

Changes in Agricultural Biodiversity and its Influence on Food and Nutrition

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Abstract

Preservation of biodiversity is mainly imperative base for food security. The diversity in food supply is vital for health. A range of varied food sources protect against climatic disasters, and a diversity in plants and animals provide a rich source of essential secondary metabolites as therapeutic compounds. Various efforts to preserve and ways to safe-guard the agricultural biodiversity particularly with reference to sustainable food production and how to protect domesticated and wild crops, along with traditional less known foods which are on the verge of extinction etc, would be briefed in this communication, as all these are essential for food security. It is also imperative to make a glance at using biodiversity for food, dietary diversity, better nutrition and health.

Keywords: Biodiversity, Environment, Food security, Nutrition, Sustainability

Introduction

Agricultural biodiversity is the sub-sect of biodiversity and is playing a crucial role in food and nutrition, and to feed the worlds hungry (Rhodes and Nazarea, 1999; Frison *et al.*, 2011). It is necessary to knock into the vast reservoir of crop biodiversity through sustainable agriculture and a common path towards global food security and sustainable development has to be developed. Recent studies have revealed that, agricultural biodiversity could provide improved nutrition, with not only micronutrients but also other important components such as fiber, and hence better health (UNEP, 2008). Various extrinsic and intrinsic factors have tremendous influence on adverse changes in agribiodiversity, mainly the rapid changes in

agricultural practices, climatic changes, inexorable human interference through gene technologies leads to a threat to biodiversity of food crops (FAO, 2007, UNEP, 2008,). Under this context, there is a need to protect our traditional food crops, as the genetic diversity adds protection to our food system. In this review we focus on some of these aspects that are relevant to food and nutrition.

Committees and policy making efforts

The International Plant Genetic Resources (IPGRI) has a mandate to advance the conservation and sustainable use of plant biodiversity. Accordingly a lot initiatives have been taken to expand food base

for the malnourished people in developing world that includes activities such as food consumption surveys, market surveys, production and use of biodiversity in leafy vegetables of both African and Asian countries though the emphasis was for the former (Welch and Graham, 1999). Some decisions have been already adopted at international level for protecting agricultural biodiversity viz., the importance of food security and nutrition particularly in the context of climate change and limited natural resources, refining targets for agricultural biodiversity for the period 2010-2020 by inviting the help of UNFAO mainly in the area of underutilized crops, rescuing wild relatives of cultivated crops and other potential food sources to improve human nutrition, on farm, *in-situ* and *ex-situ* conservation of agricultural biodiversity, potential actions to promote substantial biodiversity related agricultural practices that contribute to biodiversity and also ecosystem; to find out ways to minimize negative impacts of biofuel production, strengthening approaches which promote the sustainability of agricultural systems, promoting public awareness about agricultural biodiversity and its relationship with advancing food security, recognizing the importance of agricultural biodiversity and scientific, informal and traditional knowledge systems (FAO Document WSFS 2009/2).

There is a lot of concern to protect ethnic food plants, or wild relatives of the present day commercial food plants and traditionally known edible plants in various parts of the world. The composition of the food especially acts as a vital link for biodiversity and nutrition. Over the past few decades various scientific investigations on this aspect expanded their location, collection, preservation and also to some extent production which is a welcome sign from the context of food security. Because these local food plants are a rich source of nutrients, minerals and dietary fiber that needed for good health (Johns and Kokwaro, 1991). Moreover, the low levels of salt, sugar and saturated fats content of these local food plants is good for consumers to shun life style diseases. Diverse farming systems are a solid base on which diversity of diet exists, which actually delivers superior nutrition and better health, with extra benefits for human productivity and livelihoods. Though biofortification and dietary diversity approaches have shown some benefits in alleviating the micronutrient deficiency problems, now agricultural biodiversity could provide a valuable complement as it delivers improved nutrition, with not only micronutrients but also other important components such as fiber and phytochemicals etc, hence better health.

Many people consider that intellectual property rights in the agro-biodiversity crisis and food insecurity in developing countries is having fixed nature and affects their life and economy. But the same is considered as vital to the complex political economics of agriculture especially in the Third World (CIPR, 2002). Because of their importance in ecological, socioeconomic, and cultural lives and self-determination of indigenous and local communities in both

developing and developed countries, critically appraised, agro-biodiversity and food security are both deserving of prominent attention (Kothari and Kothari, 1995).

The importance of five As for Agricultural biodiversity

From agricultural biodiversity point of view it is essential to keep five 'A's into thought, which are *Availability* of enough food for all at all times, *Accessibility* of food for all both physically and economically, *Adequacy* to get nutritionally acceptable food produced in a sustainable way from environment perspective, *Acceptability* i.e. access to culturally acceptable food without hampering the rights and esteem of people and *Agency* where the policies and processes play a crucial role to achieve food security.

Indian scenario

India being one of the largest and oldest agricultural societies, wherein, 70% of country's population is dependent on agriculture, the influence of agricultural biodiversity on our country and lives of people particularly those directly relied on agriculture is very important. Similarly its consequences on food security and nutrition status are the things to ponder over. A recent survey by the National Bureau of Soil Survey and Land Use Planning distinguishes 20 broad agro-ecological zones in India, (Sahgal *et al.*, 1992). The Indian region is acknowledged as one of the world's eight centres of crop plant origin and diversity. A report from National Bureau of Plant Genetic Resources, states that, at least 166 food/crop species and 320 wild relatives of crops have originated in our country, though many of them also have origins or centre of diversity in other regions. Apart from species diversity among the crops, there is genetic diversity within each of the species that leads to distinct varieties (Sharma pers, comm..1992). For example one species each of rice (*Oryza sativa*) and mango have been diversified into nearly 50,000 or more and 1000 distinct varieties respectively as identified so far (Negi pers comm. 1993). Similar observations were made with reference to some root and fruit crops, vegetables etc. In fact, this genetic diversity adds insurance to our food system. Stability is an important feature for Agricultural biodiversity (Altieri *et al.* 1990; Salick and Merrick, 1990). This can be explained by a traditional practice of sowing a mixture of crops into a single plot of land as in case of 'baranaja' in Garhwal Himalaya, that is claimed as helpful for a constant supply of food (Jardhari and Kothari, 1996). Apart from this, the erosion of crop diversity is having long term impact on Indian Agriculture especially it erodes the genetic base. The erosion in homestead biodiversity is another issue one has to think. The reasons for the same was well discussed (Santhakumar, 1996). The changes in economic policies of many countries which opened door for their economy and privatization leads to rapid changes in agricultural sector thus by influencing agricultural biodiversity .

Such moves further encouraged to raise cash crops with the help of industry, commercialization of high tech agriculture, and also braving terminator technology, which pose a problem to our agricultural biodiversity (Kothari and Kothari 1995; UNEP, 2008). In order to protect the interests of our farmers in 1998, The Plant Varieties Act came into picture through the Ministry of Agriculture of the Government of India by making a draft on Plant Varieties and Farmers' Rights Protection Bill (PVFRPB, 1998). Apart from this The Government of India, in a follow-up action to the international Convention on Biological Diversity, has drafted a Biological Diversity Act (PVFRPB, 1998). The main aim of this is to preserve, protect the plant resources, deciphering community role in this through various programs, identifying biodiversity and heritage sites, developing repositories of biological resources and monitoring the risks of biotechnology etc. There is a need to protect and conserve our plant varieties which are on the verge of exploitation and extinction. This could be achieved through government and private partnership, by establishing gene bank pools of course this requires lot of funding. In this context, it is imperative to note serious threats to the security of plant genetic resources and also to look at efforts to conserve, develop, and sustainably use of genetic diversity as discussed during the International Technical Conference on Plant Genetic Resources at Leipzig, Germany, in 1996 (FAO, 1996).

Impact of climate change on agricultural biodiversity

During second half of the 20th century the global food system was able to respond to the doubling of world population by more than doubling food production (FAO 1999). This reason for this could be attributed to green revolution, hitech agriculture use of chemical fertilizers. But some of these factors along with changes in climatic factors now pose a threat to agricultural biodiversity. According to recent surveys, agriculture accounts for 44% of anthropogenic methane emissions and about 70% of nitrous oxide gases (adopted from Millennium ecosystem assessment report). In general, crop production is inherently sensitive to variability in climate. Earlier crop flowering and maturity have observed and documented in recent decades which is mainly due to the increase in CO₂ levels in our atmosphere. All these are having adverse effects on crop productivity. For example, the yield of wheat declined by ~ 5-8% or 10% per 1^oC rise in mean seasonal temperatures (Wheeler *et al.*, 1996).

Significance for food and nutrition security

Agricultural biodiversity has been valued to improve the productivity of crop varieties, and is an essential component in the sustainable delivery of a more secure food supply. For conservation and sustainable use of biodiversity the contribution of agriculture is enormous. We can find a big diversity of agricultural systems

world wide which includes rice paddies of Asia, dry land pastoral systems of Africa and hill farms in the mountaneous ranges of South America. Of the 27,000 species of higher plants, about 7,000 are used in agriculture since humans first began farming (FAO, 1999). Unfortunately today only 30 crops provide an estimated 90% of the dietary requirements of the world population. In the present scenario of burgeoning population, a major challenge will be to increase the agricultural production to meet food and nutrition security. The Food and Agricultural Organization of United Nations (FAO) defines food security as "a situation in which all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their needs and food preferences for an active and healthy life" (FAO, 1999). Over 826 million people are chronically hungry and they need 100-400 calories more per day (CBD, 2008). According to worldwide surveys, globally agricultural biodiversity is diminishing at unprecedented rates. It is known that research and technological developments were mostly centric on limited number of staple foods that leads to sidelining of traditionally known diverse foods that were available in our environment. Though significant contributions have been made in the recent past, by exploring effective phytonutrients and functionally active biomolecules from legumes, fruits and other vegetables to address the malnutrition related health problems, still there is a need to investigate on this aspect as socio economic and climatic factors influence the menace of global hunger. The deforestation, indiscriminate urbanization, changing life styles, and a surge in industrialization of agriculture are posing a threat to our biodiversity. During the beginning of 20th century most parts of the world have cultivated, semi-cultivated and wild (un-cultivated) plants of which the first two categories are part of a staple diet and the later mainly as supplement. Large scale cultivation of commercial crops along with socioeconomic pressures made the wild plants non available, and it further exacerbated the already existed food insecure. situation. It is opined that diverse diets lead to better nutrition and food security as they fight against malnutrition, obesity and other health problems. In this regard, farmer's knowledge of nutrition is vital for Agricultural biodiversity, because farmers and local communities are much aware of nutritional potential of plants and crops. In view of this identifying and encouraging the cultivation of such plant varieties would be helpful to provide better nutrition for those who need particularly to children because worldwide, 32% of pre-school children are underweight (from millennium ecosystem assessment).

In fact lot of efforts were made during the last three decades to address the malnutrition problems in children of developing nations, which are mainly based on protein-calorie ratios. In spite of this, micronutrients deficiency related problems are high in one third of population globally (Alnwick *et al.* 1996) mainly, the three important micronutrients such as vitamin A, iodine and iron, though some studies suggested the importance of 49-51 essential nutrients for

sustaining human life (Welch and Graham, 2004, Graham *et al.*, 2007). Obesity in developed nations and projected global chronic hunger figures for the year 2010 (FAO, 2010) are perturbing issues and needs to be addressed. As explained earlier though biofortification programs have helped to some extent in alleviating the malnutrition problems, promoting dietary diversity is suggested though it not yet effectively implemented in practice (Frison *et al.* 2006) except a few such as, addition of animal –derived foods to diet leads to improved in nutritional status (Neumann *et al.* 2002). It is also equally important to consider the under-utilized plant species (example minor millets) as alternate nutritional sources in view of their potential health benefits, with increased sustainable production especially in India (Bala Ravi *et al.*, 2010; Shanthakumar *et al.* 2010; Vijayalakshmi *et al.* 2010; Yenagi *et al.* 2010).

Efforts to protect agricultural biodiversity

Efforts at global level to safeguard the agricultural biodiversity for the 21st century and beyond is going on, by adopting agricultural policy with an aim of: promoting a geographical mix of systems, building on indigenous crop variety, the introduction of compulsory environmental impact assessment, the encouragement of a diversity of food crops, reorientation of agricultural research and development (R&D), strictly restricting the non-food cash cropping land, limiting urban and industrial growth, identifying places rich in traditional varieties and wild relatives of crops and conserving etc. Linking food security and biodiversity was made possible by efforts from various organizations such as FAO, The consultative group on International Agricultural Research (CGIAR), and CIGARS centres such as Biodiversity international, International potato centre, International live stock research institute. Globally, the potential of rainfed agriculture is very significant, as it is large enough to meet present and future food demand through increased productivity. Many of the benefits of agricultural biodiversity are evident at different ecological and human scales, and this requiring a cross-sectoral approach to re-examine the role of agricultural biodiversity in sustainable and secure food production.

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