Moving Towards Sustainability Oriented Agriculture

[1]Shruti Garg, [2*]Dr. Vandana Sharma
[1]Assistant Professor, Sri Aurobindo College, University of Delhi
[2]Assistant Professor, Deen Dayal Upadhyaya College, University of Delhi

Abstract: Agricultural ecosystems are the largest managed ecosystem in the world. The sustainable development of agriculture is significant to the reversion of dramatic loss of biological diversity in the world. Increases in the world population from 800 million at the start of the industrial revolution in 1790 to just over 7 billion today and the prospect that the human population will grow to around 9.3 billion in 2050 have created new concerns about our ability to feed the world in a sustainable manner. Entering a sustainable development path for agriculture and food seems like a daunting challenge, but it is feasible. Aspirations of maximum consumption should be replaced by patterns of optimized consumption. To address the development challenges facing humanity and the planet and for the implementation of goals of sustainable development, strong multi-sectoral cooperation will be needed.

IndexTerms *- Agriculture, Conservation, Food Security, Organic Farming, Sustainable Development.*

I. Introduction

Agriculture faces many challenges, making it more and more difficult to achieve its primary objective i.e. feeding the world each year. The world's population is likely to reach 9 billion by the middle of this century (Krall, 2015). When looking forward to the 2050 horizon, the world is faced with the complex problem of a growing and increasingly urban population that will create an even faster growing demand for food (FAO, 2012). This is coupled with environmental and climate pressures that threaten agricultural productivity and current land use practices (IPCC, 2014), which render the need for equitable, socially, environmentally and economically sustainable development all the more pressing (IAASTD, 2009). To address these concerns, building a common vision for sustainable food and agriculture and promoting save and grow methods (FAO, 2011) and technologies for production is required (Loconto, 2016). Over the years, convincing evidence has accumulated, indicating that agricultural production can be intensified in a sustainable manner (Conway, 2012; FAO, 2011, Loconto, 2016). Against this backdrop, how can we shape future agricultural production so that we guarantee food security for the world's population without destroying the resource base? The answer is that we need productive yet sustainable agriculture that conserves resources. Growth cannot be at the cost of natural resources and must be made as independent as possible of consumption of resources (Krall, 2015). Sustainable agriculture refers to a wide range of practices; most frequently, these practices focus on soil and moisture conservation, and reduced or no use of chemical inputs (Puttaswamaiah et al., 2005).

II. Emergence and Concept of Sustainable Agriculture

Agriculture includes both crop and animal husbandry and fisheries to produce the food requirements of humankind. The farm animals also must get their share of feed and forage. Apart from good seeds, agricultural productivity depends on soil health, irrigation water quality and quantity, clean atmosphere of proper composition of carbon dioxide, nitrogen and oxygen, in addition to diverse micro-organisms, pollination insects, birds, earthworms, farm animals and other non-domesticated flora and fauna (Swaminathan, 1983; Kesavan & Swaminathan, 2008)

During the post-World War II period, agriculture in the world dramatically intensified, in terms of external inputs such as chemical fertilisers and pesticides. Agricultural intensification has had many negative environmental externalities associated with it – for instance, soil erosion, degradation of soil quality, water and air pollution. Although this intensification was initiated in the developed nations, many of the practices and their associated negative impacts have spread to the developing countries. In order to tackle these problems, environmentally beneficial sustainable agricultural systems have been widely promoted (Puttaswamaiah et al., 2005). Agricultural sustainability connotes the maintenance of the quantity, as well as the quality of agricultural

produce over very long periods of time without signs of fatigue (Kesavan & Swaminathan, 2008). Sustainable agriculture is an "integrated system of plant and animal production practices having a site specific application that will, over the long term: (a) satisfy human food and fiber needs; (b) enhance environmental quality; (c) make efficient use of non-renewable resources and on-farm resources and integrate appropriate natural biological cycles and controls; (d) sustain the economic viability of farm operations; and (e) enhance the quality of life for farmers and society as a whole." 1990 U.S. Farm Bill [22]. SHRUTI. "Sustainability, therefore, is much more than ensuring protection of the natural resource base. To be sustainable, agriculture must meet the needs of present and future generations for its products and services, while ensuring profitability, environmental health, and social and economic equity. Sustainable agriculture would contribute to all four pillars of food security – availability, access, utilization and stability – in a manner that is environmentally, economically and socially responsible over time.*"* (FAO, 1988; 2014)

III. Principles of Sustainable Development

Based on Krall (2015) sustainable development in agriculture sector essentially focuses on the following principles:

- Puts the emphasis on methods and processes that improve soil productivity while minimising harmful effects on the climate, soil, water, air, biodiversity and human health.
- Aims to minimise the use of inputs from non-renewable sources and petroleum-based products and replace them with those from renewable resources.
- Focuses on local people and their needs, knowledge, skills, socio-cultural values and institutional structures.
- Ensures that the basic nutritional requirements of current and future generations are met in both quantity and quality terms.
- Provides long-term employment, an adequate income and dignified and equal working and living conditions for everybody involved in agricultural value chains.
- Reduces the agricultural sector's vulnerability to adverse natural conditions (e.g. climate), socioeconomic factors (e.g. strong price fluctuations) and other risks.

Strategies and Practices for Sustainable Agriculture

In line with the principles stated above, Velten *et al. (*2015) suggested different strategies which should or be applied in different areas (Fields of Action). Various themes and categories making up the strategies for sustainable agriculture are depicted in Fig. 1.

Fig 1: Themes and categories making up the strategies for sustainable agriculture (Adapted and modified from Velten *et al.* (2015))

Sustainable agriculture development has some major advantages over traditional and conventional farm practices. They misuse natural resources, reducing soil fertility causing soil erosion and contributing to global climatic change which is not ecologically sustainable. Sustainable agriculture improves soil fertility, increases organic matter content of the top soil raising ability to retain and store water, increases diversity of crops thus raising the diversity of insects and other animals and plants, reduces the use of hazardous chemicals and control pests, improves productivity and arability of soil. Sustainable agriculture practices over decades of science and practice, several key sustainable farming practices have emerged, such as:

Crop Rotation involves planting a variety of crops which have many benefits, including healthier soil and improved pest control. Crop diversity practices include intercropping and complex multi-year crop rotations. Planting cover crops includes cover crops, like clover or hairy vetch, are planted during off-season times when soils might otherwise be left bare. These crops protect and build soil health by preventing erosion, replenishing soil nutrients, and keeping weeds in check, reducing the need for herbicides.

Integrated Pest Management (IPM) involves a range of methods, including mechanical and biological controls, can be applied systematically to keep pest populations under control while minimizing use of chemical pesticides. IPM means the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimise risks to human health and the environment. IPM emphasises the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms.

Reducing or eliminating tillage. Traditional plowing (tillage) prepares fields for planting and prevents weed problems, but can cause a lot of soil loss. No-till or reduced till methods, which involve inserting seeds directly into undisturbed soil, can reduce erosion and improve soil health.

Integrating livestock and crops: Industrial agriculture tends to keep plant and animal production separate, with animals living far from the areas where their feed is produced, and crops growing far away from abundant manure fertilizers. A growing body of evidence shows that a smart integration of crop and animal production can be a recipe for more efficient, profitable farms.

Adopting agroforestry practices: By mixing trees or shrubs into their operations, farmers can provide shade and shelter to protect plants, animals, and water resources, while also potentially offering additional income. Landscape management involves sustainable farms treat uncultivated or less intensively cultivated areas, such as riparian buffers or prairie strips, as integral to the farm—valued for their role in controlling erosion, reducing nutrient runoff, and supporting pollinators and other biodiversity.

Organic Farming does not use synthetic pesticides and mineral fertilisers but attempts to work with natural methods and cycles. A number of associations and certification systems exist, but farmers can of course produce in an organic way without certification. Organic farming is one potential method of sustainable farming. For small-scale farmers who practice extensive farming with low yields, switching to organic cultivation can boost yields, for example by improving nutrient cycles. However, other types of sustainable farming can also deliver the same or, in most cases, higher yields if better-quality seed and fertilisers are used, the soil is better cultivated and greater use is made of rainwater. Switching to organic farming typically leads to a sharp drop in yields compared with intensive farming at prime locations with healthy soil and good rainfall. Yet we need the high yields that intensive farming offers to feed the world's population. Therefore organic farming alone will not be able to feed the world in its present form but will instead have to be combined with other sustainable production methods.

Climate smart agriculture is defined by the FAO as an approach to developing the technical, policy and investment conditions to achieve sustainable agricultural development for food security under climate change. It aims to bring about a sustainable increase in agricultural productivity and income, adapt and build resistance to climate change, and reduce greenhouse gas emissions.

Integrated Plant Production is a site-specific and environmentally sound production method. It uses all suitable and reasonable crop cultivation, plant nutrition and protection processes in the best possible combination to limit harmful organisms while respecting economic and ecological requirements. This approach aims to guarantee yields and commercial success in the long run.

Conservation Agriculture: Conservation agriculture is a farming method that largely forgoes tillage and involves permanent organic mulch cover and extended crop rotation. These methods make the soil much less susceptible to wind and water erosion: its structure improves, it can better absorb and store water, fewer nutrients are washed away, and the number of soil-dwelling organisms increases. All in all, crops can draw on more nutrients. In a best-case scenario, the soil releases fewer greenhouse gases and may store more carbon in the form of humus. This method can also improve soil preservation. Over the past six years, an average of 8 million hectares of conservation agriculture has been brought into cultivation each year around the world.

IV. Challenges for Sustainable Agriculture

Sustainable agriculture is undoubtedly the need of the hour, however, as any other major paradigm change; this also faces some challenges which need to be pondered upon.

1. Sustainable management of water resources

Water is a critical input in agriculture in nearly all its aspects having a determining effect on the eventual yield. The increasing demands on water resources by India's ever-increasing population and diminishing quality of existing water resources because of pollution poses a potential conflict between water demand and supply, and the competition for water will become more intense in the future. In addition to scarce water resources in India, the efficiency of agricultural water use is relatively low.

2. Productivity of land owing to excessive pressure

Land is one factor of production in India the use of which highly depends upon the socio-economic, political and environmental factors. Feeding a large population like that of India in itself is a major challenge, more so in keeping up with the sustainability issues. Policy implementation with regards to sustainable agriculture on fragmented land-holdings will be difficult. Due to rapid industrialization and urbanization, India's cultivated land is decreasing at an alarming speed, which threatens its food security and sustainable agricultural development.

3. **Obsolete techniques**

In India, agriculture practices are based on local social customs, beliefs, traditions and norms etc. Most of the traditional and conventional farm practices are not ecologically sustainable. Making people aware of sustainable agriculture practices will be a task. Owing to widespread illiteracy, spread of the technical know-how of modern innovative mechanisms will be difficult. Moreover, technological innovation, introduction and application of high technologies in agriculture are slow and do not support the expansion of eco-agriculture.

4. **Socio-economic sustainability**

For agriculture to be sustainable it should be economically and socially viable over the long term. Social sustainability in farming techniques is related to the ideas of social acceptability and justice. Economic sustainability relates to low-cost, high productivity and better quality of farming. crop and livestock production, fisheries, and forestry – provides income, jobs, food, and other goods and services

5. **Institutional constraints**

Policy constraints pose a major threat here as agriculture policy framework needs a different mindset altogether. On needs to devise certain measures which boost productivity today while aiming for future sustainability of agriculture to meet the growing demand for food, feed, fuel and fibre. Agricultural systems need to become more productive and less wasteful. Policy-makers should work upon measures that provide decent incomes for farmers, including the landless and waged agricultural workers, and create employment in the rural areas that respects labour standards. They must be more efficient and sustainable, in terms of their use of, and effects on, the natural resource base.

V. Recommendations for Reforming Agriculture towards Sustainability

There is a need to recognise the importance of sustainable agriculture and undertake corrective measures to overcome the above stated challenges, some of such policy suggestion are as follows:

1. More investments in agricultural infrastructure, especially with regards to irrigation, are needed. Technology and equipment for water saving need to be advanced. For example, sprinkler irrigation technology and equipment; drip irrigation; and micro-sprinkler irrigation technology etc.
2. Land reforms and land-use programming with the aim in keeping with the sustainability issues are required as also the harmonization of different land-use patterns to meet demands of economic development and agricultural production.
3. Policies with the objective of enhancement of ecological and environmental protection when supplementary land is brought into cultivation so that the average productivity of cultivated land is increased are desirable.
4. Increase in capital investment for land consolidation and re-cultivation of abandoned land.
5. Establishing and improving the tax system of compensation for land use and reclamation for new construction land.
6. Strengthening research in the field of eco-agricultural theory and technology which should focus on: agricultural ecological system, resource scarcity, introduction and application of high technology, information technology, assessment of the impact of modern techniques on ecosystems.
7. Establishing advanced sustainable agricultural engineering models based on current models and application conditions.
8. Formulation of model for sustainable agricultural industrialization that fits local conditions for comprehensive development.
9. Popularizing sustainable agriculture through information service and financial support to households to promote the switch from the traditional production model to the environmentally sustainable agricultural model.

VI. CONCLUSION

The primary objective of agriculture which cannot be compromised is to produce enough food to sustainably feed 9 to 10 billion people by 2050. This largely needs to be accomplished by crop and animal productivity

increases reducing food losses and waste, and changing diets, always keeping in mind that the earth's natural resource base is finite. Modernisation of agriculture which aims only at increasing production efficiency, if it is implemented in accordance with the principles of sustainable development, will enable one to limit the unfavourable external effects. Sensitization of citizens in order to follow a pattern of optimal consumption, given the scarcity of resources, is indispensible with a view to fulfil the objectives of sustainable development in agriculture. The available technical solutions require overcoming political, economic and social obstacles should be implemented emphatically. Strong multi-sectoral cooperation of all the stakeholders will be needed to address the challenges facing food security. Global implementation of practices for sustainable agriculture development has already been successfully undertaken in many countries, though India still needs to catch up in certain aspects. It has the potential to enhance productivity and cater to the food requirements of world's growing population for a century or more without destroying the resources we need for our survival. Rising awareness programmes which inculcate a sense of optimization and sustainability among the farmers is essential if sustainable agriculture is to be implemented across the world. Strong commitment of policy makers to sustainable agricultural development, strengthtthting of associations and civil society, and markets and market access must exist.

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