

## Minor millets cultivation for agricultural sustainability and nutritional security

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### Abstract:

Many people's livelihood security depends on the sustained management of various biological resources that are important for food and agriculture. Selective utilization of crops and varieties in recent times have threatened agro biodiversity leading to rapid erosion of natural resources and consequently affecting the nutritional security of people. One of the possible pathways for conservation of such neglected agro biodiversity resources is to bring them into use thereby making them viable crops within the contemporary social and economic context. Agro biodiversity is the result of the interaction between the environment, genetic resources and 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 rained 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 micronutrients. 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

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### 1. 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 [10, 12, 14]. 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 [10]. In present context, in the period of drastic change and increasing uncertainty, the adaptability of a system plays a major role. Selective utilization of crops and varieties in recent times have threatened agro biodiversity leading to rapid erosion of natural resources and consequently affecting the nutritional security of people. One of the possible pathways for conservation of such neglected agro biodiversity resources is to bring them into use thereby making them viable crops within the contemporary social and economic context. 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 [10].

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 associating 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% [15]. 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 are 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.

With hunger still widespread in India and distribution of rice and wheat having little impact, growing nutritionally rich crops at a household level can improve diets and curb malnutrition. And since these same households struggle with rising food prices, environmental impacts caused by climate change, and few options for new jobs, combining efforts to curb malnutrition, increase farmers' yields and expand job opportunities together with a locally grown grain proven to withstand harsh

environments, means a large impact on improving their lives. 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 [2]. Global food security has been increasingly narrowing down to only few crops. Over 50% of the global requirement proteins and calories are met mainly by three grains, such as: maize, wheat and rice. The narrowing base of global food security is limiting livelihood options for the rural poor, particularly in marginal areas. Minor millets, which are high in nutrients such as calcium and iron, are grown primarily in hilly, arid areas of India where, because of their high tolerance to drought, they are often more productive than other grains [1]. While locally important, in the past they were rarely traded outside the farming communities because of the grain's reputation as food for the poor. More recently, farmers have turned to cash crops such as cassava, resulting in a decline in millet cultivation.

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 [1]; 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.

## **2. 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 [1]. 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
<b>Ragi</b>							
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
<b>Small millets</b>							
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

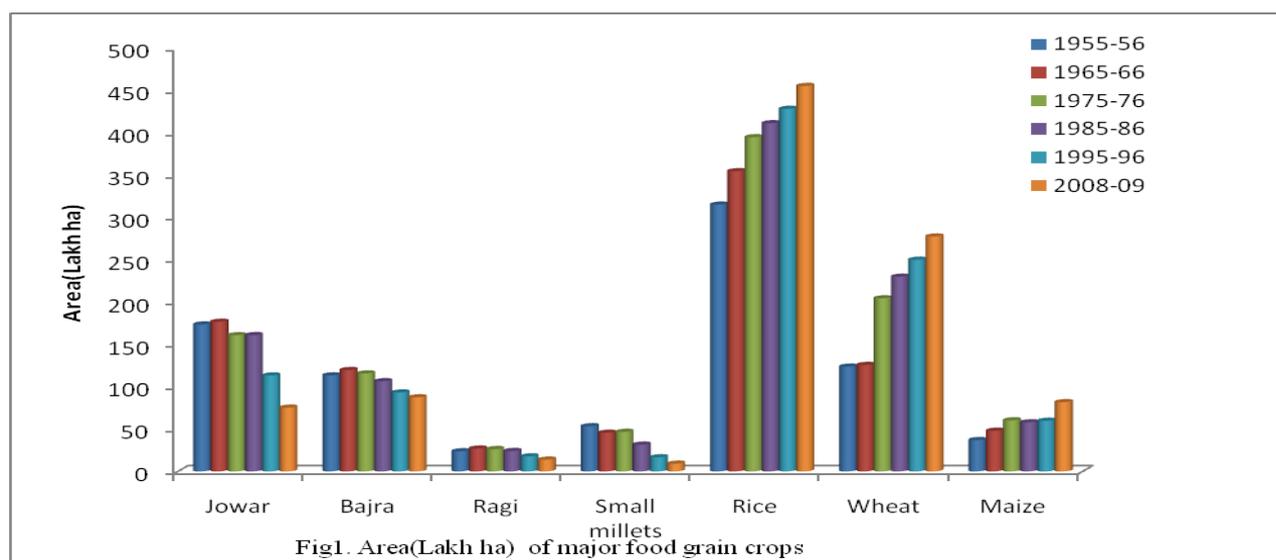


Fig.1. Area(Lakh ha) of major food grain crops

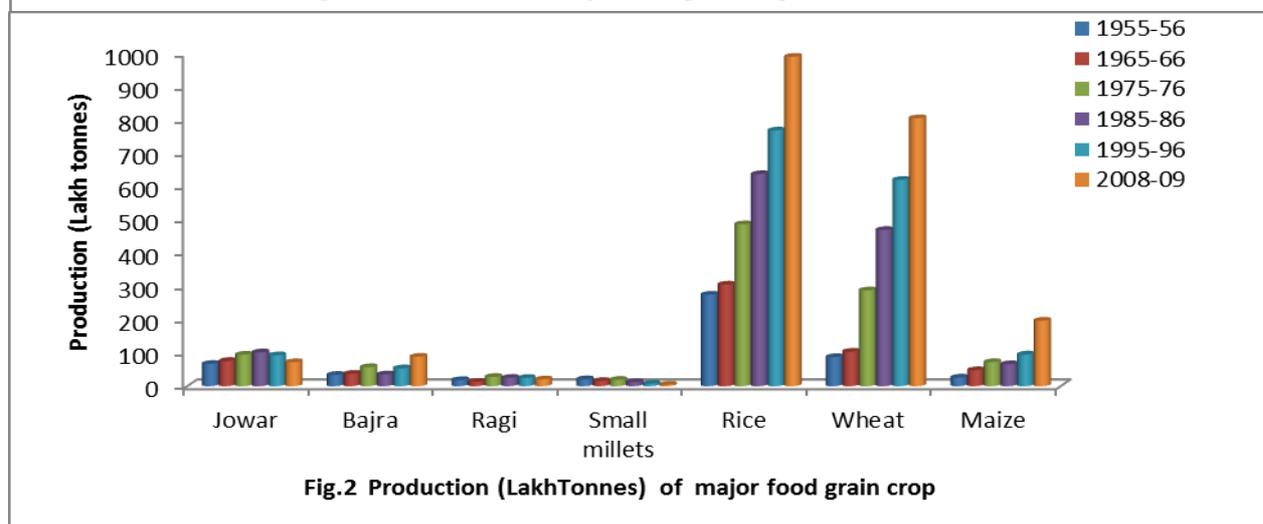


Fig.2 Production (LakhTonnes) of major food grain crop

### 3. 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 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

#### 3.1. Nutritive value of small millets

Minor millets are highly nutritive in nature, therefore these are also termed as Nutrea cereals (Table 3). Minor millets are high energy, nutritious foods comparable to other cereals and some of them are even better with regard to protein and mineral content. They are particularly low in phytic acid and rich in dietary fibre, iron, calcium and B vitamins.

As the millets are consumed by the poor, they guard them against food and nutritional insecurity imposed by various agronomic, socio economic and political factors. Minor millets can thus act as a shield against nutritional deficiency disorders and provide nutritional security. 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)	Carbo-hydrate (g)	Energy (kcal)	Ca (mg)	Fe (mg)	Thiamin (mg)	Riboflavin (mg)	Niacin (mgs)
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) [7]

These crops are micro nutrient supplement crops, especially with regard to calcium and iron, and high dietary fibre [5]. 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**). The grain protein is rich in sulphur-containing amino acid and other essential amino acids than all other major cereals. 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 [4]. 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 [8]. Health benefits of eating millets Lignans, an essential phytonutrient present in millet, are very beneficial to the human body, which act against different types of hormone-dependent cancers, like breast cancer and also help reduce the risk of heart disease. Regular consumption of millet is very beneficial for postmenopausal women suffering from signs of cardiovascular disease, like high blood pressure and high cholesterol levels. Recent research has indicated that the regular consumption of millet is associated with reduced risk of type 2 diabetes mellitus.. This is mainly due to the fact that whole grains like millet are a rich source of magnesium, which acts as a co-factor in a number of enzymatic reactions in the body, regulating the secretion of glucose and insulin. Magnesium is also beneficial in reducing the frequency of migraine attacks. It is even very useful for people who are suffering from atherosclerosis and diabetic heart disease

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 [6]. Choi *et al.*, (2005) and Park *et al.*, (2008) concluded that proso millet protein could be a potential therapeutic intervention in type 2 diabetes [3, 11]. 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 [5]. According to research and recent studies, consumption of millet can help women combat the occurrence of gallstones, as they are a very high source of insoluble fiber. 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 [16]. Therefore, there is an urgent need to increase production of these crops, as these are good source of calcium, iron, potassium, magnesium and other

micronutrients. Health benefits of eating millets

Supplementation of cereal-based products with millets has become increasingly popular due to nutritional and economic advantages. With proper preparation, 30 per cent of minor millets can be gainfully substituted in value added foods belonging to the categories of traditional foods, bakery products, extruded foods and allied mixes for the convenient preparation by rural and town folk at low cost. Poroso millet flour is used as a substitute for rice flour in various snack foods.

### 3.2. Limitations for growing millets

- Mostly millets are grown on marginal lands under rainfed conditions. Some of these are still grown in the hilly areas under shifting cultivation
- 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..
- 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.

### 3.3. 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.

## 5. 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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