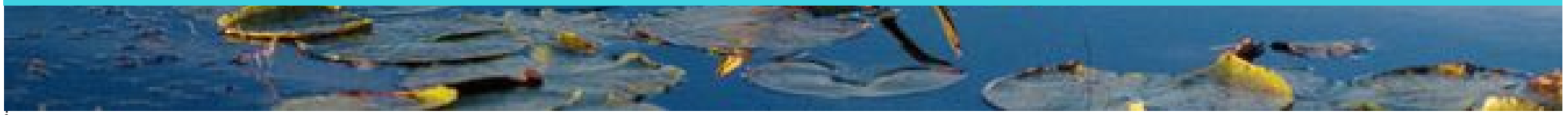
Principles & Practices for Sustainable Water Management in Agriculture

At a farm level

SAI Platform Water Working Group



Sustainable Water Management in Agriculture (version 2010): The 5 key Principles and Practices

1. **Sustainable Farming**

· Recognise agriculture is a significant contributor to water pollution

· Manage to reduce the impact of pollution from fertilisers, pesticides, manure, slurry, soil runoff

2. **Economic Sustainability**

· Good water management will cut costs for farmers, reduce pollution and will often improve productivity

3. **Social Sustainability**

· Improved working and social conditions for farmers will allow a higher priority for good water management

4. **Environmental Sustainability**

· Good water stewardship benefits the natural environment and wildlife

5. **Focus on specific crops**

· Examples from specific crops can set an example of good practice for all

Principles and Practices for Sustainable Water Management in Farming Production (version 2010)

Water is a vital component of agricultural production. It is essential to maximise both yield and quality. Water has to be applied in the right amounts at the right time in order to achieve the right crop result. At the same time, the application of water should avoid waste of a valuable resource and be in sympathy with the environment as a whole. Understanding, measuring and assessing how water flows around the farm, and recognising how farming practices affect flows, will help farmers to manage water efficiently and reduce pollution risks.

Economic, environmental and social considerations are playing an increasing role in agricultural production. Careful and effective water management will form part of these considerations, as well as helping the farmer to continue producing profitable production. Farmers aim to guarantee that the safety and quality of the water which they use will satisfy the highest expectations of the food industry and consumers. In addition, on-farm practices should ensure that water management is produced under sustainable economic, social, environmental conditions.

To that aim, **this document provides a set of principles and practices for sustainable water management for the mainstream market in all regions of the world and some crop specific ones. It is meant to be revised regularly on the basis of practical experience. Furthermore, it is meant to be completed with specific guidelines and practical tools based on local innovations and adapted to local prevailing conditions (according to the region and its climates, ecological variables, farming systems, cultures etc) as well as respecting national laws and regulations.** This document on water management in agriculture at farm level aims to address the key aspects of water and irrigation management at an environmental, economic and social level. Emphasis is given to correct management of water, both in terms of quantity and quality.

The **Basic framework** looks as follows:

1. **Item**. An item refers to an *object of management.*
2. **Principles** *identify the objective(s) of what should be accomplished* with regard to an item.
3. **Recommended Practices** provide a *set of non-exclusive tools and measures* that can be implemented to achieve the objective(s) of a principle.

It is important to note that good management of a farming system constitutes the grassroots of the system's economic, environmental and social sustainability. Therefore, it first pays attention to planning and managing well the overall farm system itself. This document's scope of management action is limited to what farmers or groups of farmers themselves can achieve.

Farmers shall have taken into consideration applying the principles and practices to the whole farm system within a philosophy of continuous improvement. The following headings and bullets summarise the sections and objectives when applied to a whole farm system. Sections of the document contain greater detail on specific practices. Some sections are linked to the technical briefs to provide further information on particular topics. Click on the underlined words to follow the links.

The report is structured as follow:

Sustainable Farming Systems (chapter 1)

- Agriculture is considered to be a significant contributor of water pollution by nonpoint[1] sources. Diffuse pollution can arise from a range of activities on the farm, such as the leaching of fertilisers or soil erosion, which are spread out over a wide area and therefore harder to pinpoint and control. Many of the substances used in agriculture can cause water pollution (fertilisers, pesticides, manure and slurry, even the soil itself) are essential elements of farming. This section provides recommended farming practices for tackling diffuse water pollution. Sustainable Farming System as a whole farm approach provides a framework for implementing the list of suggestions. It covers farm selection and management, integrated crop and pesticide management, soil protection and yards.

Economic sustainability (chapter 2)

- A good management of water resources will help farmers to cut costs while maintaining or improving the productivity of the land and reduce the risk of pollution. This section provides some practices to ensure safety, quality and transparency, financial stability, accountability, innovation and risk management from an economic perspective.

Social Sustainability (chapter 3)

- Achieving success in water conservation requires various levels of engagement and collaboration throughout the entire food sector and its stakeholders. Throughout this collaboration, it appears that several solutions exist to improve the water use at the farm level, including good practices. From a social perspective this section focuses on working conditions, capacity building and community engagement and recommends some practices to ensure an adequate water management at a farm level.

Environmental sustainability (chapter 4)

- Wise stewardship of water resources can help ensure to diminish the effect on agriculture practices on quality and availability of water resources. This section draws together various aspects of environmental water sustainability looking at irrigation, leaks, pesticides management, water quality, water conservation practices and the establishing a comprehensive water management at a farm level. The recommended practices presented in this section aim at delivering real benefits for farmers and the environment while minimising effects on the environment.

Water use for Specific Crops (chapter 5)

- This section provides a set of principles and practices for sustainable water management for some specific agriculture production (Coffee, dairy & livestock; rice; and vegetables & fruits).
- Rice is the major source of calories for half the world's population, as well as the single largest source of employment and income for rural people. But rice production has a significant environmental footprint. Current practices (e.g.: flood irrigation) are wasteful of increasingly scarce and costly resources such as freshwater, using up about one-quarter to one-third of the world's annual supply.

[1] Contamination arising from land use activities that is dispersed across a catchment or sub-catchment

1. Sustainable Farming System

Item	Principles	Recommended Practices
1.1 Farm selection and management	WSF1. When planning and managing the farm activities, properly take into account the farm specificities - such as water availability and quality.	▪ Be aware of the farm's characteristics (including surroundings water courses, the level of water stress, availability and quality of water resources, soil type) and based on these, chose the best location for crop production. Plan water harvesting and storage units if necessary. ▪ Set a management plan for potential pollutants: Nutrient & pesticide management, erosion, animal feeding operations, grazing management and irrigation water management.
1.2 Integrated crop management[2]	WSF2. Use conservation agriculture techniques to minimise the delivery and transport of agriculturally derived pollutants to surface and groundwater.	▪ To control diffuse pollution conduct conservation practices to minimise pollutants, slow the transport and/or delivery of pollutants, either by reducing water transported, and thus the amount of the pollutant transported, or through deposition of the pollutant; or to remediate or intercept the ▪ pollutant before or after it is delivered to the water resource through chemical or biological transformation. ▪ Conservation tillage -when possible applied- can help reduce overland transport of nitrogen by reducing erosion and runoff, and nutrient management will minimise subsurface losses due to the resulting increased infiltration. Buffer strips can be used to decrease nitrogen transport by increasing infiltration, and through uptake of available nitrogen by the field border crop. Nitrogen not controlled by nutrient management, conservation tillage, and filter strips can be intercepted and remediated through denitrification in riparian buffers. ▪ Establish conservation riparian buffer zones[3] alongside watercourses. Extend existing buffers to gain more efficiency in intercepting overland flow and reducing the transport of nutrients, pesticides and agrochemicals. Farming on the contour creates small ridges that slow runoff water. In strip-cropping, the small grain or hay strips slow runoff water, allowing infiltration and filtering sediment. ▪ Establish beetle banks across the slope to encourage natural predators and catch surface runoff. ▪ Regularly maintain and calibrate sprayers. Make sure that the correct pump and pipe size is used- trying to pump too much water through a small pipe will increase friction (reducing pressure at the end) and increase the chance of a leak occurring. ▪ Growing crops in a recurring sequence on the same field to control erosion, improve soil organic

[2] Integrated crop management integrates beneficial natural processes into modern farming practices using advanced technology and aims to minimise the environmental risks while conserving, enhancing and recreating that which is of environmental importance.

[3] A buffer strip is an area of land maintained in permanent vegetation that helps to control air, soil, and water quality, along with other environmental problems, dealing primarily on land that is used in agriculture.

		matter, balance nutrients, improve water use efficiency, manage saline seeps, manage pests and/or provide food and cover for wildlife. Planting forage and using grazing rotations among different fields can maximise production and reduce sediment and nutrient runoff.
1.3 Integrated pest management	WSF3. Use Integrated Pest Management (IPM) systems.	▪ Utilise Integrated Pest Management (IPM) prevention, avoidance, monitoring, and suppression techniques, and only apply the lowest risk pesticides available in an environmentally sound manner when monitoring indicates that an economic pest threshold has been exceeded.
1.4 Soil protection	WSF4. Prevent surface water pollution by reducing soil erosion.	▪ Reduce soil erosion and improve water infiltration by ploughing along contours and use conservational tillage[4] where appropriate. ▪ Block runoff pathways (relocate gates if applicable. Catch any surface runoff by establishing infield grass strips. ▪ Reduce wind erosion by using cover crops to ensure minimal amount of bare soil.
1.5 Yards	WSF5. Protect water quality by avoiding runoff and careful use of effluents.	▪ Repair damaged guttering and check for leaks. ▪ Consider installing reed beds[5] for dealing with lightly contaminated yard runoff. ▪ Make sure any effluent from silage[6] clamps is collected, stored and spread in an appropriate way. ▪ Separate clean and dirty water, recycle the clean water or divert to ditch or watercourse. ▪ Runoff liquid from manure from yards should be contained where pollution of water is a risk.

2. Economic Sustainability

Item	Principles	Recommended Practices
2.1 Safety, quality and transparency	WEC1. Ensure the safety, quality and transparency of the water use throughout the farming production.	▪ Ensure that the water saving equipment reduces the demand for water. ▪ When exposed to irrigation-water pricing, look for benefits or subsidies available. ▪ Draw a plan of all farm pipelines. In the event of a large pipe burst, readily available plans of the pipeline system can speed up repairs and reduce costs. ▪ The recording of water meters on a monthly basis and recording use can detect leaks and save money before the water bill arrives.
2.2 Financial	WEC2. Seek to achieve income long-	▪ Assess a potential future cost of adapting to water scarcity – including energy prices, insurance

[4] Tillage is an arable land that is worked by ploughing and sowing and raising crops.

[5] Reedbeds are a natural habitat found in floodplains, waterlogged depressions and estuaries. Reedbeds are part of a succession from young reed colonising open water or wet ground through a gradation of increasingly dry ground.

[6] Silage is a form of conserved grass (or other crop) that is made by farmers during the summer months when the grass supply is plentiful and not required for grazing. Silage is fed to cattle and sheep during winter months and is made by preserving the grass under naturally produced acidic conditions which effectively pickle the crop. Silage is quite moist and usually preferred by livestock to hay as it is more palatable and of higher food value.

stability	term stability of the farm for proper investments and adaptation investments, taking into account results linked to water use.	and credit costs. ▪ Assess the levels of farmer contributions (cost recovery) towards irrigation infrastructure operation and maintenance. This includes labour and payment in the long run (capital charges and depreciation). ▪ If applicable, ensure sufficient (amount and cost) and reliable power supply to enable irrigation pumping. ▪ Managing water application for maximum economic benefit with minimum impact on the environment.
2.3 Accountability	WEC3. Ensure the accountability and profitability of the farming system, taking into account results linked to water use.	Keeping a good accountability can help farmers to use water more efficiently, save cost and reduce water consumption. ▪ Calculate the profit per mega litre and yield per mega litre. ▪ Compare the crop returns (yields) against the volume of water applied. ▪ Keep record of water irrigation performance and cost. ▪ Calculate costs for irrigation water calculated on a volumetric basis (tariffs provide incentives to minimise consumption). ▪ Estimate potential saving/costs of conservation measures for water quality such as IMP, conservational tillage, buffer strips.
2.4 Innovation	WEC4. Encourage the use of Best Available Technologies (BAT) or new innovative ideas that optimise water use.	▪ Encourage innovation (this includes new ideas, technologies, methodologies, crop plan, processes, new markets and new approaches to old markets). ▪ Promote water efficiency and avoid water pollution.
2.5 Risk management	WEC5. Identify and assess economic risks linked to water use.	▪ Assess the exposure to water risks and make this information available. This would take into account the cost impact of alternative water supplies and the revenue impact of operating interruptions or restrictions due to inadequate water availability. ▪ Assess how the farm might be affected by changes in water supply, quality, reliability, and price. In addition, assess how water supply, quality, and reliability in key markets be potentially affected by climate change. ▪ Understand how the amount and source of the water withdrawals and the quantity and quality of wastewater discharges impact local communities and ecosystems. ▪ Assess the quantity/quality of the wastewater discharges in relation to permitted levels and/or industry averages. ▪ Prepare contingency plans to respond to water risks, such as supply disruptions, price increases, more stringent regulations, etc.

3. Social Sustainability

Item	Principles	Recommended Practices
3.1 Working conditions	WSOC1. Ensure water access among workers.	▪ Access to potable water and toilets should be guaranteed for all employees and workers. This equally refers to employees and workers as well as their families when living on the farm.
3.2 Capacity building	WSOC2. Support the training of farm employees and workers and increase awareness on water use and management.	▪ Develop environmental education programmes focused on the local community increasing water awareness and best water use practices. Actions should be promoted on the farm, to encourage farm employees and workers to conserve and not to pollute water courses during their duties. If applicable, conduct training programme embedding sustainability practices such as increasing awareness of the value of water in local communities and at a farmer level. ▪ Train operators and staff about optimising system performance. ▪ Provide support for adequate irrigation monitoring and scheduling. Provide training on integrated pesticide and nutrient management, conservation practices.
3.3 Community Engagement	WSOC3. Contribute to engage with the employees, workers and local communities.	▪ Understand any conflicting water use demands and the communities' dependency on water resources and/or conservation requirements that may exist in the area. ▪ Assess the impact of the water use by local communities. ▪ Establish an ongoing process for community relations management which directly addresses water issues. This could involve a designated contact person in the local community or a community relations department within the company.

4. Environmental Sustainability

Item	Principles	Recommended Practices
4.1 Irrigation For more detail see Best Management Guidelines for Sustainable Irrigated Agriculture	WENV1. Properly plan the irrigation system, if appropriate, and make sure it achieves water reduction. For more detail see TB on Irrigation	▪ Assess the different soil types, its water holding capacity and readily available water capacity of each of the soil types in the farm. See TB on The importance of soil on water ▪ Professionally design the irrigation system been designed to suit different soil types. If possible, ensure the supply system is designed to minimise losses and energy inputs. ▪ Perform an assessment of the hydrologic characteristics of the soil before adopting any irrigation system. Soil water shall be managed by drainage maintenance in wet climates and by soil moisture conservation practices in dry conditions.

4.1 Irrigation	WENV2. Ensure the irrigation system in place, if any, is working properly. For more detail see Irrigation system	▪ Make sure that irrigation works are professionally installed and commissioned. ▪ To improve the performance of infield application systems, check constantly the condition of the irrigation system, pumps, mains and hydrants periodically and repair worn items such as seals. If applicable, check sprinkler heads for wear or drip lines for blockages. If applicable, regularly check the system's operating pressures and the differential pressure across any filtration system and the system's flow rates. Ensure the pump is operating at its optimum performance if applicable. ▪ An important component of the evaluation of infield irrigation performance is the assessment of irrigation uniformity. The irrigation system should deliver irrigation uniformly throughout the farm. Evaluate the system's distribution uniformity regularly. For more detail see Calculating Distribution Uniformity ▪ Monitor with sensors the soil moisture below the root zone to monitor excess of irrigation.
4.1 Irrigation	WENV3. Schedule irrigation to reduce water use.	The crop's water requirements shall be systemically assessed in order to set the time and volume of crop irrigation. ▪ Ensure timing and amount of irrigation is tailored to crop requirements. ▪ Schedule irrigation according to accepted methods, which take account of evapotranspiration or soil moisture deficits, as this will result in using limited supplies more effectively. Irrigation should take into account predicted rainfall and evatranspiration, using either daily rainfall records or weather forecasts to plan irrigation schedules. ▪ Check regular meteorological forecasts to set irrigation schedule. ▪ Use soil suction measurement systems or soil moisture content measurement systems to manage and monitor soil moisture in the field. Monitor records and interpret soil moisture levels at various depths for each of the crops. See TB on The importance of soil on water.
4.1 Irrigation	WENV4. Properly manage irrigation use.	▪ Irrigation should only be used when it can enhance the yield and quality of crops produced. ▪ Irrigate the crops with the minimum amount of water they need plus a leaching fraction. ▪ Irrigate at night and consider using trickle irrigation. Proper use of water for irrigation as well as careful and adequate use of inputs should be made to preserve the volume and quality of water reserves and courses. ▪ Do not irrigate when it is windy as this will result in uneven application and, if you are using a spray gun, may result in water drifting onto areas that do not need watering.
4.1 Irrigation	WENV5. Properly measure the irrigation system.	▪ Maintain a water management logbook that records precipitation, rainfall, and evaporation, as well as time and amounts of irrigation applied, in order to develop an understanding of long-term trends in water use. ▪ Measure the irrigation efficiency and compare the irrigation farm's performance with local and industry level. See TB on Irrigation
4.2 Leaks	WENV6**.** Prevent and reduce water losses.	▪ Insulate pipes properly, lagging all exposed pipe work within 750 mm of ground level. ▪ Ensure all hoses, hand lances and washing equipment have trigger controls. ▪ Having appropriate maps/plans of water pipes, mains and irrigation helps in avoiding damage and

		water loss. Position of pipes, fittings and type of material should be noted. ▪ Sketch out the water supply network and check regularly for leaks. ▪ Check taps, drinkers, troughs and nozzles for leaks as part of a regular six-month audit. Replace washers when necessary. ▪ Use a sounding rod to listen for leaks. Noise means water is flowing. If the noise stops when the stop tap is turned off, then the leak is downstream of the tap. ▪ Install a control valve to reduce pressure in the system. ▪ Maps of yard schemes should be available in the event of a pollution incident to control the runoff water. ▪ Review water use quarterly. Look out for any increase in use that may indicate leaks. ▪ Regularly check the condition of the pumps, mains & hydrants and repair worn items like seals.
4.3 Pesticide management	WENV7. Ensure responsible and efficient use of pesticides and chemicals in the farm.	▪ Pesticide applications must follow all label requirements. Ensure all the pesticides used in the farm are approved. ▪ Pesticides should not be applied to water logged, steep or frozen ground with a risk of runoff. ▪ Assess the risk assessment of pesticide use on water resources. Some tools available are Field crops indicator developed by the Centre for Agriculture and Environment (CLM) and PRiME (Pesticide Risk Mitigation Engine) ▪ Monitor the impact of pesticide use on the water environment over time and implement strategy on the basis of the monitoring data. This may include pesticide management plans, pest management strategy but also ecotoxicological bioessays from soil, water and sediments samples. ▪ Implement mitigation measures for water pollution such as application rate reduction, shifting application to earlier or later date, use of buffer strips, constructed wetlands, grassed waterways, subsurface drains, and use of filters. ▪ Make sure that areas used for mixing and filling pesticides, as well as sprayer wash-down cannot contaminate surface drains. Use a covered, contained area for mixing pesticides and filling sprayers. Adequate buffer zones shall be set in case of aerial spraying. ▪ Rinsing of spraying equipment shall be done appropriately to avoid contamination of soil and ground water. In case of using sprayer, wash it down in the field, over a lined biobed[7] or over a concrete area where the liquid is drained to a lined biobed or a sump for future disposal. Internal tank rinsing can be sprayed on to an untreated part of the crop saved for that purpose or sprayed

[7] Lined Biobed has a plastic lining between the biobed material and the soil. Biobeds mixture consists of straw (50%), soil (25%) and compost (25%) and turfed over. After mixing the biobed constituent material it should be matured for approx. 6-8 weeks before placing it into the lined pit. Annual topping up with pre-composted mixture will also be required. Selecting a light, or medium, loamy soil enhances performance. Clay soils should be avoided as they can be difficult to mix and may hamper drainage. Sandy soils should also be avoided as they are too free draining and will not retain the pesticide residues adequately. For more info see: //www.biobeds.info

		over the treated crop provided the maximum label dose is not exceeded. Where there is leftover spray this can be sprayed on an untreated part of the crop saved for that purpose or sprayed over the treated crop provided the maximum label dose is not exceeded.
4.3 Pesticide management	WENV8. Ensure safe pesticide/fertiliser storage.	▪ Ensure all potential pollutants, e.g. pesticides and chemicals, are safely and securely stored. ▪ Storages structures should be located down slope from farm buildings and at a maximum distance from bodies of water (more than 10m from a watercourse and/or drain) where there is no risk of contamination of watercourses. Water/flooding should be prevented from entering storage areas. ▪ Identify and record all potential pollutant materials on the farm to provision to safely store and handle them and their risk to the environment. The inventory must indicate the potential risk and prioritise based on the risk. Consideration must be to those that pollute water and soil.
4.4 Water conservation	WENV9. Properly chose crops so they are as suitable as possible with the agri-climatic conditions.	▪ If possible select crops compatible with water availability. Assess whether the crop cultivated is appropriate to local water resource conditions (local water availability but also salt-tolerance of the crop). 'Appropriate' refers to activities that are not in conflict with current and future users and uses. Low water crops are a clear opportunity and replacement of water-intensive crops with drought-resistant crops is crucial.
4.4 Water conservation	WENV10. Minimise or/and reduce water use on the farm.	▪ Good agricultural practices as managing soil fertility and reducing land degradation can increase water efficiency. Conservation tillage systems, for example, not only protect soil architecture through minimal soil disturbance, but also can increase water use efficiency by permitting an efficient water and nutrient cycling as a result of root development and stable biological porosity. ▪ Minimise water use on the farm by reusing (where high quality water is not needed, or even cleaned and recycled for high quality use), recycling, conserving and collecting water and/or using low demand systems. ▪ Minimise water use in washing materials by using alternative washing systems such as dry cleaning techniques (scrapers, squeegees and brushes can be used to remove solid waste before cleaning them with water). This can also help reduce the risk of creating diffuse pollution. ▪ In the case of crop wash, it is recommended to recycle and reuse wash water. Instead of letting water go to waste, it can be recycled and used where high quality water is not needed, or even cleaned and recycled for high quality use. ▪ Use best available water-efficient irrigation systems. Reduce evaporation by avoiding midday irrigation and using trickle or drip irrigation techniques. ▪ Use Rainwater harvesting for irrigation, cleaning purposes. This can help to cut down on freshwater use, environmental impact and costs. Rehabilitate tanks and renovate of water harvesting structures if necessary. ▪ Storing runoff from rainy periods for use during dry spells by using tanks, ponds, cisterns, and earth dams.

4.5 Water quality	WENV11. Ensure quality of water is suitable for irrigation. For further information see Water Quality and Quantity Best Management Practices	▪ Complete an annual risk assessment for irrigation water pollution. The risk assessment must consider potential microbial, chemical or physical pollution of all sources of irrigation water.[8] Where wastewater is used for irrigation, ensure water quality complies with the WHO published Guidelines for the Safe Use of Wastewater. Also, when there is doubt if the water is coming from a polluted source (because of a village upstream, etc.) demonstrate through analysis that the water complies with the WHO guideline requirements or the local legislation for irrigation water. ▪ Where considered a risk, industrial residue water, sludge and untreated wastewater shall not be spread on the vegetation. See TB on Wastewater use in Agriculture ▪ Receiving water-body use and assimilative capacity, including the impact of other sources of discharges to the receiving water, should be considered with respect to acceptable contaminant loadings and effluent discharge quality as described in the General EHS Guidelines.
4.5 Water quality	WENV12. Minimise water pollution point and nonpoint water sources.	▪ Prevent the pollution of waterways on or near the farm and minimise it, where unavoidable. ▪ Avoid the discharge of untreated farm activity effluents into natural superficial waters. ▪ Reduce runoff by implementing methods such as conservation tillage, terraces, raised ridges, contour cropping and conservation tillage; by managing pastures in accordance to local conditions; by cultivating as soon as possible after late harvest to loosen the soil; by loosening the soil and creating a rough soil surface after harvest, then leaving it for as long as possible allowing water to soak. ▪ Avoid runoff particularly after spreading organic and/or mineral fertilisers. ▪ Avoid over and under-irrigation to decrease potential for soil salinisation.
4.5 Water quality	WENV13. Seek professional advice in assessing and planning pollution control.	▪ It is recommended to seek outside assistance from a suitable trained and qualified person. However where internal expertise exists this will be acceptable but needs to be justified. ▪ Ask advice for identifying what waste, by-products and pollution control issues exist on farm, and appropriate ways in which these may be addressed, and incorporated into the farm operations.
4.6 Water audit	WENV14. Conduct a water-use inventory to manage and optimise water use in farm.	▪ Conduct a water audit and a water balance for the farm. Record details of volumes used in compliance with collective management approaches where applicable, and at least once a month in all other cases. Update it during the season. ▪ Measure the quantity of recycled water rainwater harvesting, re-use of water. ▪ Record irrigation used for each crop and the parameters that triggered such irrigation (weather forecasts, hydrological statement, warning, signs of weakness in the plants). ▪ Indicate the date and volume per water meter or per irrigation unit. See TB on Metrics for improving water management. ▪ Implement water meter if possible and make sure they are calibrated, correctly installed and

[8] Part of the risk assessment should consider the irrigation method and the crop, frequency of analysis, sources of water, the resources and susceptibility for pollutants and drain water of the sources and the environment.

		accurate. If applicable, read the water meters frequently. If case, there is an unexpected increase in water flow it is probably a leak. Use stop taps to isolate lengths of water pipes step by step to locate leaks. ▪ If applicable, all water pumping systems on the farm should be equipped with volume meters, in order to identify the amount of water used. All water pumping systems on the farm should be equipped with volume meters, in order to identify the amount of water used. ▪ Ensure that sufficient monitoring wells are installed around cavities to enable monitoring of pressure levels, as well as water quantity and quality. If applicable, read the water meters at night and ensure night flow should be minimal.
4.7 Water management	WENV15. Minimise impacts on water courses and the environment.	▪ Take steps to mitigate impacts on ecosystem. This may include integrated pest management, low water fertilisers but also if the farming area is located in or near a site of ecological importance. ▪ Ensure that infrastructure for the delivery of water adequately maintained (inter-basin transfers may pose a greater risk than intra-basin transfers). ▪ Assess the maximum levels of water extraction above which the underlying ecosystem would get overexploited. ▪ Ensure the adequacy of resource protection related to aquatic protection. ▪ Many farms have unused wells. Pollutants that enter these wells move quickly and without filtration to groundwater. Abandoned wells are sealed by removing pumps, piping and debris, and filling the hole with a slurry of cement or bentonite chips.
4.7 Water management	WENV16. Develop, implement and manage and monitor a comprehensive Water Management Plan (WMP) for the whole farm.	▪ A WMP should be set up to plan efficient water use on farm and at the same time to preserve the volume and quality of water reserves and courses. The water management plan should: - identify where water is being used and how water use can be minimised - minimise all identified sources of pollution, and risks of pollution to the water resources - include actions to mitigate the environmental impact of water use - consider leakage detection, collection, re-use of water and irrigation scheduling - assess the farmer water-dependency on supply from another region, the expected decline in water availability within the farm's area of operation - include the level of water stress in the farming area - assess the security of sustainable water availability in quantitative and qualitative terms at river basin - aim to optimise crop yield, while conserving the quantity and quality of water resources - try to optimise water usage and reduce water waste, e.g. irrigating at night, maintenance to reduce leakage, storage of winter storm water etc - set emergency response plans in case an emergency of spillage happens. ▪ Implement the mentioned plans gradually over time, from the most important to the least important sources of pollution and risks of pollution. ▪ Revise and monitor the WMP and the irrigation plan on a regular basis.

5. Water use for Specific Commodities

Item	Principles	Recommended Practices
5.1 Coffee	WSC1. Properly manage and optimise water use.	▪ Where applicable, minimise the volume of water used to irrigate plantations. ▪ If applicable, reduce the volume of water used in wet processing of coffee via the application of efficient technologies and recycling of water. ▪ Reduce the volume of water used in "wet" processing of coffee; this in turn, reduces the amount of water requiring treatment before being discharged from the processing facilities.[ii] ▪ Reduce the amount of water used in the processing to separate the bean from the cherry pulp. ▪ Post-harvest processing should minimise the use of water and release of pollutants into natural water sources. For more information see Coffee Waste water treatment ▪ Consider sprinkler irrigation as it has the advantage of not causing erosion on steep sites. Sprinkler irrigation also creates a moist microclimate in the coffee plantations, which is very good for the foliage and the plant in general.
5.2 Dairy & Livestock	WSC2. Protect water courses.	▪ Cows should be prevented from direct access to surface water at any time. Fence off watercourses in fields regularly used for keeping livestock. Keep cattle away from watercourses especially during the winter. ▪ Construct livestock crossings for watercourses regularly used by livestock and provide alternative drinking arrangements with pasture pumps etc. ▪ Grazing of environmentally sensitive areas should be managed appropriately to allow the protection of water resources. Protection should be given to hedges, ponds, ditches, streams, rivers, buffer areas and other habitats identified as environmentally valuable / sensitive. ▪ Livestock yards (barnyards, holding areas and feedlots) are areas where livestock wastes are concentrated and therefore appropriate management is vital to protection of water quality. These yards, especially when on permeable soils or close to farm water sources can cause nitrate and bacterial contamination in ground or surface water. To minimise the possibility of contaminants leaching to groundwater or running off to surface water, such yards should be at least partially roofed, on concrete and further than 30 metres away from waterways and streams. Yards should be regularly cleaned and runoff or flood water should be diverted so that runoff from yard never enters ground or surface water. ▪ An excessive soil compaction through animals damages soil structure and can increase the risk of

		soil erosion and runoff of waste to watercourses, stocking rates and animal movements should be adapted, and supplementary feeders / supply of drinking water for cattle should be positioned accordingly.
5.2 Dairy & Livestock	WSC3. Minimise and reduce water spillage and contamination.	▪ Properly manage storage areas for manure, silage and fertiliser so as to avoid leaching and pollution into surface and groundwater. ▪ Ensure the farm has a formal wastewater management plan in operation when rearing livestock intensively, operate a diary farm or store large amounts of organic waste. ▪ Properly manage water used to clean the milk house and milk house equipments as it contains high levels of organic matter, nutrients and chemicals and micro-organisms, which can contaminate water. ▪ Install stock drinkers which avoid water spillage.
5.2 Dairy & Livestock	WSC4. Provide sufficient and clean water to animals.	▪ Ensure access to sufficient quantities of water for all animals. ▪ Provide water supplies of good quality. ▪ Drinking water facilities should be regularly cleaned.
5.2 Dairy & Livestock	WSC5. Seek water use efficient and reuse water whenever possible.	▪ Monitor water supply systems – metering to allow rapid identification of inefficiencies in water use, breakages (troughs or burst pipes) and leaks in livestock areas. ▪ Harvest rainwater from roof livestock holding areas and manure stores. Clean rainwater can be channelled and collected from roofs for livestock drinking, if there is no health risk.
5.2 Dairy & Livestock	WSC6. Minimise or/and reduce water use for drinking.	▪ Consider alternative drinking water designs, including troughs; also management of drinkers, e.g. guard rails adjacent to drinkers in pig pens. ▪ Regularly check the water drinkers to make sure they are securely fastened and there are no blockages. ▪ When replacing drinkers, consider investing in an alternative design, such as nipple and cup drinkers in poultry units or bite-type drinkers in bowls within a pig unit, as these reduce the amount of water wasted by the animals 'playing' with the drinkers.
5.3 Rice	WSC7. Reduce irrigation withdrawals for rice, and possibly the actual water consumed by the crop (ET), through relevant farming practices.	▪ *Delayed transplanting of paddy* - in arid areas, paddy transplanting date should be aligned with the normal onset of the rainy season for making good use of the monsoonal rainfall and achieving higher yields. Avoiding early translpanting in the hot dry months leads to saving of high evaporation losses and excessive groundwater pumping for irrigation. ▪ *Laser Land Levelling* - repeated ploughing can cause fields profiles to be often uneven and this requires longer groundwater pumping hours to irrigate the entire plot. An intervention of laser-assisted land leveling can thus be introduced to create an almost flat field condition with desired slopes in the required flow direction. ▪ *Intermittent irrigation of rice* - after the initial two weeks of submergence of rice fields, the continuous ponding of water is not always helpful. The fields may be irrigated after 2 or 3 days once the ponded water has disappeared and the last irrigation may be terminated two weeks prior to the harvest.

		▪ *Raising of bund heights around rice fields* – In monsoon regions of India, research has conclusively shown that maintaining a bund height of about 22 cm around the rice fields helps to capture all of the monsoonal rains in the rice fields better (above 95% capture) and thus reduces the need for extra groundwater pumping. This small intervention has good potential for saving 3-5 irrigations during rice cultivation. In these regions the average crop growth period of rice is about 130 days, and the rice crop can receive on average 45 groundwater irrigations. ▪ *Direct seeding of rice* - research by the International Rice Research Institute (IRRI) and Rice-Wheat Consortium (RWC) has shown that direct seeding of rice (instead of nursery transplanting) under favourable conditions will produce comparable yields, but will substantially save water and energy. However, some farmers have reported that such a method of rice cultivation requires more effective weed control programs. This practice is still only at a demonstrational stage.
5.3 Rice	WSC8. Where appropriate, use systems of rice intensification (SRI).	▪ *System of rice intensification (SRI), aerobic rice cultivation, cultivation of rice on flat beds* - some of these more innovative methods of rice production promise to provide good yields with lower inputs of water, fertilizers and energy. These systems are still under stages of large-scale demonstration and may be adopted under guidance of expert extension agents.
5.4 Vegetables and Fruits	WSC9. Minimise or/and reduce water use in vegetable and fruit production.	▪ Irrigation shall be carried out only in situations when it can enhance the quantity and quality of crops and trees grown for optimum fruit and vegetables quality and yield. See TB on Irrigation ▪ Mulches are a good method for increasing water efficiency as they reduce non-productive evaporation from soils, ensuring that more water is lost productively through the plant, with no physiological trade-offs. Mulching is more suited to high value, intensively produced crops such as field vegetables because of the additional costs involved, and has greater potential benefits for wide row crops, or situations where the soil is exposed (not covered by crop canopy) for a significant period. Both crop performance and efficient use of the available water can be optimised by: ▪ Knowing the water holding capacity of the soil in each field and the water requirements and response of each crop grown. ▪ Using an effective soil moisture monitoring system and using it to schedule irrigation accurately. ▪ Choosing the right application equipment for the farm´s situation and knowing how to get the best out of it in terms of uniform and timely delivery.
5.4 Vegetables and Fruits	WSC10. Reduce the amount of waste generated and therefore its water embedded.	▪ Avoid unnecessary disposal of good quality off-cuts. For example, assess using off-cuts of cabbage, carrots and lettuce, where possible, in other products for retail outlets. ▪ Review and optimise operating conditions to keep produce damage to a minimum. Check and control unsuitable fruit processes. Check if the spin-dying process damage produce, which then have to be discarded.
5.4 Vegetables and Fruits	WSC11. Minimise or/and reduce water use in cleaning and washing.	▪ Grow and harvest clean vegetables and thus reduce the volume of soil that needs to be washed off. Choice of soil type will influence amount of washing and hence water required e.g. crops grown on sands will have less soil adhering than those on peats and silts. However other factors

		need to be considered such as sandy soils not being ideal for all vegetable crops and geographical location in relation to infra-structure, labour, etc. ▪ Brush/scrape or squeegee any solid waste away before washing down. The removal of solid waste before washing down can significantly reduce the amount of water used. ▪ Install a high-pressure wash system for bulk tanks. Use pressure washers to improve efficiency of cleaning and reduce water use. ▪ Collect rainwater off packhouse roofs, yard surfaces, etc; at present on most sites runs into the drains. Consider filter and treat it before use because of contamination by birds, small rodents and pollution.

5.4 Vegetables and Fruits	WSC12. Reuse water from fruit and vegetable processing.	▪ Water used during fruit and vegetable processing can be re-used in various ways, eg:
		  ▪ Water used in flumes (for conveying solid waste) can be re-used following suitable treatment.
		  ▪ Screening water to remove grit, stones and other debris allows it to be reused.
		▪ Ultrafiltration can filter out macromolecules, eg proteins and fine colloidal material, while nanofiltration takes out smaller molecules such as sugars.
		▪ Use vegetable washing water for irrigation.
		▪ Re-circulate the water to the cruder parts of process.
		▪ Water used in flumes - e.g. for conveying solid waste - can be reused following suitable treatment screening water to remove grit, stones and other debris allows it to be reused - e.g. for rinsing.
		▪ Produce can be rinsed in a series of tanks or stages - lower rates of water use are achieved with counter-current rinsing because the produce is rinsed initially in dirty water and then in progressively cleaner water.

[i] Picture taken from www.nationalgeographic.co.uk/
[ii] http://www.nrdc.org/health/farming/ccc/chap4.asp