# ENVIRONMENTAL SUSTAINABILITY TOOLS FOR SUSTAINABLE CROP PRODUCTION INTENSIFICATION (SCPI)

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# EXECUTIVE SUMMARY

Food production will need to increase by 70 percent over the next forty years to feed a growing human population. There is global recognition that agriculture production must be achieved without passing on irreversible environmental debt to future generations, so agricultural production will need to achieve both food security and environmental sustainability.

The focus of this document is on examining existing environmental assessment and management tools and practices that can promote and support efforts to achieve sustainable production intensification. A wide range of tools and approaches are described; however, efforts in the following strategic areas are suggested to provide an environmental sustainability framework for advancing sustainable production intensification:

- **Design and implement integrated policies for sustainable production intensification that incorporate both development goals and environmental sustainability goals.** Food security and environmental agreements must be translated into integrated national policies and lead to concrete actions. Policies need to provide clear direction and commitment to achieving food security and reducing poverty while also preventing environmental degradation (e.g. soil erosion, water pollution, and loss of biodiversity). Policy development to protect air quality, soil health, water quality and quantity, and biodiversity, needs to become a central element of overall agricultural policy development in all countries to ensure that crop production and intensification is sustainable over the long-term. Actions to develop the agriculture base and achieve environmental sustainability need to be mutually supportive, as much as possible.

- **Prevent or mitigate adverse impacts and risks.** Advancing policy commitments to sustainable production intensification will require the use of a range of environmental assessment processes and risk assessment procedures to identify and predict adverse impacts and risks, and to plan and implement preventive measures and risk aversion strategies. While tradeoffs might be required to achieve food security goals, the consequences of sustainable production intensification must be fully understood, and preventative or mitigation efforts implemented when necessary and feasible. Environmental assessments and risk assessments must become essential planning tools as part of sustainable production intensification – a routine business practice. With experience and as the impacts of particular developments are recognized and effective mitigation measures proven within specific production environments, the assessment process can become streamlined to ensure that scarce financial resources are invested in mitigation, and not unnecessarily consumed in assessing impacts that are readily predicted. Streamlined processes will be particularly important in planning and implementing small-scale agricultural development initiatives. Large-scale developments, such as major agricultural infrastructure developments will likely require detailed environmental assessments and planning of measures to prevent or mitigate adverse environmental impacts. The Annex of this document comprises a set of checklists for environmental sustainability assessment that can save time and assist decision-makers and others in reviewing agricultural development projects and initiatives. The checklists can also be downloaded and used as a separate document

- **National and sub-national management strategies and plans for soil, water and biodiversity.** Ideally, sustainable production intensification will take place within the context of existing national and sub-national strategies and plans for soil, water and biodiversity. Established national strategies and plans will help to identify risks, opportunities, existing challenges, and competing interests in resources necessary for agriculture (water, land, energy, etc.). National strategies and plans for soil, water and biodiversity will also likely provide valuable information to plan sustainable use of these resources and avoid conflicts with other resources users and developers. For example, soil conservation strategies and plans should provide valuable information on causes of soil erosion in a country, areas of high erosion potential, and measures that have been effectively employed to prevent erosion. Biodiversity strategies and plans will likely provide information on national biodiversity goals and challenges, and identify areas and species of concern and importance, etc. This information will help to plan agriculture development in a way that is consistent with biodiversity conservation goals.

- **Accelerate the adoption of sustainable management practices for agriculture**. Acceleration of the adoption of improved on-farm *sustainable management practices* will make an essential contribution to achieving sustainable production intensification. While adoption of sustainable agricultural management practices is ongoing in many countries, and a wealth of guidance is available, adoption of sustainable management practices needs to be accelerated as part of sustainable production intensification. Making existing information more widely available to farmers in appropriate languages, along with training to take into account local circumstances, will facilitate efforts to achieve sustainable production intensification. Training and on-farm demonstration sites and other methods of education and instruction are likely to be needed as fundamental elements in advancing sustainable production intensification, both to enhance production and achieve environmental sustainability. Preparation of **environmental farm plans** can be achieved at all farm scales, and provide the basis for identifying priorities for capacity building in sustainable management practices. Indeed, preparation of environmental farm plans could become an important element in advancing sustainable production intensification.

- **Accelerate the adoption of environmental management systems for agriculture**. Further establishment of environmental management systems within the agriculture sector will improve the basis for achieving sustainable production intensification, particularly in relation to large-scale agricultural operations. Environmental management systems are particularly applicable to large-scale farms and crop-related processing facilities. As part of the overall production chain, reducing environmental impacts of processing facilities can play an important role in efforts to achieve sustainable production intensification – for example, by increasing their efficiencies in the use of energy and water, or reduce negative impacts on soil, water and air quality. Large-scale farms or farmer associations can also use environmental management systems and audits to promote and pursue environmental goals, and to pursue and achieve green product certification. Environmental farm plans are likely to be more practical in promoting environmental sustainability among small-scale farmers than environmental management systems.

- **Enhance integrated landscape management or the application of the ecosystem approach[1] in agricultural areas.** The application of integrated landscape management or the ecosystem approach, over the long-term, will be one of the most enduring means to achieve sustainable production intensification. These approaches promote the integration of economic, social and environmental goals and objectives within a land unit or area that is meaningful to resources managers, land-owners and members of the public or others with interests in a particular area. Advancing integrated landscape management approaches can assist in situating sustainable production intensification in the context of other resource developments and interests by diverse land and resources users occupying the same land area (landscapes and ecosystems). This integration is necessary to determine and plan for ecologically sustainable uses, to ensure understanding of responsibilities for the management of shared resources and areas, and to prevent or reduce conflicts among resource users. Integrated landscape management will bring together government agencies and development organizations and promote integration of their policies, strategies and plans.

[1] The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Convention on Biological Diversity, Decision V/6 (2000) (http://www.cbd.int/decision/cop/?id=7148) and VII/11 (2004) (http://www.cbd.int/decision/cop/?id=7748 )

# 1. INTRODUCTION

Food production will need to increase by 70 percent or more to feed a population projected to exceed 9 billion people by the year 2050. If this is to be achieved and sustained, the agriculture sector and related private sectors as well as the public sector will need to develop and implement sound policies, plans and programmes aimed at increasing production and productivity within an overall sustainability intensification framework. Farmers will need to implement improved farm management approaches that increase farm outputs and at the same time minimize adverse impacts to the farm ecosystem and the adjacent and downstream areas. This is the primary aim of sustainable production intensification. While certainly not new, the concept of sustainable production intensification is gaining momentum within the agriculture sector as awareness of the need to achieve food security without significant and permanent environmental degradation, including the loss of biological diversity (biodiversity). The agriculture sector in many countries is already paying greater attention to ecological sustainability and maintaining and enhancing ecological services and functions. The notion of inter-generational equity has never been more relevant given the need to increase food production in the face of major environmental issues such as climate change, erosion and loss of biodiversity, desertification, pollution, and the degradation of air, water and soil.

Food security must be achieved without passing on irreversible environmental debt to future generations. Over the past several decades, a number of important global agreements have been put into place committing the global community to achieving both food security and environmental sustainability. These agreements provide the global context for sustainable production intensification, and require emphasis on all three components of sustainable development – social and cultural, economic and environmental sustainability. While some countries have embraced integration of these objectives, in many countries far greater attention must be given to policy and planning for environmental sustainability, with a corresponding investment in human and financial resources, if sustainable development is to be achieved.

## OUTCOMES SOUGHT

The need to address food insecurity, malnutrition and poverty is urgent and compelling, and these matters are the main focus for sustainable production intensification. However, in the long term, and even in light of the immediate need to address current hunger, malnutrition and poverty, the application of environmental sustainability tools and approaches in the context of sustainable production intensification is essential. Significant investment is required. The following environmental sustainability outcomes should be considered in pursuing sustainable production intensification:

- Accelerated and enhanced translation of international and national agriculture and environment commitments, policies and strategies into concrete actions, in an integrated manner that achieves both agricultural development goals and environmental goals – the maintenance of ecological functions and services over the long term.

- Greater effort and attention given to the early identification of any adverse environmental impacts and risks resulting from agriculture production intensification. Decisions should be based on understanding of potential impacts, risks and tradeoffs, and of the need for and benefits of mitigation measures.

- Improved understanding of policy-makers and farmers of the concept of ecological sustainability within the context of agricultural production, resulting in enhanced policy development and efforts to maintain and enhance ecological functions and services as a key element of sustainable production intensification.

- Improved integrated planning of agricultural development and biodiversity conservation through enhanced inter-agency and inter-sectoral coordination and collaboration. Integrated landscape management or the ecosystem approach is being widely applied enabling consensus to be achieved on the main requirements for sustainability, as well as on the shared responsibilities for achieving sustainable production intensification and biodiversity conservation and sustainable use.

- Accelerated farmer training in sustainable management practices resulting in more efficient use of farm inputs and less wastes; reduced environmental degradation attributed to agriculture production; and maintenance of the resource base. Sustainability performance measures are in place to measure progress.

- Priority capacity building activities are underway as part of sustainable production intensification, enabling farmers and farming communities to both increase food production and prevent adverse environmental impacts from their operations resulting in improved food security and reduced malnutrition and poverty, without significant and irreversible adverse impacts to air, water, soil, or biodiversity.

**STRUCTURE OF THIS DOCUMENT**

Achieving environmental sustainability in relation to sustainable production intensification will require the application or use of proven environmental management tools and approaches. The following chapters describe several environmental assessment and management tools that are applicable to sustainable production intensification.

Chapter II describes a range of assessment tools that can be used to identify and predict adverse impacts and risks from sustainable production intensification, enabling understanding and planning of required preventive and mitigation strategies.

Chapter III provides operational advice to protect the natural resource base: soil, water and biodiversity.

Chapter IV calls for the acceleration of the implementation of sustainable management practices at the farm level, and suggests promotion of environmental farm plans and environmental management systems as part of efforts to achieve sustainable production intensification.

Chapter V describes the key characteristics of integrated landscape management or the ecosystem approach and indicates how these approaches could contribute to sustainable production intensification.

Chapter VI provides a brief description of other measures that can be employed to further contribute to environmental sustainability efforts, as part of sustainable production intensification.

The Annex comprises a set of checklists for environmental sustainability and impact assessment that can save time and assist decision-makers and others in reviewing agricultural development projects and initiatives. These can also be downloaded and used as a separate document[2].

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# 2. ENVIRONMENTAL ASSESSMENT TOOLS

This chapter describes a range of environmental assessment tools that have been developed and applied to identify, prevent and mitigate adverse environmental impacts related to agricultural developments and natural resource use.

## STRATEGIC ENVIRONMENTAL ASSESSMENTS AND ENVIRONMENTAL IMPACT ASSESSMENTS

For discussion purposes here, a **strategic environmental assessment**[3] is a technical assessment undertaken by teams of experts to determine potential adverse environmental impacts of projects, programmes or policies, and to determine appropriate prevention and mitigation measures. They are also referred to as **initial impact assessments**. With smaller-scale initiatives, strategic environmental assessments are often adequate to plan developments, and do not normally involve a significant stakeholder or public consultation phase, which would likely be required in formal or full-scale environmental impact assessments.

**Environmental Impact Assessment** will refer here to the formal, often legal process for identifying and describing any adverse environmental impacts of projects or polices, and to determine appropriate prevention and mitigation measures. In many countries, public consultation processes are requirements in the overall process. The environmental impact assessment is normally prepared by the project proponent under the direction of a regulatory agency. A panel of experts makes recommendations on the project or policy and a regulatory agency makes a formal determination on whether the project or policy shall proceed, or how it might need to be modified to prevent or mitigate adverse impacts to the environment. Social impact assessments are often included in environmental impact assessments or are conducted in parallel, where a project or policy might have significant impacts on local and indigenous communities.

In many countries, environmental impact assessment processes and procedures are based on legislation. Strategic environmental assessments are commonly undertaken to determine the need for a full-scale formal environmental impact assessment. Often the result is that for relatively small-scale projects, mitigation measures can be identified through the strategic environmental assessment process, and appropriate preventative or mitigation measures determined without the need for the more costly full-scale formal environmental impact assessment. Some countries and regions have prepared guidelines to assist project proponents or developers to identify the conditions under which a strategic or environmental impact assessment is likely to be required. Guidelines can be area-specific: for example, the eight Arctic countries have agreed on a general set of guidelines for use in the arctic region[4]. Impact assessment guidelines have also been prepared for various resources sectors (mining, forestry, agriculture)[5], and particular environmental values[6].

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[3] Strategic Environmental Assessment at Environment Canada – How to Conduct Environmental Assessments of Policy, Plan and Program Proposals, 2004 (http://www.acdi-cida.gc.ca/CIDAWEB/acdicida.nsf/En/EMA-218131145-PHA)

[4] Guidelines for Environmental Impact Assessment in the Arctic (http://ceq.hss.doe.gov/nepa/eiaguide.pdf)

[5] Guidelines for Preparing Environmental Impact Assessment Reports for Mining Projects, Republic of Botswana 2003 (http://www.mines.gov.bw/eia%20guidelines%20for%20mining%20projects%20vol1.pdf ); and Guidelines on Environmental Impact Assessment (EIA) for Agriculture, Scottish Executive Environment & Rural Affairs Department 2006 (http://www.scotland.gov.uk/Resource/Doc/30701/0044119.pdf)

[6] Environmental Assessment Guidelines for forest habitat of migratory birds, Canadian Wildlife Service, Canada. 1998 http://www.cws-scf.ec.gc.ca/publications/eval/forest/index_e.cfm

The Annex of this document provides checklists for environmental and impact assessment that can assist in the evaluation of projects, developments and initiatives of agricultural production intensification.

Major developments will often proceed from a strategic environmental assessment to the formal environmental impact assessment process, depending on the results of the strategic impact assessment. Some countries establish the conditions under which a full-scale environmental assessment is likely to be required through policies and legislation. Some of the conditions that are likely to trigger a strategic environmental assessment leading to a full-scale environmental impact assessment are:

- When projects are likely to result in significant alteration to landscapes and ecosystems, an environmental impact assessment is needed to anticipate specific impacts, and determine appropriate preventive and mitigation measures to minimize adverse effects. If environmental degradation is determined to be probable and mitigation measures are not likely to be effective, the proposal might be rejected.

- Agricultural developments that might be subjected to a full-scale environmental impact assessment include major infrastructural developments, for example construction of large-scale water storage facilities such as dams and reservoirs; and facility developments such as fertilizer production operations or a new food processing operation. In some countries, agricultural policies might need to undergo environmental impact assessments to determine if their application is likely to result in significant adverse impacts to the environment. For example, policies that promote land use changes might need an impact assessment to determine potential adverse impacts on biodiversity, such as the loss of native grasslands, or loss of wetlands, or other impacts on wildlife species or habitats. Strategic impact assessments will normally be adequate to identify potential adverse impacts of policies and determine appropriate prevention or mitigation measures.

- In some countries, full-scale environmental impact assessments are required when there is a demonstrated significant public concern regarding a proposed project, programme or policy. The formal environmental impact assessment process allows stakeholders to voice their concerns about a proposed initiative and to receive detailed data and information on the proposed projects, anticipated impacts and mitigation strategies. While the concept of significant public concern is subjective, common sense will most often prevail, and regulators will advise the responsible Ministry on a case-by-case basis if a full-scale environmental impact assessment is required.

- Some governments require environmental impact assessments when significant public funding is to be invested in a project. Strategic environmental assessments are extremely valuable to determine the need for a full-scale environmental impact assessment on a case-by-case basis, as public investment in developments is common in many countries, and it is not likely to be practical or necessary to undertake a full-scale assessment for each investment.

- Environmental impact assessments are often required when projects are proposed in environmentally sensitive areas, such as within protected areas, or other areas of high biodiversity value. Here again, a strategic environmental assessment can be undertaken to determine the need for a full-scale environmental impact assessment on a case-by-case basis.

**Some of the strengths and limitations of strategic environmental assessments and environmental impact assessments**

Strategic environmental assessments and environmental impact assessments will be among the most important tools for achieving environmental sustainability within the framework of sustainable production intensification. Impact assessment procedures should be considered for sustainable production intensification policies as well as projects, from planning to on-farm project developments. Strategic environmental assessments should, in particular, become a normal part of sustainable production intensification planning. They can be designed to be appropriate for the scale of the sustainable production intensification activity, and be undertaken relatively quickly and at low cost. Appropriate teams of experts can be established to provide advice as required. It will also be important to ensure that impact assessments are undertaken for non-agricultural projects that could adversely affect agriculture ecosystems, or for projects or policies that in some way could prevent or impede implementation of sustainable production intensification initiatives, or impair their sustainability.

Environmental impact assessment processes should become standard components of overall development planning in all countries, and become an integral component in efforts to achieve sustainable production intensification, in both on-farm and in off-farm areas.
Experience has shown that environmental impact assessments generally do not result in preventing developments. More commonly they assist in improving the design of initiatives and provide clear direction for procedures to prevent, mitigate or offset adverse environmental impacts. With experience and the application of strategic environmental assessments, project delays are minimal, except in cases where impacts are likely to be significant, or when projects are proposed in areas with high environmental values, where development planning must proceed in a cautious manner.

Environmental impact assessment applied to sustainable production intensification initiatives might not only prevent adverse environmental impacts, they can also identify means for improved outcomes for food and agriculture. Environmental impact assessment processes bring together diverse experts and interests, often with expertise beyond the agriculture sector. Their knowledge and experience can not only contribute to examining environmental impacts, they can also assist in planning for sustainable production intensification. For example, involving aquatic resources experts in planning irrigation initiatives in some Southeast Asian countries has resulted in projects that both improved the availability of water for crop production and caused the least adverse impact on aquatic living resources that contribute to local food security and nutrition (Box).

*In a study called Smallholder Irrigation Impacts on Wetlands Livelihoods and Aquatic Resources Use, the researchers determined that joint management of irrigation and aquatic resources use was feasible by prudent planning and by providing incentive-based water withdrawal (timing and amounts of water). They also found that an irrigation project had been over-engineered, and that the scale, size and nature of the scheme could have been better adjusted, saving nearly half of the irrigation construction cost, if prudent irrigation planning and consultation with the community had occurred.*

Undertaking strategic environmental assessments and environmental impact assessments of projects, programmes and policies will help to ensure that projects, programmes and policies do not have unanticipated impacts, and that project costs fully cover mitigation needs. Early identification of adverse impacts in the project planning and approval phase and employment of mitigation measures can be far more cost-effective than costly restoration of unexpected adverse impacts from projects, programmes or policies.

Environmental impact assessments also play an important role in providing opportunities for stakeholders to voice their opinions and concerns regarding proposed sustainable production intensification projects and policies. The participation of stakeholders serves to alleviate concerns through interaction and exchange of information with project proponents and can result in better project design and implementation by addressing the concerns expressed by stakeholders.

While there are many benefits in conducting strategic environmental assessments and environmental impact assessments, both processes require investments of money and time, and significant multi-disciplinary expertise to undertake the assessments. Full-scale environmental impact assessments will include investments of budget and expertise to ensure a stakeholder involvement processes. Strategic environmental assessments will normally be far less time-consuming and less expensive than full-scale environmental impact assessments. Deciding which process should be used requires experience and judgement, and is often based on legislation and/or established guidelines. With experience, deciding on the most appropriate process and undertaking the assessments will become a routine part of doing business. Environmental assessments may actually reduce projects costs by identifying adverse impacts and planning for their prevention, which will also reduce long-term financial and legal liabilities that would arise from such adverse impacts.

To be most effective, environmental impact assessments should identify the potential environmental change to the pre-existing conditions, which requires baseline surveys. The better the understanding of the receiving environment and the more experience in understanding the likely impacts of particular activities, the greater the predictive capability. The extent to which data and information gaps prevent or impair understanding of potential environmental impacts should be evaluated, and the appropriate limitations on the reliability of predictions should be specified in the assessment report.

One of the main strengths of strategic environmental assessments and environmental impact assessments is that they focus on specific projects, programmes or policies and specific areas. This implies that they should not be considered as substitutes for long-term planning approaches, such as integrated landscape management or application of the ecosystem approach. Environmental impact assessments complement long-term integrated land and resource planning – they do not replace it. Also, monitoring is required to ensure compliance with agreed mitigation measures identified through the environmental impact assessment and approval process. Failure to monitor implementation of agreed mitigation measures, or to evaluate their effectiveness, can significantly weaken the overall process.

**Operational Guidance**

1. **Plan for all major intensification initiatives to be subject to a strategic environmental assessment, or as appropriate, a risk assessment, as discussed below.** Sustainable production intensification should be planned with the understanding that all major programmes, projects and policies, and other sustainable production intensification initiatives will undergo at least a strategic environmental assessment to determine any potential adverse environmental impacts, and to decide upon appropriate prevention and mitigation options. It is likely that for most small-scale initiatives, a strategic environmental assessment will be adequate.

2. **Undertake strategic environmental assessments to provide the approval or regulatory bodies with necessary data and information to decide to**:

    - Proceed with the sustainable production intensification initiative without modification and/or without mitigation measures (no significant environmental impacts are likely from the initiative); or
    - Proceed with the initiative with modifications and/or preventative or mitigation measures (significant environment impacts are likely without modification or mitigation); or
    - Proceed to a full-scale environmental impact assessment (results from the strategic environmental assessment indicate significant adverse environmental impacts are likely and that a full-scale environmental impact assessment is required to determine whether the initiative can proceed, and if so, under what conditions).

3. **All project proponents and project managers should understand the requirements of the country's legal and policy requirements for undertaking environmental impact assessments in relation to agriculture development.**

4. **Plan all major sustainable production intensification initiatives that will result in significant land-use pattern changes or will require large-scale infrastructural developments with the assumption that a full-scale environmental impact assessment will be required.** The proponents of the sustainable production intensification project should prepare the assessment or have it implemented by an independent body. Terms of reference for the assessment should be in accordance with specifications of the appropriate approval or regulatory agency or organization or be provided or approved by them. Proponents should plan the timing, budget and range of expertise for their major sustainable production intensification initiatives with the understanding that these will likely be subject to a full-scale environmental impact assessment. For large-scale initiatives, such as major infrastructure projects, the cost of the assessment and the possible impact on project timing should be planned for. International organizations and recipient national governments will need to establish arrangements for undertaking environmental impact assessment procedures to be in compliance with national laws.

5. **Consider establishment of networks of experts in environmental impact assessment in relation to agricultural development.** There may not be adequate capacity to undertake strategic and environmental impact assessment procedures in relation to sustainable production intensification in some countries, and perhaps in the least developed countries where sustainable production intensification is most needed to improve the livelihoods. Such networks will enable rapid recruitment and establishment of teams of experts to undertake both strategic and full-scale environmental impact assessments. Without a network of experts readily available to different organizations and countries, sustainable production intensification initiatives may be significantly delayed.

6. **Streamline the environmental impact assessment process for sustainable production intensification initiatives as experience is gained.** With experience and enhanced technical capacity, data and information, the regulatory agencies will be able to streamline environmental impact assessment and approval processes. Proponents can then be informed of the likely assessment requirements of proposed projects, and be provided with an early indication of which initiatives are likely to be approved subject only to a strategic environmental assessment, and which initiatives are likely to require a full-scale environmental impact assessment. Streamlining of the process with experience will reduce the assessment burden without compromising the quality of the assessments. After particular projects have been assessed and their likely impacts determined, regulatory and approval agencies might be able to specify mitigation and preventative measures, with limited investment in unnecessary assessment procedures. This can only be accomplished with significant experience.

> *In Canada, Fisheries and Oceans Canada is developing a process for the **streamlining of regulatory reviews for low-risk activities**, which is focused on eliminating the need for repetitive and time-consuming reviews through the development and implementation of management tools such as "Operational Statements" as well as guidelines that identify up-front the mitigation measures needed to avoid harm to fish habitat for routine low-risk activities in or near water. These tools provide proponents with the certainty that they will be in compliance with the* Fisheries Act *and the measures Canadians need to follow in order to protect their fish habitat [http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/modernizing-moderniser/streamlining-rationalisation_e.asp](http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/modernizing-moderniser/streamlining-rationalisation_e.asp) ).*

7. **Undertake strategic environmental assessments and full-scale environmental impact assessment for major developments that could potentially adversely impact agriculture ecosystems and agriculture biodiversity:** Not only is it essential to subject sustainable production intensification initiatives to environmental impact assessments; these tools also need to be employed to assess non-agricultural developments (such as major energy and mining developments or infrastructure development) to protect agricultural biodiversity and agricultural resources, such as soil and water, against their potential adverse impacts.

## RISK ASSESSMENT – ENVIRONMENTAL or ECOLOGICAL RISK ASSESSMENT

Risk assessment is another important environmental management tool. Risk assessments are sometimes referred to as Environmental Risk Assessment or Ecological Risk Assessment. Environmental or ecological risk assessments are usually focussed on the predicting the effect of a stressor on an ecosystem. In general, risk assessments are tools that are used to identify and quantify the risks associated with a potential threat or stressor. This may be a natural event such as a flood or drought, or the impact of a technology or management practice, or the introduction of agents into the environment, such as chemical and biological agents, etc.

While there are a number of definitions of risk assessment, the process can be viewed as a formalized basis for the objective evaluation of risk in a manner in which assumptions and uncertainties are clearly considered and presented. Risk assessments are science-based, requiring a critical review of available data for the purpose of identifying and if possible quantifying the risks associated with a potential threat. Risk assessments consider the likelihood or probability of an event and the impacts or consequences of the event. In quantitative analysis, efforts are made to define specific probabilities of an event. When this is not possible, risks maybe assigned to scaled categories, (e.g. low, medium or high risk). The purpose of risk assessment is to consider which measures could be applied to eliminate or reduce the identified and assessed risks of the threat.

**Examples of risk assessment procedures and guidelines**

Many types of risk assessment procedures and guidelines are available. For example, the International Plant Protection Convention[7] has established a number of international standards for agriculture that will be beneficial in pursuing sustainable production intensification. This includes standards and procedures to prevent the movement or introduction of invasive plants or plant pests; to establish plant pest-free areas; and guidelines for the import and release of biological control agents and other beneficial organisms[8].

*The key to enhanced use of environmental and risk assessment tools to underpin sustainable intensification in the agriculture sector is that their application is practical and cost-effective. Failure to advance the use of environmental assessment tools as part of sustainable production intensification might result in unsustainable practices, and thus failure to sustain increased production over the long term.*

The goal of the Cartagena Protocol on Biosafety to the Convention on Biological Diversity[9] is an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity**.**

Article 15, *Risk Assessment,* of the Cartagena Protocol notes the need for risk assessment to be conducted in a scientifically sound manner, in accordance with *Annex III* of the Protocol. *Annex III* describes the objective of risk assessment in relation to evaluating the potential for adverse effects of living modified organisms on the conservation and sustainable use of biological diversity in the potential receiving environment. It notes that risk assessment should be carried out on a case-by-case basis. Article 16, *Risk Management*, calls for Parties to establish and maintain appropriate mechanisms, measures and strategies to regulate, manage and control risks identified in the risk assessment provisions of the Protocol, associated with the use, handling and transboundary movement of living modified organisms.

Countries and regional bodies have established legislation and guidelines for the conduct of various types of risk assessment on the use of chemical and biological agents. For example, the ASEAN Guidelines on Risk Assessment of Agriculture-Related Genetically Modified Organisms provides a common framework for ASEAN Member Countries to undertake such risk assessments. In Canada, plants with novel traits undergo risk assessments. This includes plants with novel traits derived from both traditional and genetic engineering methods. The assessments consider plant biology, the new characteristics, the potential environmental impacts and how the plant might affect human or animal health.

In Australia, the National Weed Risk Assessment system was established to pre-screen materials so that species with low potential to become weeds can be imported while preventing the importation of species with a high potential to become weeds in the agricultural system or the environment. The weed risk assessment process is a science-based quarantine risk analysis tool for determining the weed potential of proposed new plant imports. Weed risk assessments are conducted on all new plant species proposed for introduction into Australia as seeds, tissue culture or any other material for propagation.

[7] www.ippc.int/

[8] http://www.aseansec.org/6226.htm
Some information can be found at: http://www.daff.gov.au/ba/reviews/weeds; and the Australian National Weed Risk Assessment Database at: http://www.weeds.org.au/riskassessment.htm

[9] http://www.cbd.int/biosafety/

The European Union has established a wide-range of risk assessment procedures for chemicals, pesticides and plant protection products, and the use of genetically modified organisms[10]. Many individual Member States have additional policies and procedures for risk assessments.

There are a large number of commercially available guidelines and books on risk assessment and ecological and environmental risk assessment. Numerous consulting firms offer risk assessment as a service and commercial risk assessment software is available for many subject areas.

**General steps in risk assessment**

- **An analysis of the context:** In the early planning phase of an initiative, the receiving environment is examined to determine how the proposed initiative may cause adverse effects. Risks are identified based on the understanding of the receiving environment: **site-specific risks.** Risk assessment determines the risks associated with particular activities at a specific location or determines the risks that affect a particular type of site. This is sometimes referred to as environmental site assessment: a systematic process to determine site-specific conditions and the vulnerability of a particular site to specific risks or threats. This type of assessment may establish a baseline of environmental conditions and gather information in support of remedial measures or site development or redevelopment efforts. Identifying site-specific risks is also important in avoiding or reducing liability, including long-term environmental liabilities.

- **Identification of the perceived risks:** The perception of risk is based on beliefs, values, attitudes and feelings. The way in which people perceive risk is an important part of risk assessment and the subsequent management of risks. Risk perception can be a major determinant in whether a risk is deemed to be "acceptable" and whether the risk management measures are adequate to address the risk or threat.

- **Analysis of the identified risks:** This step requires an analysis of the risk and an expression of the outcome from the risk. Risks are often expressed in terms of an environmental, social or economic outcome. For example, what is the risk of an initiative on pollinators? The risk analysis should identify potential stressors, indicate the potential impacts that the loss of pollinators would have, determine the susceptibility of pollinators to the stressor, and note the relevance of the impacts to management goals in both qualitative and quantitative terms (magnitude and probability).

- **Determination of the relative priority of risks or threats:** When several risks or threats are identified, the risk assessment process should determine the relative risk and importance of addressing each threat, and which risk or threat should be dealt with first, or the best sequence for addressing them.

- **Examination of the comparative risks:** The relative risks should be compared when more than one course of action is possible: for example, the risks posed by untreated water versus the risks posed by chemicals used to treat water.

- **Description of the certainties and uncertainties:** Risk assessment should attempt to describe the certainties and unknowns. Some risk assessment processes include describing the possible worst-case scenario when there are uncertainties.

[10] Information on EU enviornment impact assessment and strategic impact assessment can be found at: http://ec.europa.eu/environment/eia/home.htm

- **Suggested courses of action:** The risk assessment process should provide suggested courses of action for decision-makers. For example, a risk assessment might conclude that an initiative be **accepted as planned**, **accepted with suggested modifications**, or **rejected as the risks are high and cannot be adequately mitigated**. The course of action could also be expressed as a **maximum acceptable risk,** for example, the maximum concentration level of a particular pesticide in drinking water or water used by livestock.

- **Risk communication:** Once the risks and uncertainties are identified and described, risk assessment usually involves communicating the results of the assessment to decision-makers and stakeholders.

- **Risk management strategies:** Risk management strategies are normally developed as part of risk assessment processes, by identifying options to prevent or mitigate adverse impacts from proposed initiatives.

**Strengths and Limitations of Risk Assessment**

Risk assessment is one of the important tools for achieving sustainable production intensification. Risk assessment is similar to strategic environmental assessment and environmental impact assessments, in that it is a decision support tool that assists decision-makers by providing them with essential information on potential adverse results of a development and measures that could be taken to prevent or minimize the adverse impacts or threats.

Risk assessment, a science-based approach, relies on high levels of expertise and should provide stakeholders with confidence that potential issues related to an initiative will be identified and addressed in order to achieve or maintain environmental or human health standards.

One of the main strengths of risk assessment is that it is strategic in nature, as the process, scope and scale are adapted to address a particular situation. This makes risk assessment relatively cost-effective and reliable. Risk assessments provide a means to examine risks where there are a number of complex variables. For example, toxicologists undertake a quantitative risk assessment to assess the adverse impacts of a chemical in a particular receiving environment. The risk assessment is designed to be as technically and scientifically rigorous as necessary, given the uncertainties. The ability to adjust or scale up or scale down risk assessment, depending on the initiative and the receiving environment, provides a highly flexible approach to assessing environmental impacts of various sustainable production intensification initiatives. The number of complex variables and underlying assumptions encountered during a risk analysis, however, could pose limitations, for example not always a consensus is reached amongst scientists.

A key benefit of risk assessment is that as a systematic approach to identifying risks and options, it can be used to address a wide range of issues or topics, from assessing the impacts of current or emerging technologies, to helping consider future management practices in the light of changing production conditions or market trends. For example, risk assessments have been employed to predict the likely impacts of increased atmospheric concentrations of carbon dioxide and associated temperature increases and changes in rainfall patterns on crops, so that adaptation strategies can be identified. Assessing the impact of future climate change scenarios is likely to be extremely important in efforts to achieve sustainable production intensification.

**Operational Guidance (*continued*)**

8. **All project proponents and project managers should understand the requirements of each country's legal and policy requirements for undertaking risk assessments, including adherence to international agreements and standards in relation to agriculture development and its associated impacts.**

9. **International organizations should encourage and support governments that have not yet established risk assessment procedures in relation to sustainable agriculture and environmental sustainability to do so, and to make necessary policy and legislative changes.** Existing risk assessment procedures, guidelines and standards are widely available to assist governments in establishing risk assessment policies and implement science-based risk assessment procedures.

10. **All major sustainable production intensification initiatives should be planned on the assumption that they will be subject to either a risk assessment procedure or an environmental impact assessment, as appropriate.** As noted previously, with experience, small-scale, low-risk initiatives would generally need only a rapid strategic environmental assessment, enabling scarce financial resources to be allocated to any necessary prevention and mitigation measures.

11. **As much as possible, the types of sustainable production intensification initiatives that will likely require a risk assessment should be pre-determined.** The following are examples where risk assessment should be considered:

    - Where plants with novel traits derived from both traditional and genetic engineering methods are being considered for use, transfer or handling or where other organisms with novel traits are being considered for use, transfer, or handling**.**
    - Where new or increased amounts of chemical farm inputs are being considered for use, including pesticides and fertilizers.
    - Where there are concerns that a plant being considered for use for sustainable production intensification might become an invasive alien species, or transmit a plant or other disease that could adversely affect agricultural production or produce, or escape into the agricultural production system and become a weed.
    - Where there are unknowns regarding both potential agricultural pests and potential pathways for agricultural pests.
    - Where bio-fertilizers are being considered for use, such as nitrogen-fixing bacteria and fungi.
    - Where new or improved livestock feeds and veterinary products or techniques are being considered for use.

12. **Consider undertaking risk assessments to assist in determining any risks and threats from the introduction or expansion of the use of technologies and equipment in relation to sustainable production intensification.** For example, risk assessments could identify risks and options for dealing with waste oil, batteries and other wastes resulting from increased farm mechanization, leading to sound waste management and disposal practices.

13. **Risk assessments should be considered to anticipate future impacts and threats to agricultural production related to climate change, in order to identify appropriate adaptation strategies.**

14. **The significant expertise and software for risk assessment available from the private sector can be used to build capacity or undertake specific types of risk assessments. Education and research institutions should also be encouraged to assist developing countries to develop capacity in risk assessment.** International research institutions can also help to build capacity in risk assessment and assist in undertaking particular types of risk assessment.

15. **Establishment of international networks of experts in risk assessment should be considered in relation to agricultural development, as capacity to undertake risk assessments might not be adequate in some countries.**

**LIFECYCLE ASSESSMENT**

Lifecycle assessment, also referred to as lifecycle analysis, is an important environmental management tool that has been used for decades. Lifecycle assessment helps decision-makers to fully understand costs and benefits of various options over the long term. Recently, for example, lifecycle assessment was employed to explore the impacts of various feedstocks (such as maize, sugarcane, crop by-products) for the production of biofuels and their benefits in terms of reducing emissions of greenhouse gases. This application revealed very different outcomes depending on which feedstocks were used to produce the biofuel, demonstrating the important role that lifecycle analysis can play in relation to sustainable production intensification.

While lifecycle assessment can be used for a variety of needs, it is particularly valuable as a tool to assess environmental sustainability. It is an analytical approach to investigation and valuation of environmental impacts of products or services over their complete lifespan, from production through use to disposal. This comprehensive approach is sometimes referred to as a Cradle-to-Grave Assessment or Full Cycle Assessment.

Another lifecycle assessment approach is called Cradle-to-Gate assessment, which is a partial product assessment with the disposal phase omitted. Cradle-to-Cradle is an assessment approach whereby the disposal phase involves recycling or reuse of the end products. For example, glass bottles being recycled as coating for highway signs or scrapped vehicles to new rolled steel plate. While there are several types of approaches, in general, lifecycle assessment includes the following four main phases:

- **Goal and Scope Definition:** the assessors formulate the goal and determine the scope, approach and method for assessing potential environmental impacts.

- **Lifecycle Inventory:** the process of collecting data and information and modelling the product system. This might include resources consumed and emissions to the environment. Often computer software is used to enable modelling of lifecycle costs and impacts.

- **Lifecycle Impact Assessment: Categorization or Characterization.** In this phase, the types of environmental impacts are indicated and evaluated or calculated. Impact categories are identified, such as resource use, energy use, water use, land-use change, and contributions to climate change, acidification, eutrophication and toxicity.

- **Interpretation:** the outcomes of the analysis are reported. The uncertainties identified and assumptions made during the course of the analysis are indicated. The main results and conclusions are presented and independent peer reviews are sometimes undertaken, especially when there are major uncertainties and assumptions that underlie the analysis.

**Strengths and Limitations of Lifecycle Assessment**

A study on eco-efficiency of increasing intensification scenarios of milk production in New Zealand demonstrates how lifecycle assessments could contribute to assessing sustainable production intensification options[11]. The study examined the impacts of increased inputs and intensification (fertilizer, pesticides, capital and energy) on farm profits and on the environment. It showed that under low produce values (low milk price) intensification would actually reduce farm profits. High commodity prices would likely increase farm profits resulting from intensification, but would also increase environmental impacts. Overall, the case study indicated that the low-input production system had the greatest eco-efficiency for all functions assessed except for land use. Intensification resulted in higher production, but only when commodity prices are favourable in higher profit. Intensification overall was detrimental to eco-efficiency on dairy farms.

Perhaps the greatest value of lifecycle assessment resulting from the New Zealand study is that it highlights the need to proceed with caution in on-farm intensification. A sustainable approach to increasing production must consider eco-efficiency and environmental protection, which might significantly change the development approach.

One of the core strengths of lifecycle assessments is that is that it provides a highly objective approach to support decision-making. While assumptions are often part of the process, they generally are stated explicitly in the report, which provides transparency as well as assists decision-makers to understand the reliability of the predictions.

Lifecycle assessment is a valuable tool in situations where there is potential for multiple impacts on the environment from a development activity, and various implementation options exist, as in the New Zealand case on intensification in the dairy sector.

The main challenge in applying lifecycle assessment to sustainable production intensification is that it is a highly complex analytical process, which depends on reliable and significant data and information, and considerable expertise to analyse and model the data and information. Lifecycle assessment is both complex and rigorous in nature, and to be most effective, requires site-specific information in order to enable evaluation of environmental impacts. Otherwise, the models will depend on many assumptions.

While lifecycle assessment is an excellent environmental sustainability approach or tool, it will be best used by technically highly competent individuals and organizations. It should also be kept in mind that like other assessments, they only provide a snapshot in time, and that the assessments will need to be repeated as conditions change.

Perhaps the greatest limitation of lifecycle analysis is in the quantification of environmental impacts. Impacts such as land use change, acidification, eutrophication are very difficult to estimate in monetary terms. This makes it challenging to fully evaluate impacts under various intensification options. The market price of farm products also varies over time, which may have considerable impact on tradeoffs and feasibility of options. Environmental costs may be borne by society at large, whereas profits may accrue to the farm or enterprise, which also makes it difficult to model tradeoffs and costs.

[11] *Eco-efficiency of increasing intensification scenarios of milk production in New Zealand* Basset-Mens, Claudine; Ledgard, Steward; Jensen, Roger; Clark, Dave; and Boyes, Mark. 2007.

**Operational Guidance (*continued*)**

16. **Lifecycle assessment should be considered for evaluation of initiatives or projects to achieve sustainable production intensification, especially if the envisaged intensification involves new inputs or significant additional amounts of farm inputs which could have multiple adverse environmental impacts** (lifecycle analysis is most useful for examining full cropping systems rather than a change in a single input). This would include the following categories of potential environmental impacts:
    - Land use changes affecting landscapes;
    - Changes in water quality and quantity – amount used;
    - Changes in emissions of greenhouse gases;
    - Changes in energy use;
    - Impacts on soil biodiversity and soil erosion and soil health;
    - Chemical impacts: acidification, eutrophication, toxicity; and
    - Impacts on biodiversity within and downstream from farms.

17. **Researchers and research organization should be encouraged to develop lifecycle analysis and models, in particular where agricultural intensification will involve a significant increase in production inputs.** Increased research and partnerships among research organizations and agriculture development organizations are necessary so that lifecycle assessment and models can focus on the specific needs of the agriculture sector, and in particular, focus lifecycle assessments on the anticipated or potential adverse environmental impacts from various intensification measures, taking into account the specific conditions of the different regions of the world.

# 3. CONSERVATION AND SUSTAINABLE USE OF SOIL, WATER AND BIODIVERSITY

This chapter provides operational guidance on suggested approaches to protect three critical natural resources: soil, water and biodiversity, as a key element in the overall approach to promoting and achieving sustainable production intensification. These essential resources can be adversely affected by agriculture and can be affected by non-agricultural activities, reducing agriculture production potential. Maintaining air quality is also important in efforts to achieve sustainable development, and addressed in chapter IV below.

National and sub-national policies and strategies that promote and support the sustainable use and conservation of soil, water and biodiversity are key elements for achieving sustainable production intensification. They are directly relevant to both on-farm sustainability and environmental sustainability across agricultural landscapes and beyond. While detailed guidance on the sound management of all important resources for food and agriculture is beyond the scope of this paper, general operational guidance for the conservation and sustainable use of soil, water and biodiversity in relation to sustainable production intensification is provided in the following sections.

## SOIL HEALTH MANAGEMENT STRATEGIES AND POLICIES

Soil health management will be important in advancing sustainable production intensification in most countries. It comprises strategies and practices to maintain soil quality, for example, to prevent soils from becoming chemically altered by overuse, salinization, acidification, or chemical contamination; and preventing soil erosion. Soil health management also includes maintaining or enhancing soil biodiversity. In areas where soils have already been degraded, soil rehabilitation practices may be required.

Sound health management practices are well established in a number of countries. Sustainable production intensification may require assessing and implementing measures to ensure sustainable soil management practices. It would be highly beneficial to have already in place, a national framework for soil health management, from which to plan and implement sustainable production intensification. Greater understanding of the many roles and ecological services of soil biodiversity would also assist in advancing sustainable production intensification.

Better understanding of the impacts of farm practices on soil biodiversity and promotion of sustainable practices to maintain and enhance soil biodiversity would be an environmentally friendly and cost-effective approach to increasing production and productivity in some farm systems. Moreover, the benefits of soil conservation can extend beyond agricultural production goals. For example, FAO indicates that adoption of Conservation Agriculture, in addition to protecting soil resources, will enhance soil as a carbon sink, reduce energy costs by eliminating costly tillage and will reduce labour costs. In Canada, it has been estimated that a government-funded permanent cover programme to reduce soil erosion in highly erosion-prone areas could actually be generating financial benefits if carbon capture were considered and depending on the assigned economic value per ton of carbon sequestered.[12]

[12] Luciuk, Bonneau, Boyle and Viberg. Carbon Sequestration - Additional Environmental Benefits of Forages in the Prairie Farm Rehabilitation Administration Permanent Cover Program..2007.
http://www4.agr.gc.ca/AAFC-AAC/display-afficher.do?id=1187979341393&lang=eng

**Operational Guidance (*continued*)**

18. **Encourage countries to develop national strategies and policies that promote long-term soil health and conservation, including guidelines and legislation, as required**.

19. **Undertake environmental impact assessment or risk assessment for all major sustainable production intensification initiatives that could result in significant soil degradation.** Site-specific assessments are necessary to identify risks to soil and soil biodiversity and should involve farmers, extension officers and other technical experts. The assessments should examine *inter alia* rainfall patterns, drainage and water runoff potential; soil types and conditions in terms of potential for degradation; slope; and current farming practices in terms of erosion and erosion potential.

20. **If a proposed sustainable production intensification initiative involves substantial increases of inputs, including water, fertilizer or chemical inputs, a soil quality risk assessment should be considered.** The assessment should examine, *inter alia,* the potential for adverse impacts on soil biodiversity and on soil nutrients and health; identify the risks of soil contamination from various inputs (hydrocarbons, pesticides, solvents and heavy metals); the potential for salinization, especially in relation to irrigation; the potential for adverse impacts from changes to soil chemistry, (pH, nutrients,); and any potential downstream impacts. Identification of highly erosion prone areas would also be valuable.

21. **As a general approach, maintain a permanent vegetative cover or maintain the crop residues on the field after crop harvesting to reduce the potential for soil erosion and degradation.** FAO is supporting the advancement and adoption of Conservation Agriculture principles, aimed to minimize mechanical disturbance to the soil, maintain a permanent organic soil cover and follow appropriate crop rotations in order to prevent soil erosion and maintain soil quality.

*Conservation agriculture aims to achieve sustainable and profitable agriculture and consequently improved livelihoods of farmers through the application of the three principles: minimal soil disturbance, permanent soil cover and crop rotations. Conservation agriculture holds tremendous potential for all farm sizes and many agro-ecological systems, but its adoption is most urgent for smallholder farmers, especially those facing acute labour shortages. It is a way to combine profitable agricultural production with environmental concerns and sustainability and it has been proven to work in a variety of agro-ecological zones and farming systems. Conservation agriculture is multidisciplinary in nature and requires a range of expertise to promote the concept worldwide.*

22. **In areas where soil erosion is already significant, consider establishing permanent cover programmes or other erosion reduction measures**. Incentives may be required to encourage farmers to maintain permanent vegetative cover in highly erosion-prone areas. For example, financial support might be needed to enable farmers to convert cropland at risk of soil degradation into perennial forages for hay or pasture, or to establish wind barriers using trees and shrubs to reduce wind-caused soil erosion.

23. **Maintain and promote soil biodiversity as a key element of sustainable production intensification**. Soil biodiversity performs numerous beneficial services including maintaining soil nutrition, structure and aeration. Maintaining and enhancing essential ecological services such as nitrogen fixation, carbon cycling and micro-nutrient cycling will raise production and reduce input costs.

24. **Invest in research to better understand and enhance the many ecological services provided by soil biodiversity, as well as to ensure that farming practices have the least negative impact on soil biodiversity.**

25. **Carefully plan specific management interventions at each site being considered for sustainable production intensification, to protect against soil degradation and erosion.** Where feasible, promote no-till farming to protect against soil degradation and erosion. Where direct planting is not feasible, employ management practices to protect surface soils from water and wind erosion. This might include applying mulch on the soil and use of surface runoff barriers. Contour farming and terracing should be considered on slopes.

26. **As much as practical, select crops taking into account soil erosion potential and soil quality issues.** While crop selection must address local needs, food culture, nutritional needs and market conditions, the impacts of various crops on soils should also be an important consideration.

27. **Undertake farmer training, education and awareness programmes and provide incentives if required to achieve soil management objectives**. Through farmer field schools, demonstration sites and conservation programmes, improved on-farm soil management practices can be promoted in order to prevent soil degradation, providing both on-farm and downstream environmental benefits.

28. **Promote integration of soil management objectives with other environmental management goals.** For example, soil protection should be considered in light of the need to enhance soil as a carbon sink. Conservation Agriculture should be promoted to protect soil and to reduce energy use, reducing both costs and the release of greenhouse gases and other pollutants.

29. **Establish soil sustainability indicators within an overall outcome framework for sustainable production intensification**.

**WATER CONSERVATION AND MANAGEMENT STRATEGIES AND POLICIES**

Conservation and sustainable use of water resources and protection of water quality are key global issues. Agriculture is the largest user of water in many countries, and agricultural practices have resulted in adverse impacts to water resources in the past, which can be avoided in the future.

A recent publication, *Life on Farms Supporting Environmentally Sustainable Agriculture in Europe*[13], notes that several countries in Europe are implementing projects to demonstrate new management techniques for irrigation that rehabilitate and protect aquatic ecosystems and promote organic practices; and to support development of codes of conduct for good agricultural practices to reduce pollution from farming and to reduce impacts of pesticides and nitrate concentrations in surface and ground water.

Efforts are being made in many countries to improve water use efficiency. For example, research is underway in many countries to improve technologies and methodologies to determine the most effective ways to irrigate crops, and to develop improved technologies for irrigation[14]. In some countries, farmers practicing irrigation are requested to prepare a water conservation plan and indicate the sustainable irrigation management practices they intend to adopt[15]. Many countries have developed guidelines, sustainable management practices and legislation to address the impacts of agriculture wastes on water resources. For example, guidelines and sustainable management practices are in place in many countries to address wastes from crop production, livestock production and food production facilities.

Water use and drainage of surface water to expand agriculture production have been areas of conflict among diverse users of this resource. Drainage of wetlands for example, has been a significant contributor to the decline of waterfowl and wildlife in many regions of the world.

**Operational Guidance (*continued*)**

30. **Ensure that sustainable production intensification occurs within the framework of national water management strategies and policies (within national development frameworks or as stand-alone strategies and policies).** If water conservation and sustainable use policies and strategies are not in place, encourage their formulation and establishment, so that sustainable production intensification initiatives take place with an understanding of current water issues, demands and constraints, and future water resource needs.

31. **The impacts on water resources of all proposed major sustainable production intensification initiatives should be considered using appropriate environmental impact assessment or risk assessment processes.** Assessments should be undertaken in general, for projects that propose significant uses of water resources, drainage or modifications to stream and river flow, or where there may be impacts on shared water resources (rivers, streams, wetlands, etc.). Transfer of water between watersheds should be avoided as a

[13] 2008. http://ec.europa.eu/environment/life/publications/lifepublications/lifefocus/documents/agriculture.pdf

[14] Be Water Smart for Today and Tomorrow. Agriculture Water Conservation Pactices. Texas Water Development Board. United States of America (for brochure, see: http://www.scribd.com/doc/1688353/USDA-AgBrochure )

[15] 2009 Agricultural Water Conservation Plan. Monterey County Water Resources Agency. California, United States of America http://www.mcwra.co.monterey.ca.us/forms/GEMS_Ag_Forms/AWCP_ONLINE.pdf ; http://www.mcwra.co.monterey.ca.us/forms/GEMS_Ag_Forms/AWCP_APPENDIX.pdf

general rule. Strategic environmental assessments and full-scale environmental impact assessments with public consultations should be considered for large water management projects. Smaller-scale projects might only require a strategic environmental assessment or a risk assessment, and depending on the scope of impacts, community-based consultations might be adequate for small-scale, low-risk initiatives.

32. **Implementation of sustainable production intensification initiatives should be planned to ensure the sustainable and efficient use of water resources and the efficient use of energy and other inputs associated with the use and distribution of water.** For example, consider crop selection in terms of water demand and availability in planning sustainable production intensification.

33. **Minimize surface water runoff and optimize infiltration to assist in recharging aquifers.**

34. **Strategic or environmental impact assessments should be considered for policies that will significantly affect water resources.**

35. **Consider a range of conservation incentives for improving water efficiency on farms and at crop processing facilities, and implement measures to prevent or reduce conflicts among water resource users.**

36. **As part of sustainable production intensification, implement measures to eliminate or minimize nutrient loss and other pollutants flowing off-farm into aquatic and other ecosystems.** If chemicals, fuels and other industrial products or soil nutrients from mineral or organic origin are going to be used or increased as a result of sustainable production intensification, measures need to be implemented to prevent water contamination from use of these inputs.

*About half a million tonnes of obsolete pesticides are scattered throughout the developing world. These toxic chemicals, often stored outdoors in leaking containers, are seeping into the soil and contaminating groundwater. Eliminating these dangerous stocks is a development priority. FAO's Programme on the Prevention and Disposal of Obsolete Pesticides is working to inform the world about the dangers of obsolete pesticide stocks and collaborating with countries on their safe disposal.*

37. **Carefully plan water related infrastructure projects to prevent or minimize adverse environmental impacts.** Water storage and other infrastructures can provide beneficial impacts for agricultural production. However, they can also have long-term adverse impacts. For example, dams and other irrigation infrastructure can adversely affect surface and ground water as well as fish and wildlife and their habitat.

38. **Involve farmers and communities in planning both large and small-scale irrigation projects to maximize benefits and prevent or mitigate adverse environmental impacts, especially in areas where many people are dependent on aquatic life for food and income.**

39. **Undertake initiatives where appropriate, to eliminate current inefficiencies in water use and to address adverse impacts on water resources resulting from agricultural systems.** Poorly designed irrigation networks and improper irrigation practices are commonly cited as being responsible for wasting water in many countries; part of thise could be addressed through sustainable production intensification projects.

40. **Undertake farmer training, education and awareness programmes to advance implementation of sustainable management practices for water resources.** Programmes might be directed at:

    - Ensuring the rate of water use is sustainable, and that its use does not exceed its replacement rate;
    - Ensuring that sustainable production intensification does not compromise water quality;
    - Maximizing water use efficiency in undertaking sustainable production intensification, so that water is available for non-agricultural users or in other areas or to support other developments, and to prevent conflicts among water users;
    - Maximizing energy use efficiency for delivering water to agriculture systems and utilizing sustainable energy sources where feasible; and
    - Ensuring that efforts are made to prevent or minimize adverse impacts of water use and infrastructural development on fish and wildlife and their habitat, and ensuring that ecosystems are able to maintain their processes, productivity and functions.

41. **Undertake inventories of water resources that are particularly important as critical wildlife habitat, so that sustainable production intensification can take place with an understanding of the importance of these resources to biodiversity, and appropriate mitigation action is taken.**

42. **Establish water sustainability indicators within an overall outcome framework for sustainable production intensification**.

**BIODIVERSITY CONSERVATION STRATEGIES AND POLICIES**

While the main focus of sustainable production intensification is to enhance food security and address malnutrition and poverty, agricultural production must increasingly take into account biodiversity issues and national commitments to biodiversity conservation. In many countries, agricultural production has dramatically altered the conditions for native biodiversity (fish, wildlife and other organisms and their habitats). Native grasslands and other vegetation have been cleared for crop production. Wetlands and other aquatic habitats have been drained or contaminated with agricultural chemicals, or fenced to keep out wildlife.

In response to declines of native biodiversity, many countries have initiated biodiversity conservation and sustainable use initiatives, including the protection and recovery of threatened species and restoration or rehabilitation of degraded ecosystems in agricultural production areas. Nearly all countries in the world are now Parties to the Convention on Biological Diversity, which requires them to prepare a national biodiversity strategy and action plan.

Numerous programmes of work, and approaches, have been developed under the Convention. The *programme of work on agricultural biological diversity*, the programme of work on the *biological diversity of dry and sub-humid lands*, and the *ecosystem approach as a strategy for the integrated management of land, water and living resources*, are directly relevant in terms of sustainable production intensification. The programmes of work on invasive alien species and inland water biodiversity also provide helpful guidance.

Other conventions are also relevant to sustainable production intensification and the conservation and sustainable use of biodiversity in agricultural areas. For example, the Ramsar Convention on Wetlands is devoted to conserving wetlands of international significance and has been adopted by

156 States. Its broad aims are to halt the worldwide loss of wetlands and to conserve through wise use and management those that remain. It provides guidance on designating various types of wetlands and on the criteria for identifying wetlands of international importance, which can be extremely helpful in determining the national importance of wetlands in agricultural landscapes.

There are numerous national and international guidelines available to assist planning sustainable production intensification to reduce impacts to biodiversity. The *Ecosystem and Human Well-being Biodiversity Synthesis: a Report of the Millennium Ecosystem Assessment*[16] provides a list of actions that can be taken to prevent the loss of biodiversity. The Government of Australia has recently released a practical guide for conserving biodiversity in areas that are subject to significant resource development, including agricultural areas[17].

The following provides operational guidance on measures that can be taken to reduce impacts to biodiversity resulting from agricultural production. Provisions of national biodiversity strategies and actions, programmes of work under relevant conventions, and available guidelines on biodiversity conservation and sustainable use should be considered in planning sustainable production intensification.

**Operational Guidance (*continued*)**

43. **National strategies and action plans, programmes or policies on biodiversity and agricultural biodiversity conservation and sustainable use should be taken into account in planning sustainable production intensification.** This is necessary to understand national commitments, objectives and compliance measures, and to determine areas of particular importance to biodiversity, or conservation initiatives that are planned or underway, which could be impacted by sustainable production intensification.

44. **Ensure that sustainable production intensification initiatives are planned in collaboration with agencies responsible for biodiversity conversation and sustainable use.** Integrated resource management policies and programmes are essential to maintaining biodiversity across landscapes. Too often agriculture and other resource development have not been planned in an integrated manner, resulting in conflicts among resource users. Conservation initiatives have also been planned and implemented without adequate consultation and collaboration with agricultural interests, resulting in conflicts and sometimes ineffective conservation measures.

45. **If not already undertaken, prepare biodiversity assessments or sensitive ecosystem inventories in areas proposed for sustainable production intensification.** Sensitive ecosystem inventories are aimed at identifying remnants of rare and fragile ecosystems. Annex 1 of the Convention on Biological Diversity, *Identification and Monitoring,* provides guidance in terms of what should be assessed. The Annex suggests, *inter alia, to* identify and monitor ecosystems and habitats; areas containing high levels of biodiversity; species and ecosystems that are threatened; areas required for migratory species; and species and genomes of social, economic and ecologic importance.

[16] Milennium Ecosystem Assessment. Ecosystems and Human Well-Being: Biodiversity Synthesis. 2005. http://www.millenniumassessment.org/documents/document.354.aspx.pdf

[17] Conserving biodiversity in highly modified production landscapes: Ten Key Strategies. Land and Water Australia. 2008. http://lwa.gov.au/files/products/native-vegetation-program/pn21582/pn21582.pdf

46. **Minimize disturbance to natural habitats as much as feasible.** Sustainable production intensification should proceed in a manner that minimizes conversion or loss of natural grasslands and other vegetation, or loss of wetlands and other aquatic resources, etc. As a general rule, the less conversion to other land use, the better for biodiversity. Where disturbance cannot be avoided, habitat enhancements and rehabilitation and offsets should be considered.

47. **Identify wetlands of international, national, sub-national and local importance, and avoid adverse impacts to these areas as much as feasible.** Wetlands are particularly important for wildlife habitat, and are also extremely important for water conservation. The criteria provided under the Ramsar Convention on Wetlands will be helpful in identifying important wetland areas.

48. **Maintain structural complexity and heterogeneity of vegetation across the agricultural landscape.** Structural and species complexity and age structure variation are effective measures to maintain and enhance biodiversity, and relatively easy to accomplish. For example, vegetation planting to maintain structural complexity can also provide beneficial wind breaks to reduce soil erosion and provide products such as nuts, fruits, spices and wood, diversifying farmer income and food sources.

49. **Establish and maintain protected areas within agricultural landscapes, to enhance and support conservation efforts across the entire landscape.** Protected areas are extremely important conservation measures in intensely used landscapes. Also, refuge provided by protected areas is sometimes essential to maintain sustainable use levels of populations of harvested species. Protected areas are important in providing a basis for comparative monitoring of the status and trends of biodiversity outside and inside protected areas, to determine the effectiveness of conservation and sustainable use management practices.

50. **Maintain or establish buffer zones and connectivity of habitat across the agricultural landscape, especially as required to meet the needs of particular species.** Buffer zones can provide many benefits in agricultural landscapes. In addition to providing wildlife habitat, they may be essential for some species in order to maintain a viable population size. Filtration buffers can be used to protect water bodies against siltation, pollution, and nutrient runoff from farm operations. Vegetative buffer zones between farms and rivers or lakes are extremely important in this regard. Siltation ponds can also be established not only to conserve water, but also to support wildlife conservation, and perhaps even to develop aquatic food resources.

51. **Implement species protection and recovery plans for threatened species and rehabilitate degraded areas.** While species recovery and habitat restoration are not directly related to sustainable production intensification, the presence of endangered species and degraded sites can prevent or delay or prevent proposed agriculture developments. In areas where endangered species are present or where habitat restoration is required, it will be highly desirable to have species recovery and ecosystem restoration plans in place as a prerequisite to sustainable production intensification. This will be challenging and will require bringing wildlife and agriculture interests together. However, in the long term, recovery of endangered species to viable levels and reclamation of degraded ecosystems will facilitate development planning, and assist countries to achieve both food security and biodiversity conservation.

52. **Identify and maintain keystone species.** Keystone species are those that have a disproportionate role relative to abundance in maintaining ecosystem processes and services. Pollinators and large predators are keystone species in many ecosystems. Knowledge and protection of keystone species will help to integrate sustainable production intensification objectives and biodiversity conservation objectives.

53. **Maintain ecosystem integrity: the structure, functions and composition of ecosystems, as much as feasible, above and below ground.** This is one of the greatest management challenges for agricultural landscapes and other highly modified landscapes. Significant impacts on ecological processes can result from changes in natural processes, for example, increasing or decreased water flows, or suppressing fire in grasslands or changing historic grazing patterns. It is difficult to maintain natural processes, such as fire, when there are multiple interests in the resources of the same area.

54. **Prevent runoff from farm operations in order to prevent siltation, pesticide release into the ecosystem, chemical contamination, and nutrient runoff.** While this is an important general environmental objective, it is important particularly to protect fish, waterfowl and other aquatic life.

55. **Prevent the escape of alien species and genetically modified organisms from farm operations into the environment.** Globally, invasive alien species are a leading cause of the erosion and loss of native biodiversity. Sustainable production intensification must not lead to further introductions of invasive alien species. There is also a growing need for public assurances that risk assessments for genetically modified organisms have been conducted and risk prevention measures are in place to guard against adverse impacts.

56. **Assess the importance of native biodiversity (fish and wildlife) as a source of food and income to local communities as part of sustainable production intensification planning.** Fish and wildlife within and adjacent to agricultural systems often provide essential food and income to local and indigenous communities; such resources must be safeguarded for their use. Opportunities to link conservation and food production initiatives should be considered. For example, water storage and irrigation development might be planned to increase water availability for crop production while at the same time increasing aquatic habitat for fish and other wildlife used by local people.

# 4. SUSTAINABLE PRACTICES, FARM PLANS AND MANAGEMENT SYSTEMS

### SUSTAINABLE MANAGEMENT PRACTICES

Establishment and implementation of *Sustainable Management Practices*, also referred to as *Beneficial Management Practices* (BMPs), *Good Farming Practices* or *Good Agricultural Practices*, will be one of the most important steps in achieving environmental sustainability in the context of sustainable production intensification. In previous chapters, the main emphasis was on planning and assessments. The implementation of sustainable management practices will bring environmental sustainability efforts to the farm, community and landscape, to prevent, minimize, or mitigate adverse impacts to both the farm agro-ecosystem and the surrounding or downstream environment. Practical, cost-effective approaches and measures must be promoted to farmers in order for them to consider adoption of new practices.

Many countries have programmes to promote the voluntary adoption of sustainable management practices in agriculture. In some countries, legislation is also in place that requires particular measures in order to protect biodiversity and soil, water and air quality. Sustainable management

practices are promoted through extension services and field technicians, demonstration sites, stewardship and recognition programmes, and through cross-compliance, whereby farmers receive financial or other benefits for adopting beneficial management measures and complying with environmental regulations or standards.

Numerous guidelines are available globally on how to implement sustainable management practices in agricultural areas and systems. They address a wide range of farm issues such as farm waste management, practices to prevent nutrient loss, and practices to protect water and air quality and to maintain soil health. For example, many guidelines and standards address soil erosion and other forms of degradation and measures to reduce impacts on native biodiversity from farming practices. There are also many guidelines concerning the use, storage and disposal of pesticides and other farm chemicals, and fuels. There is an increasing number of guidelines promoting adoption of more energy-efficient farm practices and practices that reduce the release of greenhouse gases. As understanding of ecological services increases, there is growing awareness of the need to adopt practices to protect soil biodiversity; to maintain pollinators and their habitats; to maintain decomposers above and below ground; and to conserve aquatic resources, including living resources, and guidelines have been developed to assist farmers in achieving these management objectives.

While sustainable farm management practices need to be developed for site-specific conditions and to address environmental priorities, much in the available guidelines and many sustainable practices will be directly transferable to most farming systems or transferable with some adaptation. Indeed, enhanced distribution of already available information on sustainable management practices would be highly beneficial in promoting and supporting sustainable production intensification.

**ENVIRONMENTAL FARM PLANS**

Preparation of **environmental farm plans** could provide an effective means for greater awareness of environmental sustainability issues and needs. The process will also facilitate farmer understanding of priority areas for training and capacity building to implement improved sustainable management practices. Establishing environmental farm plans will demonstrate awareness by farmers of their responsibilities and can provide a basis for providing incentives to farmers for ecological services and participation in conservation programmes.

**Operational Guidance (*continued*)**

57. **Provide support and incentives to farmers to encourage the preparation of environmental farm plans.**

58. **Provide incentives to farmers and communities for biodiversity conservation, including as appropriate, payments to maintain species and ecosystem services as part of efforts to ensure equitable sharing of conservation costs.** Conservation of biodiversity benefits society as a whole, and conservation costs should be equitably shared as well as the benefits. The agriculture community should not be expected to accept a larger share of conservation costs than others.

59. **Examine current agricultural subsidies and benefit payments in the context of sustainable production intensification to determine their effects on achieving environmental sustainability.** Current agricultural incentives should be assessed to ensure they do not conflict with environmental goals. Adjustment and redirection of payments could provide the incentive to adopt more environmentally sound farming practices. The cross-compliance approach and assistance in preparation of environmental farm plans are examples of ways to support and promote farmers to adopt improved sustainability practices.

60. **Identify and implement sustainable management practices through the involvement of all stakeholders: farmers, researchers, extension staff and agribusiness professionals, to ensure the practices are practical and effective and have the support of all interests.**

61. **Ensure that local and traditional knowledge is fully considered to complement modern science-based approaches in advancing sustainable management practices.**

62. **In market-based agricultural systems, internalization of environmental externalities should be encouraged**. Internalization of environmental costs will help to prevent adverse impacts and pay for preventive measures. Internalization of environmental externalities would also facilitate the adoption of environmentally sustainable farm practices, especially if there is pressure from consumers demanding and willing to pay for farm products derived from sustainable farming systems.

63. **Enhance the capture by farmers and local communities of benefits from adoption of biodiversity-friendly agricultural practices.** Integration of sustainable production intensification with incentives for conservation would help farmers and local communities better capture benefits from both initiatives. For example, farmers might be requested to establish buffer zones to protect riparian areas. Watershed protection is a societal benefit, so this would provide the justification to pay the farmer for lost production as a result of devoting land to a buffer zone. Similarly, finding ways to provide benefits to local communities and farmers through the establishment of protected areas and fish and wildlife habitat will help to sustain both biodiversity and farmers.

64. **Establish priorities for providing extension officers and farmers with information and training on sustainable management practices in relation to sustainable production intensification. The following key subject areas should be considered :**

    - **Water quality:** the need for sustainable practices to protect inland waters, including surface and ground waters, and coastal areas against contamination from farm runoff. Practices that reduce runoff of nitrogen, phosphorus and pesticides into the surrounding environment are particularly important.

    - **Soil health and soil erosion:** the need for sustainable practices to protect soil health. Numerous guidelines are available to assist farmers protect the quality of their soils and soil biodiversity. Soil erosion is an issue in many farm systems around the world and guidelines are available to address soil erosion by both water and wind. Methods to control salinity are well established.

    - **Conservation Agriculture**: this approach is increasingly gaining popularity as an effective measure to prevent soil erosion as well as reduce energy costs, and adapt to climate change by enhancing storage of carbon.

    - **Organic farm wastes:** the need for sustainable practices to reduce farm wastes, and impacts of farm wastes on the environment. Turning organic farm wastes into on-farm resources and controlling nutrient loss are key management approaches for which significant guidance is available. Guidelines are available to address specific farm wastes, including waste from livestock and crop residues.

    - **Pesticide use:** the need for sustainable practices to ensure proper use by farmers of pesticides. Guidelines on all aspects of pesticide application, storage and disposal are

available. There are numerous guidelines available addressing how and when to spray, cleaning of equipment, storage of product, and disposal of containers. Guidelines have even been developed for specific pesticides and used on specific crops.

- **Integrated Pest Management (IPM):** the need for sustainable practices to control agriculture pests. Numerous guidelines are available to promote ecologically-based integrated approaches to pest management, often with the result of reducing reliance on chemical pesticides. Farmer Field Schools have proven successful in advancing IPM.

- **Fuel and chemicals storage:** the need for sustainable practices to ensure proper use, storage and disposal by farmers of fuels and farm chemicals. Increasing mechanization will result in greater use of farm fuels, oil products and other potentially hazardous products. Guidelines are available for the storage and management of farm fuels, waste oils, and other products. Guidelines are also available to assist in establishing collection sites for wastes and waste containers.

- **Air quality and greenhouse gases:** the need for sustainable practices to reduce the impacts of farm operations on air quality, including release of soil particles and chemicals into the atmosphere, odours that affect air quality and aesthetic quality, and release of greenhouse gases associated with climate change. There is a growing volume of guidelines to address these issues.

- **Water management:** the need for sustainable practices to ensure the efficient use of water resources for agriculture, and reduce water use where practical to reduce impacts on the water resources. There are numerous guidelines on sustainable management practices to enhance the efficiency of water use, and to reduce adverse environmental impacts, such as soil erosion and nutrient runoff resulting from water use and irrigation. Guidelines are also available on the proper design of irrigation infrastructure to prevent and reduce adverse impacts on fish and wildlife and their habitats. Numerous guidelines are available on the establishment of buffer zones to assist farmers to establish and maintain buffer zones to filter any sediments, nutrients and chemicals out of farm runoff before the water enters streams, ponds, lakes and coastal areas, in order to protect aquatic living resources and waterfowl.

- **Fertilizer application:** the need for sustainable practices to ensure the efficient and proper use of fertilizer. Guidelines are available to help farmers assess the environmental risks of fertilizer use and to improve the application of fertilizers.

- **Fish and wildlife habitat conservation:** the need for sustainable practices to reduce impacts to native biodiversity from farm operations. Guidelines to conserve various components of biodiversity are widely available in relation to agricultural areas. Sustainable management practices for stream bank, shoreline protection and wetlands conservation are commonly used in a number of countries. Many conservation groups and agencies work directly with farmers and farmers' organizations to develop sustainable practices and measures aimed at reducing impacts of farming on biodiversity, sometimes with a particular focus such as on fish and wildlife conservation, maintaining waterfowl and wetlands, or conserving grasslands. Many long-term partnerships between farmer organizations and conservation groups have been established that can serve as models for developing and implementing sustainable management practices achieving native biodiversity conservation objectives with minimal disruption to farm production.

- **Environmental Farm Plans:** numerous guides and resources are available to help farmers prepare environmental farm plans.

65. **Consider codes of conduct to promote environmental responsibility among farmers and communities.** Codes of conduct are agreements among stakeholders to conduct practices to achieve a particular outcome. Codes of conduct can be used to promote collaboration on the sustainable management of shared resources such as water. They can provide frameworks for farmers and others to work collectively to prevent an adverse impact, such as preventing the introduction or spread of an invasive alien species. Codes of conduct can be useful to achieve agreement on how best to manage products and wastes within a country or farming community, for example, on how to use pesticides and store and dispose of pest control products.

**ENVIRONMENTAL MANAGEMENT SYSTEMS FOR AGRICULTURE**

Establishment and implementation of environmental management systems as a component of sustainable production intensification can prove extremely valuable in achieving environmental goals and objectives. An environmental management system is a systematic and continuous approach that an enterprise or organization undertakes to improve its business management practices in order to achieve improved environmental performance or outcomes.

In its simplest application, an environmental management system involves four main steps: plan, implement, review, and adapt or improve. The planning phase includes assessing current environmental performance, identifying risks, evaluating options, and establishing environmental policies, plans, goals and targets. Policies and plans are implemented to achieve desired outcomes. Monitoring and evaluation is essential to understand progress and compliance, and to identify any necessary adjustments.

The adoption of environmental management systems is normally voluntary. However, incentives are used in some countries and regions to encourage organizations to adopt them. Environmental management systems are also established to order to achieve compliance with legislation and regulations. Environmental management systems tend to promote sustainable management practices. Environmental standards, independent audits and certification of compliance are key elements in the application of environmental management systems in many countries. Independent audits provide assurance to regulators and consumers that organizations are meeting environmental performance standards.

The adoption of environmental management systems and certification systems in agriculture is relatively new but rapidly evolving. For example, for several years the European Union has been promoting a gradual approach to environmental management systems, which allows organizations to implement a voluntary system of environmental management and auditing.

Australia has developed a national framework for environmental management systems in agriculture to provide the context for coordinating and facilitating voluntary, industry-led approaches to environmental and quality management in agriculture[18]. The framework cites multiple beneficiaries in establishing environmental management systems for agriculture, including producers, consumers, and financiers concerned with risk management.

[18] Autralia's National Framework for Environmental Management Systems in Agriculture. Natural Resources Management Ministerial Council. 2002 http://www.daff.gov.au/__data/assets/pdf_file/0006/29238/ems-national-framework.pdf

The International Organization for Standardization (ISO) is the world's largest developer and publisher of International Standards, and constitutes a network of the national standards institutes of 157 countries. ISO standards provide requirements or give guidance on good management practice. ISO 14001:2004 is an environmental management standard which specifies a set of management requirements for environmental management systems. The purpose of the standard is to assist all types of organisations of any size to operate in an environmentally sustainable manner by identifying and controlling environmental impacts of its activities, products or services; to improve its environmental performance continually; to implement a systematic approach to setting environmental objectives and targets; and to demonstrate that they have been achieved.

ISO 14001:2004 does not specify levels of environmental performance. Rather, it provides a framework for a strategic approach to the organization's environmental policy, plans and actions and indicates the generic requirements for an environmental management system. This has the effect of establishing a common reference for communicating about environmental management issues between organizations and their customers, regulators, the public and other stakeholders. As ISO 14001:2004 does not specify the level for environmental performance, the standard can be implemented by a wide variety of organizations. However, a commitment to compliance with applicable environmental legislation and regulations is required, along with a commitment to continual improvement.

ISO 14001:2004 is a tool that can be used to meet both internal and external management objectives. It provides assurance to management that it is in control of the processes and activities that may have an impact on the environment, and employees can feel comfortable that they are working for an environmentally responsible organization. Compliance with an international standard also assures customers, the community and regulatory agencies that the organization is complying with environmental regulations, especially if there are independent audits and certification.

ISO 14001:2004 describes a higher level of complexity in identifying the elements of environmental management systems beyond the simple four steps indicated above. The following elements of environmental management system are suggested by this ISO standard:

- Establish the organization’s environmental policy and use this policy as a framework for planning and action.
- Identify the organization’s products, activities, and services and determine those that could have significant adverse impacts on the environment.
- Identify and ensure compliance with laws and regulations, as well as other requirements to which the organization adheres.
- Establish environmental goals, objectives and targets for the organization.
- Implement management programmes to achieve the goals, objectives and targets.
- Establish roles and responsibilities for environmental management and provide appropriate resources to establish the environmental management system.
- Deliver programmes to ensure that the organization’s employees are trained and capable of carrying out their environmental responsibilities.
- Establish communication procedures for internal and external communications on environmental management issues.
- Document and maintain information on the organization’s environmental management system.
- Control environmental management documents to ensure effective management of procedures and other system documents.
- Control environmentally significant operations – identify, plan, and manage operations and activities in line with policy, objectives, and targets.

- Identify potential emergencies and develop procedures for preventing and responding to them.
- Establish monitoring and measurement procedures – monitor key activities and track performance and conduct periodic assessments of compliance with legal requirements.
- Address non-conformance and implement corrective and preventive action to correct problems and prevent their recurrence.
- Maintain and manage records of environmental management system performance.
- Perform audits to periodically verify that the environmental management system is operating as intended.
- Perform environmental management reviews to determine the suitability, adequacy and effectiveness of the organization's environmental management system with a view to continual improvement.

**Strengths and Limitations of Environmental Management Systems**

Environmental management systems are powerful tools that can support the achievement of sustainable production intensification. Their application is not only to provide environmental benefits - they can assist organizations to identify and correct inefficiencies and liabilities, providing economic, financial and social benefits. Environmental management systems will become increasingly important to comply with regulations as countries further develop environmental regulations for agriculture, and to address growing consumer demands for environmentally friendly products from all sectors.

Environmental management systems can be introduced gradually. An approach of assessing current environmental performance, identifying risks, evaluating options, and establishing environmental plans would be an excellent way to begin establishment of environmental management systems for agriculture in many areas of the world. Preparation and implementation of environmental farm plans could be the first step in the establishment of robust and complex environmental management systems required for compliance with the ISO 14001:2004 Standard. Indeed, in subsistence and combined local market and subsistence farm systems, the establishment of environmental farm plans might the most effective means to introduce an environmental management system in agriculture. Environmental farm plans would facilitate discussion of environmental issues, and enable farmers to identify and take practical environmental measures given their capabilities and circumstances. Internal audits could be undertaken by farmers and community leaders.

In larger-scale, commercial farms and food processing operations, development and implementation of environmental management systems should be encouraged and supported, working toward adopting the ISO 14001:2004 Standard. Future market access might depend on having this standard in place.

The greatest weakness of promoting and advancing environmental management systems in the agriculture sector, as in other sectors, is the large initial effort needed to establish the system. Costs to implement a comprehensive approach, such as involving third party audits and certification, can be significant and may be too high for individual small farms. High levels of organization among farmers and farmer associations will therefore be required to implement environmental management systems and achieve certification of products, if this is demanded by consumers.

Small-scale and resource poor farmers will find it difficult to establish complex environmental management systems. While, for example, it will be difficult for subsistence and local markets farmers to implement the 14001:2004 Standard, implementing less complex systems such as preparation of farm environmental plans might be feasible, if adequate external support is provided, and still achieve improved environmental performance.

**Operational Guidance (*continued*)**

66. **In advancing sustainable production intensification, encourage and support preparation of environmental farms plans**.

67. **Based on environmental farm plans, establish priorities for introducing a range of sustainable management practices to address identified needs, especially to protect and conserve air, soil, water and biodiversity.**

68. **Encourage the establishment of environmental management systems for all large-scale farm operations, and food processing and agriculture-related facilities, with eventual progress toward the adoption of the ISO 14001:2004 Standard.** Establishment of national frameworks for environmental management systems should be considered to promote and explain to the agricultural sector the benefits and requirements of environmental management systems.

## 5. INTEGRATED LANDSCAPE MANAGEMENT/THE ECOSYSTEM APPROACH

Integrated Landscape Management is similar or equivalent to other management approaches including Land Use Planning, the Ecosystem Approach, Integrated Resource Management, Watershed Management and Sustainable Forest Management. For the purpose of this paper, Integrated Landscape Management and the Ecosystem Approach are used interchangeably.

> *The application of integrated landscape management will require significant investments well beyond direct investments in sustainable production intensification. However, to be fully successful, sustainable production intensification over the long term must be advanced within the overall sustainable development context of the country.*

Integrated Landscape Management aims to improve the integration of economic, social, cultural and environment goals to achieve both development goals and long-term ecological sustainability. It is a management approach that translates diverse societal needs and wants into collaborative on-the-ground action, and thus is highly relevant to the achievement of sustainable production intensification. Integrated Landscape Management can be defined as the management of human activity so that ecosystems, their structure, function and composition, and the physical, chemical, and biological processes that shaped them, continue at appropriate temporal and spatial scales. Integrated Landscape Management is the management of human activity in order to sustain landscape ecological integrity – its biodiversity and ecosystem benefits and services they provide to humans.

The following section describes several of the key characteristics of Integrated Landscape Management and indicates how this management approach can contribute to the advancement of sustainable production intensification. The characteristics presented are consistent with the principles of the ecosystem approach adopted by Parties to the Convention on Biological Diversity.

**Transparent decision-making:** Integrated Landscape Management requires transparent decision-making processes from initiation of policies and programmes through to their implementation. Transparent decision-making will be necessary to achieve sustainable production intensification, as all stakeholders will need to be involved from planning to implementation phases, enabling them to

provide their perspectives on how to move forward and to identify their needs and priorities. Efforts must be taken to ensure that traditional practices and norms are respected, and impediments to the involvement of local and indigenous people are removed. This is a fundamental element in the application of Integrated Landscape Management.

**Ecological sustainability:** Integrated Landscape Management requires a commitment to ecological sustainability, which is also a requirement for sustainable production intensification. Ecological sustainability requires a multi-scale management approach that involves building understanding of the cumulative effects of human activities, and ensures that the scale and intensity of development and use of ecosystems are within predicted thresholds and carrying capacities, measured over appropriate spatial and temporal scales. Establishment of sustainability baselines or indicators (economic, social, cultural and ecological) from which to measure progress toward sustainable development is essential, and will help to promote and measure progress toward sustainable production intensification.

**Equitable responsibility:** Equitable resource sharing arrangements are essential to prevent conflicts among resource users and prevent unsustainable use of shared resources. Equitable sharing of conservation costs is also an important in designing and implementing conservation programmes. Individuals, communities or business interests should not be expected to unfairly bear the costs of conservation measures. Integrated Landscape Management brings together the users of common landscapes and facilitates negotiation of sharing arrangements.

**Hierarchical and collaborative management:** Collaboration among diverse interests, agencies, organizations, communities and individuals is a key element of Integrated Landscape Management, and will also be the basis for advancing sustainable production intensification. Various levels of government will be involved, all with diverse sets of goals, laws and regulations and programmes. Accordingly, appropriate hierarchical institutional arrangements must be established with responsibilities clearly understood among all agencies, stakeholders and others. Sustainable production intensification cannot take place in isolation of other land uses and resource demands. Mechanisms are required to derive consensus on priorities, demands made on the landscape by all users, and to prevent conflicts among resource developers and users and other stakeholders. This is a primary role for Integrated Landscape Management.

**Adaptive management:** Integrated Landscape Management is continuous and adaptive, as is the case for sustainable production intensification. One of the major advantages of Integrated Landscape Management over environmental impact assessment processes is that it is an ongoing management process. Initiatives are planned, implemented and monitored, and management changes are made as required. Ongoing management processes are essential, given the complexity and dynamic nature of ecosystems, the constant evolution of economic, social and cultural objectives, and the fact that new, unexpected issues will almost certainly arise as sustainable production intensification is pursued. Having in place institutional arrangements for planning and management at the landscape and community levels will greatly facilitate advancement and achievement of sustainable production intensification.

**Knowledge-driven:** Integrated Landscape Management is a knowledge-driven management approach. Not only is planning and management ongoing, there is a commitment to gain further knowledge of the landscape, of ecosystem composition, function, structure, and ecological services, and to improve understanding of the impacts of human activities and development opportunities. This is crucial in order to achieve sustainable development. These same requirements hold true for sustainable production intensification. It must be a knowledge-driven approach that will require continuous monitoring, evaluating and adaptation both within the context of improving food security

and in terms of environmental sustainability. Integrated Landscape Management can provide the framework for continuous monitoring, evaluating and adaptation toward sustainability.

**Inventories, assessment and zoning:** Integrated Landscape Management requires undertaking resource inventories and assessments. These are requirements for planning sustainable production intensification as well. Integrated Landscape Management strives to identify opportunities and constraints based not only on development objectives, but also on the ecological conditions. Collaboration among sectors to build inventories of existing resource and land use, biophysical inventories, identification and assessment of risks to biodiversity, resource demands and human growth projections, is essential. The data and information from such inventories is necessary to plan the long-term environmental sustainability of agricultural landscapes, and to identify development opportunities and constraints. **Land use zoning** is often used in Integrated Landscape Management to establish land use zones and conditions for resources development. Land use zoning is particularly valuable when there are multiple interests in the same landscapes (agriculture, mining, oil and gas extraction, tourism, hunting and fishing, recreation pursuits, etc.).

**Strengths and Limitations of Integrated Landscape Management**

Integrated Landscape Management could provide an important management approach and framework to advance sustainable production intensification. Sustainable development requires integration of economic, social, cultural and environmental goals. In many areas it is likely that sustainable production intensification will take place in landscapes where there are diverse interests, and there will be need to understand ecological sustainability in relation to the intensity and types of uses. Current understanding of ecological thresholds and responses of ecosystems to human activity remains relatively low, and must be advanced as part of implementation of sustainable production intensification. This will not be achieved without collaboration among sectors and diverse interests in the same landscape. Integrated Landscape Management provides an approach to bring all interests together, to promote collaboration, and promote understanding of sustainability in economic, social and ecological terms. Significant investments in planning, undertaking assessments and developing inventories will be required. A community-based management approach might be required to advance broader scale integrated landscape planning approaches.

**Operational Guidance (*continued*)**

69. **Sustainable production intensification should be promoted and implemented within a broader landscape management approach or integrated resource management approach, wherever practical to do so, in order to integrate agriculture development with other resource development and biodiversity conservation goals and objectives.**

70. **Where an integrated planning and management approach is not yet established, sustainable production intensification should develop or establish collaborative resources management mechanisms.** The full involvement of farmers, their communities and established organizations is required to advance integrated development, which is essential to achieve environmental sustainability across working landscapes.

# 6. OTHER TOOLS AND MANAGEMENT APPROACHES

The main environmental tools and applications for advancing sustainable production intensification have been presented in the previous sections along with recommendations on their application. There are other tools and approaches that would also contribute to sustainable production intensification. These are briefly presented below.

**LIVELIHOOD ANALYSIS**

Livelihood analysis could assist in achieving sustainable production intensification as a means to bring plans and projects to the village and household, and within household levels. Livelihood analysis can serve to deliver sustainable production intensification initiatives to local people with understanding of local needs and conditions. As livelihood analysis provides an explicit focus on what matters to local and often poor people, the approach will provide project proponents and managers with an understanding of how people's livelihoods will be affected by a particular sustainable production intensification initiative. This will help to ensure that a particular project or intervention fits within the livelihood strategies to achieve better outcomes for local people. Directly involving local people will help project managers to understand traditional practices and impacts of these practices on the environment and farm systems. This could provide a basis for farmers to consider introducing new practices and approaches, and discuss with people sustainable options of resource harvesting methods and levels, if necessary. Through livelihood analysis, local people can find solutions to unsustainable practices, rather than having solutions imposed upon them.

**STEWARDSHIP AND CONSERVATION INCENTIVES**

Broadly speaking, stewardship means farmers, landowners and others, private companies and organizations taking voluntary action to protect air, land, water and biodiversity, and to sustain natural processes on which life depends. In a number of countries, stewardship programmes involve partnerships among farmers, conservation organizations and government agencies. They work together to achieve various environmental or land stewardship objectives, for example to protect water quality of rivers and streams flowing through agriculture landscapes, or to conserve wetlands for wildlife. Stewardship brings farmers and landowners to understand new concepts and ideas they may consider and at the same time, allows them a chance to express understanding of their needs, conditions and constraints in participating in particular stewardship programmes.

Stewardship programmes aimed at enhancing environmental sustainability of farms often include conservation incentives, sometimes referred to as "green payments". Conservation incentives, which may or may not be financial in nature, are generally provided to farmers as compensation for taking action that provides benefits beyond the producer. Proven financial incentives include: property tax incentives, income incentives and direct funding. In some countries payment is provided for provision of ecological services such as carbon capture, watershed protection, or wildlife conservation.

Conservation incentives could prove valuable to gain support for sustainable production intensification initiatives, such as maintaining pollinators and their habitat; and to assist in the adoption of environmental sustainable farming practices, such as zero tillage or conservation agriculture.

**SUSTAINABILITY FRAMEWORKS**

Establishment of outcomes frameworks for sustainable production intensification could be extremely valuable in promoting sustainable production intensification. The primary purpose of a sustainability outcomes framework in relation to sustainable production intensification would be to:

- Reach consensus on the sustainability results that an agency or organization wants to achieve (the outcomes sought);
- Acknowledge the current state and what is currently being done;
- Identify what further actions are needed to reach the desired outcomes;
- Instil a sense of co-ownership among those making the commitment to achieve the outcomes; and
- Reach agreement on performance and environmental quality, adoption of a common set of indicators, establishment of monitoring and reporting systems, and performance reporting.

Sustainability outcomes frameworks are increasingly being established in government agencies as part of their business planning. Parties to the Convention on Biological Diversity have been encouraged to adopt biodiversity outcome frameworks, and a number of decisions have been taken to provide guidance on the use of indicators for performance monitoring and measurement.

Resources sectors, including agricultural organizations, have been activity engaging their producers and private sector companies to develop environmental sustainability outcomes for their sector or sub-sector, with agreed indicators. Established outcomes often include improving energy efficiency; reducing contributions of greenhouse gases; eliminating, reducing or better managing wastes; reducing water use; preventing or minimizing impacts to biodiversity; and improving economic and social well-being of communities.

Sustainability outcomes frameworks can be established at all levels, from global to farm level. They can be established by government agencies, the private sector and non-government organizations.
In terms of sustainable production intensification, sustainability outcomes frameworks could be established by a particular agricultural group to promote awareness of environmental issues and to collectively pursue sustainable management practices aimed at sustainability. Stakeholder agreement on performance indicators is also necessary. Sustainability outcomes frameworks could also be established for sustainable production intensification by governments, government agencies and international agencies, to serve as overall guides to environmental sustainability in the pursuit of sustainable production intensification. They could address specific sustainability outcomes such improved water efficiency and reduced nutrient runoff and sediment loading of streams.

# ANNEX I. CHECKLISTS FOR ENVIRONMENTAL SUSTAINABILITY AND IMPACT ASSESSMENT

## USING THE CHECKLISTS

This set of checklists can be used as a rapid assessment tool to determine whether the environmental sustainability components of sustainable production intensification initiatives are adequately addressed in the preparation of project proposals. The checklists are meant to assist decision-makers and others that participate in reviews of agriculture development projects and initiatives.

**Part A, Overview and Rapid Assessment,** is intended to assist in reviewing all proposed sustainable production intensification initiatives. It includes five short checklists to assist in determining the overall impacts of the proposed initiatives on soil, water, ecosystems and biodiversity, air quality and climate change, energy use and waste management. A set of potential recommendations is provided to assist project reviewers in deciding whether an initiative should proceed.

Completion of **Part A** will assist the reviewer to determine whether adequate attention has been given to examining potential adverse environmental impacts as well as positive outcomes of proposed projects. Completion of Part A should be adequate to provide reviewers with an overview of potential impacts resulting from small-scale initiatives that have low risk in terms of adverse environment impacts. It will assist reviewers to recommend proceeding with the initiative as planned, or to suggest additional assessment studies, or to suggest appropriate preventative and mitigation measures that should be part of the implementation of the initiative. A set of potential recommendations is provided in Part A to assist the reviewer is this regard.

If the reviewer is not convinced that the project proponent has adequately addressed environmental sustainability, or if the project is a large-scale initiative with potentially significant adverse environmental impacts, the reviewer should also complete **Part B**, which goes into more detail.

**Part B, Detailed Assessment**, starts with a checklist for an overall assessment of the national policy context for environmental sustainability and the capacity to use the relevant assessment tools. This is to assist the reviewer in assessing the capacity to implement environmental sustainability tools within the receiving country, as well priority capacity-building needs in relation to sustainable management practices in the context of sustainable production intensification.

This is followed by five sets of structured checklists to assist in determining the specific impacts of the proposed initiatives on soil, water, ecosystems and biodiversity, air quality and climate change, energy use and waste management. Reviewers might decide to approve a sustainable production intensification project with the condition that sustainable management measures are also advanced as part of the initiative or as a complementary activity.

Completion of both **Parts A** and **B** is suggested for all large-scale initiatives, especially those that will potentially result in adverse environmental impacts without appropriate preventive and mitigation measures. The checklists can also be used to assess the potential impacts of proposed policies or changes in existing policies in relation to sustainable production intensification.

## PART A. OVERVIEW AND RAPID ASSESSMENT

### Soil Health and Erosion Risk

*Principle*: Sustainable production intensification must be managed to enhance soil ecosystems, improving soil health and fertility and reversing degradation and pollution of land.

| **Overview Assessment** | Yes | No | *N/A |
|---|---|---|---|
| Soil health issues need to be assessed at the site prior to the implementation of the initiative | | | |
| Soil health issues are of concern in relation to the initiative and mitigation measures or adoption of practices to prevent or mitigate adverse impacts to soil health are required | | | |
| Soil health will be improved by this initiative | | | |
| Farmer practices to maintain soil health are already widely employed and will assist in ensuring sustainability of the proposed initiative | | | |
| Farmer training in practices to maintain soil health is a priority need and should occur prior to or as part of the proposed initiative | | | |
| Soil erosion potential has been assessed on the site and is an issue of concern in relation to the initiative, and mitigation measures or adoption of practices to mitigate or prevent soil erosion are required | | | |
| Soil erosion potential needs to be assessed at the site prior to the implementation of the initiative | | | |
| Farming practices to prevent soil erosion are already widely employed and will assist in ensuring sustainability of the proposed initiative | | | |
| Farmers training to prevent soil erosion is a priority need and should occur prior to or as part of the proposed initiative | | | |
| National Soil Health and Conservation Strategies and Policies are in place and the initiative will contribute to the objectives of these Strategies and Policies and is in line with existing legislation | | | |
| National Soil Health and Conservation Strategies and Policies are not in place and should be developed as part of the initiative | | | |
| *N/A Not applicable | | | |

**Water Quantity and Quality and Aquatic Living Resources**

*Principle*: Sustainable production intensification must contribute to maintaining and improving, and efficiently utilizing water resources (quantity, access, stability and quality), especially promoting practices that minimize risks of water pollution from agrochemicals.

| **Overview Assessment** | Yes | No | *N/A |
|---|---|---|---|
| Water quantity issues need to be assessed on the site prior to the implementation of the initiative | | | |
| Water quantity issues are of concern in relation to the initiative and mitigation measures or adoption of practices to prevent or mitigate further adverse impacts are required | | | |
| Water availability will be improved by the initiative | | | |
| Farming practices protecting water resources are already widely employed and will assist in ensuring sustainability of the proposed initiative | | | |
| Farmers training in practices to maintain water efficiency is a priority need and should occur prior to or as part of the proposed initiative | | | |
| Water quality issues need to be assessed on the site prior to the implementation of the initiative | | | |
| Water quality issues are of concern in relation to the initiative and mitigation measures or adoption of practices to prevent or mitigate further adverse impacts are required | | | |
| Water quality will be improved as a result of this initiative | | | |
| Farmers training in practices to maintain water quality is a priority need and should occur prior to or as part of the proposed initiative | | | |
| National Water Management and Conservation Strategies and Policies are in place and the initiative will contribute to the objectives of these Strategies and Policies and is in line with existing legislation | | | |
| National Water Management and Conservation Strategies and Policies are not in place and should be developed as part of the initiative | | | |
| The initiative will not adversely impact important aquatic living resources | | | |
| The impacts of the initiative on important aquatic living resources have not been assessed at the site and need to be determined along with appropriate mitigation measures | | | |
| Farmers training in practices to conserve and protect aquatic living resources is a priority need and should occur prior to or as part of the proposed initiative | | | |
| *N/A Not applicable | | | |

## Ecosystem Services and Biodiversity

*Ecosystem Services, Principle:* Sustainable production intensification must stabilize or enhance ecosystem structure and function, thereby leading to improved ecosystem services to increase opportunities for production.

*Biodiversity, Principle:* Sustainable production intensification must respect the integrity of areas of high conservation value, and enhance the management of agricultural biodiversity (e.g. plant genetic resources for food and agriculture, seeds, pollinators, soil biodiversity, natural enemies as well as wildlife).

| **Overview Assessment** | Yes | No | *N/A |
|---|---|---|---|
| The initiative will contribute to efforts to conserve or enhance ecosystem structure and functions, increasing opportunities for improved production | | | |
| The initiative will not impede ecosystem structure and functions, maintaining opportunities to increase production | | | |
| The initiative will reduce adverse impacts on crop and crop-associated biodiversity, including soil biodiversity, or will not adversely impact crop and crop associated biodiversity | | | |
| The initiative will contribute to efforts to conserve plant genetic resources for food and agriculture and other genetic resources important of cultural or scientific interest, or will not cause further erosion of genetic resources | | | |
| The initiative will contribute to efforts to prevent, eradicate or control invasive alien species, plant pest and diseases, or will not enhance impacts of invasive alien species, pests and diseases | | | |
| The initiative will assist to reduce degradation and depletion of natural resources, protecting natural ecosystems and biodiversity, or will not further contribute to unsustainable use | | | |
| The initiative will contribute to efforts to conserve native species of ecological, social, economic, cultural or scientific interest, or will not adversely impact them | | | |
| The initiative will contribute to efforts to conserve protected areas, wetlands, areas of high biodiversity, and other important wildlife corridors and other wildlife habitat, or will not result in further losses of wildlife and wildlife habitat | | | |
| National Biodiversity Strategies and Action Plans are in place and the initiative will contribute to the objectives of these Strategies and Plans and is in line with existing legislation | | | |
| National Biodiversity Strategies and Action Plans are not in place and should be developed as part of the initiative | | | |
| *N/A Not applicable | | | |

## Climate Change and Air Quality

*Principle*: Sustainable production intensification must be managed to increase adaptation to climate change, reduce greenhouse gas emissions and ozone-depleting substances to a minimum possible, and seek to minimize contributions to air pollution and reductions in air quality.

Sustainable production intensification should seek to ensure that farm agro-ecosystems are carbon-neutral or capture more greenhouse gases than they produce.

| **Overview Assessment** | Yes | No | *N/A |
|---|---|---|---|
| Air quality issues have been assessed and the initiative will not degrade air quality | | | |
| Air quality issues have not been assessed and this should be done as the initiative might have an adverse impact on air quality | | | |
| Air quality will be improved by this initiative | | | |
| The initiative will potentially degrade air quality by increasing emission of gases, particulates and unpleasant odours | | | |
| The contributions of the proposed initiative to the emission of greenhouse gases have been assessed and the initiative will not significantly increase the emission of these gases | | | |
| The potential contributions of the initiative to the emission of greenhouse gases are significant and mitigation measures need to be implemented | | | |
| The potential contributions of the initiative to the emission of greenhouse gases have not been assessed and this should be done | | | |
| Emission of greenhouse gases will be reduced by this initiative | | | |
| Farmers training to maintain air quality and to reduce the emission of greenhouse gases is adequate | | | |
| Farmers training to maintain air quality and to reduce the emission of greenhouse gases is a priority, and should occur prior to or as part of the proposed initiative | | | |
| National Climate Change and Air Quality Strategies and Policies are in place and the initiative will contribute to the objectives of these Strategies and Policies and is in line with existing legislation | | | |
| National Climate Change and Air Quality Strategies and Policies are not adequate and should be developed as part of the initiative | | | |
| *N/A Not applicable | | | |

## Energy and Waste Management

*Principle*: Sustainable production intensification must be managed to ensure reduction in fossil fuel-based inputs, efficient application of energy and energy-based inputs, recycling of waste and the use of appropriate renewable energies where possible. It should promote appropriate waste management, safe storage of agricultural inputs, minimize non-usable wastes and dispose of them responsibly.

| **Overview Assessment** | Yes | No | *N/A |
|---|---|---|---|
| The initiative will potentially significantly improve energy efficiencies, and thereby decrease the use of non-renewable fuels in farm operations | | | |
| The initiative might significantly increase energy use | | | |
| The initiative will improve waste management and result in reduced release of wastes into the farm system and surrounding environment | | | |
| The initiative will potentially increase the release of wastes into the farm system and surrounding environment | | | |
| Farmers training in energy efficiency is adequate | | | |
| Farmers training in energy efficiency is a priority and should occur prior to or as part of the proposed initiative | | | |
| Farmers training in waste management is adequate | | | |
| Farmers training in waste management is a priority and should occur prior to or as part of the proposed initiative | | | |
| National Energy Efficiency and Waste Management Strategies and Policies are in place and the initiative will contribute to their objectives and is in line with existing legislation | | | |
| National Energy Efficiency and Waste Management Strategies and Policies need to be developed and the initiative will contribute to improved policy and strategy development | | | |
| *N/A Not applicable | | | |

**Overall Recommendations**

| **Overview Assessment** | Yes | No |
|---|---|---|
| The initiative should proceed as proposed – there are no significant adverse environmental impacts anticipated | | |
| Or | | |
| The initiative should proceed with appropriate preventative and mitigation measures being employed, which are identified in the proposal and assessments | | |
| Or | | |
| The initiative should proceed as proposed with the introduction or expansion of the sustainable management practices to improve the overall environmental sustainability of the proposed initiative | | |
| Or | | |
| The initiative should not proceed as proposed – an initial environmental impact assessment or risk assessment is recommended to identify unanticipated environmental impacts and to determine appropriate preventative and mitigation measures | | |
| Or | | |
| The initiative should not proceed as proposed – a full-scale environmental impact assessment is recommended to identify potentially significant environmental impacts and to determine appropriate preventative and mitigation measures and to address public concerns regarding the initiative | | |

## B. DETAILED ASSESSMENT

### Overall Assessment of the National Policy Context for Environmental Sustainability and Priority Capacity Building Needs for Sustainable Management Practices

*Knowledge Creation and Validation, Principle:*Sustainable production intensification must facilitate a process that promotes continuous learning and exchange of knowledge between different actors (from local indigenous to scientific knowledge) and disciplines (from technical to social domains).

*Collaboration, Principle:* Sustainable production intensification is of multidisciplinary nature and therefore an opportunity for strengthening collaboration between different sectors, institutions and their development priorities and agendas. In addition, sustainable production intensification must engage as far as possible different segments of society (including land users, researchers, academia, government, farmers' and community organizations, non-governmental organizations and the private sector).

*Community Participation, Principle:* Sustainable production intensification must include open and transparent discussion among communities and other stakeholders in order to solve shared problems and arrive at decisions to increase opportunities for production.

| **Overall Assessment** | Yes | No |
|---|---|---|
| The national policy context for environmental sustainability is well developed and will be supportive of efforts to achieve sustainable production intensification | | |
| The national policy context for environmental sustainability is adequate; however, implementation capacity is weak and will be need to be addressed as part of efforts to achieve sustainable production intensification | | |
| Environmental impact assessment practices and legislation are in place and projects and policies are routinely screened for environmental impacts | | |
| Expertise and capacity to undertake environmental impact assessment of sustainable production intensification initiatives is adequate, and capacity building needs are understood | | |
| Risk assessment practices and legislation are in place and projects and policies are routinely screened for risks as part of the overall decision-making process | | |
| Expertise and other capacity within the country to undertake risk assessment in relation to sustainable production intensification initiatives is adequate, and capacity building needs are understood | | |
| The application of Sustainable Management Practices for sustainable production intensification is well advanced, and priorities for capacity building are understood | | |
| Environmental Farm Planning is well advanced and capacity building needs to advance Environmental Farm Planning are understood | | |
| The application of integrated landscape management and the ecosystem approach is well developed and will support long-term efforts to achieve sustainable production intensification | | |

| | | |
|---|---|---|
| Expertise and other capacity within the country to implement application of integrated landscape management approaches and the ecosystem approach is adequate, and capacity building needs are understood | | |
| Environmental Management Systems for agriculture are well advanced, and capacity-building needs to advance Environmental Management Systems for agriculture are understood | | |
| Land Use Plans and Land Use Zoning are being employed in agricultural areas | | |
| Watershed management strategies are in place or are being developed in agricultural areas | | |
| Expertise and other capacity within the country to implement application of integrated landscape management approaches and the ecosystem approach is inadequate, and should be developed to assist in the long-term success of sustainable production intensification initiatives | | |

| **Priority Capacity Building Needs** | Yes | No |
|---|---|---|
| ***Capacity building is required for sustainable management practices to:*** | | |
| • Prevent, reduce or mitigate soil erosion and degradation | | |
| • Prevent or reduce water pollution and inefficient use of water resources | | |
| • Reduce the use of pesticides | | |
| • Reduce the inputs of synthetic fertilizers and other chemicals | | |
| • Prevent or reduce nutrient loss from farms to the environment | | |
| • Prevent or reduce impacts to ecosystem functions and biodiversity | | |
| • Reduce the emission of greenhouse gases | | |
| • Promote energy efficiency | | |
| • Promote sound waste management practices | | |

**Soil Health and Erosion Risk**

| **Site Assessment** | Yes | No |
|---|---|---|
| Soil health issues have been assessed on the site | | |
| A soil erosion risk assessment been conducted for the site | | |
| Soil health issues and soil erosion are already issues on the site and mitigation measures or adoption of practices to prevent or mitigate adverse further impacts to soils are required | | |
| The cropland area is steep in many areas and vulnerable to water-caused soil erosion, and mitigation measures or adoption of practices to prevent or mitigate further water-caused soil erosion are required | | |
| The area is prone to wind-caused soil erosion, and mitigation measures or adoption of practices to prevent or mitigate further wind-caused soil erosion are required | | |
| Farmers are well trained in erosion control measures | | |
| Farmers training in erosion control measures is a priority and should be conducted before, or as part of the proposed initiative | | |

| **Adverse and Positive Impacts to Soils** | Yes | No |
|---|---|---|
| ***The initiative could potentially adversely impact soil health by:*** | | |
| • Increasing tillage and introducing or expanding other practices that adversely impact soil biodiversity | | |
| • Enhancing use of chemicals that might alter soils leading to increased acidification or salinity or leaching | | |
| • Significantly reducing vegetation cover | | |

| | | |
|---|---|---|
| • Expanding crop production in highly erosion-prone areas | | |
| • Increasing soil compaction, reducing crop yields over the long term | | |
| • ***The initiative could potentially benefit soil health by:*** | | |
| • Introducing practices that will assist in maintaining or enhancing soil biodiversity | | |
| • Introducing measures to prevent or mitigate chemical alteration of soils, including addressing: soil acidification, soil salinity; chemical spills/soil contamination | | |
| • Introducing or expanding erosion control measures – windbreaks, improved vegetation cover, permanent cover, etc. | | |
| • Reducing soil erosion by introducing or expanding Conservation Agriculture | | |
| • Improving soil nutrients and raising organic matter to optimum levels | | |
| • Increasing the efficiency of input use, particularly fertilizers | | |
| • Improving management of wastes and by-products from processing units that damage soil health | | |
| • Reducing crop production in highly erosion-prone areas | | |
| • Reducing soil erosion by enhancing the physical, chemical, and biological health of the soil to its optimal level under local conditions | | |

| **Recommendations** | Yes | No |
|---|---|---|
| The initiative will <u>not</u> adversely impact soil health or result in significant erosion, and thus, should proceed as planned without further assessments or mitigation measures | | |
| The impacts of the initiative on soil health and/or increased soil erosion are <u>potentially significant</u> and further assessment is required to identify appropriate mitigation measures and practices to prevent adverse impacts | | |
| The impacts of the initiative on soil health and/or increased soil erosion <u>are known</u>, as are appropriate mitigation measures, and thus, the initiative should proceed with implementation of the mitigation measures and practices to prevent or minimize adverse impacts | | |
| The impacts of the initiative on soil health and/or increased soil erosion are <u>potentially severe</u>, and thus, the initiative should not proceed as currently planned | | |

**Water Quantity and Quality and Aquatic Living Resources**

| **Site Assessment** | Yes | No |
|---|---|---|
| Water availability assessment has been undertaken at the site | | |
| Water resources are at maximum use levels and further water demand is a limiting factor | | |
| Water quality issues have been assessed at the site | | |
| Agriculture-related water quality issues have already arisen at the site (siltation, pollution, etc.), and the initiative might further adversely impact water quality | | |
| Slope and drainage patterns have been assessed at the site | | |
| Slope and drainage patterns must be carefully considered in planning and implementing the initiative to prevent soil erosion, water siltation, leaching and pollution and other impacts | | |
| Sustainable use practices for water conservation and water quantity protection are widely practised by farmers | | |
| Adoption of sustainable use practices for water conservation and water quantity protection are not widely practised by farmers and should be promoted and supported prior to or as part of the initiative | | |
| The importance of aquatic living resources as sources of food and/or income resources have been assessed in the area, and conservation of aquatic living resources must be carefully considered in planning and implementing the initiative | | |
| Sustainable use practices for conserving important aquatic living resources are not widely practised by farmers, and the initiative should be promoted and supported prior to or as part of the initiative | | |

| **Adverse and Positive Impacts** | Yes | No |
|---|---|---|
| ***The initiative could potentially significantly increase water consumption and adversely impact water quality by:*** | | |
| Increasing demand on water resources by planting or expanding crops that have high water demands | | |
| Increasing demand on water resources by expanding the total area of cropland | | |
| Increasing nutrient waste runoff with increased bacterial contamination | | |
| Increasing demand on water resources by expanding the use of irrigation | | |
| Increasing nutrient runoff from farms resulting in increased contributions to eutrophication of nearby or downstream water resources | | |
| Increasing farm runoff of chemicals that pollute nearby or downstream water resources | | |
| Expanding crop production near water resources without adequate buffers and other controls | | |

| | | |
|---|---|---|
| Expanding crop production in highly erosion-prone areas such as steep slopes | | |
| ***The initiative could potentially benefit water quantify and quality by:*** | | |
| Decreasing the use of water resources by promoting crop selection that will reduce water demand | | |
| Decreasing the use of water resources by introducing enhanced water efficiency measures for irrigation and other uses | | |
| Enhancing or establishing nutrient waste management controls | | |
| Establishing or enhancing buffer zones to protect water resources | | |
| Reducing the use of pesticides and other chemicals, especially near water, and by adopting management practices that reduce the use of pesticides | | |
| Reducing use of synthetic fertilizers, especially near water, and by adopting management practices that reduce the use of synthetic fertilizers and other chemicals inputs | | |
| Implementing soil erosion measures to reduce siltation of water resources | | |

| **Recommendations** | Yes | No |
|---|---|---|
| ***Water quantity and quality*** | | |
| The initiative will not adversely impact water quantity or quality, and thus, should proceed as planned without further assessments or mitigation measures | | |
| The impacts of the initiative on water quantity or quality are potentially significant and further assessment is required to identify appropriate mitigation measures and practices to prevent adverse impacts | | |
| The impacts of the initiative on water quantity or quality are known, as are appropriate mitigation measures, and thus, the initiative should proceed with implementation of the mitigation measures and practices to prevent or minimize adverse impacts | | |
| The impacts of the initiative on water quantity or quality are potentially severe, and thus, the initiative should not proceed as currently planned | | |
| ***Important aquatic living resources*** | | |
| The initiative will not significantly adversely impact important aquatic living resources, and thus should proceed as planned without further assessments or mitigation measures | | |
| The impacts of the initiative on important aquatic living resources have not been adequately assessed, and therefore assessments are required before the initiative is implemented | | |
| The adverse impacts of the initiative on important aquatic living resources are known as are mitigation measures, and thus, the initiative should proceed with implementation of the mitigation measures and best practices to prevent or minimize adverse impacts | | |
| The impacts of the initiative on aquatic living resources are potentially severe, and thus, the initiative should not proceed as currently planned | | |

**Ecosystem Services and Biodiversity**

| **Site Assessment** | Yes | No |
|---|---|---|
| The initiative is proposed in an area that is also important for waterfowl, fish and wildlife and their habitat | | |
| The initiative is proposed in an area not previously significantly used for agriculture | | |
| The initiative is proposed in an area that is occupied by threatened and endemic native species | | |
| The initiative is proposed in an area designated as of high biodiversity importance or near an existing or proposed protected area | | |
| The initiative is proposed in an area where loss of wildlife habitat is already a conservation concern | | |
| Farmers are aware of biodiversity issues and are participating in conservation initiatives | | |
| Guidelines are in place for the use, transfer or handling of organisms with novel traits | | |

| **Adverse and Positive Impacts** | Yes | No |
|---|---|---|
| ***The initiative could potentially adversely impact ecosystem services and biodiversity by:*** | | |
| Potentially introducing or spreading weeds, crop pests, crop diseases, or invasive alien species | | |
| Reducing crop pollinators | | |
| Impacting protected areas, wetlands, areas of high biodiversity, and other important wildlife corridors and other wildlife habitat | | |
| Reducing natural vegetation within the agricultural landscape, such as forests and grasslands | | |
| Impacting threatened, endemic or keystone species | | |
| Impacting migratory species and their habitats and corridors | | |
| Impacting native species of social, economic, cultural or scientific interest | | |
| ***The initiative could potentially benefit ecosystem services and biodiversity by:*** | | |
| Enhancing on-farm ecosystem services and functions, including decomposition of organic wastes, carbon sequestration, nutrient cycling, water purification) | | |
| Conserving and enhancing crop pollinators, natural enemies of crop pests, soil biodiversity and other crop and crop-associated biodiversity | | |
| Conserving genetic resources for food and agriculture | | |
| Reducing nutrient loss from farms into the surrounding environment | | |

| | | |
|---|---|---|
| Reducing the release of potentially harmful substances from farms, (pesticides and other chemicals) into the surrounding environment | | |
| Improving water and energy efficiency and use of other inputs, thereby reducing demand on natural resources, wetland, streams, ground and surface water | | |

| **Recommendations** | Yes | No |
|---|---|---|
| The initiative will not significantly adversely impact ecosystem functions or biodiversity, and thus, should proceed as planned without further assessments or mitigation measures | | |
| The impacts of the initiative on ecosystem functions or biodiversity are potentially significant and further assessment is required to identify appropriate mitigation measures and practices to prevent adverse impacts | | |
| The impacts of the initiative on ecosystem functions or biodiversity are known, as are appropriate mitigation measures, and thus, the initiative should proceed with implementation of the mitigation measures and practices to prevent or minimize adverse impacts | | |
| The impacts of the initiative on ecosystem functions or biodiversity are potentially severe, and thus, the initiative should not proceed as currently planned | | |
| Improved practices for maintaining ecosystem functions and biodiversity need to be developed and used by farmers as part of the initiative | | |

**Climate Change and Air Quality**

| **Site Assessment** | Yes | No | *N/A |
|---|---|---|---|
| Air quality issues need to be assessed on the site prior to the implementation of the initiative | | | |
| Air quality issues are of concern in relation to the initiative and mitigation measures or adoption of practices to prevent or mitigate further adverse impacts are required | | | |
| Farmers awareness of air quality and climate change issues is adequate | | | |
| Farmers training in practices to maintain air quality is a priority need, and should occur prior to or as part of the proposed initiative | | | |
| Emissions of greenhouse gases need to be assessed prior to the implementation of the initiative | | | |
| Emissions of greenhouse gases are of concern in relation to the initiative, and mitigation measures or adoption of practices to prevent further adverse impacts are required | | | |
| Farmers training in practices to reduce the emission of greenhouse gases is adequate | | | |
| Farmers training in practices to reduce the emission of greenhouse gases is a priority need, and should occur prior to or as part of the proposed | | | |

| | | | |
|---|---|---|---|
| initiative | | | |
| *N/A Not applicable | | | |

| **Adverse and Positive Impacts** | Yes | No |
|---|---|---|
| ***The initiative could potentially adversely impact air quality or further contribute to the emission of greenhouse gases by:*** | | |
| Increasing the use of fossil fuels in production and other activities that increase the emission of greenhouse gases (carbon dioxide, methane, etc.) from farm operations | | |
| Reducing the carbon storage capacity of agro-ecosystems | | |
| Increasing the generation of organic wastes that will potentially degrade and affect air quality and increase the emission of greenhouse gases | | |
| ***The initiative could potentially benefit air quality and reduce the emission of greenhouse gases by:*** | | |
| Improving energy efficiencies and reducing the use of fossil fuels in farm operations | | |
| Introducing or expanding production practices that will increase the carbon storage capacity of agro-ecosystems | | |
| Improving the management of organic wastes, crop residues, manure, etc, to improve air quality and decrease the emission of greenhouse gases | | |
| Improving farmer awareness of air quality and climate change issues | | |
| Contributing to the assessment of climate change vulnerabilities (climate risks, perceptions of climate risk, site profiles, etc.) and assessment of future risk from climate change (long-term impacts on agriculture, economic and ecological conditions) | | |
| Contributing to climate change adaptation planning, identification and testing of adaptation options and design of adaptation strategies, improving climate change forecasting and information management | | |

| **Recommendations** | Yes | No |
|---|---|---|
| The initiative will not significantly adversely impact air quality or increase the emission of greenhouse gases, and thus, should proceed as planned | | |
| The impacts of the initiative on air quality or the potential to increase the emission of greenhouse gases are significant and further assessment is required to identify appropriate mitigation measures and practices to prevent adverse impacts | | |
| The impacts of the initiative on air quality or the emission of greenhouse gases are known, as are appropriate mitigation measures, and thus, the initiative should proceed with implementation of the mitigation measures and practices to prevent or minimize adverse impacts | | |
| The impacts of the initiative on air quality are potentially severe, and/or the emission of greenhouse gases will be significant, so the initiative should not | | |

| | | |
|---|---|---|
| proceed as currently planned | | |
| Improved practices for maintaining air quality and reducing the emission of greenhouse gases need to be further developed and farmers trained in these practices as part of the initiative | | |

**Energy and Waste Management**

| **Site Assessment** | Yes | No | *N/A |
|---|---|---|---|
| Management practices to improve energy efficiency are widely used by farmers | | | |
| Management practices to improve energy efficiency are not widely used by farmers, and training in energy efficiency should occur prior to or as part of the proposed initiative | | | |
| Pesticides are commonly used in the area | | | |
| Farmers are well trained in the use of pesticides and in their safe handling and disposal | | | |
| Farmers need to better trained in the use of pesticides and in their safe handling and disposal and this should occur prior to or as part of the proposed initiative | | | |
| Mechanization is increasing and resulting in significant increases of farm fuels, oils and solvents | | | |
| Farmers are well trained in the use, safe handling and disposal of farm fuels, waste oils and other products used in mechanization | | | |
| Farmers need to be trained in the use, safe handling and disposal of farm fuels, waste oils and other products used in mechanization and this should occur prior to or as part of the proposed initiative | | | |
| *N/A Not applicable | | | |

| **Adverse and Positive Impacts** | Yes | No |
|---|---|---|
| ***The initiative could potentially increase energy use and waste generation by:*** | | |
| Increasing the use of fossil fuels in production from farm operations | | |
| Increasing the amounts of waste oils, pesticides, and other chemical farm waste products which may be released into the farm system or the surrounding environment | | |
| Increasing release of organic wastes into the farm system or the surrounding environment | | |
| Significantly increasing the use of synthetic fertilizers | | |
| ***The initiative could potentially benefit efforts to improve energy efficiency and reduce wastes by:*** | | |
| Improving energy efficiencies and decreasing the use of fossil fuels in farm operations | | |

| | | |
|---|---|---|
| Increasing the use of renewable energy resources | | |
| Improving the management of organic wastes, crop residues, manure, etc. | | |
| Improving farmer awareness of the need for energy efficiency and improved wastes management | | |
| Increasing the number of farmers that are trained in the use of pesticides and in their safe handling and disposal and in integrated pest management practices | | |

| **Recommendations** | Yes | No |
|---|---|---|
| ***Energy*** | | |
| The initiative will not significantly increase energy consumption or may decrease energy consumption, and thus should proceed as planned without further assessments or mitigation measures | | |
| The initiative will potentially significantly increase energy consumption, and further assessment is required to identify appropriate mitigation measures and practices to prevent adverse impacts | | |
| The initiative will significantly increase energy consumption, and should not proceed as currently planned | | |
| Improved practices for reducing energy use need to be further developed and farmers trained in these practices as part of the initiative | | |
| ***Wastes*** | | |
| The initiative will not significantly increase wastes or result in the release of harmful wastes into the environment, and thus, should proceed as planned without further assessments or mitigation measures | | |
| The initiative will potentially significantly increase wastes or release harmful wastes into the environment, and further assessment is required to identify appropriate mitigation measures and practices to prevent adverse impacts | | |
| The potential impacts of the initiative in are known in terms of increasing wastes or releasing harmful wastes into the environment, as are appropriate mitigation measures, and thus, the initiative should proceed with implementation of the mitigation measures and practices to prevent or minimize adverse impacts | | |
| The impacts of the initiative in increasing wastes or releasing harmful wastes into the environment are potentially severe, and should not proceed as currently planned | | |
| Improved practices for reducing wastes and preventing the release of harmful wastes into the environment need to be further developed and farmers trained in these practices as part of the initiative | | |