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Millets-Foods of Twenty First Century

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A B S T R A C T

Climate change has deleterious effect on both human welfare and agriculture production. Millets are smart foods of the 21st century because they are "good for human being, the farmer and the planet." They are the last crops standing during droughts. Millets are also good for animals. Millets are the amazing crops best suited for dry land soils. These can sustain even under aberrant weather conditions (climate of twenty first century) where most of other major crops fail. These are nutritionally rich and help in overcoming malnutrition and food insecurity. Though, millets cultivation is advantageous, the research in improving the age-old cultivation practices is still at an infant stage and this needs to be addressed in order to popularize these healthy foods. Recently introduced millets fetch higher market value (than even major cereals) and hence help in uplifting the socio-economic status of the marginal farmers under dryland conditions.

Introduction

"Climate change, global warming" are the most chanting words nowadays, among the environmentalists and scientific community. Climate change, is the change in the weather parameters *viz.* temperature, rainfall-amount and distribution, wind velocity, etc., in a manner that is not favourable to both plant and animals on earth. Climate change has deleterious effect on both human welfare and agriculture production. Humans however can escape those effects through their intelligence, while crops suffer a lot by climate change, resulting in lower yields and reduced quality of the produce (Theerthankar *et al.*, 2017). This results in increased malnutrition and insufficiency of food for the increasing population. Researchers are looking for novel ways to combat the adverse climatic effect on agriculture sector, which has to feed the whole world.

Major cereals *viz.*, rice, maize, wheat, etc., have dominated the agriculture sector with their capability of meeting rising food demands due to their high potential yields, but fail to sustain under changing climate (Cheng

et al., 2017). India ranks second in the incidences of malnutrition among children and more than one third of the world's malnourished children live in India (Nainwal *et al.,* 2018).The major cereals are deficient in many of the nutritional factors, hence cannot check the nutritional balance that are essential components of one's daily diet for being healthy. Scientists/researchers have concluded that cultivation of alternate crops that can potentially meet nutritional security and can yield sustainably even under variable climate is the only best option to overcome the dominance of the major cereals. Millets are one of the oldest foods known to humans & possibly the first cereal grain to be used for domestic purposes. Millets are the small-seeded grasses that belong to the family, Poaceae/Graminae. There are two major millets (sorghum and bajra) and six minor millets (finger millet, foxtail millet, little millet, proso millet, kodo millet and barnyard millet). Recently few more minor types of millet have been added to this group *viz.*, tef, fonio, quinoa and browntop millet (IIMR, 2020) (Table 1). Since centuries, millets have been a prized crop in India and are staple diet for nearly 1/3rd of the world's population. Millets have potentiality of contributing to increase food production, both in developing and developed countries. Millets are most commonly available in the form of pearled and dehulled rain. Millets are tasty grains that have a mildly sweet, nut-like flavour. Millets are amazing in their nutrient content and are commonly known as "nutri-cereals or nutri-millets".

Millets statistics

Millets are most likely to be originated from and around India where they are largely cultivated with a production of 10.91 m t and stand first among the top ten countries having largest area under millet cultivation. In India, Rajasthan stands first in production of millets with a production of 6.57 m t from 5.91 m ha (Indiastat, 2018). Karnataka state is majorly known for cultivation of minor millets in India with finger millet (recently Karnataka was awarded with the GI tag for finger millet by central government) as staple food in southern parts (Table 2).

Millets are the indispensable constituents of Indian traditional foods because of their taste and nutritional aspects. Hence, India is the major consumer of millets (Fig. 1) since ages and is the main reason for a healthy life of those Indians consuming the nutritionally rich food made from millets (Fig. 2 and 3).

Importance/benefits of millet cultivation

Agronomic

Short duration (crop duration varies from 75-110 days) of the millets has the greater advantage in growing them as catch crops (efficient utilization of resources) and best suited under water scarce conditions (escapes seasonal drought by maturing early). Millets have high water productivity as compared to other crops (finger millet-13.4, sorghum-9.0, pearl millet-8.0 and rice-3.0 kg ha^{-1}) (Yellamanda Reddy and Sankara Reddy, 2016). These characters make them highly tolerant to aberrant weather. Grains can be stored for more than two years and hence, are known as 'famine reserves'. Sahu (1965) stated that the millets are the crops that have potentiality of contributing to increased food production, both in developing and developed countries. Millets are grown under harsh environmental conditions. Some of them are best suited to high soil moisture and drought situations. Thus, they do not burden the state with demands for irrigation or power (Kole *et al.,* 2015).

Millets are adapted to a wide range of ecological conditions often growing on

skeletal soils that are less than 15 cm deep (Tilahum, 2004). It does not demand rich soils or inputs for their survival and growth. Hence, for the vast dry land area, they are a boon. They have remarkable rejuvenation capacity due their tillering habit and recover very fast once the moisture stress conditions are alleviated (Adekunle, 2012). These millets are grown under traditional methods and no millet attracts any pest. They can be termed pest-free crops. A majority of them are not affected by storage pests either. Therefore, their need for pesticides is close to nil. Thus, they are a great boon to the agricultural environment.

Nutritional

Each of the millets is three to five times nutritionally superior to the widely promoted rice and wheat in terms of proteins, minerals (calcium and iron) and vitamins and fibre hence, are known as “super foods” (Amadou *et al.,* 2013). Millets are the ideal food group for all the people irrespective of age. Calcium and iron are essentially required for growing children, pregnant and lactating women who are more sensible for anaemic condition. Among all food crops, finger millet has a higher calcium (344 mg per 100 g) and that of in foxtail millet (12.9 mg per 100 g) followed by little millet (10.0 mg per 100 g) (Veena *et al.,* 2005). Millets provide energy for a long time due to slow digestion, which makes them best diabetic food. The millets are ‘free of gluten’- wheat protein that is responsible for celiac disease (damage of the small intestine), is being seen predominately in western countries due to consumption of wheat (Nainwal *et al.,* 2018). These millets have diversified high food value but the consumption of these millets is being declined due to lack of standardized processing techniques to compete with fine cereals. Recently these millet products are marketed as 'health foods’- to increase the utilization of small millets in popular foods. Small millet-based value-added products including traditional recipes, bakery products, pasta products, flaked and popped products instant food mixes were developed and standardized (Table 3).

Table.1 Top 10 millet producers in the world

Country	Production (m t)
India	10.91
Nigeria	5.00
Niger	2.955
China	1.620
Mali	1.152
Burkina faso	1.109
Sudan	1.090
Ethiopia	0.807
Chad	0.582
Senegal	0.572
World	29.87

Source: Indiast at, 2018

Table.2 Millets common and scientific names with their special characters

Sr. No.	Millets	Scientific name	Vernacular names	Special characteristics
1.	Sorghum	*Sorghum bicolor*	Jowar, jowari, durra, great millet	Known as camel of dryland
2.	Pearl millet	*Pennisetum glaucum*	Bajra, sajje, kambu, kambam, sajjalu	Highly tolerant to drought, heat and soil salinity
3.	Finger millet	*Eleusine coracana*	Ragi, mandua, kapai, marua, nagli	Wider adoptability, rich source of calcium
4.	Proso millet	*Panicum milacium*	Cheena, baragu, panivaragu	Short duration tolerant to heat and drought
5.	Foxtail millet	*Setaria italica*	Navane, kauni, kangni, korra, rala	Short duration, tolerant to low soil fertility and drought
6.	Little millet	*Panicum sumatrense*	Same, samai, samulu, kutki	Short duration, withstand both drought and waterlogging
7.	Barnyard millet	*Echino chloacolona*	Sawan, oodalu, jhingora	Fastest growing and voluminous fodder
8.	Kodo millet	*Paspalums corbiculatum*	Kodo, varagu, haraka, arikalu	Long duration, grown well in shallow and deep soil
9.	Teff grass	*Eragro stistef*	Williums Love grass, teffa	Ethopian staple food, high market price
10.	Quinoa	*Chinopodium quinoa*	Inca wheat goosefoot, pigweed	Nutritionally rich
11.	Fonio millet	*Digita riaexilis*	Findi/fundi, white fonio, acha rice, hungry rice	Long panicles, erect habit, long stem, strong and resistant to lodging
12.	Browntop millet	*Brachiaria ramosa*	Baragu	Nutri rich

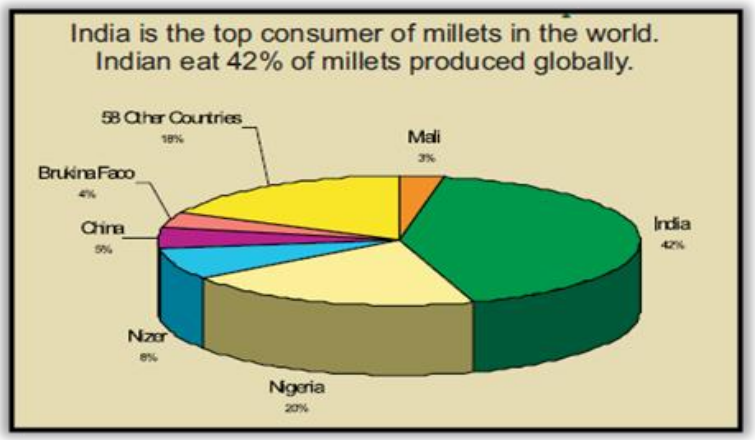
Source: IIMR, 2020

Table.3 Nutrient content of millets (per 100 g)

Crop/nutrient	Protein (g)	Fiber (g)	Minerals (g)	Iron (mg)	Calcium (mg)
Sorghum	10	4	1.6	2.6	54
Pearl millet	10.6	1.3	2.3	16.9	38
Finger millet	7.3	3.6	2.7	3.9	344
Foxtail millet	12.3	8	3.3	2.8	31
Proso millet	12.5	2.2	1.9	0.8	14
Kodo millet	8.3	9	2.6	0.5	27
Little millet	7.7	7.6	1.5	9.3	17
Barnyard millet	11.2	10.1	4.4	15.2	11
Browntop millet	11.5	12.5	4.2	0.65	0.01
Quinoa	14.1	7	-	4.6	47
Teff	13	8	0.85	7.6	180
Fonio	11	11.3	5.31	84.8	18
Rice	6.8	0.2	0.6	0.7	10
Wheat	11.8	1.2	1.5	5.3	41

Source: IIMR, 2020

Fig.1 Global millet consumption pattern



(Source: Indiastat, 2018)

Fig.2

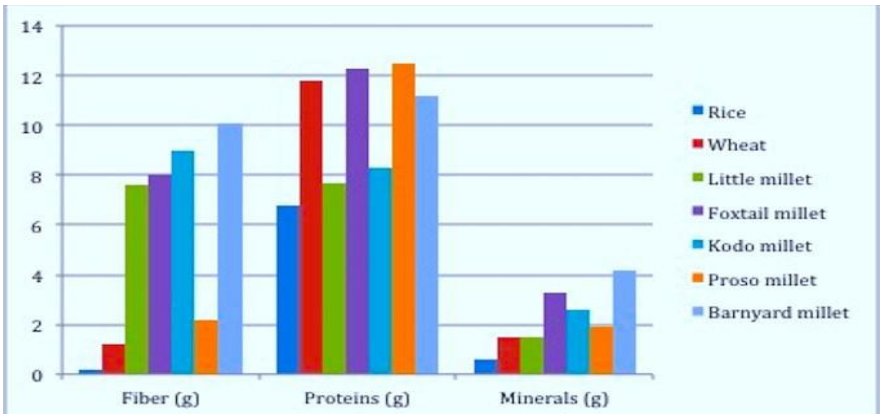
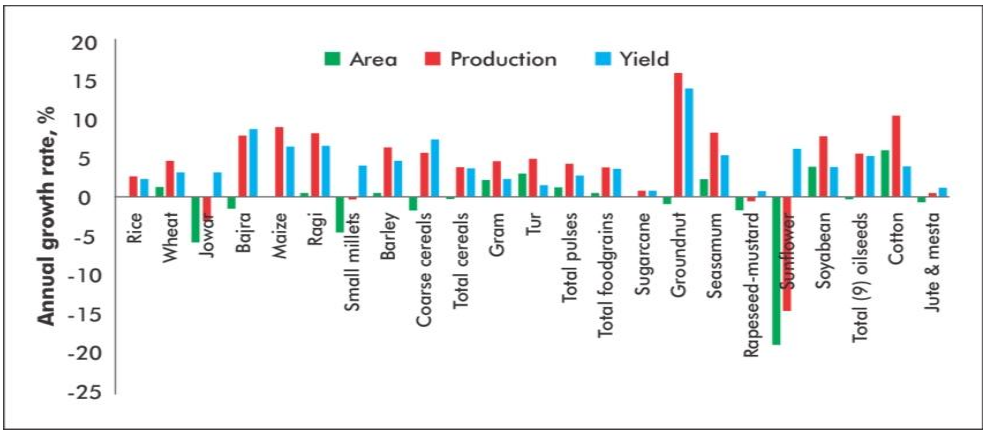


Fig.3 Annual growth rate in area, production and productivity of different crops



(Source: India stat, 2018)

Socio-economic

Along with many agronomic and nutritional aspects, millets cultivation also helps in uplifting the socio-economic status of the small/marginal and medium farmers. Cultivation of millets is an integral part of integrated farming system. Millets cultivation helps in getting an average of Rs. 11,506 and 12,116 ha^{-1} net returns (little millet and foxtail millet) under dryland conditions (Amban Gouda *et al.,* 2019). Nearly 2 to 3 times higher returns than the money invested in millet cultivation can be obtained under better management of agronomic practices *viz.*, fertilizer, irrigation, spacing, date of sowing, etc. (Ambresha, 2017 and Shankar, 2017). Apart from this, millets cultivation is environment friendly because of lesser pollution involved in its cultivation which requires fewer amounts of external chemical fertilizers, herbicides and pesticides which are essentially required by major cereals, hence, polluting the environment and ultimately adding to climate change.

Some of the factors hindering the popularization of millets

Production constraints

Grown on poor shallow and marginal soils under rainfed conditions.
Often broadcast - major bottle neck in taking inter-cultivation operation and effective weed control.
Non adoption of improved varieties.
Non adoption of recommended practices.
Lesser use of manures and fertilizers.
Commercialization in today's agriculture.
Research on crop improvement and agro-techniques was neglected till recently.

Nowadays farmers are much interested in commercial agriculture and are replacing the sustainable crops with cash crops, hence, area under millets is decreasing day by day (Michaelraj and Shanmugam, 2013; Durgad *et al.,* 2019).

Factors responsible for lower consumption

Lack of regular supply due to less preference.
Availability of cheap and preferred millets.
Marketing channels were not well developed between producing areas and consumption.
Food aid systems like public distribution system which supply cereals readily.
Higher social prestige associated with the consumption of rice and wheat.

On the darker side, these crops have been included under "Orphan crop" list, due to lack of trade across the world. Government is trying hard to encourage cultivation of such nutri-millets through different schemes, and introducing new generation nutri-millets that are both nutritionally rich and can fetch higher price for the farmer *viz.*, teff millet, chia, brown top millet, quinoa, etc., in order to dissect the social stigma attached to these crops as "food for the poor" and to overcome malnutrition among the community.

In conclusion the millets are the amazing crops best suited for dry land soils. These can sustain even under aberrant weather conditions (climate of twenty first century) where most of other major crops fail. These are nutritionally rich and help in overcoming malnutrition and food insecurity. Though, millets cultivation is advantageous, the research in improving the age-old cultivation practices is still at an infant stage and this needs to be addressed in order to popularize these healthy foods. Recently introduced millets fetch higher market value (than even major cereals) and hence help in uplifting the socio-economic status of the marginal farmers under dryland conditions.

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