

# **Land Use Planning: A Key to Sustainable Agriculture**

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## **Abstract**

Sustainable use of the soil is a form of land management which retains the natural fertility of the soil and allows for the production of food and fiber supplies and renewable natural resources on a long-term basis. It implies that the natural environment should be treated and managed in such a way that the cycles and energy fluxes among the soil, bodies of water and atmosphere are considered, preserved or restored. To this respect, the term “sustainable land use” is more comprehensive than the term “sustainable soil use”. Land, commonly, stands for a section of the earth’s surface with all the physical, chemical and biological features that influence the use of the resource. It refers to soil, spatial variability of landscape, climate, hydrology, vegetation and fauna, and also includes improvements in land management, such as drainage schemes, terraces and other agrobiological and mechanical measures. The term “land use” encompasses not only land use for agricultural and forestry purposes, but also use of the land for settlements, industrial sites, roads and other human activities. Land use, in this meaning, can be termed sustainable only if it is achieved such a spatial distribution or configuration of the different uses, as to guarantee biodiversity and preserve the eco-balance of the whole system. Rational land use planning is fundamental to this process. With reference to the aforesaid issues, the paper describes the main physical, social and economic features of land use planning projects, along with their environmental impacts and constraints to sustainable development. The importance and role of institutional strengthening, sound financial and managerial frameworks, availability of human resources involved, research thrust, technology transfer and networking improvement are also analyzed.

**Key-words:** Land use planning, sustainable agriculture, networking system.

## **Foreword**

The world’s population is expected to grow from 6 billion today to at least 8 billion in the year 2025. It is, therefore, clear that achieving food security and improving the quality of life, while preserving the environment, will continue to pose major challenges to scientists, decision-makers and technicians in the years to come. The main activity of agriculture is the production of food, so increasing agricultural development in a sustainable manner will be crucial in responding to these challenges.

In the past, demand for growth in food has been met by expanding agricultural land. Nowadays, the availability of new land is limited; moreover, the more or less uncontrolled growth in agricultural production, during the past few decades, in industrial as well as developing countries, has pushed agricultural production to and, in many cases, over the edge of sustainability. This means that the traditional ways to increase production are facing a new challenge: to find a new balance between agricultural development and the conservation of the natural resources.

Agricultural engineering has been applying scientific principles for the optimal use and management of natural resources for centuries, and its role is increasing with the dawn of the new millennium. There are, at least, two reasons for this growing significance. First, it is well understood that the wise use of land resources will play a role of paramount importance in the provision of food for future generations. Second, the demand for different land uses is increasing tremendously, especially in the developed world. The land demands for cropping, grazing, forestry, wildlife, infrastructure, outdoor recreation, landscape and industrial and urban development are greater than the land resources available. To this end, rational land use planning will help to find a balance among these different demands and assure agricultural production, while conserving the natural environment.

With reference to the afore-mentioned issues, the paper, firstly, describes the main physical, social and economic features of the land use planning process, along with its environmental impacts and constraints to sustainable agricultural development. Finally, the importance and role of institutional strengthening, sound financial and managerial frameworks, availability of human resources involved, research thrust, technology transfer and networking improvement are analyzed.

## **The Concept of Sustainable Land Use**

To meet future challenges of food security, further development of agriculture is necessary. This development has to guarantee both the growth in agricultural output and the conservation of natural resources. The conservation of the natural resources is important because of the dependence of agriculture on these resources. This means that the natural environment should be treated and managed in such a way that food production is secured now and in the future. So, food security is not only a matter of quantity, but also of continuity. Agriculture, thus, is forced to find a balance between development and conservation. In this process the responsible use of natural resources plays a role of paramount importance. Among the basic natural resources, upon which life depends, is the soil.

The responsible use of the soil can be described in terms of sustainability or sustainable development. Sustainability has been defined in many different ways and there is no single, universally accepted definition. According to the Brundtland Commission “sustainable development is a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional changes are all in harmony and enhance both current and future potential, to meet human needs and aspiration”. This process implies long-term perspective for planning and integrated policies for implementation. FAO has formulated its own definition of sustainability, specifically in the context of agriculture, forestry and fisheries: “sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for the present and future generations. Such sustainable development conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable”.

Scarcity of suitable soil is a major constraint for further agricultural development in many countries of the world. Therefore, as the demand for soil continues to increase, it is imperative that this limited resource be used efficiently for agricultural and other uses.

Sustainable use of the soil is a form of land management which retains the natural fertility of the soil and allows for the production of high quality of foodstuffs and renewable natural resources on a long-term basis. This means that the natural environment should be treated and managed in such a way, as to preserve or restore the cycles and energy fluxes among soil, bodies of water and atmosphere.

The term “sustainable land use” is more comprehensive than the term “sustainable soil use”. Land, commonly, stands for a section of the earth’s surface, with all the physical, chemical and biological features that influence the use of the resource. It refers to soil, spatial variability of landscape, climate, hydrology, vegetation and fauna, and also includes improvements in land management, such as drainage schemes, terraces and other agrobiological and mechanical measures. The term “land use” encompasses not only land use for agricultural and forestry purposes, but also land uses for settlements, industrial sites, roads and so on. Land use, in this sense, can be termed sustainable if, and only if, is achieved such a spatial distribution or configuration of the different uses, as to guarantee biodiversity and preserve the eco-balance of the whole system. In other words, land use that limits the interactions among soil, water and atmosphere and degrades the habitat standards vital to biological diversity of flora and fauna cannot be defined sustainable. In this respect, the term “sustainable land use” combines technology, policies and activities aimed at integrating socio-economic principles with environmental concerns. The term bears more dimensions or meanings:

- Sustainable use in the meaning of husbandry. In this sense, it is related to concepts such as continuity, durability and equity in the exploitation of natural resources over long periods of time. The dimension refers to methods by which land is managed – crop rotation procedures, tillage systems and so on – all striving to preserve or restore the quality and fertility of the soil. This meaning is strongly related to the long-term physical and economic sustainability.
- Sustainable use in term of interdependence. This meaning is related to the spatial dimension of sustainability. It involves such aspects as fragmentation and relations among different land uses. On this facet of sustainability are, nowadays, focusing many land use planning studies, due to the fact that there is still a great lack of knowledge and uncertainty.
- Sustainable use in terms of ethical obligations to future generations. This refers to the losses and depletions of natural resources in combination with the expected increase in population. Land is not a simple commodity that can be stored and replaced, destroyed and remade, or even recycled in exactly the same way as manufactured goods. It is a complex and biological system, built up over long periods of time. The land could have lost its suitability for cropping or other uses by means of natural or anthropogenic causes. To restore its capacity for beneficial use, while protecting the environment, methods of reclamation have to be tailored to the specific problems at hand. In this field much needs to be done to ensure the future of mankind.

Any assessment of sustainability would be incomplete if it did not address all the dimensions previously described.

Clearly, there are conflicts among these goals. More equity may mean less efficiency. In the short term it may not be possible to meet the needs or demands of even the present generations, let alone the future ones, if these needs or demands are greater than what the environment can afford. Furthermore, degrading the natural resources will reduce their capacity to meet future needs, whatever those needs will be. So, demand management and degradation prevention play a basic role in the process of sustainable use and development of land. Decision – makers have to consider and agree upon a trade-off among different goals but, if the ecosystem as a whole is to survive, the use of natural assets must be compensated by the development of human or physical assets of equal or greater worth. In this regard, good and reliable information is essential, that is, information on the people’s needs, land resources and on the economic, social and environmental consequences of alternative decisions. To this end, the task of the land-use planners is to ensure that decisions are made on the basis of consensus, to avoid disagreements on the ways and directions the natural resources should be exploited. Wise land use planning will help to reduce the trade-off costs and resolve conflicts by involving the community in the decision process.

## Land Use Planning: A Tool to Achieve Sustainability

Land use planning is the systematic assessment of land and water potential, alternatives for land use and economic and social conditions in order to select and adopt the best land use options. Its purpose is to select and put into practice those land uses that will best meet the needs of the people while safeguarding resources for the future. The driving force in planning is the need for change, the need for improved management or the need for a quite different pattern of land use dictated by changing circumstances. In the process all kinds of land use are involved: agriculture, forestry, wildlife conservation, urban and industrial expansions, tourism and amenities. Planning also provides guidance in case of conflicts among manifold alternatives, by indicating which areas are most valuable for any particular land use. Land use planning can be viewed as an iterative and continuous process, whose aim is to make the best use of land resources by:

- assessing present and future needs and evaluating the land's availability to meet them;
- identifying and resolving conflicts among competing uses and needs;
- devising alternative options and choosing those that best fit identified targets;
- learning from experience.

At every stage, as better information is available, the process may have to be changed to take account of it.

Goals are important elements in the planning process. They define what is meant by the best use of the land and they have to be specified at the outset of every planning project. Goals, normally, are divided into objects and targets.

Objectives are the general aims within the planning process. They allow the judging of different solutions of a concrete problem in the planning area, and lead to suitable propositions and projects for the use of the land. The targets are the most detailed aims of land use planning. They lead to the design of actual measures that have to be taken and carried out in an area to solve the problems at hand.

The objectives and targets identify the best use of the land. If two different forms of land use bring forth exactly the same profit (economically and socially), the objectives will determine which of the two land uses should be implemented, while the targets will indicate which procedures should be followed.

The goals, as a whole, may be grouped under three main headings: efficiency, equity and acceptability and sustainability.

- Efficiency refers to the economic viability of the land use plan.  
The plan should yield more than it costs. So one goal of planning development is to make efficient and productive use of the land. In general terms, for any particular land use, certain areas are better suited than others. Efficiency is achieved by matching different land uses with the areas that will yield the greatest benefit at the least cost. However, it is not always clear which land use is the most profitable one; this depends on the point of view. The point of view of individuals, for instance, focuses on the greatest return on capital and labour invested or on the greatest benefit from the area available. Government's point of view is more complex: it may include improving the foreign exchange situation by producing for export or for import substitution.
- Equity and acceptability represent the social features of land use planning.  
The plan must be accepted by the local population, otherwise the proposed changes will not take place. Equity refers to the levelling of the living standards of the residents. People living in the planning area are expected to gain from the land use plan, even if they do not own the land. Living standards may include levels of income, food security and housing. Planning to achieve these standards then involves the allocation of land for specific uses as well as the allocation of financial and other resources.

- Sustainability, as stated before, refers to a development in land use planning that meets the needs of the present while conserving resources for future generations.

This requires a combination of production and conservation: the production of the goods needed by the people now, combined with the conservation of the natural resources on which the production depends. So, land use to be sustainable, has to be planned for the community as a whole, because the conservation of soil, water and other land resources is often beyond the means of individual land users.

Other goals of the planning process could be:

- Livability After the land use plan is implemented, the area should still be a suitable place to live for the inhabitants;
- Flexibility The plan should be flexible and leave options for using the land in different ways, if needed, in the future;
- Public involvement Every group or individual with an interest in the plan should be allowed to participate in the process, to keep their land use from disappearing through the plan, or to be offered a new land use, as part of the plan.

On the whole, the land use planning, to be sustainable, should develop into an interdisciplinary, holistic approach that gives attention to all functions of the land and actively involves all land users through a participatory process of negotiation platform, be it at national or local levels. The aim of the process is to create the conditions to achieve an environmentally sound, socially desirable and economically appropriate form of land use.

## Research and Development

International and national research, nowadays, needs to be focused more effectively than in the past on problems of land use planning and management. This is the only way to provide land users and planners with suitable and tested technologies for targeted measures to increase agricultural production while protecting the natural resources. The lack of research, application of research findings and access to new and advanced technology in this field is seen as one of the main reasons for the problems that plague the sector: poor land use efficiency, environmental degradation, high costs and lack of responsiveness to beneficiaries.

Successful research thrust on sustainable land use planning should include the following actions:

- Data base improvement;
- Adaptive research;
- Institutional strengthening;
- Socio-economic analysis;
- Environmental protection and conservation;
- Technology transfer and infrastructure.
- Data base improvement.

Availability of reliable hydro-climatic and other associated natural resource data is an essential prerequisite for sustainable land use planning development. As long as adequate and reliable data are not available, planning, design and management of land use programs will continue to remain guesswork, use of other natural resources haphazard and wasteful, and the development process unsustainable. Many land use projects were conceived and designed on a medium – to long-term basis, on the assumption that future climatic conditions will not be different from the past ones. This will not be so in the years to come, due to the global warming and greenhouse effect. Therefore, land use planning designers and managers should begin a systematic re-examination of engineering design criteria, operating rules, contingency plans and land allocation policies. Demand management and adaptation are essential components for increasing project flexibility to meet uncertainties of climate change. On the whole, land use

planning programs can only be soundly formulated on the basis of adequate data on soil and its production capacity, potentially available water resources, performance of existing land use projects and other related factors.

- Adaptive research.

A wide variety of techniques or methods are used in land use planning. They are taken from the natural sciences (climatology, hydrology, soil science, ecology), from technology (agriculture, forestry, irrigation and drainage engineering) and from the social science (economics, sociology). Research for land use planning requires enhanced field investigations and a large variety of tools such as: Information Management, System Analysis, Decision Support Systems, Multicriteria Analysis, Geographic Information Systems, Remote Sensing, Computer Image Analysis, Sensors, Modeling Technique, Neural Network Technology, Land Evaluation. All these tools have to be considered under a broad and integrated approach related to food and other agricultural commodity production, rational land use planning, water saving, resource conservation, environmental impacts and socio-economic effects. Current research thrust needs to be reoriented by recognizing the complex role of the land resources in agricultural development, and by following a broad-based holistic approach. To this end, adaptive research programs must be directed to investigate the actual and real problems associated with the planning, design, implementation and management of land use projects. It is important that the resulting methodology be technically feasible, environmentally and economically viable and socially acceptable.

- Institutional strengthening.

The importance of a functional and coherent institutional framework aiming to promote, at both national and international levels, sustainable land use planning development, has been fully recognized at present. The solution may not always require the creation of new and enlarged institutions and establishment of larger governmental services. An important criterion in reorganizing and/or establishing new institutions should be the ability of such institutions to address successfully the multi-dimensional problems that are generally faced by the land users at both local and national levels. Such institutions should be capable of undertaking, regulating, stimulating and facilitating the roles and the tasks carried out by the land users. These institutional frameworks need to be strengthened or restructured to meet more efficiently the land users' requirements and to promote sustainable land use planning development. Principal institutions should have effective linkages with all other related frameworks, so as to optimize the use of physical, financial and human resources involved.

The necessary actions are the following:

- review, strengthen and restructure, if required, existing institutions in order to enhance their capacity in land use planning activities;
- review, assess and revise, if needed, existing legislation on land management within the broader framework of legislation for the development, use and conservation of land resources.

- Human resource development.

Successful technology and research thrust on land use planning depends on the number, orientation and quality of human resources (decision makers, professionals and research-related people) involved. They orient appropriate knowledge and skill to solution of priority issues and emphasize the adaptation of available techniques to solve local problems. These knowledge and skill will include the ability to:

- identify local hurdles and constraints;
- formulate research strategies;
- design suitable technologies for testing, monitoring and evaluating;
- assess the technical, economic, social and institutional aspects regarding the application and adaptation of modern and advanced technology.

Moreover, this body of human resources will help national and international institutions, improve educational contents and training in land and other natural resources related topics, as well as scientific organizations identify subjects to be further analyzed and investigated.

The necessary actions can be summarized as follows:

- assess training needs for land use planning and management;
- develop practical training courses for improving the ability of extension services to disseminate technologies and strengthen land users' capabilities;
- enhance the capabilities of decision makers, administrators and officers at all levels, involved in land use planning programs.

- Social economic analysis.

Social and economic analyses are important features of the land use planning process. A land use project, like many other projects, can be implemented only if the total benefits exceed the total costs. Therefore, sustainable land use planning should meet two basic considerations, namely economic viability and social acceptability. Comparisons of social with economic analyses can highlight the need for policy changes. A particular land use may be degrading and thus destroying other land resources. If the economic analysis shows the use to be advantageous from a land user's point of view, it is likely to continue, whether the process is environmentally sound or not. Economic analysis should take account of damage to land resources and the consequent lowering of their productivity.

A great many land use planning projects in the past have failed due to the inadequate attention given to social and economic aspects in their design and implementation. Application of appropriate socio-economic analysis in all phases of the planning process is urgently required in the development of land use projects. In this regard it is recommended that:

- effort should be made to incorporate economic and social analyses in land use planning methodologies;
- governments, relevant international and national institutions and decision – makers should ensure that socio-economic analyses are adequately applied in the formulation and selection of land use planning projects for implementation.

- Environmental protection.

Sustainable land use planning has to find a balance between agricultural development and conservation of natural resources. Thus, development and environment are two aspects of the same process. Much agricultural land is deteriorating due to inappropriate soil and water management. Soil erosion, nutrient depletion, salinization and waterlogging all reduce productivity and jeopardize long-term sustainability. Wise management of the environment requires ability to forecast, monitor, measure and analyze environmental trends and assess the potentials of the land resources at different levels, ranging from the farm to the watershed. Adopting suitable environmental impact assessments will enable decision-makers, professionals and institutions to plan land use without irreversible environmental damage and allow sustainable natural resource use. Environmental impact assessments should be followed by monitoring and appropriate actions in order to maximize positive impacts of development and minimize environmental hazards. In this regard, environmental protection and conservation of natural resources must be made an integral part of development. The necessary actions have to:

- carry out objective environmental impact assessments in order to ensure the sustainability and environmental acceptability of land use projects and programs;
- establish environmental monitoring, evaluation and feedback systems on a long term basis;
- expand, improve and coordinate international assistance to enhance the capabilities of less developed countries to assess, manage and protect their environment and natural resources.

- Technology transfer and infrastructure.

The success of a land use planning project is strongly influenced by the availability of technology and whether or not appropriate choices have been made to suit the local conditions.

So, a framework for information transfer which includes storing, disseminating, receiving feedback and updating information is urgently needed to support sustainable land use activities. As in all economic activities, agricultural development, particularly involving the land use sector, has infrastructural requirements to ensure its success. Farmers and other land users must have appropriate funds, food supplies must be delivered in time and in adequate quantities, and proper marketing facilities and pricing structures must be assured. In addition to physical infrastructure, services such as education and health are also necessary. The necessary actions have to:

- establish effective methods to facilitate the transfer of new and tested techniques and practices;
- encourage and provide required facilities for transfer of knowledge and experiences among developed and developing countries;
- enhance the development of a more effective production environment.

### **Strategic action program**

The above described themes and principles, strike at the root of the major problems encountered in the land use planning process. To be effective, they have to be translated into actions through the formulation of programs which have to take into account the actual conditions of the environment where they are expected to be implemented. These programs have to include:

- ◆ the adoption of a comprehensive approach that views land and water use and management and environment in an integrated manner;
- ◆ the promotion of regional cooperation to ensure that the concerns of all parties are factored into decisions;
- ◆ the recognition of the linkages among the different land uses;
- ◆ the encouragement of broad-based participation, including governments, professional and research institutions and non-government organizations;
- ◆ the endorsement of a phased program of action at the national and local levels.

This regional approach makes up and outlines the body of a Strategic Action Program, which is a critical measure for implementing priority actions at both national and local levels. The objectives of the Strategic Action Plan are to:

- ◆ evaluate trends;
- ◆ assess causes and implications;
- ◆ provide a cost estimate for investments;
- ◆ establish a framework for monitoring and evaluating;
- ◆ identify priority actions to address key issues.

Priority selection has to follow the criteria listed below:

- ◆ ensure selectivity, in order to concentrate resources on significant problems;
- ◆ avoid duplication and overlap;
- ◆ emphasize adaptive and cost effective solutions through adaptation and/or improvement of existing technology to specific tasks;
- ◆ select topics for investigation and research that are likely to realize the greater benefit, considering return on investment, response time, probability of success and impact on agricultural production.

This integrated approach is expected to bring forth clear benefits in environmental and economic terms, a more sustainable use of land resources in agriculture and higher yields and incomes.

## **Concluding Remarks**

- Sustainable land use planning is a process that aims to integrate ecological with socio-economic, and political with ethical principles in the management of land, for productive and other functions, to achieve intra – and inter – generational equity.
- For formulating and implementing policies and strategies for land use planning it is essential to collect, process and disseminate timely and reliable information and utilize modern land assessment and evaluation technologies, to create sound scientific knowledge for proper decision support.
- The establishment of an effective networking system can greatly improve, enhance and speed up the process of collection, selection and exchange of information avoiding duplication and overlap.
- No detailed layout for sustainable land use planning can be drawn up for a region as a whole. A regional strategy can, at best, give a general idea of what needs to be achieved at the country level. Each country, then, will have to tailor its sustainable development strategy in view of its particular problems, constraints and comparative advantages.
- Regional strategies must set priorities and identify relevant projects, assess the environmental impacts of policies, investigate mechanisms to mobilize resources, enhance and encourage the participation of all concerned parties.
- The promotion and implementation of land use planning projects will not come free of cost. Major emphasis should, therefore, be paid on developing new sources of funds to supplement the national budgetary allocations. Chief among these approaches are measures that seek to mobilize local funds, in particular under the “user pays” principle.
- The challenging, but widely acceptable concept of sustainable land use planning calls for new approaches on development and, therefore, on land use and management. To this respect, new perspectives are required to manage the land and its associate resources. This is not only a question of allocating and controlling the use of the land, but of combining the knowledge of pressure influencing the resources themselves, with the relations among users and human and social objectives, the technologies available to improve and enhance the land use planning process, and the maintenance of both the biodiversity and the natural equilibrium.
- The lessons learned demonstrate that it is necessary to make a decisive break from past policies to embrace a new holistic approach in land use planning and management, that is comprehensive, participatory and environmentally sustainable.
- There is an urgent need for adequately trained professionals who can work in the multisectorial environment of integrated natural resource management.
- Finally, to achieve a sustainable land use planning development, objectives and goals, policies and regulations should be grounded in local realities, traditions and natural resource management strategies. The environmental and socio-economic impacts of such policies and regulations should be assessed before they are implemented.

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