

Sustainable Agriculture – An Overview

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Agriculture in Pakistan is not only a matter for food security but has already established itself as an engine for economic growth. This is evident from the fact that it contributes nearly 25% to the GDP and nearly 60% of the work force is dependent in one way or the other on this sector. However, we are now faced with natural resource constraints especially in case of water and soil, two important ingredients of agriculture. Sustainable Development has thus to be seen in this context.

Over the last few years the term Sustainable Development especially Sustainable Agriculture has been very liberally and excessively used so much so that it has lost its real meaning. Therefore it will be appropriate if the concept could be explained at some length. Sustainable development as agreed by IUCN, UNEP and WWF in book entitled "Caring for The Earth" published in October 1991, has defined it as:

"Sustainable development is improving the quality of human life while living within the carrying capacity of supporting ecosystems."

The underlined concept is that the quality of human life and the living standards of our people must be improved. This can only be done if we make use of all the knowledge, developments in science and technology blended with indigenous traditional wisdom. Another aspect of sustainable development is related to nature and environment. In order to conserve nature we must have a thorough understanding of all the natural processes affecting our livelihood. In this context, agriculture becomes the most important human activity that has a direct relevance to sustainable development. The sustainable economy, thus, maintains its natural resource base and continues to develop by adopting new knowledge, organization, technical efficiency and wisdom. Therefore, when we talk about sustainable agriculture, we must be absolutely clear of the strategy of agricultural growth to be followed.

Sustainable agriculture should not be confused with sustenance or keeping agriculture as a means of fighting hunger. As has been mentioned, sustainable development is to improving human life and living standards which can only be done if the involvement of farming communities is increased. In order to do that we must be aware of the problems of agriculture as a sector. In the "Agricultural Strategy in the New Millennium" recently published by the Pakistan Agricultural Research Council (PARC) in collaboration with FAO, the following problems have been outlined:

Problems of Agriculture as a Sector

- Transfer of resources from rural to urban communities
- Impoverishment of rural communities
- Land distribution
- Lack of capital investment
- Biological constraints
- Marketing
- Extension/transfer of technology
- Education

In this context, the objectives of our National Agricultural Policy are:

- Social equity
- Self-reliance
- Export orientation
- Sustainable agriculture
- Enhanced productivity

Many of the problems listed above are related to the socioeconomic and political developments in the country. Nevertheless, all these factors are important for developing sustainable agriculture. However, the focus of this workshop is primarily on the biological constraints and the strategies to overcome these.

One of the biological constraints of our agriculture is the decrease in overall soil fertility due to the depletion of soil organic matter resulting in many secondary problems. A comprehensive understanding of the biodynamics of organic matter formation can greatly help in managing critical levels of organic matter in our soils. Long-term studies have been carried out at NIAB to study the decomposition of ^{14}C labeled plant material and its transformation to stable organic matter fractions. The details of this information and its use in maintaining appropriate levels of organic matter in soil have been discussed in one of the papers in this book. All such interventions not only have a direct relevance to maintaining soil fertility but are also responsible for increasing nutrient use efficiencies whether applied or indigenous. The issues related to soil fertility and various strategies to overcome them are summarized in Table 1.

Sustainable agriculture should not be confused with Organic Farming or Nature farming. Sustainable agriculture requires the use of all modern technologies responsible for increasing income of the farming community by reducing production costs and also ensuring environmental conservation. This does not debar the use of agrochemicals including pesticides for increased agricultural productivity but it has to be done in a sustainable manner. For example an effective pest scouting must be an essential component of any pesticide spray strategy. However maximum reliance be placed on various IPM (Integrated Pest Management) strategies including Sterile Insect Techniques (SIT), biological control through parasitoids, pheromones etc. Such strategies are summarized in Table 2.

Table 1. Soil fertility issues and strategies

Issues	Strategies
<ul style="list-style-type: none"> ▪ Low organic matter content affecting soil fertility ▪ Rapid nutrient depletion/decreased soil nutrient supplying capacity ▪ Declining soil quality/health ▪ Low and imbalance fertilizer use ▪ Poor fertilizer use efficiency 	<ul style="list-style-type: none"> ▪ Incorporation of legume crops in the system ▪ Use of bio-fertilizers ▪ Incorporation of crop residues in the soil ▪ Use of green manure in rice-wheat cropping system ▪ Soil characterization at key sites ▪ Identify soil sustainability indicators (includes soil health and nutrient supply capacity) ▪ N dynamics and crop simulation modeling ▪ Use of chlorophyll meter or leaf colour chart for improved timing of late N applications ▪ Long-term soil fertility experiments ▪ On-farm monitoring, experiments, and testing of technologies

Table 2. Pest management issues and strategies

Issues	Strategies
<ul style="list-style-type: none"> ▪ High yield losses by pests ▪ Increased incidence of insect pests of rice ▪ Minor pests are changing into major ones ▪ Misuse of pesticides ▪ Residues in the produce ▪ Disturbance in the natural balance ▪ Herbicide resistance 	<ul style="list-style-type: none"> ▪ Development and implementation of IPM in system perspectives ▪ Judicious and need-base use of pesticides ▪ Conservation of biocontrol agents ▪ Cultivation of pest resistant varieties

Similarly chemical fertilizers are to be used after proper soil testing and in a manner that allows the maximum use/uptake. Even here many biofertilizers based on bacteria capable of providing plant nutrients in addition to synthesizing plant growth hormones have to be incorporated into the Integrated Plant Nutrient Management Strategies. All these technologies go a long way in reducing the production cost and improving soil fertility.

Sustainable agriculture relies heavily on several resource conservation technologies may it be water or environment. Water plays a crucial role in development

of sustainable agriculture. Its conservation and utilization in most judicious manner is essential in view of water shortage and prevalent drought condition. Some issues regarding water management and the strategies to overcome are summarized in Table 3.

Table 3. Water management issues and strategies

Issues	Strategies
<ul style="list-style-type: none"> ▪ Shortage of water ▪ Poor underground-water quality ▪ Low water use efficiency ▪ Increasing competition for water or agriculture with other sectors 	<ul style="list-style-type: none"> ▪ Precision land leveling ▪ Bed planting ▪ Wheat sowing with zero-till drill ▪ Need-base use of water ▪ Cultivation of varieties having high water use efficiency/ drought tolerance

Some of the issues related to environment are listed in Table 4. The overall management of agriculture and adopting practices which help in conserving our natural resources is the cornerstone of sustainable agriculture. There has to be continuous campaign to create awareness among the practitioners of agriculture about all such technologies that lead to sustainable agriculture.

Table 4. Environmental Management Issues and Strategies

Issues	Strategies
<ul style="list-style-type: none"> ▪ Burning of crop residues ▪ Climate changes due to emission of greenhouse gases ▪ Environment contamination due to indiscriminate use of pesticides and other agrochemicals ▪ Degradation of natural resource base 	<ul style="list-style-type: none"> ▪ Burning of crop residues should be discouraged ▪ Managing crop residues: <ul style="list-style-type: none"> - Utilization of crop residues - Incorporation of crop residues into the soil - Using of crop residues as much ▪ Developing appropriate technologies to minimize emission of greenhouse gases such as judicious use of agrochemicals, minimize N-losses, and appropriate use of water

The purpose of this workshop has, therefore, been to review different technologies which can be used for sustainable agriculture by reducing the use of noxious chemicals, agro-chemicals and increasing the use of biological processes and products for meeting the demands of increased agricultural production and reducing production cost. Pakistan Atomic Energy Commission (PAEC) has been alive to all these issues and has established four Institutes in the country namely, Nuclear Institute of Agriculture (NIA), Tandojam; Nuclear Institute of Agriculture & Biology (NIAB), Faisalabad; Nuclear

Institute of Food and Agriculture (NIFA), Peshawar; and National Institute of Biology & Genetic Engineering (NIBGE), Faisalabad. The main objective of these R&D centers is to evolve various technologies directly related to sustainable agriculture. These centers have been able to evolve and release for commercial cultivation 42 crop varieties through radiation mutation. These varieties have ability of tolerance to both biotic and abiotic stresses, thus, allowing lesser use of pesticides and can be grown in different environments. These varieties are presently covering a significant area of arable land. Several other technologies related to crop production and conservation of resources have been developed by PAEC centers that have been discussed in this workshop proceedings. NIAB hasf also done pioneering work on economic utilization of salt affected wastelands and brackish underground water. International Atomic Energy Agency (IAEA) has acknowledged our achievements and now PAEC is providing assistance to seven other countries through a regional IAEA project. Recently, a Farmers' Participatory Saline Agriculture Project has been approved by the Government of Pakistan to help extend this technology to all four provinces of the country. The efforts of NIBGE are focused on developing crop varieties tolerant to biotic and abiotic stresses through genetic engineering which are directly contributing to the sustainable agriculture.