Sustainable Development and Agriculture

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Abstract

Sustainability rests on the principle that the needs of the present must be met without compromising the ability of future generations to meet their own needs. The problem of global warming in particular and climate change in general poses new challenges to agricultural activities. The sustainability of the agricultural sector depends to a great extent how proactively we meet this global challenge. The present paper provides an insight into the various important issues concerned with sustainable development and agriculture and provides some suggestions to achieve sustainable development in agriculture.

Introduction to Sustainable Development

The concept of sustainable development was propounded for the first time in 1987 by the World Commission on Environment and Development in Broundtland Report entitled as 'Our Common Future'. By Sustainable Development is meant that, real income, production and economic welfare of an economy should increase in such a manner so as to maintain environmental conservation and quality of life and as a result of which present and future generations may enjoy maximum net advantage. Sustainable development occurs only when goals and actions are ecologically viable, economically feasible and socially desirable. The underlying concept of sustainability is that of productivity and quality of the environment and the natural resources.

Main rationale behind the use of this concept is that the process of economic growth in almost all developed countries and economic development in underdeveloped countries has been at the cost of natural resources and environment. Economic development may cause excessive exploitation of natural resources. Diverse crops may be grown on land causing fall in its productivity. Excessive mining of iron, coal, gold, silver and extraction of crude oil may lead to gradual depletion of their stocks. Smoke and other injurious emissions from factories and means of transport often lead to pollution of environment. Economic development may compound the problem of pollution. Accordingly, Quality of life of the present and future generations may be adversely affected. In such a situation, present

development may be at the cost of future development. Prosperity of present generations may be at the cost of future generations. Here comes the significance of the concept of Sustainable Development.

Main features of Sustainable Development

- Efficient use of natural resources.
- Check on rising Pollution.
- Maintenance of quality of life of future generations.
- Distributional Equity among present and future generations.
- Preservation of human, physical and natural capital for future generations.
- Keeping population densities, if possible, below the carrying capacity of the region.
- Adjusting consumption patterns and the design and management of systems to permit the renewal of renewable resources.
- Conserving, recycling, and establishing priorities for the use of non-renewable resources.

Review of Literature

The word 'sustain' which has been derived from the Latin word 'sustinere' (sus means below and tenere means to hold), implies long-term support or permanence. Sustainability in the context of agriculture means farming systems that are capable of maintaining their productivity and usefulness to society indefinitely. Such systems must be resource conserving, socially supportive, commercially competitive, and environmentally sound. (Richard 1990)**.**

Sustainable agriculture was addressed by Congress in the "1990 Farm Bill". Under that law, the term sustainable agriculture means an integrated system of plant and animal production practices having a site-specific application that will, over the long term:

- satisfy human food and fiber needs;
- enhance environmental quality and the natural resource base upon which the agricultural economy depends;
- make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls;
- sustain the economic viability of farm operations; and
- enhance the quality of life for farmers and society as a whole.

Judy (1993) has found that many in the agriculture community view sustainable agriculture as a personal criticism, or an attack, on conventional agriculture of which they are justifiably proud. People get defensive when talked about sustainability because they feel that it implies that what they've been doing is not sustainable.

Sustainable agriculture is a philosophy based on human goals and on understanding the long-term impact of our activities on the environment and on other species. These systems reduce environmental degradation, maintain agricultural productivity, promote economic viability in both the short and long term, and maintain stable rural communities and quality of life. (Francis and Youngberg, 1990)

Consumers can play a critical role in creating a sustainable food system. Through their purchases they can send strong messages to producers, retailers and others in the system about what they think is important. Food cost and nutritional quality have always influenced consumer choices. The challenge now is to find strategies that broaden consumer perspectives, so that environmental quality, resource use, and social equity issues are also considered in shopping decisions (SAREP, 1998).

Need for Sustainable Agriculture

Agriculture is the dominant use of land. Use of land for this purpose can affect the environmental sustainability of the natural resource base which in turn has implications for the economic viability of farming. Agriculture is central to the drive for sustainable development and the challenges which agriculture faces reflect almost every aspect of global life. Agriculture has changed dramatically, especially since the end of World War II. Agricultural productivity has gone high due to new technologies, mechanization, increased chemical use, specialization and government policies that favour maximizing production. Although these changes have had many positive effects and reduced many risks in farming, there have also been significant costs. Prominent among these are topsoil depletion, groundwater contamination, the decline of family farms, continued neglect of the living and working conditions for farm labourers, increasing costs of production and the disintegration of economic and social conditions particularly in rural communities.

Many in the agricultural community have adopted the sense of urgency towards the concept of sustainable agriculture. Lack of sharp definition has not lessened its authenticity. Sustainability has become an integral component of many government, commercial and non-profit agriculture research

efforts and it is beginning to be woven into agricultural policy. Increasing numbers of farmers have developed their own paths to sustainability, incorporating integrated and innovative approaches into their own enterprises.

Various adverse affects of current practices of agriculture include the following:

- Decline in soil productivity due to erosion of exposed topsoil; loss of soil organic matter, reduced water holding capacity and salinization of soils and irrigation water in irrigated farming areas. Desertification due to overgrazing is also a growing problem.
- Agriculture is the largest single non-point source of water pollutants including sediments, salts, fertilizers (nitrates and phosphorus), pesticides, and manures. Pesticides from every chemical class have been detected in groundwater and are commonly found in groundwater beneath agricultural areas. Reduced water quality impacts agricultural production, drinking water supplies and fishery production.
- Water scarcity in many places is due to overuse of surface and ground water for irrigation with little concern for the natural cycle that maintains stable water availability.
- Destruction of tropical forests and other native vegetation for agricultural production has a key role in elevated levels of carbon dioxide and other greenhouse gases.
- Economic and social problems associated with agriculture can not be separated from external economic and social pressures. Disparity among farmers' incomes is widening. Market competition is limited. Farmers have little control over farm prices and they continue to receive a smaller and smaller portion of consumer money spent on agricultural products.

Due to these adverse effects of agriculture, there is an utmost need of a concept like Sustainable agriculture**.** The Sustainable agriculture may be defined as any set of agronomic practices that are economically viable, environmentally safe and socially acceptable. Sustainable agriculture addresses many environmental and social concerns and also offers innovative and economically viable opportunities for growers, labourers, consumers, policymakers and many others in the entire food system. Sustainable agriculture integrates three main goals - environmental health, economic profitability and social and economic equity. Reaching towards the goal of sustainable agriculture is the responsibility of all participants in the system including farmers, labourers, policymakers, researchers, retailers and consumers. Each group has its own part to play, its own unique contribution to make to

strengthen the sustainable agriculture community. Critical discussions of the sustainable agriculture concept may deepen the understanding and prevent the situation from further deterioration.

The objectives of Sustainable agriculture are as under.

- To conserve and enhance the natural resources that agriculture uses and shares.
- To be compatible with other environmental resources that are affected by agriculture.
- To be proactive in protecting the agri-food sector from the environmental impacts caused by other sectors and factors external to agriculture.
- To develop sustainable agro-ecosystems which maintain their natural resource base.
- To manage pests and diseases through internal regulating mechanisms.
- To recover from the disturbances caused by cultivation and harvest.
- To rely on minimum artificial inputs from outside the farm system.

Sustainable agriculture does not mean a return to either the low yields or poor farmers that characterized the 19^{th} century. Rather, sustainability builds on current agricultural achievements, adopting a sophisticated approach that can maintain high yields and farm profits without undermining the resources on which agriculture depends.

Sustainable agricultural practices include the following.

- Improvement of existing production systems (e.g. altered crop rotations, introduction of green manuring) which provide alternative sources of soil nitrogen; reduce soil erosion; and reduce risk of water contamination by agricultural chemicals.

- Pest control strategies that are not harmful to natural systems, farmers, their neighbours, or consumers. This includes integrated pest management techniques that reduce the need for pesticides by practices such as proper timing of planting and biological pest controls.

- Increased mechanical/biological weed control; more soil and water conservation practices and strategic use of animal and green manures.
- Use of natural or synthetic inputs in a way that poses no significant hazard to man, animals or the environment.

- Increase in efficiency of existing resources (e.g. irrigation, use of technology, basic and advanced training)

Issues related with Sustainable Agriculture

Many traditional and most conventional farm practices are not ecologically sustainable. They overuse natural resources, reducing soil fertility, causing soil erosion and contributing to global climatic change. Sustainable agriculture has several major advantages over traditional and conventional practices.

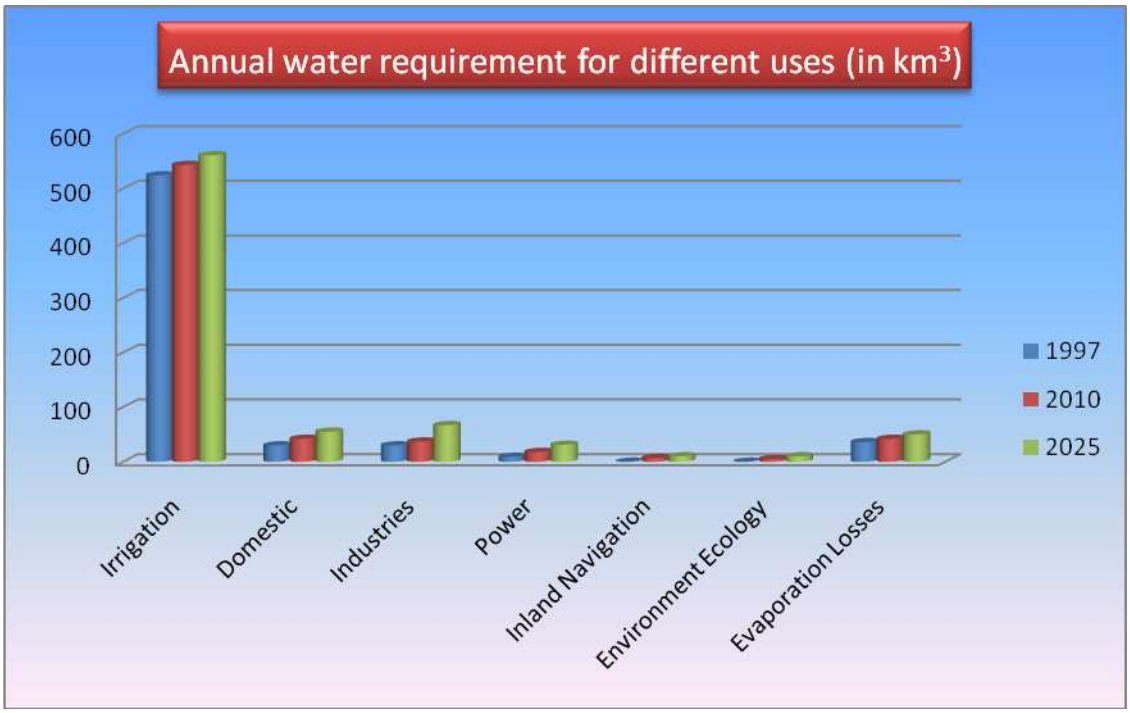
Soil: Top soil erosion due to agriculture continues to be a serious threat. Numerous practices have been developed to keep soil in place, which include reducing or eliminating tillage, managing irrigation to reduce runoff and keeping the soil covered with plants. Sustainable agriculture improves fertility and soil structure and prevents erosion, so would be an answer to this problem.

A Centrally-sponsored scheme of reclaimation of alkali soils was taken up in Punjab, Haryana and Uttar Pradesh during the Seventh Five Year Plan. The scheme was further extended to the States of Gujarat, Madhya Pradesh and Rajasthan during the Eighth Five Year Plan. The scheme aimed at improving physical conditions and productivity status of alkali soils for restoring optimum crop production. The major components of the scheme included assured irrigation water on farm development works like land leveling and ploughing, community drainage system, application of soil amendment, organic manures etc. An area of 0.53 million hectares out of 3.58 million hectares of alkali land has been reclaimed till the end of 1998-99 in the country.

Soil Fertility Management: Application of required quantity of organic manures and inorganic fertilizers in a balanced way based on the needs of the crops is essential to get maximum productivity. Soils in many areas are found to be highly deficit in organic matter and micro nutrients content. The decline in organic matter content reduces the biological activity of soil, water holding capacity, nutritional availability which affects productivity of crops. In order to improve soil health and soil fertility, the application of Bio-fertilizer, cultivation of green manure crops, vermi compost, composting of farm wastes through Pleurotus are recommended.

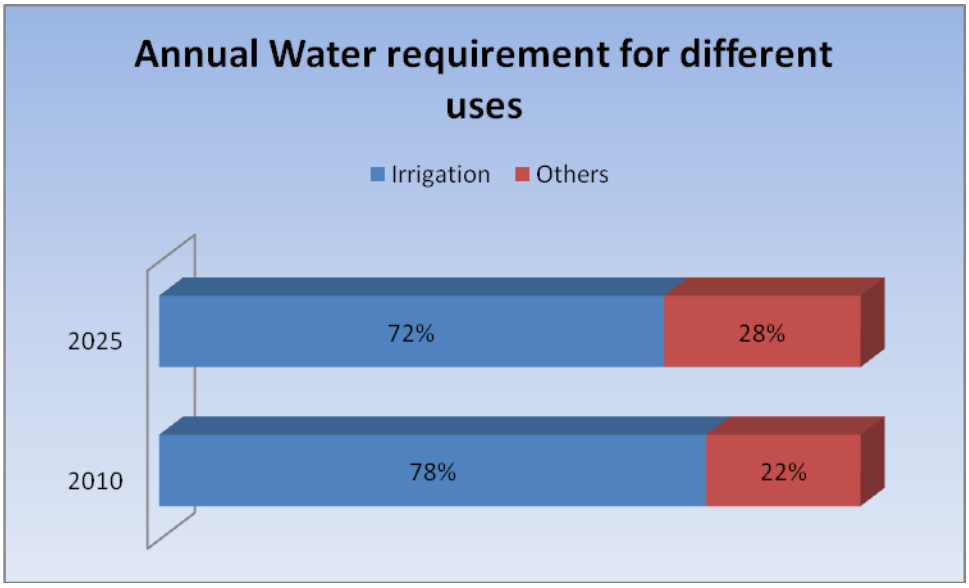
Water Resources: The surface water and groundwater resources of a country play a major role in agriculture, hydropower generation, livestock production, industrial activities, forestry, fisheries,

navigation, recreational activities, etc. According to National Water Policy in the planning and operation of systems, water allocation priorities should be broadly as: (i) drinking water, (ii) irrigation, (iii) hydropower, (iv) Ecology, (v) agro-industries and non-agricultural industries and (vi) navigation. Apart



from the water available in the various rivers of the country, the groundwater is also an important source

of water for drinking, irrigation, industrial uses, etc. It accounts for about 80% of domestic water requirement and more than 45% of the total irrigation in the country As per the international norms, if per-capita water availability is less than 1700 m^3 per year then the country is categorized as water stressed and if it is less than 1000 m^3 per capita per year then the country is classified as water scarce. In India per capita surface water availability in the years 1991 and 2001 were 2309 and 1902 m^3 and these are projected to reduce to 1401 m^3 by the years 2025. Now water is an important factor in agriculture as irrigation. Here we can see that in annual water requirement for different uses, stress of irrigation is top most, which will increase in future. The use of water for irrigation in 2010 and 2025 is above 70%.



Now there are three ways of irrigation.

a. From starting we depend on direct natural *rainfall* for agriculture

wettest and driest years of the country						
	Wettest years			Driest years		
S.No.	Year	Annual rainfall (mm)	% of mean annual	Year	Annual rainfall (mm)	% of mean annual
1	1917	1446	121.7	1918	961	80.9
2	1956	1396	117.5	1920	1004	84.4
3	1933	1363	114.7	1905	1028	86.5
4	1955	1338	112.6	1941	1056	88.9
5	1959	1327	111.7	1901	1062	89.4

Rain is uncertain from starting to this time. But nowadays we can see two kinds of problems regarding rain; one when rain is very low and second is very high which make even the situation of flood. In both these ways, agriculture production suffers.

b. Making of *canals* to use the water of rivers.

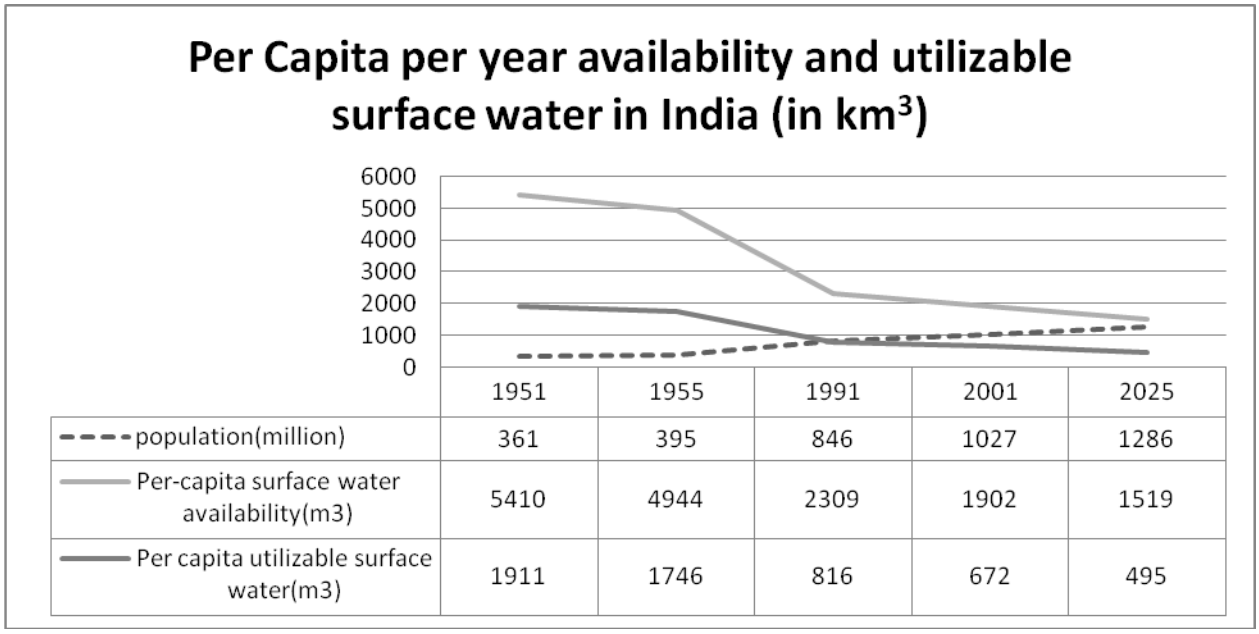
Use of canals is affective but still there are some problems in this way. Recently, the National Commission for Integrated Water Resources Development estimated the basin-wise average annual flow

in Indian River systems as 1953 km^3. Within limitation of socio-political environment, legal and constitutional constraints and the technology of development available at present, the utilizable annual surface water of the country is 690 km^3. Availability of this utilizable water is uncertain, 1st it depends on water availability in rivers and as all we all know that it again depends on rain for most of the rivers in India. Second making of canals is costly and not possible in all areas.

c. Use of *underground water*.

In the absence of rain it is most efficient method for irrigation, but due to over stress on underground water for irrigation, level of underground water is regularly declining.

The annual potential natural groundwater recharge from rainfall in India is about 342.43 km3, which is



	1951	1955	1991	2001	2025
population(million)	361	395	846	1027	1286
Per-capita surface water availability(m3)	5410	4944	2309	1902	1519
Per capita utilizable surface water(m3)	1911	1746	816	672	495

8.56% of total annual rainfall of the country. The annual potential groundwater recharge augmentation from canal irrigation system is about 89.46 km^3. Thus, total replenishable groundwater resource of the country is assessed as 431.89%. After allotting 15% of this quantity for drinking, and 6 km^3 for industrial purposes, the remaining can be utilized for irrigation purposes. Thus, the available groundwater resource for irrigation is 361 km3, of which utilizable quantity (90%) is 325 km^3. The basinwise per capita water availability varies between 13,393 m^3 per annum for the Brahmaputra–Barak basin to about 300 m^3 per annum for the Sabarmati basin. Second, to extract underground water for irrigation we need energy resources like electricity but in India production of electricity is not sufficient. According to the estimates adopted by NCIWRD, by the year 2025, the population is expected to be 1333 million in high-growth scenario and 1286 million in low growth scenario.

Sustainable agriculture increases the organic matter content of the topsoil, so raising its ability to retain and store water that falls as rain.

*Biodiversity***:** Sustainable agricultural practices frequently involve mixed cropping, thereby increasing the diversity of crops produced and raising the diversity of insects and other animals and plants in and around fields.

*Pollution***:** Pesticides are hazardous to human health as well as to the local ecology. Incorrect handling, storage and use of pesticides lead to health and pollution problems. Sustainable agriculture reduces or eliminates the use of hazardous chemicals; instead it controls pests with a variety of biological and agronomic measures and the use of natural substances. Many agricultural activities affect air quality. These include smoke from agricultural burning; dust from tillage, traffic and harvest; pesticide drift from spraying; and nitrous oxide emissions from the use of nitrogen fertilizer. Options to improve air quality include incorporating crop residue into the soil, using appropriate levels of tillage, and planting wind breaks, cover crops or strips of native perennial grasses to reduce dust.

*Energy***:** Modern agriculture is heavily dependent on non-renewable energy sources, especially petroleum. The continued use of these energy sources cannot be sustained indefinitely. In sustainable agricultural systems, there is reduced reliance on non-renewable energy sources and a substitution of renewable sources or labor to the extent that is economically feasible.

*Landscape***:** Inappropriate use causes erosion, landslides and flooding, clogs irrigation channels and reduces the ability of the land to support the local population. Impoverished rural people flock into the cities in areas needs huge investments that few countries can afford. Sustainable agriculture avoids these problems by improving productivity, conserving search of jobs, and preventing insanitary slums that further destroy the landscape. Sustainable agriculture helps in rehabilitating ecologically damaged soil, avoiding the expansion of farming into unsuitable areas and preserving rural jobs.

*Climate***:** The way agriculture is practiced contributes significantly to global climatic changes. Conventional agriculture contributes to the production of greenhouse gases in various ways: by reducing the amount of carbon stored in the soil and in vegetation, through the production of methane in irrigated fields and through energy-intensive activities such as the production of artificial fertilizers. Adopting sustainable agriculture would reduce these impacts significantly.

Rising Population mounting pressure on Land

Land has multiple uses. Prime uses include animal and plant habitat and agriculture. As the population expands there is greater demand for land for recreational purposes and for housing in urban areas. With the primary use of the land being for grain production, the incipient decline in the grain economy gives rise to the issue of whether the present use of the land is appropriate. The relative contribution of the agriculture to the economy generally has also declined, further compounding the land use issue. On the other hand, demand for land for purposes other than agriculture is increasing.

World population continues to grow. According to recent United Nations population projections, the world population will grow from 5.7 billion in 1996 to 8.19 billion in 2025, 10.4 billion in 2100, and 10.8 billion by 2150, and will stabilize at slightly under 11 billion around 2200. The rate of population increase is especially high in many developing countries. In these countries, the population factor, combined with rapid industrialization, poverty, political instability, and large food imports and debt burden, make long-term food security especially urgent.

Sustainable agriculture could provide a better use of this resource named as land to support this rising population and at the same time the realization that population is not merely about numbers but about the health and quality of life of people must be reinforced and sustained by an informed debate to bring key population issues into ever sharpening perspective at various levels of policy making from the national and state legislatures to local government institutions. The following table gives the details.

World Population 1996, 2010 and 2025 (in 1,000)

Region	*Years*		
	1996	*2010*	*2025*
World	5,771,000	6,974,000	8,193,000
More developed	1,171,000	1,231,000	1,268,000
Less developed:	4,600,000	5,743,000	6,925,000
○ Africa	732,000	1,039,000	1,462,000
○ Latin America	486,000	584,000	678,000

○ Asia	3,375,000	4,110,000	4,772,000

Source: Population Reference Bureau (Ed.):
World Population Data Sheet 1996, Washington, D.C. 1996

Suggestions

1. To ensure the sustainability of the natural resource base, the recognition of all stakeholders in it and their roles in its protection and management is essential.
2. Water governance arrangements should protect ecosystems and preserve or restore the ecological integrity of all natural water bodies and their catchments. This will maintain the wide range of ecological services that healthy ecosystems provide and the livelihoods that depend upon them.
3. Since Biomass is a major source of fuel and energy especially for the rural people appropriate mechanisms must be evolved to make such consumption of biomass sustainable, through both resource management and the promotion of efficient and minimally polluting technologies, and technologies which will progressively reduce the pressures on biomass, which cause environmental degradation.
4. Incentives should be provided by Government to the farmers for selecting drought-tolerant crop species. Banks should think of how best to provide incentives and credits, accessible to poor farmers, to make investment in dry land farming possible.
5. Reduced-volume irrigation systems should be used in agriculture.
6. Farmers must be placed at the centre of policy-making and their needs must drive innovation and programmes.
7. More research and innovation is needed to meet new and existing challenges and greater efforts made to ensure that these reach farmers, especially smallholders.
8. Investing in knowledge sharing and training should be a key element of a sustainable strategy.
9. Government policies should encourage development of practices which are either consistent with or lead to the sustainability of agriculture.
10. The relationship between the costs and returns of agricultural practices is important for sustainability. The prices of resources determined in the market place as well as those which must be derived by other means must be taken into account when determining production costs from the standpoint of sustainability.

11. A greater priority must be given to the environment if economic policies are to be sustainable, such as in agricultural policy.
12. Attention is required to ensure that economic growth is also sustainable growth.
13. Better resource management (targeted use of crop protection, irrigation technology, fertilizers and resistance management) and increased yields through innovative technologies like hybridization, plant biotechnology etc. are required.
14. Develop new varieties using state-of-the-art technologies. Plant health and nutrient uptake should also be improved.
15. Associations like EISA (The European Initiative for Sustainable Development in Agriculture) which was founded with the common aim of developing and promoting Integrated Farming throughout Europe, should be formed in India also.

Conclusion

Planning for sustainable agriculture requires a judicious combination of information about new technologies with the wisdom of traditional ones. The challenge today is to revive and improve traditional methods with the aid of modern scientific knowledge. This will ensure "food and farm productivity" with ecological safety. The integration of agriculture with land and water management and with ecosystem conservation is essential for both environmental sustainability and agricultural production. Major adjustments are needed in agricultural, environmental and macroeconomic policy at both national and international levels, in developed as well as developing countries, to create the conditions for sustainable agriculture and rural development. To usher in an era of Sustainable Agriculture to maintain food productivity, the fertility of the farm and prosperity of the farmers, civilization has to seek economically viable and ecologically sustainable alternatives to the chemical fertilizers and pesticides whose production depends upon the dwindling resources of the earth – the fossil fuels and whose practice threatens to damage the very productive and survival base of the earth – the land.

Sustainable development is a process of change, in which exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations. This meaning of sustainable development itself provides clues to design the process of development, choice of

technology, the kinds of property rights system, institutional structure to manage the resources and the expected social order.

Under the changing agricultural scenario, the agricultural technologies need a shift from production oriented to profit oriented sustainable farming. The conditions for development of sustainable agriculture are becoming more and more favorable. New opportunities are opening the eyes of farmers, development workers, researchers and policy makers. They now see the potential and importance of these practices not only for their direct economic interest but also as the basis of further intensification and ecological sustainability. The principles essential for sustainable agriculture include management, conservation, rehabilitation, market viability, internalization of costs, scientific and technical innovation, trade policy, societal consideration and global responsibility.

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