



ROLE OF AGRICULTURE IN ENHANCING FOOD SECURITY

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ABSTRACT

Food security means ensuring a sustainable supply of food at affordable prices that meets existing dietary preferences. Today, there is a need of food security at national as well as global level, but there is no quick fix to the food security crisis that continues to afflict the world's poorest nations. However, action can be taken to lay the necessary foundations for a lasting solution to the crisis enhancing the sustainability of food production and agriculture while simultaneously improving the quality and safety of the food available for consumption particularly in the least developed countries. Role of agriculture plays important part in providing food security through crop production, livestock, land, water, fisheries and aquaculture and biodiversity. But due to climate change, it affects all dimensions of food security i.e. food availability, food accessibility, food utilization and food systems stability. It has an impact on human healthy livelihood assets, food production, distribution channels and changing purchasing power and market flows. To combat, climate change, some practices have been started to the global and national level, including, climate smart agriculture in China, sustainable forest management in Mexico and participatory rangeland management in the Syrian Arab Republic. In India, National action plan on climatic change has been developed. Beside that many international organizations including IAEA, ASAP and APAARI are actively working for sustainable agriculture and food security.

KEY WORDS: agriculture, food security, climate change, food demand, crop.

INTRODUCTION

Food security exists when all people, at all times, have physical and economic access to sufficient safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life¹. Food security means ensuring a sustainable supply of food at affordable prices that meets existing dietary preferences. Food security has three components, *viz.*, availability, access and absorption (nutrition). These three are interconnected². Performance in availability of food related to food production, per capita availability of food grains and other edibles and policies for improving availability. While performance in access to food implies that hunger, access to Public Distribution System (PDS), Targeted Public Distribution System (TPDS) and related issues and policies. The nutritional indicators for food security include the calories, protein and fat intake, macro and micronutrients deficiencies, nutritional status assessment and nutritional programmes².

Need for food security

There is an urgent need of food security to provide food to each and every person and to improve nutritional status because a complex issue with both global and local dimensions that are intimately linked together. There is no quick fix to the food security crisis that continues to afflict the world's poorest nations. However, action can be taken through government policies to lay the necessary

foundations for a lasting solution to enhance the sustainability of food production and agriculture while simultaneously improving the quality and safety of the food available for consumption.

IMPORTANCE OF AGRICULTURE SECTOR TO ENHANCE FOOD SECURITY

1. Role at Global Level

Agriculture is important for food security as it helps in the production of the food for consumption. It provides the primary source of livelihood for 36 percent of the world's total workforce. In the heavily populated countries of Asia and the Pacific, this share ranges from 40 to 50 percent and in sub-Saharan Africa, two-thirds of the working population still make their living from agriculture². If agricultural production in the low-income developing countries of Asia and Africa is adversely affected by climate change, the livelihoods of large numbers of the rural poor will be put at risk and their vulnerability to food insecurity increased.

2. Role at National Level

The agriculture sector employs nearly 58 percent of the total Indian workforce and generates more than 55 percent of the rural income. So the potential for agriculture to influence nutrition at scale is large. More than 80 percent of rural women engaged in agriculture sector. This provides a significant opportunity to unleash the gender

dimensions of agriculture- food linkages. Agriculture– nutrition pathways include agriculture as a source of food, as a source of income. Gender dimensions include the women’s status and intra household decisions and resource allocation. Moreover, women’s ability to manage young child care and nutritional status also inflicted the food security at National level.

The Challenge of Feeding the World⁴

In the 19th century, world population was less than 1 billion and increase food production by increasing the area of land under the plough. While in 20th century population was 1.6 billion and increase in global food production by increasing crop productivity through the green revolution and other agronomic improvements. In 21st century, estimated population was 6.1 billion and increase production by integrating the best of conventional crop technology and the best of crop biotechnology application including novel traits. At the beginning of the 21st century, with a population of 6.1 billion in 2000 and headed for 9.2 billion by 2050, the challenge of yet again doubling food production on approximately same area of arable land using less resources in only 50 years is very difficult task⁵. Other problem is to mitigate with enormous challenges associated with climate change. An increased demand put pressure on global agricultural production. New technologies and more efficient sustainable production methods are needed to address these challenges. This could be achieved by developing and disseminating new technologies and crop management techniques.

Role of Agricultural implies in terms of following applications

Crop production, livestock, land, water, fisheries and aquaculture and biodiversity.

Crop Production: Technological Advancements in Food and Agriculture⁶

Plant breeding: It is a science of optimizing a plant’s genetic makeup to develop desired characteristics. Through plant breeding techniques, higher yielding crops can be produced which are better in quality, tolerant to environmental pressures, insecticides, herbicides and resistant to pests and diseases.

Hybridization: Since early 1900s, hybridization is a tool which is used to develop high-yielding seeds. It involves crossing of two or more crop lines to produce hybrid crops with more favorable traits, resulting from combining genes from the selected parents. It provides more tolerance to diseases, pests and environmental stresses. Such as hybrid corn, sorghum, sunflower and rice.

Molecular Marker-Assisted Selection

Molecular markers are small sequence differences between various lines in a plant breeding population that can be used, when physically linked to traits, as a surrogate for the presence or absence of a desired trait without having to field test for the attributes of that trait. Molecular markers are detected through DNA sequencing methods using DNA derived from plant samples. The practice of molecular marker-assisted selection enables plant breeders to combine desirable plant traits rapidly and

in large numbers. This technique is being used for breeding tomato to make it pathogen resistance⁶.

Nuclear Techniques

Nuclear techniques are used widely in agriculture to make food crops more resistant to disease, boost crop yields and combat pests and animal diseases, manage soils - water management and identify causes of ocean acidification, largely responsible for the depletion of fish stocks in our oceans. These techniques are being applied in extensive soybean cultivation in Brazil⁶.

Genetically Modified (GM) Food⁷

GM technology plays an increasingly important role for agricultural sustainability. It is likely to produce varieties of crops which can resist to pest or drought and thus they will increase yield and enhance productivity to combat the food security problems in the developing countries. It is the fastest adopted crop technology. India has 8 years (2002 to 2009) of impressive benefits from India’s biotech food crop Bt cotton and Bt brinjal (eggplant). The benefits of biotech crops are demonstrated not only by increases in productivity but also by the rapid adoption of these crops by growers. Farmers recognize that their productivity goes up and costs go down when they grow these crops, providing for more sustainable production for the world’s consumers.

GM Crop- First Wave

The first generation of GM crops, mainly GM soybeans, canola, corn and cotton, was approved for commercialization in 1996. These GM crops were aimed at improving pest management such as herbicide tolerance or insect resistance but not targeted to yield enhancement⁸.

GM Crop - Second Wave

Golden rice contains beta-carotene, a precursor of vitamin A is a common micronutrient deficiency in poor countries. So golden rice can be proven highly beneficial to the third world. Modified starch in rice, potato and maize and modified fatty-acid content in field tests and drought and salinity tolerance in cereals in laboratory tests. Pest-resistance GM papaya found in Taiwan and drought-resistance GM rice in China are also examples of second wave of GM crop.

Achievements of GM Crop

GM crops have a role to play in prevention of mass starvation across the world caused by a combination of climate change and rapid population growth. It also reduced the use of pesticides.

Fate of GM Crops

Consumer acceptance is a major obstacle for development of agricultural biotechnology in genetic engineering. The biotechnology industry and governments need to work on promoting the positive aspects of the GM technologies. Perhaps the best strategy is to commercialize GM crops with tangible benefits to the consumer from the second wave⁹. There is a need to find ways to make these advanced technologies affordable to poor farmers in the developing world because GMOs has a power to bring next Green Revolution¹⁰.

Livestock- As a supplier of production inputs for sustainable agricultural development

Marginal lands and crop residues are utilized by livestock as a source of animal feeds. Livestock are also a source of

fertilizer and soil conditioner. One tonne of cow dung contains about 8 kg nitrogen, 4 kg P₂O₅ and 16 kg K₂O. Chemical composition of manure varies, according to the animal species (poultry manure appears to be a more efficient fertilizer than cow manure). It is also a source of energy for biogas and dung for fuel. The vast semi-arid or arid areas where crop production is extremely risky, livestock can use vegetation that would otherwise be wasted and convert it to valuable, high-quality products. Poultry manure is commonly used for ruminant feeding and poultry and pig manures can be used to generate algae as a feed for fish. By-products such as slaughterhouse wastes, when adequately processed, make a good source of protein and mineral supplements in animal feeds.

Per caput nutrient supply in developing countries through livestock¹¹

Calories- In developed countries, they provide more than 30 percent of calories in the diet. In developing countries, this proportion is less than 10 percent.

Protein- In developed countries, about 60 percent of the dietary protein supply is derived from animal products which are considered good to prevent malnutrition which contains essential amino acids.

Fats- Excessive consumption of animal fat can be consumed by people in developing countries. In fact, animal fats can be used to fulfil calorie requirement.

Livestock help to alleviate seasonal food variability- Milk cannot be stored as easily as cereal grains, it can be stored as milk products for weeks or months in the form of clarified butter, curds or various types of cheese. Meat preserved by drying, salting, curing and smoking can be used when other food sources are scarce.

Livestock as a source of income

Animal products not only represent a source of high-quality food, but, equally important, they are a source of income for many small farmers in developing countries, for purchasing food as well as agricultural inputs, such as seed, fertilizers and pesticides. At the national level, livestock food products represent 27 percent of the total agricultural output. This subsector has achieved the greatest growth in production over the last three decades, and it is expected that it will continue to grow faster than all other agricultural subsectors in the next 20 years.

II. Land

Agricultural lands include a variety of habitat types, such as wetlands and forests. Agricultural lands are divided into four categories: Farmlands, Woodlands, Riparian areas and Aquatic areas. The most abundant type of habitat is farmlands which include pastures, croplands, windbreaks and hedgerows. Woodlands are the areas on a farm that are covered with forest and vegetation and include both naturally occurring forests as well as plantations. Riparian areas are transitional zones where the land meets water. A healthy riparian area is often well-vegetated and provides useful habitat for many species. Riparian areas are important because they reduce erosion, prevent sediment from entering the water, trap moisture from snow and provide habitat and corridors for terrestrial and aquatic wildlife. While areas associated with water such as streams ponds or wetlands are called aquatic areas. These areas contain some of the most diverse and productive

habitats and are home to insects, fish, reptiles, amphibians, birds and mammals¹¹.

III. Water

Water is an essential production factor in agriculture, both for crops and for livestock. Climate change will have a significant impact on agriculture in terms of water quantity and quality. This will be aggravated by the increasing demand for food worldwide as population. Agriculture depends on the climate and on natural conditions. Changing climatic conditions lead to imbalances between rainfall and crop needs during vegetation and have a strong impact on yields and the quality of agricultural products.

IV. Agricultural Biodiversity

Agricultural biodiversity pertains to the biological variety exhibited among crops and livestock used for food and agriculture as well as among organisms that constitute agricultural ecosystems. This diversity exists at ecosystem, species and genetic levels and is the result of thousands of years' worth of interactions among the natural environment, available genetic resources, and agricultural management systems and technological innovations. Agricultural practices to sustain food security include, agricultural biodiversity for improved livelihood, more food products development from neglected and underutilized species, improving ecosystem by nutrient cycling and soil fertility, water management, pollination, erosion control, CO₂ sequestration and climate regulation, pest and disease regulation¹³.

Climate Change and Food Security

Climate refers to the characteristic conditions of the earth's lower surface atmosphere at a specific location weather refers to the day-to-day fluctuations in these conditions at the same location¹². Climate change will affect all four dimensions of food security i.e. food availability, food accessibility, food utilization and food systems stability¹³. Changes in growing conditions increase in new diseases, water scarcity and desertification. Global warming is creating new climate which is less predictable and cause greater risk. There is a need to adopt agriculture system which produces more and better food under harsher conditions while protecting the environment.

The overall effect of climate change influences the world's oceans which are gradually becoming more acidic due to increases in atmospheric carbon dioxide¹⁴. Increasing acidity could harm shellfish by weakening their calcium containing shell which is vulnerable to acidity. Acidification may also threaten the structures of sensitive ecosystems upon which aquatic species depend.

Impacts of climate change on crops

Extreme weather events have caused reductions in corn yield in some years. Higher CO₂ levels can increase yields of wheat and soybeans, upto 30% or more¹⁵. Some factors may counteract potential increases in yield. Like, if temperature exceeds a crop's optimal level or if sufficient water and nutrients are not available, yield increases may be reduced or reversed. Extreme temperature and precipitation can prevent crops from growing. Extreme events, especially floods and droughts, can harm crops and reduce yields. If water supplies are reduced, it may be more difficult to meet water demands. Many weeds, pests

and fungi thrive under warmer temperatures, wetter climates and increased CO₂ levels.

Impacts of climate change on fisheries

The ranges of many fish and shellfish species may change due to climate change. Many marine species like cod have certain temperature ranges at which they can survive. Increased temperature would force aquatic species to find colder areas of streams and lakes. Moving into new areas may put these species into competition with the other species for food and other resources. Some diseases that affect aquatic life may become more prevalent in the warm water. Like number of lobsters declined due to a temperature-sensitive bacterial shell disease. Changes in temperature and seasons could also affect the timing of reproduction and migration of aquatic species¹⁶. Many stages in an aquatic animal's lifecycle are controlled by temperature and the changing of the seasons, like salmon.

Impacts of climate change on livestock

Changes in climate could affect animals both directly and indirectly. Heat waves are projected to increase climate change which could directly threaten livestock. Over time, heat stress can increase vulnerability to disease, reduce fertility and reduce milk production. Drought may threaten the pasture and feed supplies. Drought reduces the amount of quality forage used for grazing livestock. Changes in crop production due to drought could also become a problem for the animals which rely on grains. Some areas could experience longer, more intense droughts, resulting from higher summer temperatures and reduced precipitation. Climate change may increase the prevalence of parasites and diseases that can prove harmful for livestock¹⁵. Increases in carbon dioxide (CO₂) may increase the productivity of pastures, but may also decrease their quality. As a result, cattle would need to be fed more to get the same nutritional benefits.

STRATEGIES ADOPTED AT GLOBAL AND NATIONAL LEVEL TO COMBAT CLIMATE CHANGE

Scenario at Global Level

a) Climate Smart Agriculture (CSA): It is a “Triple Win” approach which includes the agricultural, climate and food security. Climate-smart farming techniques would help to increase farm productivity, incomes and make agriculture more resilient to climate change¹⁷. CSA includes proven practical techniques like mulching, intercropping, conservation agriculture, crop rotation, integrated crop-livestock management, agro-forestry, improved grazing, improved water management, better weather forecasting, drought and flood-tolerant crops, risk insurance¹⁸.

b) Sustainable forest management in Mexico¹⁹

IFAD is beginning implementation of a sustainable forest management project in Mexico. This Community-based Forestry Development Project will strengthen the capacity of indigenous peoples for better management of natural resources, enhancing conservation practices and providing sustainable income options for the most disadvantaged groups.

c) Participatory rangeland management in the Syrian Arab Republic¹⁹

In the Syrian steppe, IFAD is working on participatory rangeland management with local communities to reduce herders' vulnerability to climate change and restore the long-term productivity of rangelands. By reintroducing native plants that help meet fodder requirements, fix the soil and stop sand encroachment, ecosystems were restored and the local population's vulnerability to the effects of climatic instability was reduced.

B). Scenario at National level (India)

One of the important and emerging issues in food security is climate change and its impact on agriculture. India has many reasons to be concerned about climate change because India's majority of population depends on climate-sensitive sectors like agriculture, forestry, and fishery for their livelihood². The adverse impact of climate change in the form of declining rainfall and rising temperatures is bound to threaten food security and livelihoods in the economy. So on June 30, 2008, Prime Minister Man Mohan Singh released India's first National Action Plan on Climate Change (NAPCC) outlining existing and future policies and programs addressing climate mitigation and adaptation²⁰. This National Action Plan on Climate Change provides a direction for changes at the national level in policy, planning, and public-private partnerships. The plan identifies eight core “National Missions” which are as follows:

Eight National Mission

- National Solar Mission
- National Mission For Enhanced Energy Efficiency
- National Mission For Sustainable Habitat
- National Water Mission
- National Mission For Sustaining The Himalayan Ecosystem
- National Mission For A “Green India”
- National Mission For Sustainable Agriculture
- National Mission On Strategic Knowledge For Climate Change

International Atomic Energy Agency (IAEA)²¹

IAEA, in partnership with the Food and Agriculture Organization of the United Nations (FAO), helps member states to produce better and safer food by using nuclear technology while promoting the sustainable use of agricultural resources. For global development activities, Eight Millennium Development Goals (MDGs) have been adopted by the international community as a foundation. These goals are directed to combat poverty, hunger, disease, illiteracy, environmental degradation and discrimination against women.¹¹

Adaptation for Smallholders Agriculture Programme (ASAP)

International Fund for Agricultural Development (IFAD) launched a programme in 2012 to make climate and environmental finance work for smallholder farmers. ASAP is driving a major scaling up of successful ‘multiple-benefit’ approaches to smallholder agriculture which improves production while reducing and diversifying climate-related risks²². ASAP is directed to improve land management, increase availability and efficient use of water and increase capacity to manage short- and long-term climate risks and reduce losses from weather-related disasters.

International and National Research Organizations:

There are many national and international organizations, working on agriculture and enhancing food security. These are as follows:

Asia-Pacific Association of Agricultural Research Institutions (APAARI), Consultative Group on International Agricultural Research (CGIAR) and Indian Council of Agriculture Research (ICAR).

Asia-Pacific Association of Agricultural Research Institutions (APAARI) Vision 2025

APAARI's mission is to promote the development of NARS (National Agriculture Research System) in the Asia-Pacific region through inter-regional and inter-institutional cooperation. Agricultural Research for Development (ARD) in the Asia-Pacific region is effectively promoted and facilitated through novel partnerships among NARS and other related organizations so that it contributes to sustainable improvements in the productivity of agriculture to enhance food and nutrition security²³.

Consultative Group on International Agricultural Research

An international organization which funds and coordinates research into agricultural crop breeding. It has a network of 15 research centers known as the CGIAR (Consortium of International Agricultural Research Centers) with the objectives of reduction in rural poverty, improving food security, improving nutrition and health and sustainably managing natural resources²⁴.

Indian Council of Agricultural Research (ICAR)

It is an autonomous organization under the Department of Agricultural Research and Education, Ministry of Agriculture, government of India. The Council is the apex body for coordinating, guiding and managing research and education in agriculture including horticulture, fisheries and animal sciences in the country²⁵.

CONCLUSION

As with any crisis of time, hunger and malnutrition will require the efforts of all stakeholders. Through increased collaboration and partnerships, resources, expertise, and tools can be used to overcome the problem. The Green Revolution is the example to prove the potential for science to bring countries from famine to a surplus of food. The world must again embrace collective innovation to achieve global food and nutrition security by sustaining agriculture. To rid the world of extreme poverty and hunger, continued investment and the application of research and development in agriculture and food production is essential. There is a need to support the full array of innovative solutions, available to farmers, including agricultural biotechnology to meet global food demand. Agriculture sustainability is needed to enhance food production and security, nutritional value and safety of food to improve the health and nutritional status of people around the world.

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