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# Conservation of minor millets for sustaining agricultural biodiversity and nutritional security

**Kanchan Nainwal, Omvati Verma and Reena**

**Abstract**
Many people's food and livelihood security depend on the sustained management of various biological resources that are important for food and agriculture. Agro biodiversity is the result of the interaction between the environment, genetic resources, management systems and practices used by culturally diverse peoples. The management of agro biodiversity by the indigenous communities is for a variety of reasons. The land use types, land use stages, aspect, soil fertility, availability of water and quality seed of crops etc. are essential variables which an indigenous farmer considers while cultivating a diversity of traditional landraces in the farm for food security. India is the largest producer of many kinds of millets, which are often referred as coarse cereals. However, realizing the nutrient richness of these grains they are now considered as nutria-cereals. Small millets, as a group includes several grain crops namely finger millet (ragi), proso millet, barnyard millet, italian millet, kodo millet and little millet. In the four decades since 1961, the area under millets declined by nearly 50% from about 18 million hectares to about 9 million hectares. During this time, production of millets declined from about 8.8 million tons to about 7.2 million tons; a decline of 18%. Tremendous decrease in area and production is directly or indirectly resulted in the loss of agro biodiversity of these crops as these crops are grown on marginal or rainfed areas without any fertilizers. Therefore, more emphasis should be given for maintaining bio diversity of these highly rich crops by increasing area under these minor millets and developing proper agro techniques for increasing its productivity.
On the other side, India ranks second in the incidences of malnutrition among children and more than one third of the world's malnourished children live in India. Therefore, there is an urgent need to increase production of these crops as these are good source of calcium, iron, potassium, magnesium and other micro nutrients. Among small millets, ragi has about 10 times more calcium than wheat or rice. These crops also have the potential for tackling the hidden hunger caused by micronutrient deficiencies but, they are grown in marginal land with improper management cultural practices. Therefore need of hour is to conserve these underutilized crops for food security and also for sustaining the agro-diversity. Traditional farming systems need to be strengthened to achieve the goals of sustainable development and biodiversity conservation.

**Keywords:** Agro biodiversity, conservation, sustainability, food security and minor millets

## Introduction

Agro-biodiversity can be understood as the diversity within and among species found in an agro-ecosystem that contribute to food and agriculture, including domesticated biodiversity i.e., the diversity of crops and livestock genetic resources as well as all other plant and animal genetic resources i.e. crop wild relatives (Perrings *et al.*, 2006; Jackson *et al.*, 2007 and Smale and Drucker, 2008). On the other hand, sustainability refers to, the properties and assets of a system that sustain the ability of agents to adapt and meet their needs in new way (Jackson *et al.*, 2010). In present context, in the period of drastic change and increasing uncertainty, the adaptability of a system plays a major role. Farmers may have to change their farming systems by switching to new crop species/varieties or livestock breeds that are better adapted to the new conditions. Agro biodiversity can thus be seen as a crucial asset to keep multiple options open, sustaining the ability to rapidly adapt and transform farming systems under unpredictable future conditions (Jackson *et al.*, 2010).
The small farmers, particularly in regions of rich agro-biodiversity immensely contribute to the on-farm conservation and enrichment of this diversity, often at personal cost. The agricultural progress in the past and present would not be possible if these genetic resources and associated knowledge were not conserved by the farmers. In the four decades since 1961, the area under millets declined by nearly 50% from about 18 million hectares to about 9 million hectares. During this time, production of millets declined from about 8.8 million tons to about 7.2 million tons; a decline of 18% (Stanly Joseph Michaelraj and Shanmugam, 2013). Tremendous decrease in area and production is directly or indirectly due to negligence of scientists and

farmers for these crops and this all resulted in the loss of agro biodiversity.

In the present scenario, lack of attention from researchers, policy makers, donors, farmers and consumers is increasingly threatening the genetic diversity of minor millets. This is an irreversible loss to those farmers, particularly who depends on these crops for their food and nutritional security and meager income generation. Therefore, there is urgent need to conserve these crops for the improving genetic diversity and sustainability of the system. Conservation of minor millets plays crucial role to the future global food and nutritional security. In addition to this, agro biodiversity conservation needs to be demonstrated and captured for the future agricultural development for sustainability of resources.

India ranks second in the incidences of malnutrition among children and more than one third of the world's malnourished children live in India (Anonymous, 2012). Global food security has been increasingly narrowing down to only few crops. Over 50% of the global requirement for proteins and calories are met mainly by only three grains, maize, wheat and rice. The narrowing base of global food security is limiting livelihood options for the rural poor, particularly in marginal areas. To act in accordance with the needs of the population of these areas, focus of research and development should be broadened so that wider range of crop species may be one of the option for the farmers. So, the farmers, scientists and the policy makers should fit in the minor millets in their cropping systems as these crops have a comparative advantage in marginal lands and can withstand stress conditions and contribute to sustainable production with low inputs at low cost of production. Thus, they can also contribute to the diversity-richness as well as to the stability of agro-ecosystems. There are hardly any alternatives to these species for their strategic role in fragile ecosystems, such as found in arid and semi-arid lands, in mountains, steppes and tropical forests.

Minor millets are drought resistant crop and can be stored for a long time without insect damage (Adekunle, 2012); hence, it can be important during famine and therefore these are taken as "famine reserves". This aspect is very important as Indian agriculture in the context of climate change, which is the burning problem of our country at the local level. Therefore, farmers, scientists and policy makers should develop certain new eco-friendly strategies for obtaining higher production and for maintaining the agro-biodiversity of these crops.

**Change in Scenario of small millets**

India has the third largest area under small millets cultivation in the world, which is mainly confined to semi-arid, hilly and mountainous regions. These crops are hardy and quite resilient to a variety of agro-climatic adversities. They are grown mostly in marginal areas under agricultural conditions in which major cereals fail to give substantial yields (Adekunle, 2012). Presence of these minor millets has been declining in the Indian food basket over the years. From 1955-56 to 2008-09, there was drastic reduction in the area and production of small millets i.e. 83.0% decrease in area and 78.26% decrease in its production but about 26.5 % increase in productivity was observed during this period (Table 1).

The main reason of this decline is the inception of green revolution which tremendously increased the area, production and productivity of wheat crop due to release of HYV's which are high input responsive. In addition to this, during last five decades, there is an increase in the availability of other cereals like rice, maize etc (Fig 1 and Fig 2). Another reason is the negligence of farmers and scientists in its development and planning of its production techniques. The lack of modern technologies for their effective processing and utilization may also be the reasons for their declining acreage.

**Table 1:** Change in area (lakh ha), production (lakh tons) and productivity of (kg/ha) of ragi and small millets from 1955-56 to 2008-09

| Particulars | 1955-56 | 1965-66 | 1975-76 | 1985-86 | 1995-96 | 2008-09 | % decrease /increase |
|---|---|---|---|---|---|---|---|
| **Ragi** | | | | | | | |
| Area (lakh ha) | 23.7 | 26.9 | 26.3 | 24.01 | 17.74 | 13.81 | 41.7 % decrease |
| Production(lakh tons) | 18.5 | 13.3 | 28.0 | 25.2 | 25.0 | 20.4 | 10.3 % increase |
| Productivity (kg/ha) | 800 | 492 | 1064 | 1049 | 1410 | 1477 | 84.6% increase |
| **Small millets** | | | | | | | |
| Area (lakh ha) | 53.4 | 45.6 | 46.7 | 31.6 | 16.6 | 9.1 | 83.0% decrease |
| Production(lakh tons) | 20.7 | 15.6 | 19.2 | 12.2 | 7.8 | 4.5 | 78.3% decrease |
| Productivity (kg/ha) | 388 | 341 | 412 | 386 | 469 | 491 | 26.5 % increase |

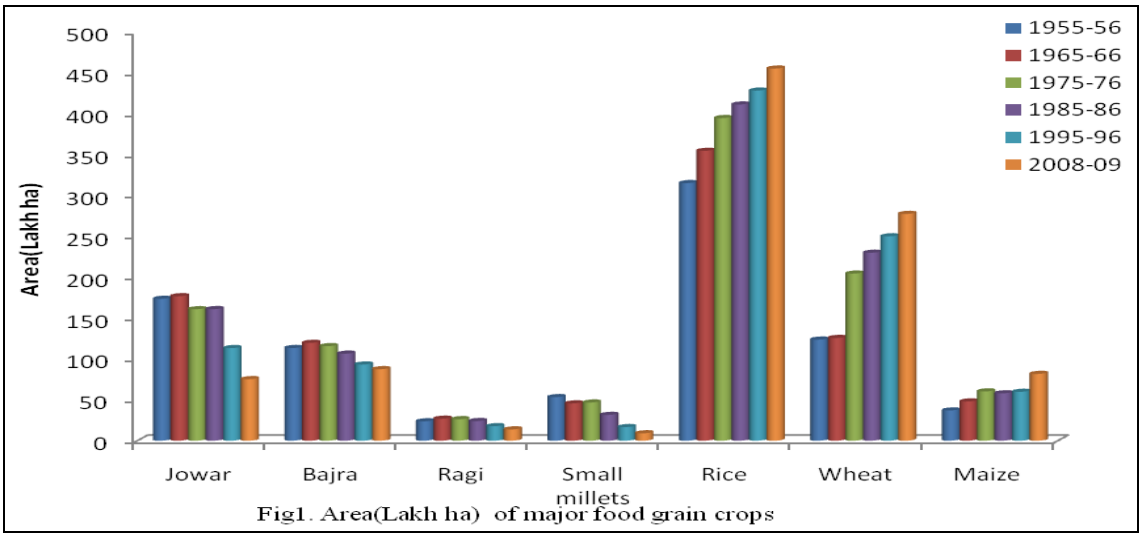

Fig1. Area(Lakh ha) of major food grain crops

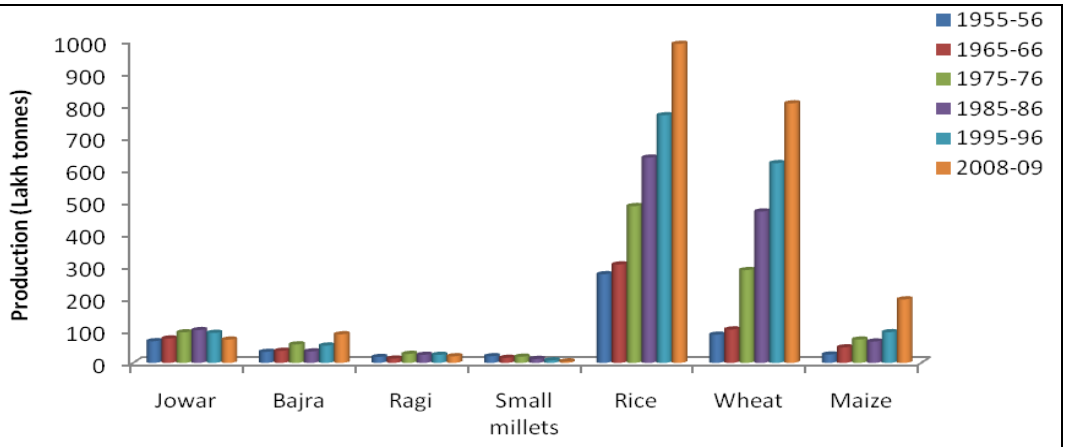


**Fig.2 Production (LakhTonnes) of major food grain crop**

**Minor millets: Overview**

Minor millet may be defined as millets cultivated for their small grains which are borne on short, slender grassy plants. In other words they refer to a group of small seeded cereal crops. The most important minor millets cultivated in India are finger millet (ragi), foxtail millet, proso millet, barnyard millet, kodo millet and little millet. The detail description is as given in Table 2.

**Table 2:** Common name, scientific name, area and major growing states of small millets in India

| Crop | Scientific name | Chromosome No. | Area of Domestication | Major States |
|---|---|---|---|---|
| Ragi (Finger millet) | *Eleusine coracana* | 2n=36 (4x) | East Africa | M.P., Maharashtra, Orissa, Uttarakhand, U.P. and Tamil Nadu |
| Foxtail /Italian millet/Kauni | *Setaria italica* | 2n=36 (2x) | Central Asia-India | Karnataka, Rajasthan, M.P. and Chattisgarh |
| Proso or Common millet (cheena) | *Panicum miliaceum* | 2n=36 (4x) | Central Asia-India | Bihar, North East and Maharashtra. |
| Indian Barnyard millet (Sawan) | *Echinochloa frumentacea* | 2n=54 (6x) | India | Karnataka, M.P., Uttarakhand, U.P. and North East |
| Kodo millet | *Paspalum scrobiculatum* | 2n=40 (4x) | India | Maharashtra, Tamil Nadu and Chattisgarh |
| Little millet/ Kutki | *Panicum miliare* | 2n=36 (4x) | India | Karnataka, Tamil Nadu, Andhra Pradesh, M.P., Jharkhand, Orissa Maharashtra & Chattisgarh |

**Nutritive value of small millets**

Minor millets are highly nutritive in nature, therefore these are also termed as Nutrea cereals (Table 3). Therefore minor millets could be a better option for overcoming this problem of malnutrition in India

**Table 3:** Nutrient composition of small millets and other cereals (per 100 g edible portion; 12 % moisture)

| Crops | Food Protein (g) | Fat (g) | Ash (g) | Crude fibre (g) | Carbohydrate (g) | Energy (kcal) | Ca (mg) | Fe (mg) | Thiamin (mg) | Riboflavin (mg) | Niacin (mg)s |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Rice (brown) | 7.9 | 2.7 | 1.3 | 1.0 | 76.0 | 362 | 33 | 1.8 | 0.41 | 0.04 | 4.3 |
| Wheat | 11.6 | 2.0 | 1.6 | 2.0 | 71.0 | 348 | 30 | 3.5 | 0.41 | 0.1 | 5.1 |
| Maize | 9.2 | 4.6 | 1.2 | 2.8 | 73.0 | 358 | 26 | 2.7 | 0.38 | 0.2 | 3.6 |
| Sorghum | 10.4 | 3.1 | 1.6 | 2.0 | 70.7 | 329 | 25 | 5.4 | 0.38 | 0.15 | 4.3 |
| Pearl millet | 11.8 | 4.8 | 2.2 | 2.3 | 67.0 | 363 | 42 | 11.0 | 0.38 | 0.21 | 2.8 |
| Finger millet | 7.7 | 1.5 | 2.6 | 3.6 | 72.6 | 336 | 350 | 3.9 | 0.42 | 0.19 | 1.1 |
| Foxtail millet | 11.2 | 4.0 | 3.3 | 6.7 | 63.2 | 351 | 31 | 2.8 | 0.59 | 0.11 | 3.2 |
| Proso millet | 12.5 | 3.5 | 3.1 | 5.2 | 63.8 | 354 | 8 | 2.9 | 0.41 | 0.28 | 4.5 |
| Little millet | 9.7 | 5.2 | 5.4 | 7.6 | 60.9 | 329 | 17 | 9.3 | 0.3 | 0.09 | 3.2 |
| Barnyard Millet | 11.0 | 3.9 | 4.5 | 13.6 | 55.0 | 300 | 22 | 18.6 | 0.33 | 0.10 | 4.2 |
| Kodo millet | 9.8 | 3.6 | 3.3 | 5.2 | 66.6 | 353 | 35 | 1.7 | 0.15 | 0.09 | 2.0 |

*N × 6.25 (Source: Hulse, *et al*., 1980)

These crops are micro nutrient supplement crops, especially with regard to calcium and iron, and high dietary fibre (Devi *et al*., 2011). Finger millets has about 8-10 times more calcium than other food crops while barnyard millet has 2-10 times more Iron as compared to other crops (Table 3). Their grain protein is rich in sulphur-containing amino acid and other essential amino acids than all other major cereals. (Bala *et al*., 2010). For these reasons, many people depend for their nutritional, food and livelihood security on these crops. The grain is also rich in phytochemicals, including phytic acid,

which is believed to lower cholesterol, and phytate, which is associated with reduced cancer risk (Coulibaly *et al.*, 2011). These health benefits have been partly attributed to the wide variety of potential chemo preventive substances, called phytochemicals, including antioxidants present in high amounts in foods such as millets (Izadi *et al.*, 2012). Millet is gluten-free, therefore an excellent option for people suffering from celiac diseases often irritated by the gluten content of wheat and other more common cereal grains. It is also useful for people who are suffering from atherosclerosis and diabetic heart disease (Gélinas *et al.*, 2008). Choi *et al.*, (2005) and Park *et al.*, (2008) concluded that proso millet protein could be a potential therapeutic intervention in type 2 diabetes. Devi *et al.*, (2011) review the nature of polyphenols and dietary fiber of finger millet and their role with respect to the health benefits associated with millet. Millets extract from the seed coat where reported to have shown high antibacterial and antifungal activity compared to whole flour extract due to high polyphenols content in seed coat (Viswanath *et al.*, 2009). Therefore, there is an urgent need to increase production of these crops as these are good source of calcium, iron, potassium, magnesium and other micro nutrients.

**Limitations for growing millets**

- Lack of proper package and practices for small millets is being followed by the farmers. Seeds are mostly sown through broadcasting and no fertilizers and manures are used.
- Mostly millets are grown on marginal lands under rainfed conditions. Some of these are still grown in the hilly areas under shifting cultivation.
- Quality seeds of improved varieties are not available to the farmers.
- Agriculture operations like tillage, sowing, inter culturing are not done timely.
- Lack of availability of latest post-harvest operations techniques.
- Marketing facilities for the disposal of surplus produce at a remunerative price is not available.

**Strategies for enhancing productivity and maintaining Agro biodiversity**

- Strengthening of basic and strategic research in crop improvement.
- Development of varieties tolerant to biotic and abiotic stresses.
- Strengthening the delivery system of proper technology for growing small millets.
- Strengthening of research on post-harvest technologies like processing, value-added foods, medicines, nutraceuticals, bio-fuel and other products.
- Development of integrated strategy for the conservation and sustainable use of agricultural biodiversity.
- Changing the mindset of farmers and imparting information about the nutraceutical properties of the minor millets.

**Conclusion**

Since genetic diversity tends to reduce when local varieties are replaced by improved cultivars. Increasing efforts should be done to store local crop varieties and wild relatives in seed collections .Such gene banks can function as a low-cost conservation instruments in order to safeguard genetic resources for many years, thereby avoiding loss through changing environmental or economic conditions. These crops also have the potential for tackling the hidden hunger caused by micronutrient deficiencies but, they are grown in marginal land with improper management cultural practices. Therefore need of hour is to conserve these underutilized crops for food security and also for sustaining the agro-diversity. Traditional farming systems need to be strengthened to achieve the goals of sustainable development and biodiversity conservation.

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