groundwater sources registered with the Water Services Corporation in accordance with Legal Notices 120 of 1997 and 182 of 1999.

It has been estimated (Mangion, 2001) that the utilisation of groundwater for irrigation purposes in Malta and Gozo amounts to 12.5 $mm^3$ per year (37,000 $m^3$ per day), or approximately 40% of the total productive capacity of the aquifers. In addition to groundwater resources, irrigated agriculture also makes use of harvested rainwater.

Estimates for the billed potable water supplied through the public distribution system to a total of 1,822 premises classified as 'farms' for the period 1999/2000 amounted to approximately 6 % of the total billed potable water consumption for this period, as shown in Table 4.8.14 (A. Riolo, Water Services Corporation, letter dated 30th November, 2001).

In Malta, there are several areas where localised salinity problems have been experienced as a result of irrigating previous dry land with poor quality irrigation water. Such cases were documented as early as 1960 (Bowen-Jones *et al.*, 1961) in the South-east region, Bur ta' Sufa, and are increasingly common nowadays. In the past decades, several fields in the coastal zone of Armier, which are exposed to the prevailing north-westerly winds, have been abandoned as a result of the combined effects of soil erosion and soil salinity.

The use of treated sewage effluent for irrigation has been identified as a source of salinity in the southeast region (Muscat, 1997). Chemical testing of the soils in the irrigated area has shown that the electrical conductivity of the saturated extract increased by 278 % of its original value within one year by the end of the irrigation season. The accumulation of salts is prevented by irrigating in excess of crop requirements and maintaining a high leaching ratio. Compared to non-irrigated soils, the boron concentration of the soils in the southeast region was also found to be up to three times higher (Camilleri, 2000). In a study (Vella & Camilleri, *in press*.) on the extent of salt-affected soils in three selected sites – a dryland area, an intensively cultivated irrigated valley and the south-eastern irrigated area, it was reported that the highest percentage of saline fields (35%) were diagnosed in the latter.

## *1.4 Availability of data*

Substantial data on the fertility status of Maltese soils is insufficient. A small number of unpublished dissertation studies have been conducted (e.g., Sacco, 1997; Vella 1997; Sciberras 1999). In particular, a study undertaken by Mr J. Callus (EPD), contains data on pH, conductivity, N and phosphorus (P) content of agricultural soils between October 1999 and March 2000, but to date no comprehensive survey has been conducted to assess the fertility status of soils on a national basis. There is also a complete lack of experimentation and related data to enable the quantification and dynamics of nutrient uptake by the most important crops and their response to fertilisation. The levels of extractable nutrients in the soils as determined by soil analysis have not been calibrated against crop response until today.

# 2 Good Agricultural Practices in Animal Husbandry and Manure Handling

## *2.1 Introduction – Objectives and Background*

Livestock breeding and animal production is a source of food production. Farm animals are bred for the production of good quality food, namely meat, eggs and milk, for human consumption. Production entails the use of high amounts of feeds, many of which originate from importation. Eventually, these nutrients will find themselves in the local agricultural nutrient cycle. Most of these nutrients end up in waste and it must be assured that these nutrients are not lost into the air or into underground water but kept in the waste and recycled or removed as the need arises. It is the duty of the producers rearing animals, and thus producing waste, to see that pollution by these nutrients is avoided. This entails a set of rules which everyone involved must keep in mind in order to achieve these goals. This set of rules is better known as the ***Code of Good Agricultural Practice (COGAP)***

If farmers and producers follow the Code of Good Agricultural Practice regulations, it would be beneficial for the farmers because they would observe: -

- An increase in production, efficiency and profitability.
- A decrease in labour and costs.
- Better quality of produce.
- Better quality of life for producers and farmers.
- A reduction in pests, chiefly rats and fly populations
- An improvement in animal welfare and nutrition.
- Better air quality and less odours.
- Better quality of the underground water reserves.
- Better quality of the surrounding seas.
- An improvement of soil quality.
- An improvement in quality and quantity of crop production.

Maltese soils are a limited non-renewable resource. They lack humus and therefore are very poor in organic matter. Therefore, the use of organic fertilisers including farmyard manure is important for the soil. The use of straight inorganic fertilizers should be kept to a minimum.

It is uneconomical to use inorganic fertilizers in large quantities when there is a surplus of animal manure. The use of compost also helps, but this should be of prime quality otherwise it can also be a health hazard. Compost coming from municipal waste will improve the carbon to nitrogen ratio.

The main guiding principles in waste management are to reduce, reuse and recycle waste where possible. This entails cautious use of water. Saving water and preventing it from the waste streams would not only save money but would make the treatment, reuse and recycling of waste more efficient and less costly.

Similarly, the saving of nutrients in feeding animals would also make treatment, reuse and recycling of waste more feasible.

In the coming years 2004/2005, Malta will start treating the urban sewage waste before reusing water or before draining the surpluses into the sea. In doing so, the mixing of urban sewage waste with animal waste will not be allowed. This is because such combined treatment is impossible and in fact the separate treatment of such waste is a must. Therefore producers will have to address this issue and any waste produced will need to be transported to special animal waste treatment units for treatment and reused in agriculture where and when possible. The discharge of animal effluent into the drainage system shall end with the enforcement of the Drainage Regulation AL139/2002.

In addition, in view of the Directive 96/62 EC relating to air quality and ammonia emissions from farms, manure, slurry storage and its application has to be reduced to a minimum. This entails the taking of precautions during the rearing of animals, the collection and containment of waste and also in transport treatment and application of such waste.

## 2.2 *Animal Nutrition*

**1. Nutrients saved in the feed decrease nutrients in the excretions. (Vc)**

Avoid direct losses of feed to the manure by good management (feeding equipment).

Prepare the right particle size of feed (mash and pellet) suitable for the type of animal.

The feed requirements should be as near to the requirements of the animal as possible in order to decrease avoidable nutrient excretions. To meet the requirements every time, use feeding in stages (multiphase feeding). In this case the best option is to use more than one silo.

The feed (for ruminants) should contain the right relation of forage and concentrates. Forage quantity and quality should be as high as possible.

**2. Have careful preparation, storage, and transport of feed. (Od)**

Storage site must be clean, cool and dry and preferably away from where animals are kept.

Silos should be well ventilated in order to avoid condensation, regularly cleaned and foul feed should be removed.

Pellets should be of good quality so they do not break down during transport/handling.

Mash should be transported carefully so that mixing/separation is avoided.

Storage sites should be rodent/insect/bird proof.

**3. Antibiotics should only be used as and when prescribed by a Veterinarian. (Od)**

Withdrawal periods must be respected.

**4. Silage should be stored in appropriate leak-proof clamps. (Nd)**

Production of silage makes it possible to feed ruminants (cattle, sheep and goats) independent of the season with the consistent quality of forages. Good silage conserves nutrients well for a long time.

During silage preparation, silage effluents (seepage) are produced which must be immediately directed to cesspits. Silage clamps must be covered and rain water prevented from entering the clamp and the silage. Rain water will not only increase effluents, but also spoil the silage. The clamp floors should be waterproof and have means and slopes for guiding all effluents to cesspits without the inclusion of any rain water. Similarly, forages with high moisture content packed in big bales should be well wrapped.

## 2.3 *Animal Welfare*

**5. Good animal welfare and health conditions ensure good animal performance. (Od)**

Adequate space per animal should be provided in accordance with the provisions under the Animal Welfare Act. A good climate in the stables should be ensured.

Labels should inform the consumer about production methods and the animal welfare and health conditions.

**6. Animal carcasses have to be disposed off in the civil abattoir. (Od)**

## 2.4 *Farm Buildings*

**7. Farm buildings should be built and operated in such a way as to meet animal requirements and welfare and prevent environmental pollution. (Od)**

Good husbandry practices will secure a high performance and the production of good quality products.

**8. Wherever possible adequate covering should be provided over open animal areas prone to manure exposure. (Vc)**

Covering reduces the amount of foul water generated that would have to be collected and stored.

Covering avoids nutrient losses and consequently environmental pollution. A farm should be built in such a way as to prevent pollution of nearby sea, valleys or underground water reserves and reduce air pollution to the minimum.

Rainwater should be collected as clean water in reservoirs and any surplus should be directed outside. Collected water can be used for washing purposes.

Covering should be done in such a way as to give the best ventilation and provide heat and condensation removal for the best healthy environment for the animals.

**9. Ventilation should always secure good indoor air quality for animal health and welfare without creating environmental hazards. (Od)**

Good indoor air quality improves productivity and performance.

Use atomising spraying systems for cooling the input air during summer. This practice is a good and cheap cooling system.

Air change should be proportionate to the animal density and to the outside temperature.

**10. Drinkers and water troughs should be clean and sited in areas where any spillages and urine can be easily collected and directed into the cesspit. (Gf)**

Drinkers should be sited in areas where spillages and urine can immediately be removed and directed to a cesspit and any dunging will fall directly into the dung passages.

Leakages from drinkers not only create water losses but create large volumes of slurry and wet manure. Avoid blockage or leaking of drinkers.

Location of drinkers is important to reduce the possibility of accidental water spillages.

**11. Feed should be distributed properly. (Vc)**

Mangers should be located and constructed in a way to avoid losses of feeds and nutrients.

Mangers should be covered from direct sunlight and rain.

**12. Floors and walls must be impervious to outside substances and kept in a good state of repair. (Vc)**

Floors have to be kept clean and dry as possible and constructed taking into account species, age, weight of animal as well as management practices.

Floors should be easy to clean, well sloped but not slippery. These should slope to traps through which foul water is directed into the cesspit avoiding gases and pests from entering the stables from such areas.

**13. Good artificial lighting should be secured in production areas. (Od)**

Good artificial lighting should be provided if natural light is not sufficient as per the provisions of the Animal Welfare Act.

**14. Building materials used should be impervious, easy to clean and disinfect and should have a long life time (Vc)**

**15. Manure and slurry have to be stored outside the stable in proper storage facilities. (Od)**

Manure or slurry should not be stored underneath the animals but should be kept outside in a proper manure clamp or cesspit except for slatted animal housing systems.

Deep litter systems can be only allowed if there is sufficient bedding material to provide a clean and dry environment. Ideally manure should be removed daily from the animal stables.

**16. Keep the water consumption for cleaning purposes as low as possible. (Vc)**

Reduction of surplus water consumption means water savings, therefore the use of power washers is recommended.

Lower consumption of washing water will lower the transport costs of slurry and effluent.

Reduction of water will produce less wet manure and improves its fertilizer value with a reduction of bad odours and loss of ammonia.

Dairies use huge amounts of water for washings purposes and it is advisable that this water should be contained in a separate small cesspit. This water can then be used for washing parlour and collecting yards floors and directed to the main cesspit.

**17. A vehicle disinfection pit is recommended to be present at the entrance of the farm. (Vc)**

This should be available ready for use if the need arise especially when a warning of disease spread has been issued. This practice reduces the possibility of spreading of diseases.

## 2.5 *Fuel tanks*

**18. Diesel and any other fuels should be stored in a safe place away from hay storage and on a concrete platform so that any spillages can easily be cleaned and collected. (Vc)**

**19. Unserviceable equipment should not be left unattended in the farmyard or stables and should be removed as soon as possible. (Gf)**

If left to rot on the farm, such equipment will only serve to harbour pests, including rodents, which would increase the incidence of disease and losses of feed. Such equipment and similar rubbish should not be left on farms.

## 2.6 Manure And Slurry Cleaning Techniques

**20. Manure and slurry cleaning techniques should be frequent with complete movement of manure and slurry from the stables into a covered clamp or cesspit. (Od)**

Frequent cleaning reduces possible emissions sources affecting the indoor air quality and thus creating a healthy environment for the animals.

Frequency of cleaning should be higher in summer.

Frequent cleaning reduces nitrogen losses.

Scrapers should be maintained in good condition in order to ensure good and complete cleaning, avoiding emission losses.

## 2.7 Cesspits

**21. Cesspits must be leak proof and covered. (Nd)**

Cesspits should be covered to reduce emissions because of significantly reduced air exchange rates, but not air-tight to avoid formation and accumulation of explosive gases.

Cesspits should be leak proof to avoid nutrient losses and consequently the fertilizer value of slurry is maintained.

Back flow of gases and liquids into the stables should be avoided.

Toilets for human use should not be connected to farm cesspits but should be connected to a small separate cesspit.

## 22. Cesspits should not be connected to sewers. (Od)

Cesspits should not be connected to sewers, and collected effluents should be discharged by bowsers/tankers according to the directions issued by the competent authorities.

Nutrients present in slurry and manure should be preferably recycled and reused in agriculture as fertilizers.

## 23. Cesspits should have pre-settling for solid separation. (Od)

Cesspits should have at least one but ideally two pre-settling tanks to avoid difficult to remove solid sedimentation in the cesspit.

Settling tanks should be connected to cesspits via T-pipes to retain floating particles.

Settling tanks should be open, not very deep and easy to clean.

Sediment accumulated in settling tanks should be treated as waste and disposed of appropriately, either in manure clamps or a landfill.

## 24. The cesspit capacity must be sufficient to collect all urine and washings for at least 15 days. (Nd)

Cesspits in pig production should be emptied every week but extra space for at least another week should be available. This is required for possible bowser break downs. No rain water should attain the cesspit.

**25. Emptying of cesspits by tankers should not create any pollution hazard. (Vc)**

The area around the cesspit should be concrete, sloping towards the cesspit so that any spillages can be easily cleaned.

There should be a supply of cleaning water available so that any spillages, hosepipes, etc., can be cleaned.

## *2.8 Utilization of farm effluent and slurry*

**26. The producer has to keep records of slurry disposal. (Od)**

This record keeping should include the date, volume and where it was discharged in case the producer himself has the facilities to transport it. Otherwise, if a contractor is used, the name and signature of the contractor taking over the slurry for disposal as directed by the authorities should be taken. This will avoid environmental hazards.

**27. Liquid slurry and foul water can only be discharged in approved areas. (Od)**

Slurry can be used to fertilize agricultural land, however the rate of application should meet the crop requirements.

Slurry is high in nutrient content and its use requires prior approval by the authorities concerned (Agriculture, Health Authority).

## *2.9 Manure storage*

**28. Manure clamps should be sited adjacent to the stable and not in areas where surface water can reach them. (Od)**

In doing so, there is a reduction of the area which may be polluted, less emission losses and a reduction in bad odours.

Input of surface waters creates wet manure and consequently problems in its transportation, treatment and increase odours.

**29. Manure should be stored in a leak-proof, covered storage clamp which is connected to a cesspit. (Nd)**

Outside storage of manure under cover avoids nutrient losses and reduces emissions.

Covering of the manure clamp prevents the input of rainwater and the production of wet manure and foul water, thus decreasing the possibility of pollution.

Manure clamps should be rendered leak-proof with a concrete base to avoid leaching that can cause pollution to the surroundings and the underground water.

**30. Manure clamps should be built with three rendered high walls with the least possible surface : volume ratio. (Od)**

A reduction in the surface area implies a reduction in the emission of ammonia. The storage of manure in high heaps lowers nutrient losses.

A manure clamp with a small surface area is easier to construct and less costly to cover.

High heaps of manure can be obtained with dry manure. In the case of wet manure, check possible water losses, put water absorbing material in before filling or starting to fill up the clamp, or consider mechanical separation of manure.

The floor of the manure clamp should have a high gradient slope in order to facilitate the separation and collection of fluids.

**31. Filling and emptying of the manure clamp should be carried out in such a way as to avoid spillage and pollution of adjacent areas and roads. (Od)**

Trucks should not enter the clamp for emptying. Only the mechanical shovel can be allowed to enter the clamp. The loading area should be also have a concrete floor.

**32. Solid and liquid manure has to be stored in covered clamps from the 15th October to the 15th of March. (Nd)**

The rainy season is between these dates and manure and slurry application onto land is prohibited in order to prevent excessive nutrient run off and leaching.

The input of rainwater into the clamp prevents the manure from drying, while creating nutrient losses and consequently emissions and drainages that cause environmental problems.

Mechanical separation should be considered on large cattle farms to reduce the storage capacity required for the solid phase.

**33. Field storage of solid manure is possible between 16th of March to 14th of October if the dry matter content is at least 30% . (Nd)**

Field storage of manure can create atmospheric and underground water pollution and environmental pollution can only be avoided if the dry matter content is at least 30%.
High dry matter content requires the best water regime in husbandry or mechanical separation.

## *2.10 Manure transport and recording*

**34. Manure transport should not create any pollution hazards. (Od)**

Transport is allowed only in the summer prior to planting.
Trucks should not be overfilled and must be covered in order to prevent spillages.

**35. The producer and/or contractor has to keep records of manure transports. (Nd)**

Such records must contain at least the address and farm name of the contractor, the amount and kind of manure, the date of delivery and to where transported.

# 3 Good Fertilisation Practices

## 3.1 *Introduction: Benefits from Fertilisation*

Fertilisation means the application of those nutrients essential to crops that cannot be delivered by the soil in sufficient amounts to give optimum yields. There are 16 elements that are essential for plant growth (C, O, H, N, P, K, S, Mg, Cl, Ca, Fe, Mn, Cu, Zn, B, Mo). Many of these elements are already available in the soil. Those that are not available to plants and/or available in insufficient quantities may be added as fertilisers. Fertilisers should be added in a form that can be utilised by the plants and only in quantities that are needed for plant growth. It is not appropriate to apply fertilisers in excess of the amount essential for optimum plant growth, crop yield and crop quality. Excessive application of fertilisers results in over-fertilisation, which is ineffective, costly, and harmful to the environment. Both mineral and organic fertilisers can be used for fertilisation.

The availability of nutrients to the crop depends on the nutrient in question. Some nutrients are highly soluble in the soil water, such as nitrate and ammonium, while others, like phosphorus, are less soluble and are more or less fixed to the soil matrix. Nutrient plant availability decreases the more the nutrients are fixed to the soil matrix. Nutrient fixation also depends on some soil properties such as the content of clay and organic matter, and especially the pH value. Phosphorus and most microelements (e.g., iron, manganese, copper, zinc) are less plant available on calcareous soils with a high pH value. Such soils are frequently found in Malta.

There are different types of mineral fertilisers available. Single component fertilisers such as ammonium sulfate, urea, super-phosphate and potassium sulfate contain the major nutrients (N, P, K), and other elements such as sulfate, which is also essential for plant growth. Compound fertilisers, e.g., 12/12/17, contain several nutrients (12 % of N, 12 % of $P_2O_5$, and 17 % of $K_2O$). Organic fertilisers are multi-component fertilisers and contain all the essential elements. Most fertilisers are applied to the soil, however some, especially micronutrient liquid fertilisers, need to be spread on the plant leaves if the soils have a pH value above 7. Under these conditions, most micronutrients would not be available to the plants.

Besides fertilisers, there are other important sources for nutrient delivery that have to be taken into consideration for correct fertilisation planning. One of these is nitrogen fixation by legume crops such as clover, sulla, etc. These crops can fix nitrogen from the atmosphere and make most of it available to the following crop. Irrigation with treated sewage effluent also delivers significant amounts of nutrients that have to be considered in fertilisation planning.

It is highly unfeasible and uneconomical to apply fertilisers in a period without crop growth and in a way that the applied nutrients will not become plant available. In such periods, nutrients might get lost to the ground water by leaching, to surface or coastal waters by surface runoff and soil erosion, by volatilisation as ammonia gas or by denitrification to the atmosphere (see also Chapter 2: The situation of the agriculture and the environment in Malta). Easily soluble fertilisers like nitrogen fertilisers and liquid manure must be applied before sowing or planting or during plant growth when the crop needs the nutrients most. This keeps the time period in which nutrient losses from fertilisers occur as short as possible.

This chapter of the Code contains regulations on the proper use of mineral and organic fertilisers in relation to Maltese environmental conditions.

### *3.2 Storage and handling of mineral fertilisers*

**36. Mineral fertilisers must be stored in the original containers inside suitable storage facilities. (Vc)**

The storage area of mineral fertilisers should be enclosed and protected from rainfall, excessive humidity and heat. High air humidity compacts fertilisers and makes them unsuitable for application; moreover they will pollute the environment in the event of precipitation.

**37. Fertilisers should be stored in areas separate from fresh produce, nursery stock, animal food and food for human consumption. (Vc)**

Fertiliser dust can easily contaminate other products stored in the same facility. Fertilisers, pesticides and mineral oils may be stored in the same area provided that they are physically separated from each other and properly labelled.

**38. All fertilisers should be stored with the original label. (Vc)**

For a correct fertilisation plan, the concentration of each compound in a mineral fertiliser must be known. Mistakes in fertiliser application can be avoided if the fertilisers are properly labelled.

**39. Liquid fertilisers must be stored in original containers or corrosion-resistant leak-proof tanks . Overfilling of tanks must be avoided. (Vc)**

**40. No fertilisers should be stored within 150 m of a drinking water well and 300 m from the coast. (Vc)**

Leakage from containers or tanks containing liquid fertilisers poses a high risk for ground water pollution. Care must taken to avoid losses during storage, mixing and transport to the fields. Any spills should be cleaned up immediately and provisions must be made to deal with spills effectively.

### *3.3 Fertilisation planning*

**41. Application of mineral and organic fertilisers including livestock manure, should be based on a fertilisation plan. Input and output of plant nutrients should be balanced. (Nd)**

A **fertilisation plan** has to take into account the

- nutrient demand of the crop in relation to the yield level
- nutrient content in the soil determined by an officially accepted analytical method
- nutrient content in the mineral and organic fertilisers that will be applied
- nutrient content of other sources, especially from irrigation water
- regulations for fertiliser application
- best time for application

- potential to incorporate the mineral fertilisers

A **fertilisation plan** should be made **for each field and each crop** individually.

Soil samples for nutrient analysis should be taken before fertilisation and before sowing and planting. Soil analysis determines how much plant available nutrients are present in the soil. If soil analysis reveals sufficient or high levels of nutrients in the soil, it is completely inefficient and uneconomic to apply further nutrients by fertilisers. The purchase of fertilisers for fields that already have high nutrient levels will result in cost increase without any related increase in crop yield. Regular soil analysis helps farmers and advisory staff to draw up fertiliser plans correctly.

Trends of increasing or decreasing soil nutrient levels indicate that the fertiliser application was too high or too low in the past. Based on this information the fertilisation plan can be corrected.

According to this code, soils must be analysed for their P and K status every $6^{th}$ year, but it is recommended to determine the nutrient status more frequently, preferentially every three years. Levels of other nutrients should be analysed occasionally, e.g., in cases of plant deficiency symptoms or negative nutrient balances. It is also recommended to regularly monitor the pH value and the salinity of the topsoil to detect unfavourable trends in soil quality.

If soil analysis indicates high levels of plant available phosphorus ($P_2O_5$) and/or potassium ($K_2O$), it is highly inefficient and uneconomic to apply more of these nutrients through expensive compound fertilisers, since additional applications will not increase crop yield and yield quality. In such cases it is recommended to use single component fertilisers. Further application of compound fertilisers will increase the potential of nutrient losses by soil erosion and surface runoff and should strictly be avoided.

It is well known from international agricultural research that alkaline soils with a high pH, as they are frequently found in Malta, need a higher phosphate level for optimum crop production. At the date of drafting this Code, no data from Maltese fertilisation experiments were available to evaluate that soil concentration for phosphorus and potassium that is essentially needed for sustainable crop production. They will be published as soon as possible in a later version.

**42. Within a protection zone around a drinking water well, a fertilisation plan has to be followed. Organic fertilisers should not be applied within this zone. The minimum distance from the well should be 30 m. (Vc)**

Areas close to drinking water wells need special protection as they especially vulnerable to pollution from the surface.

### 3.3.1 Fertilizer application rates

**43. To determine fertiliser application rates, N, P and K delivered by mineral and organic fertilisers as well as by other sources (e.g. irrigation water) must be taken into account. (Vc)**

The total amount of fertilisers applied is the sum of

- mineral fertilisers
- organic fertilisers (liquid manure, solid manure, any type of compost)
- irrigation water containing significant amounts of N, P and K.

The data presented here are average values. They can be used for fertilisation planning in cases where no actual analytical data are available.

**Approximate application rates of different kinds of manure to 170 kg N/ha rep. 19 kg N/tumulo**

| Type of solid manure | Dry matter content (%) | Application rate |
|---|---|---|
| Cattle | 26 | 23 t/ha<br>2.5 t/tumolo |
| Layer | 35 | 8.5 t/ha<br>1 t/tumulo |
| Broiler | 85 | 6.5 t/ha<br>0.7 t/tumulo |
| Pig | 73 | 8.2 t/ha<br>0.9 t/tumulo |
| Rabbit | 27 | 22 t/ha<br>2,4 t/tumulo |

1 ha = 10,000 m2 = 9.1 tumuli
1 ton = 1000 kg
These data are calculated from initial manure analyses. More analysis are essential to get more precise data.

Nutrient supply by irrigation water must be taken into account for the calculation of fertiliser plans and the calculation of nutrient balances. Sewage effluent might contain remarkable amounts of plant nutrients, especially nitrate and phosphorus. From the concentration of nutrients in the sewage effluent, the amount of nutrient supply by irrigation can be calculated.

### 3.3.2 Timing of fertilisation

**44. Mineral nitrogen fertilisers and organic fertilisers including livestock manure must be applied close to sowing. Splitting of fertiliser application is recommended whenever possible. (Nd)**

Nitrogen from mineral and organic fertilisers is easily leached, and there is also a high risk of ammonia losses by volatilisation during and after the application of organic fertilisers and urea. The risk of volatilisation losses is extremely high on soils with a high pH value. Therefore fertilisers should be applied as close as possible to the planting or sowing of the crop. As soon as a crop has been established, it will take up the fertiliser nutrients, and the potential for losses decreases.

Close to sowing means:

- Liquid manure and mineral nitrogen fertilisers not longer than one week before sowing or planting
- Solid manures not longer than four weeks before sowing or planting

The intensity of nutrient uptake by crops is low during early stages of growth, but increases with plant growth and is usually highest at flowering. The fertilisation efficiency can be increased by splitting the fertiliser application, e.g. 1/3 of the fertiliser dose is applied before sowing or planting and 2/3 of it is applied before intensive crop growth. This minimises the risk of nitrogen losses.

### 3.3.3 Appropriate application techniques

**45. All types of mineral and organic fertilisers should be distributed uniformly on the field. (Nd)**

Non-uniform application of fertilisers on a field results in over-fertilised areas and under-fertilised areas. In those areas with excess fertiliser, fertiliser nutrients are wasted as they do not result in a yield and/or quality increase, while yield and quality is lost in those areas with under fertilisation.

**46. Fertilisers (mineral and organic) should not be applied to any type of fresh water courses. A minimum distance of 5 m must be kept from natural water courses and boreholes (pumping stations and galleries and gallery shafts) during fertiliser application. (Nd)**

Fertilisers should not be applied to natural water courses, fresh waters of any type and coastal water, as this has an extremely negative effect on lake and marine ecosystems. Accidental spilling of mineral fertilisers into fresh water courses is avoided by keeping a safety distance

of 5 m from the border when applying fertilisers. It is forbidden to pour fertilisers into boreholes.
Special conditions apply for organic fertilisers as per specific reference.

**47. Whenever possible, subsurface placement of mineral and organic fertilisers is recommended. (Od)**

Fertilisers applied on the soil surface are not immediately available to the crop. The nutrients first have to be dissolved in rain and irrigation water and then be transported to the root zone. Moreover, fertilisers on the soil surface are highly vulnerable to nutrient losses by surface runoff and ammonia volatilisation.
Moreover, on soils with a high pH, the availability of several nutrients is low, esp. the availability of phosphorus and most micronutrients. Measures to lower the pH value on the whole field scale are expensive and usually not economical.

Whenever possible, fertilisers should be incorporated into the soil.

An effective way to improve the fertilisation efficiency, especially on alkaline soils as frequently found in Malta, is subsurface placement (subsurface band or dripple application) of solid and liquid fertilisers before or after planting close to the roots of the crop. Subsurface placement improves the plant availability of the nutrients with the consequence that the amount of fertiliser needed for optimum yield and quality is generally lower. Thus, the soil nutrient status can be kept at a lower level, which minimises the risk of losses to the environment. The method is used successfully in many countries for phosphorus and nitrogen fertilisation, and machinery for subsurface placement is available worldwide.

### 3.3.4 Specific regulations for the use of organic fertilisers

A regular application of farmyard manure improves important soil properties like water storage capacity, water infiltration capacity, soil aeration, penetration resistance for plant roots, compactability, etc. Several farmyard wastes are used as fertilisers as well as to improve the soil structure. Livestock manure is very important to keep the organic matter content at an appropriate level.

Livestock wastes contain all the necessary plant nutrients, hence the amount of nitrogen, phosphorus and potassium has to be taken into account when making fertiliser plans. The total nitrogen consists of ammonium, nitrate and organic nitrogen. Ammonium and nitrate are plant available when they are incorporated into the soil and reach the root surface, while the organic nitrogen has to be mineralised to ammonium to become plant available. Liquid manure contains more ammonium than solid manure. Consequently, the level of plant available ammonium is lower in manure with a high dry matter content.

If not done correctly, the application of manure is a significant source of environmental pollution. Most of the ammonium is likely to get lost as ammonia gas (ammonia volatilisation), during or after application in hot and windy weather and if the manure is not incorporated immediately after application. The released ammonia is subsequently a source of pollution of fresh water and marine water ecosystems. The risk of ammonia volatilisation is extremely high on calcareous soil with a high pH value (>7).
If accumulated in the soil after excessive application, the organic nitrogen will be a permanent source of microbial mineralisation, and the nitrates that are formed on bare soils are likely to be leached during rainfall seasons.

Therefore it is a general rule that all manure has to be applied in a way that minimises losses during and after application.

**48. The amount of “total nitrogen” applied from livestock manure (solid manure, liquid manure, slurry and urine) including excreta by the animals themselves must not exceed 210 kg N/ha per year on farm scale as per point 2a in Annex III of R676/91 for the first four years of the action programme, and 170 kg N/ha per year afterwards. (Nd)**

Purchased manure should be accompanied by a certificate of nutrient analysis. This analysis should be carried out by an authorised laboratory and should contain the nutrient composition of manure in terms of total N, P and K.

**49. All types of livestock manure should not be applied between the 15th October to the 15th of March. (Nd)**

**50. Liquid manure should not be applied to soils with a slope of 10 m/100 m or more. Solid manure and mineral fertilisers should not be applied to sloping land unless they are incorporated immediately after application. (Nd)**

The risk of surface runoff during heavy rainfall increases with the slope of the soil. If fertilisers and manure are applied on the soil surface without any incorporation they are likely to be transported downslope. Liquid manure easily flows downwards during application.

**51. Liquid and solid manure should not be applied within 100 m from the coast. (Nd)**

Marine waters need special protection from pollution as nutrient input might easily produce favourable conditions for algae growth with all negative consequences for the marine ecosystem and tourism.

**52.** **Liquid and solid manure should be incorporated into the soil as soon as possible. Liquid manure can be applied close to soil surface if it cannot be incorporated without damaging a growing crop. (Nd)**

If the manure DM content is 30% or higher and application takes place in the dry season it does not need to be incorporated on the same day of application.
Most of the ammonia losses occur during the first 3 hours after application.

**53.** **Fertilisers (mineral and organic) should not be applied to water saturated soils and to soils that are likely to be flooded. (Nd)**

Soils that are water saturated or are likely to be flooded during the rainy season have an increased risk for nutrient losses from fertilisers and manures by surface runoff.

### 3.3.5 Record keeping on fertilisation

**54.** **Purchase of all types of mineral, organic fertilisers and livestock manures should be recorded by the farmer. (Nd)**

The following information should be recorded **for mineral and organic** fertilisers

- Quantity purchased per year
- Fertiliser type/ nutrient content
- Date and quantity of each application
- Location (location and size of the field)

If **sewage effluent** is used for irrigation the following information should be recorded

- Date and quantity applied

# 4 Good Irrigation Practice

## 4.1 Introduction

### 4.1.1 Need for irrigation

The climate of the Maltese Islands is typically Mediterranean, with short, mild winters and long, hot and dry summers. The islands can therefore be classified as semi-arid. On average, rainfall on the islands is sufficient for agricultural purposes only during the three to four winter months. During the rest of the year, agriculture is only possible through irrigation. Since excessive irrigation can be a means of groundwater contamination, good irrigation practices should be followed to prevent this.

### 4.1.2 Groundwater contamination by irrigation

When water is applied to a field, the water is absorbed by the soil. The maximum water holding capacity of a soil is known as the field capacity. Any water applied in excess of this field capacity will drain downwards by gravity, carrying with it the salts and nutrients present in the soil solution. This leaching process can result both from rainfall as well as from excessive irrigation. If these nutrients reach the groundwater, it will be contaminated by them.

Moreover, further water application to a soil that has already reached its field capacity will result in water saturation of the soil. In this stage, the soil is unable to absorb any more water, and therefore the excessive water runs off on the soil surface, across other fields and into valleys where it can percolate into the soil and might contaminate the aquifer.

To avoid this, suitable irrigation methods and good management of the irrigation systems are essential. Good irrigation management helps to avoid excessive water application and unnecessary leaching.

On the other hand, it has to be noted that leaching is necessary from time to time under semi-arid conditions to flush away salts which have accumulated in the soil. These salts may originate from irrigation water of high salinity, from the soil as well as from artificial fertilizers. Increasing soil salinity affects crop growth negatively, depending on the salt tolerance of the crop. Therefore, there is an obvious conflict since the application of excess irrigation water to remove the salts will also flush away the nutrients. Therefore a compromise has to be found.

The Code of Good Irrigation Practice provides guidelines to the farmers to help them make good decisions which will eventually protect the groundwater from being contaminated.

## *4.2 Crop water requirement and available water*

**55. The quantity of irrigation water applied to a field should be based on the requirements of the crop and the amount of available water in the root zone. (Vc)**

To be healthy and without stress, crops must find water readily available in the soil. When the crop has consumed the plant available water, it must be refilled by irrigation. The amount of water that has to be applied by irrigation is depends on the intensity of two processes: (1) the evaporation from the soil surface and (2) the transpiration from the crops leaves. The sum of both is known as **evapotranspiration (ET)** and is considered as the crop water requirements.

Crop water requirements can be estimated by a number of methods, e.g., evaporation pans, weather data or soil-moisture monitoring. ET is expressed in mm/d (= litre/m²). In the future, the irrigation extension service will compile basic data from the local weather service and distribute it in newspapers, journals or by telephone.

The **Root Zone** is that part of the soil which contains the highest concentration of crop roots. Therefore, the majority of the water is extracted from this zone by the crop roots. The depth of this zone has to be known to calculate the amount of water available for a specific crop.

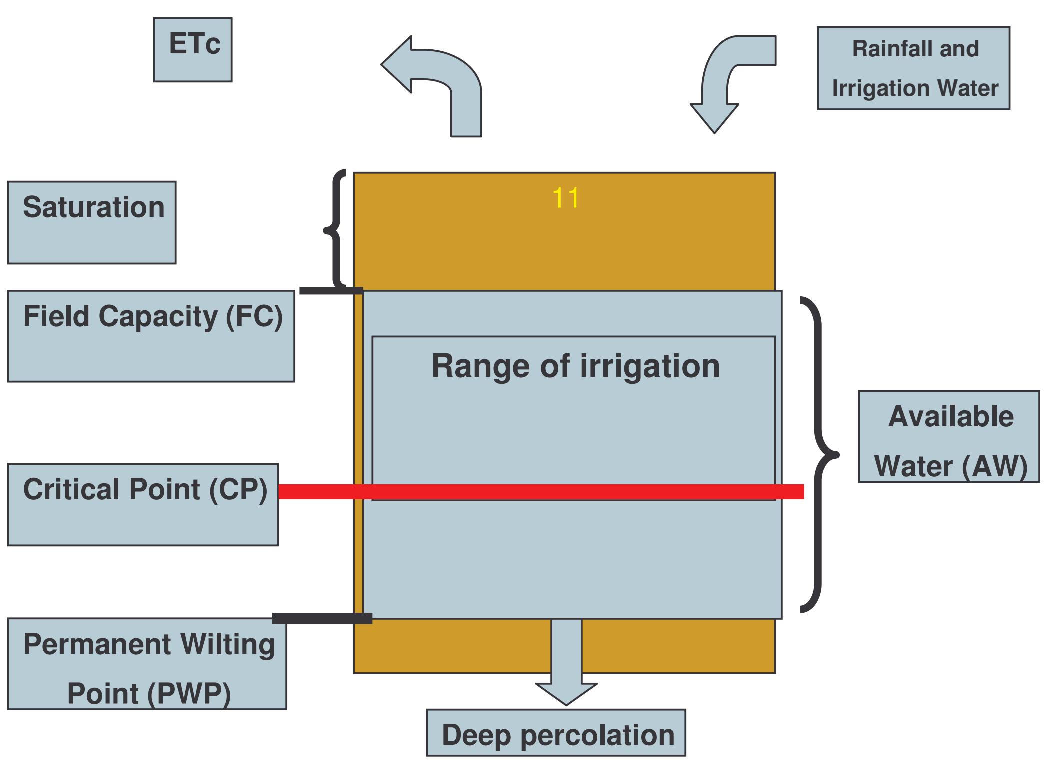
The soil of the root zone can be likened to a water reservoir, which receives water from irrigation and rainfall, and is emptied by evapotranspiration and deep percolation. During irrigation or rainfall, water infiltrates through the soil surface and moves into the soil. When this downward percolation stops, soil moisture in the root zone may be considered to be in balance which is known as **Field Capacity**: The field capacity is defined as the maximum amount of water which the soil can store against gravity.

If water is irrigated in excess of the field capacity of the soil, it starts draining downwards below the root zone where it is not available for the crops.

Not all the water stored in a soil in the stage of field capacity is plant available as a specific amount of water – known as "dead water" – cannot be used by the crop. Consequently only the amount of water between field capacity and the permanent wilting point is plant available. Therefore the aim of irrigation is to reach the Field Capacity in only the rooting zone.

Under cropping conditions, irrigation should start before the soil water content reaches the level of the permanent wilting point, as this will reduce crop yield irreversibly. The soil moisture content only decreases to a crop specific critical level (Critical point = CP). Depending on the crop species, the critical point is defined as 50 to 70 % of the plant available water. Irrigation should start when the critical soil water level has been achieved.

**Figure: Soil water characteristics**



To make sure that no deep percolation occurs, it is advised to apply less irrigation water than is necessary to reach Field Capacity (FC): 100 % of the available water capacity should be applied in the summer when no rain is expected and for crops under plastic tunnels, and 80 % of the available water capacity during those months during months with rainfall. Good irrigation only supplies irrigation water to make up the difference between the critical point (CP) and the Field Capacity (FC).

The amount of available water is a soil characteristic: Clay soils have higher AW values since they can hold a higher amount of moisture. The values of FC and PWP for any soil can be found by soil analysis or in the literature.

**Typical soil characteristics, the water content is valid for 10 cm soil**

| *Soil Texture* | *Apparent Specific Density($g/cm^3$)* | *Field Capacity FC (mm)* | *Permanent Wilting point PWP ( mm)* | *Available Moisture AW (mm)* |
|---|---|---|---|---|
| *Sandy* | *1.6 – 1.8* | *6 - 12* | *2 - 6* | *6 - 10* |
| *Sandy loam* | *1.4 – 1.6* | *10 - 18* | *4 - 8* | *9 - 15* |
| *Loam* | *1.4 – 1.5* | *18 – 26* | *8 - 12* | *14 - 20* |
| *Clay loam* | *1.3 – 1.4* | *23 – 31* | *11 - 15* | *16 - 22* |
| *Silty clay* | *1.3 – 1.4* | *27 – 35* | *13 - 17* | *18 - 23* |
| *Clay* | *1.2 – 1.3* | *31 – 39* | *15 - 19* | *20 - 25* |

The values of critical points (CP) depend on the type of crop and its stage of growth. The CP is low for small crops and crops at their initial growth stages, but higher for large crops and crops at their mature growth stage.

## 56. Water losses by evaporation can be reduced by good cultivation practices. (Gf)

Some examples of good practices are the following:

- Refrain from any furrow irrigation between 11.00a.m. and 3.00 p.m. in winter.

- Refrain from any irrigation between 11.00a.m. and 3.00 p.m. in summer.
- Refrain from overhead irrigation by sprinklers or rain-guns between 11.00a.m. and 3.00 p.m. during summer and windy days, with wind over 5 degrees of "Beaufort Scale" (when small trees start to bend with the wind).
- For agricultural crops grown under cover in a soil medium, controlled irrigation by drip or misting is recommended.

These strategies and techniques reduce the quantity of water needed for irrigation and hence reduce the possibility of nitrate leaching from the soil.

### *4.3 Irrigation scheduling*

**57. Irrigation should be scheduled by use of actual agrometeorological data and the soil water content. (Vc)**

Good irrigation scheduling means applying the right amount of water at the right time - making sure that the water is available when the crop needs it. The quantity of water to be applied to the field has been discussed in the previous chapter. The time of application is likewise very important.

**Determination of the irrigation interval:**

Irrigation needs to be scheduled every few days, known as the "irrigation interval." This can be determined by the following relationship:

$$\text{Irrigation Interval} = \frac{AW \;*\; PWA\,(\%)}{ETc \;*\; 100}$$

PWA = Percentage Wetted Area (the area of soil surface wetted by the irrigation system)

Since the crop water requirement varies along the growing stage of the crop and is also dependent on the weather conditions, the irrigation interval is not constant. Therefore it should be re-calculated from time to time, preferably every two weeks.

Irrigation can also be scheduled by a regular monitoring of the soil moisture by means of appropriate instruments. The monitoring frequency depends on the irrigation interval. If the soil moisture indicated by the instrument is lower than the critical point, the field should be irrigated. Instruments that can be used for this purpose are Tensionmeters, Gypsum blocks and TDR-Sensors.

Scheduling maximises irrigation efficiency by minimising runoff and percolation losses. This also results in lower energy and water use and optimum crops. The most important benefit however, is that the groundwater is not polluted by fertilisers which are leached with excessive irrigation water due to too long irrigation times and too frequent irrigations.

## *4.4 Irrigation Systems*

**58. The irrigation system with the highest water use efficiency should be used. (Vc)**

The most widely used irrigation systems in Malta are pressurized irrigation systems, although some furrow irrigation is still practiced in some parts of the island. Various forms of drip and sprinkler irrigation systems are used.

**Drip irrigation :**

The most widely used method of irrigation is drip irrigation, where water is applied to the soil around each crop or a group of crops so as to wet locally and only the root zone. This is done by means of various kinds of nozzles, emitters and drip tape. This method is used for many crops, especially for those crops which will not perform well if constantly wetted, and also for trees and vines. However, it is not practical for forage crops. Another major disadvantage is the problem of clogging of the emitters and therefore the use of appropriate filters is a must. Although the initial cost to install a drip irrigation system is high, the system efficiency is considered to be the best of all irrigation methods, and therefore the long term benefits due to saving of water and energy will be paid back. Another very important advantage is that since the application rate of a drip system is low, the quantity of water being applied to the soil can be more accurately monitored and controlled, resulting in less surface run-off and deep percolation.

**Sprinkler irrigation :**

This method is used especially for the irrigation of potatoes and fodder crops. By sprinkler irrigation, the water is applied in the form of a spray and reaches the soil very much like rain. The initial cost is also high and the efficiency is lower than with drip irrigation. However it is the best practical method for certain crops like cereals and forage crops. One very good advantage of sprinkler irrigation is that it can influence the microclimate around the crop. It is in fact used to protect crops, especially potatoes, from frost attack, and to cool trees in extremely hot weather.

## 59. Losses out of the boundary of the field must be avoided. (Vc)

This is a very important management aspect. Sometimes, sprinkler systems, especially spray guns, are more attractive since they are more versatile and can be installed in a shorter time. However, most of the Maltese fields are small and of irregular shape and with these methods it is very difficult to control the wetted area. In many cases, in order to cover the whole soil surface, the jets of the sprinkler or spray guns reaches beyond the field boundaries, resulting in water losses. This problem gets even worse under windy conditions, which is common in Malta. In these cases, and whenever possible, drip irrigation systems should be used. If sprinklers must be used, one must be very careful in selecting the appropriate nozzles; use of nozzles which have semi-circular or quarter circle patterns should be considered.

## 60. The irrigation system should be maintained regularly to ensure even distribution of water. (Vc)

Good and regular maintenance must be done on the irrigation equipment to ensure that the water being supplied to the field is distributed among all the emitters as evenly as possible.

The system should first of all include a filter of the appropriate grade (depending on the type and amount of particles in the water), which should be cleaned regularly. The use of the filter is absolutely important especially in drip irrigation to avoid clogging of the tiny emitters. Pipes and joints should also be regularly inspected for leakage to prevent loss of water from the system. Leaks from damaged pipes will often result in excessive water supply in that particular area, and this should be avoided.

From what has been discussed above, the farmer should choose the best type of irrigation system that will result in the most efficient use of water. Unfortunately this is not always the cheapest option. The parameters on which an irrigation system is selected are crop type, soil type, size of field and field topography.

**61. The farmer must seek technical assistance when installing a new irrigation system. (Vc)**

It is important that before installing a new system, the farmer must consult with the extension service centre or other private irrigation companies or dealers on the technical aspects of the system. Technical persons from these organisations can help in the planning of the system to produce an irrigation system with the best possible efficiency in water use.

## *4.5 Irrigation water quality*

**62. Irrigation water must be of good quality to maintain soil fertility and productivity. (Vc)**

The evaluation of the water quality covers the physical, chemical, biological and hygienic condition of the water.

For the waste water irrigation in vegetables the hygienic parameters have to be considered (see **Table 1.)**

The salinity (the salt content of the water) of the irrigation water has to be particularly considered. The salt content determines the suitability of the water for the irrigation purposes. Generally, the total salt content or rather the electric conductivity (EC) is used to characterise the salinity of water. Among the different evaluation frames the four-level classification, prepared by the US Salinity Laboratory, has found the widest propagation, as per **Table 2.**

## Table1 :Uses of irrigation water based on microbiological classification

| Quality category | Use | Faecal *streptococci* colony count per 100 ml (as in [3] or [9][1)]) | *E. coli* colony count per 100 ml (as in [3] or [9][1)]) | *Salmonellae* per 1,000 ml (as in DIN 38414-13) | Potentially infectious stages of human and domestic animal parasites[2)] per 1,000 ml |
|---|---|---|---|---|---|
| 1(Drinking water) | All greenhouse and outdoor crops | Not detectable | Not detectable | Not detectable | Not detectable |
| 2[3)] | a) Outdoor and greenhouse crops intended for raw consumption<br>b) School sports grounds, public parks | ≤100[4)] | ≤200[4)] | Not detectable | Not detectable |
| 3[3)] | a) Greenhouse crops not intended for consumption<br>b) Outdoor crops for raw consumption before fruit development or vegetables up to 2 weeks before harvesting<br>c) Fruit and vegetables for preserving<br>d) Pasture or herbage up to 2 weeks before mowing or grazing<br>e) All other outdoor crops<br>f) Other sports grounds[5)] | ≤400 | ≤2,000 | Not detectable | Not detectable |
| 4[3), 5)] | a) For protecting wine and fruit crops from frost<br>b) Cultivated forests, logging sites and wet habitats<br>c) Sugar beet, starch potatoes, oilseed fruits, non-food plants for industrial processing and seed stock up to 2 weeks before harvesting<br>d) Cereals up to green ripeness (not for raw consumption)<br>e) Fodder for silage up to 2 weeks before harvesting | Waste water which has passed through at least one biological purification stage | | | a) No standard recommendation possible for intestinal nematodes.<br>b) Taenia stages not detectable. |

1) Microbiological assays by methods standard for bathing waters.

2) If it necessary to safeguard human and animal health, the intended irrigation water may be examined for intestinal nematodes (Ascaris and Trichuris species and hook worms) or tape worm life stages (in particular Taenia) in accordance with the relevant WHO-Recommendations [1].

3) If the irrigation method prevents the consumable parts of crops becoming wet, the classification given in this table does not apply.

4) As in [3], the value should be as far as possible below this level as the state of the art, acceptable expenditure and individual circumstances allow. See subclause 5.4 for measures for improving water quality.

5) Where sprinklers are used, steps shall be taken to ensure that personnel and the public not put a risk.

**Table 2: Classification of the water quality for irrigation** [1] (from Richards 1954)

| Category | Electrical conductivity Mikrosiemens/cm at $25^0$ C | Comparison salt content Mg/l |
|---|---|---|
| Low C 1<br>Water use for all crops and soils | 0 –250 | 0 – 160 |
| Middel C 2<br>Water use for crops with low salt tolerance. Leaching is nessecary. | 250 – 750 | 160 – 480 |
| Strong C3<br>Water use for crops with moderately salt tolerance and draining soils. Leaching is nessecery. | 750 – 2250 | 480 – 1140 |
| Very strong C 4<br>Water use for very salt tolerant crops and very good draining soils. Leaching is nessecary. | 2250 – 5000 | 1440 – 3200 |

Long-termed, the water salinity categories C1 and C2 have to be achieved. The categories C 3 and C4, which are predominant on Malta, will lead to irreversible damage to soil and groundwater in the long run.

[1] Richards, L.A. (Editor) (1954): Diagnoses and improvement of saline and alkali soils. US Dept. Agric., Agric.Hamdb. No. 60

## *4.6 Fertigation*

**63. Whenever possible, the fertilizers should be applied by fertigation. (Vc)**

Fertigation is the application of fertilizers with the irrigation water. Incorporating fertilizers in the irrigation water is a vital part of irrigation, especially with drip irrigation. Drip irrigation eshows a good degree of success due to the improved supply of nutrients to the crops. In many cases, the application of fertilizers in the usual manner, that is, on the soil surface, would result in a waste of time and money since only a very small proportion of this fertilizer would be available for the crops. This is because with drip irrigation or mini sprinklers, only relatively small areas are wetted, and it is only here that the crops will be planted. Fertilizers in the dry areas will not be used and will be leached by the rainwater, thus contaminating the groundwater.

Fertigation with sprinkler irrigation systems is also recommended since the nutrients can be supplied to the crops in smaller doses with a number of irrigations, and at the exact time that they need them. In contrast, when the fertilizers are applied by spreading on the soil surface generally, the total seasonal crop needs are applied at once. In the eventuality of heavy rainfall, some of these nutrients will be leached downwards, or carried away by surface runoff. There are however some limitations to using fertigation with sprinklers, mainly with crops which are susceptible to leaf burn when the fertilizers dry on the surface of the leaves. To minimize this effect, it is advisable to apply clean water without fertilizer during the last 10 minutes of irrigation so that the fertilizer is washed away from the crop leaves.

**64. The quantity of fertilizers applied with the irrigation water must be based on the crop's needs and the nutrient content of both the soil and the irrigation water. (Vc)**

The quantity of fertilizer applied with the water must be calculated according to the needs of the crop at that particular stage of growth. One must not forget, however, that both the soil and water might already contain reserves of nutrients. The soil could still contain remaining nutrients from previous fertilizations or from decaying organic matter. Similarly, the irrigation water might contain nutrients, especially second class water derived from sewage. The amount of nutrients available in the soil and delivered with irrigation water should be recognised to determine the dose of mineral and organic fertilisers. Undue consideration of these amounts will result in excess supply of nutrients in the soil which are not used by the crops and will eventually be leached to the groundwater. Please refer to the chapter "Good Fertilization Practice".

Good irrigation practice means applying the correct amount of water to the soil. Therefore a means of measuring the quantity of water delivered by irrigation is needed. The best way of doing this is by means of a water meter installed on the irrigation system. Instead of recording the duration time of irrigation, the farmer can record the volume of water supplied to the field, and this will help him to better plan the future irrigations.

**65. For better irrigation management, measuring and recording the quantity of water delivered and the system pressure is recommended. (Vc)**

Similar to water meters, pressure gauges have a control and regulation task. The use of pressure gauges is important to check the pressure at various parts of the system to ensure that the water pressure is reasonably uniform throughout. This will ensure uniform discharge of water from the emitters or sprinkler and hence a uniformity of the water distribution. The installation of a pressure gauge at the pump outlet can also help to detect eventual pipe bursts or open pipe ends more quickly.

# 5 Good Plant Protection Practice

## 5.1 *Preface*

**Legislation**

Pesticides in the Maltese islands have been in use on a regular basis since the early 1960s. The first Maltese legislation concerning pesticides dates back to 1966. The present Pesticides Control Act of 2001 is a more updated and comprehensive version and covers both Plant Protection Products as well as Biocides.

**Registration**

The Plant Health Department has adopted a new system for pesticide registration. All authorised dealers and vendors of pesticides must be registered with the Department as in the former system. Any authorised dealer wishing to deal in pesticides can only do so with those products that have been registered and authorised in Malta. Registration of plant protection products must contain only those active substances listed in Annex 1 of Directive 91/414 or have a provisional authorisation pending a decision to enter such Annex. Registration of plant protection products follows a submission of a product dossier by the firm (first notifier) of the active substance/s contained in that product, or by a manufacturer having a letter of access from the first notifier. Biocides registration follows on the same lines, however, as there is as yet no approved list of active substances for the biocides only those products having active substances that were on the market in Malta or any European Member state prior to 14$^{th}$ May 2000 can be registered without submitting a dossier of the active substance. Other biocides having more recent active substances must submit a complete dossier prior to registration. All plant protection products and most of the biocides used in Malta are imported. The registration process is kept on an electronic database. A new and more extensive database computer programme has been commissioned and will be ready in the coming months.

**Monitoring**

The Plant Health Department implements an annual programme for the monitoring of pesticides' residues in crops. Every month representative samples of fruit and vegetables are taken from the wholesale market and sent to an accredited lab for multiple tests for over 70 different active substances. Results arrive with days of sending the samples. It is envisaged that during 2004 over 100 samples would have been analysed for pesticides' residues according to the annual programme submitted to the EU Commission (Decision 2004/449).

**Application**

The most frequent type method used for the application of plant protection products is by means of medium-volume sprays. As the fields are rather small, application is usually by means of motorised knapsack sprayers. Use of pesticides in Malta is not so frequent when compared with other developed countries. Very little amounts of herbicides are used, as growers prefer to rotovate their fields for weed control. The use of highly toxic or persistent pesticides is prohibited. The most frequent pesticides in use are the insecticides. Very hazardous pesticides are restricted to professional users.

## *5.2 Definition*

**Good plant protection practice (GPPP) is a basic strategy in plant protection and means the application of plant protection measures that:**

- are safe for humans, animals and the environment from a scientific point of view,
- have been recognised by the competent authorities as suitable, appropriate, and necessary in practice,
- are recommended by official extension services or recognised and qualified consultants, and
- are practised by skilled users.

The principles of good plant protection practice constitute a framework of action for those concerned with plant protection measures in agriculture, horticulture and forestry. Together with the national law on the placing of plant protection products on the market and on their use, namely:

- Pesticides Control Act XI of 2001 (CAP 430),
- the Plant Protection Products Regulations 2004 (LN 115)

The principles of good plant protection practice guarantee the consumer safe plant production by means of established plant protection measures. Possible risks to man, animal and environment are at the same time reduced to a minimum.

GPPP is therefore a process of a wider concept known as Good Agricultural Practice. Good plant protection practice does not selectively concern solely the usage of plant protection products, but all those other aspects that lead to plant protection.

## *5.3 General principles*

The following principles apply in general:

> **66. Plant protection measures shall be carried out so as to fit the site, the crop, and the situation, and the use of plant protection products shall be reduced to what is absolutely necessary. (Vc)**

> **67. Proven cultural, biological and other non-chemical measures to reduce damage from pests and diseases shall be used as far as possible wherever practical and economically feasible. (Vc)**

**68.** **The aim shall be not to eliminate harmful organisms, but to reduce infestation so that there is no economic damage. There may be cases, however, which require zero tolerance such as for quarantine pests or vectors of quarantine pests and quality pests associated with certification schemes. (Vc)**

**69.** **Growers shall use the diverse assistance of official and other extension services, look for advanced training and any other decision aids. (Vc)**

*5.4 Principles of measures to prevent infestation by harmful organisms*

**70.** **The growers should consider the possibility of prevention of infestation by harmful organisms through choice of adequate cropping systems, resistant seeds, crops, crop rotation, physical barriers and tillage. (Vc)**

**71. Cultivars and origins which are resistant or have at least a certain tolerance of important site-specific pest organisms should be considered especially in known cases of soil-borne diseases. (Vc)**

**72. Hygienic measures must be taken to create the conditions for healthy and vigorous crop stands. (Vc)**

Hygienic measures in agriculture and horticulture have the aim of reducing the potential spread of harmful organisms and of preventing or delaying the first infection with harmful organisms as much as possible. This is done by preventing the introduction and spread of harmful organisms, such as nematodes and virus diseases through seeds, planting stock, contaminated soil, substrates, propagation containers, tools or diseased plants.

The most important hygienic measure to be taken by the grower is to use healthy seed and planting material. This means regular purchase of certified seeds and planting stocks and confining replanting to seed and planting material from healthy and vigorous stocks.

If several growers share agricultural machinery, this must be carefully cleaned. Important hygienic measures in glasshouses and propagating centres are regular cleaning, steaming of substrates, disinfection of cultivation facilities if necessary, and clearing of weeds, crop residues and decayed plants. Newly imported plants should be quarantined for some time if necessary.

**73. Growers should not resort to calendar spraying, instead, regular monitoring should be carried out on the crops to determine the degree of infestation before a decision is made on what method is used to control any possible harmful organism. (Vc)**

Growers can apply control threshold values for a number of harmful organisms. In any case this requires that the infestation in a field or crop be quantified by sampling. For some pests, there are also specific methods for estimating extent of infestation such as yellow/blue sticky traps, pheromone traps, warning systems using weather data for late blight of potato.

The grower has to make his own decision about the control measure and he bears the sole responsibility for it. On the other hand, he bears the risk of losses when necessary measures have not been taken. In assessing the need for a particular control measure, growers have to use their experience and observations from previous years, consider advice by official and other extension services, and use other extension aids if available.

**74. In making a decision on what control measures to apply, growers should be aware of the availability of other official information included in informative leaflets, information by the meteorological office, grower meetings, radio broadcasts, training courses and laboratory/ extension office advice. (Vc)**

## 5.5 *Principles of application of non-chemical plant protection measures*

**75.** **If there are effective and environmentally friendly non-chemical measures, they should be preferred. (Vc)**

Non-chemical measures of plant protection can be very special methods, which are often expensive and difficult to handle. They must be adapted to the site and to the situation.

Biological methods in a more narrow sense, that have a selective effect and are environmentally friendly, are often very expensive, require adequate training prior to introduction and are practical only for use under protected cropping.

Mechanical weeding techniques are an example of non-chemical plant protection measures in agriculture and horticulture.

## 5.6 *Principles of correct and intended use of plant protection products*

**76.** **Authorised plant protection products, well maintained suitable equipment and competent users are the fundamental conditions for proper use of plant protection products. Plant protection products must only be introduced, distributed or used if they are authorised in Malta after registration and authorisation by the Department of Plant Health. (Gf)**

With the authorisation, the Department of Plant Health, Ministry for Rural Affairs and the Environment, stipulates the use, conditions and instructions to protect humans, animals, and the environment so that any requirement of correct and intended use of good plant protection practice becomes clear from the label. Plant Protection Products should only be used on listed crops approved for that product.

The operator has an obligation to use particular care when handling, storing or disposing of plant protection products. Operators who misapply plant protection products, e.g., applications other than for their intended purpose, will be prosecuted according to law. Defective equipment should be repaired or put out of service.

**77. Plant protection products are chosen after consideration of the target organism, their efficacy and cost, the site, and the crop. The most suitable products for the specific circumstances should be chosen. (Vc)**

If various products are suitable for one intended use, the grower should prefer those which are less toxic, spare beneficial organisms, e.g., harmless to bees, and not restricted by special use conditions. Selective products should be preferred to broad spectrum ones unless several pests occur simultaneously or are likely to occur. Selective Plant Protection Products are ecologically less damaging.

Using a product as a general precaution without prior ascertainment (as is calendar spraying) of the need of control is not good plant protection practice. Products which are most suitable for the crop and to control the pest in question must be used according to the situation with preference to opt for the lower indicated dosage rates. Site and weather conditions should be carefully noted to avoid drift of pesticide products. Measures should be taken to reduce the frequency and rate of application and at the same time reduce the cost of crop protection and contribute to minimising the general risk arising from use of plant protection products.

**78. Treatments and dose rates should be adapted to the given conditions. The grower should be aware of the possibility of reducing the maximum indicated number of applications and application rates. (Vc)**

This is carried out following careful monitoring of pest infestation, collection of other reliable information, including advice from official extension service and grower experience; all of which help in the decision making.

Resistant pest populations develop through selection pressure caused by repeated application of pesticides belonging to the same family. How often and how fast resistant populations develop depends on the active substance's mode of action and on the harmful organism (its life cycle, feeding habits, natural spread and so on).

**79. Appropriate strategies of resistance management, namely use of different families of active substances, combination of active substance and other chemicals, e.g. mineral oil shall be used to try and prevent development of resistance. (Vc)**

The use of plant protection products containing active substances with different modes of action during the vegetation period, can be a suitable measure to prevent development of resistant pest populations. The measures to be taken should be clarified with official extension services, case by case.

### 5.6.1 Principles and instructions for correct and intended use of plant protection equipment

Plant protection products can be applied in various ways using various technologies depending on the purpose and field of use. It is known that the majority of plant protection products are applied by spraying using motorised knapsack sprayer equipment and water as the carrier medium.

**80. Only suitable plant protection equipment in good working order should be used. During applications of plant protection products, smoking, eating and drinking should not be permitted. (Vc)**

These principles must be followed when employing field sprayers:

- Spraying equipment serves the purpose of evenly depositing plant protection products on target areas in exact doses and with as low-target losses as possible. Possibly loss-reducing technology should be used (for example drift-reducing nozzles). The water application rate per hectare must be determined before starting operation. It depends on the walking speed of the operator, the growth stage of the crop and on the weather.
- When mixing the spray liquid, the instructions on the product label with regard to product application rates, miscibility and necessary precautions and measure of operator protection must be followed. For measuring and filling chemicals into the sprayer tank or into the chemical introduction bowl, only suitable calibrated measuring containers and appropriate methods reserved for that purpose must be used.
- Attention must be paid to the filling of sprayers. Tanks must not be over-filled above the indicated level and must not foam over. It must be ensured that no spray liquid can return when the tank is filled with water from a water pipe.
- Empty pesticide containers must be thoroughly rinsed. The wash water is added to the spray liquid. Empty pesticide containers must be perforated, crushed and safely disposed of in an appropriate site.
- To avoid having any spray liquid leftover at the end of treatment, the spray liquid consumption is to be estimated from the rate of application, and the size of the area to be treated. The number of tank fillings is calculated from the spray liquid consumption and the tank size. The last filling must be metered correctly or even so as to fall a bit short of the needed amount. The grower should consider the possibility of allocation of a small field patch which will remain untreated. Such field patch shall be used for the spraying of pesticide mix left over that will inevitably remain in the tank after every treatment.

- To achieve even horizontal distribution, the walking speed should be uniform and not more than one km/h. In the case of tractor operated spraying, the driving speed should be six km/h. A higher speed distribution causes many problems.
- Spraying during strong wind spells, very hot temperatures or relatively low humidity under 30% will cause high losses through drift and volatilisation and should therefore be avoided.
- If objects neighbouring the treatment area might be endangered, the current wind direction must be considered. When treating the nearest lengths along a body of water (for example a stream valley), in addition to following the label instructions, drift reducing measures, namely slowing down the speed, and applying coarser drops should be taken. The same measures should be taken when spraying in the vicinity of residential areas, gardens, amenity and sports grounds and tourist areas. If pesticide spray drifts to neighbouring areas, despite all precautions, the user of these areas must be immediately contacted and informed. Special precautions such as waiting periods or, if necessary, a ban on consumption should be applied.
- Spraying equipment must be regularly calibrated and nozzles checked before every use.
- After finishing spraying, the spray residue in the tank is diluted by 1:10 with clear water and sprayed over the remaining untreated area. In the case of tractor operated sprayers, the water should also be used to clean the tank from inside.
- Small residues, which have been repeatedly diluted, may be left in the tank and applied with a later spray if this is compatible with the product being used.
- The outside of the sprayer should be cleaned somewhere in the field that is treated. Sprayers should be carefully cleaned and maintained on a regular basis.

### 5.6.2 Principles of storage and other handling of plant protection products

**81. Storage of plant protection products should be limited to the necessary minimum in time and amount, and is subject to particular legal responsibility to exercise caution. (Vc)**

Storage of plant protection products requires particular precautions to preclude dangers to humans, animals and the environment. Storage and disposal of plant protection products by the user are often unavoidable and are subject to particular legal prescriptions. Special legal regulations apply.

Common means of transport and traffic routes are used when plant protection products are transported from distribution centres to stores and from there to the fields. Therefore special precautions must be taken to prevent damage to containers and contamination of man, animal or the environment.

**82. If an accident happens and pesticides leak from transport containers, the Department of Plant Health, Ministry for Rural Affairs and the Environment, and if necessary the distributor must be called. (Vc)**

**83. Special safety precautions must be taken to protect the user and the environment when preparing the spray liquid. (Vc)**

The preparation of the spray mix  and the handling of the concentration of plant protection products can cause dangers both to the user and to the environment and are a critical phase in the handling of these products.

**84. To avoid danger, the safety precautions described in the user instructions, in particular with regards to protecting skin absorption and respiratory organs, must be followed when handling the concentration and preparing the spray mix. (Vc)**

The operator and his employer bears full responsibility for non-observance of the safety precautions. Leakage and contamination during the preparation of the spray mix must be avoided by competent handling and appropriate wear of protective garments. Prepared spray mixes, pesticide residues, containers, and tools which have not yet been cleaned must not be left unattended to preclude risks to third persons. Contaminated containers and tools must be protected from rain. Appropriate hygiene at work helps to keep risks to the user as low as possible, for example washing gloves thoroughly before removing them.

### 5.6.3 Principles of verification of success and documentation of plant protection measures

The success of plant protection measures should be verified by suitable means.

**85. Every plant protection measure should be followed by an inspection to see whether it was successful. This allows competent decisions about further steps and gathering experience about the effect of plant protection measures in certain situations. (Vc)**

Growers should inspect treated crops and assess infestation some time after treatment to verify the efficacy of a plant protection measure and its effect on the crop.

If the treatment was not sufficiently effective, the possible causes for the ineffectiveness or damage have to be carefully weighed, and it must be considered whether repeated treatments are possible and make sense. Plant protection experts should be consulted for that decision.

If there is some particular concern about the efficacy of a spray application, or a grower has applied pesticides while unsure about its success, it is recommended to leave an untreated patch. This allows for the monitoring of the natural development of infestation/infectivity and an assessment of the advantages of the measure over time after treatment in comparison with the rest of the field. However, leaving untreated patches cannot be recommended for all plant pests and diseases because they may represent a focus of re-infection/infestation that would later require additional treatments. Potato late blight would be such a case.

**86. The usage of plant protection products must be documented by the growers as a minimum for all edible crops. (Gf)**

Documenting plant protection measures serves critical analysis, and in the long run, the optimisation of plant protection at the location concerned.

Growers may document plant protection measures in different ways in the framework of general book-keeping, for instance, in a kind of logbook or in a computer database.

Recording at least the following is recommended:

- name of product,
- justification for application,
- date and time of application
- name of user,
- details of spray quantity and dose,
- equipment used,
- prevailing weather conditions.

## 5.7 *Record keeping*

> **87. Farmers must record all sales and purchases of animals, animal feedstuff, fertilisers, manures and animal products and the use of sewage water for irrigation. (Gf)**

Nutrient budgeting is a suitable instrument for checking if the farming strategy is good and if the nutrient budget on farm level is balanced. If the nutrient budget is negative, a deficiency can be detected. If the nutrient budget is high over a long period, it indicates a nutrient accumulation inside the farm and a risk for environmental pollution. Based on unbalanced nutrient budgets, the fertilisation recommendation authorities can provide advice on how to adjust the nutrient budget.

Authorities may monitor Good Agricultural Practice in farms by periodically reviewing records kept by farmers. Beside these records, farmers must keep each bill about sales and records. The records and the relevant bills must be stored for at least 10 years and must be made available to the authorities for inspection. Based on these records, nutrients balances can be calculated on the farm level by the authorities. Excessive nutrient input onto a farm over several years indicates nutrient accumulation in the soils and a risk for ground water pollution.

Farmers should use the official form provided by the authorities for recording the farm sales and purchases. The records must be made on annual basis and must be finished by the end of the year.

The following data have to be filled in the form by the farmer

Purchase:

- For each type of animal purchased during the year: the number of animals, type of animal, the live weight
- For each type of feedstuff ,the amount purchased
- For each type of manure purchased or imported into the farm from other farms or from contractors, the amount of manure (in m3 or t) and the nutrient analysis

- For each type of organic fertiliser (e.g. municipal waste composts), the amount and the nutrient analysis
- The amount of sewage effluent applied to his fields during the year, and the source of the effluent water and the nutrient content (delivered by the effluent delivering company)
- For each type of mineral fertiliser, the amount purchased during the year and the nutrient content as indicated on the label
- For each type of legume cultivated on the fields, the area on which the legume is grown, and the yield/ha

Sales

- For each type of animal, the number of sold animals and the live weight
- For each type of animal product, the amount sold from and exported from the farm
- For each type of plant product, the amount that has been sold or has been exported out of the farm for free
- For each type of manure that is sold or exported out of the farm in any way

# 6 Good Agricultural Practice in Field Cropping

## *6.1 Introduction*

**88. Sustainable crop production practices including farming activities, crop rotation and fertilization should be the approach of field management practices. It has to be popularised among Maltese farmers on a long term basis. (Vc)**

**Good agriculture practice will:**

- Select cultivars or varieties on an understanding of their characteristics, including response to sowing or planting time, productivity, quality, market acceptability, disease and stress resistance, edaphic and climatic adaptability, and response to fertilizers and agrochemicals,
- Devise crop sequences to optimize use of labour and equipment and maximize the biological benefits of weed control by competition and herbicide options, provision of non-host crops to minimize disease, fully explore soil, and where appropriate, include legumes to provide a biological source of nitrogen,
- Maximize the benefits to soil and nutrient stability by re-cycling crops and other organic residues,
- Reduce the amount of nitrates in the soil lost by leaching by avoiding bare soils.

## *6.2 Crop Rotation*

**89. Agricultural crops should be cultivated in crop rotations. (Gf)**

Crop rotation solves economical, land use planning and agritechnical questions at the same time. Crop rotation is the type of arable land use in which crops are rotated on divided fields according to a predetermined order and taking into consideration farm natural, economic and organisational conditions. The order of crop change is called the crop rotation scheme and the time period in which all crops are planned in the scheme pass one crop rotation field is the Crop rotation period**.** Crop changes makes the fight against weeds cheaper, because soil water and nutrients are explored better and soil fertility does not diminish for long time. However crops such as potatoes which do not exhaust soil fertility can be cultivated over a long period.

The order of crop change should protect crops from diseases and pests. Vegetable crops originating from the same botanical family, cannot be successively cultivated on the same field. Soil borne diseases are reduced mainly when resistant crops are grown on the same field following a particular infestation.

**90. Crops which exhaust soil fertility should not be cultivated one after another several times. (Vc)**

This is achieved when the crops are sown after a break of some years. Crops in crop rotation have their own forecrops and aftercrops. Crops can be divided into two groups according to their value to serve as forecrops: some of them exhaust soil fertility and do not contribute to its increase, while other crops restore, maintain and increase soil fertility. Crops of the first type are, for example, cereals, while row crops, legumes cereals and perennial grasses comprise the second type.

**91. Bare soils should be avoided as far as possible. (Gf)**

Different cultures, market- and forage crops have to cover the soil all year to avoid nutrient losses by leaching. Should one crop leave a lot available nutrients in the soil, e.g. nitrogen after a legume harvest, it is very important to fix these nutrients by sowing or planting an aftercrop with high nutrient uptake rates as soon as possible. Catch crop cultivation can be helpful as well as undersown crops.

## *6.3 Intercropping in Permanent Cultures*

> **92. In permanent wide spacing cultures, soil between the plants should preferably be covered by suitable intercrops or mulch. (Gf)**

In order to avoid bare soils intercropping or inter-seeding covers the soil between rows, decreasing weed competition for space and light. Intercropping or inter-seeding with legumes produces further benefit from nitrogen fixation. Intercropped plants are harvested and inter-seeded ones are either incorporated or left on the surface.

## *6.4 Soil Protection*

### 6.4.1 Soil Tillage

> **93. Soil tillage should be adapted as far as possible to soil conditions and crop needs. (Gf)**

Soil tillage should be adapted as far as possible to soil conditions and crop needs. Soils are a scarce and non-renewable resource. The productivity must be conserved. During the soil tillage by agricultural machinery weeds, diseases and pests are eradicated, plant residues are incorporated and physical and chemical soil conditions favourable for the growth of crops are provided. The soil tillage is usually related to incorporation of organic and mineral fertilisers, sometimes to the application of pesticides. The tillage of every field depends on the current grown crop, forecrop and aftercrop. The use of heavy equipment and transport vehicles as well as the intensity of soil use and tillage support erosion by water and wind and soil compaction.

**94.** **Soil cultivation should be carried out in such a way, that soils are not compacted, crushed and ground. (Gf)**

The fertility of compacted soil is always lower than non-compacted soil. Soil compaction risk may be reduced if a better tillage time is chosen and the power of agricultural machinery and equipment are adjusted to power needed for soil tillage. At high soil moisture compaction of soil surface is lower if the weight of the tractor or of the equipment is spread over a greater ground contact area, e.g. using wider tyres or doubling the tyres. The bearing capacity of wet soils will be increased.

Agricultural machines should be run on the same wheel tracks for all operations (fertilization, spraying and cultivation) on the field. With this method fertilizers and pesticides are distributed more evenly and growth conditions for all plants become more equal.

### 6.4.2 Soil Erosion

**95.** **Crop cover practices should be increased in order to reduce soil erosion. (Gf)**

Crop cover is managed by leaving plant residual substances of the forecrop and/or catch crop near or on the soil surface. The objective is to maintain surface coverage as long as possible during the year over an intact soil structure to ensure protection against soil erosion by water and wind and puddled soil surface.

**96. Soil tillage for fields situated at an inclination has to be carried out across the slope. (Gf)**

Cultivating and planting crops in fields on the contour is recommended for controlling erosion. For mechanised agriculture, it is only likely to be effective for crops grown in gently sloping fields with simple slope design. For steeper sloping field with complex slope patterns, it is not practical to follow the contours accurately. In these fields, attempts at cultivations across the slope often lead to channelling of run-off water, particularly in tramlines or wheels, which can cause severe erosion.

**97. Rubble walls and shelterbelts should be preserved in order to reduce soil erosion by wind and water. (Gf)**

Most of the agricultural land in Malta is terraced, providing level ground and maximising the soil and water resources, while minimising soil erosion. Where the terraces and rubble walls to degrade overland flow would increase, accompanied by flooding and soil erosion. Shelterbelts create a barrier which reduces speed of wind, and lowers its ability to carry soil away from fields. Shelterbelts, e.g., trees, give an added value for the reduction of soil erosion together with the preservation of rubble walls. Rubble walls repaired under EU rural development programmes should be maintained and conserved for 25 years.

### 6.4.3 Mulching Strategies

**98. Mulching should be resorted to whenever possible. (Vc)**

Mulches cover the soil under the crop canopy, physically suppressing weed growth. Mulch can be organic, plastic, or paper, all having similar advantages but with different life expectancies. Organic mulches include live crops (cover crops), as well as organic materials such as straw. Mulching is widely used for intensive cropping systems, including strawberries and horticultural crops, and also for protected crop cultivation, e.g., tomatoes. Its good agricultural practices are:

- Mulches protect the soil from the impact of rain drops and regulate soil surface temperatures.
- Organic mulches improve soil structure and stimulate soil life.
- Mulches retain soil moisture.
- Aid in moisture retention during dry periods and avoid evaporation.
- Crop roots may exploit topsoil more efficiently under organic mulches.
- Mulches improve infiltration of rainfall and irrigation water and therefore improve the efficiency of irrigation.

#### 6.4.4 Soil sterilisation

**99. Soil sterilisation methods should only be used when necessary. (Vc)**

Soil sterilisation practices in Malta are used extensively due to the soil borne diseases. The different practices include chemical and non-chemical alternatives. Since the application of methyl bromide has to phase out by 2005, other alternatives should be applied and carried out. One process which is common in the Maltese Islands and in the Mediterranean countries is the Soil Solarisation Process, which reduces nematode and weed population by physical means.

### *6.5 Field Records*

**100. Good agricultural practice includes the keeping of a field file. (Gf)**

Field files for each individual field supports the farmer by:

- Getting information about the historical field management.
- Planning of field management in future.
- Preparation of field balances.

It should contain at least:

- Soil nutrient content, pH-value.
- Soil tillage practices.
- Current crop: name, sowing date and density.
- Fertilization: fertilizing practice, fertilizer material, nutrient compound, application rate and date.
- Plant Protection: plant protection measure, pesticide name and active ingredient, application rate and date.
- Harvest: date and data about yield and nutrient removal.

# 7 Legislation List

## 7.1 *European Legislation*

- Council Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources.
- Council Directive 80/778/EEC relating to the quality of water intended for human consumption.
- Council Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances.
- Council Directive 76/464 EEC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community.
- Council Directive 92/46 EEC laying down the health rules for the production and placing on the market of raw milk, heat treated milk and milk based products.
- Commission Decision 95/165/EC establishing uniform criteria for the grant of derogations to certain establishments manufacturing milk based products.
- Council Regulation (EC) No. 1255/99 on the common organization of the market in milk and milk products.
- Commission Regulation (EC) No. 213/2001 laying down detailed rules for the application of Council Regulation (EC) No. 1255/99 as regards methods for the analysis and quality evaluation of milk and milk products and amending Regulations (EC) No. 2771/99 and (EC) No. 2799/99
- Council Regulation (EC) No. 3950/92 establishing an additional levy in the milk and milk products sector.
- Commission regulation (EC) No. 1393/2001 laying down detailed rules for applying Council Regulation (EEC) No. 3950/92 establishing an additional levy on milk and milk products.

## *7.2 National Legislation*

- A.L. 25 0f 2001, Animal Welfare Act.
- A.L. 208 of 2001, Environment Protection Act.
- A.L. 90 of 2001, Food Safety Act.