

Amaranthus: Development opportunity

crop for marginal farmers livelihood and nutritional security

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Marginal holdings are very essential for improving agricultural growth and economy of India as these holdings contribute to more than 80% of the country's agriculture. However, marginal farmers face several challenges in the form of reduced yields, reduced soil quality, total crop failures, limited access to fertilizers and irrigation, pest and disease build up in the farm, and climate changes. Adding diversity in the fields with alternative crops could help to mitigate such issues and can contribute to the economic and ecological sustainability. Amaranthus is a highly nutritious pseudo-cereal which can grow well on marginal lands under demanding environment being a short cycle, drought and salinity tolerant crop. It is a multipurpose C4 plant used as a '4F' crop (Food, Feed, Fuel and Fiber) which makes it a remunerative crop highly suitable for crop diversification on marginal lands.

Key words: Amaranthus, Crop diversification, Marginal farmers

AGRICULTURE plays a significant role in Indian economy. Around two third of the working population depend on agriculture for their livelihood. Agriculture sector accounts for 18% of India's gross domestic product and it is one of the most dynamic sectors of Indian economy ensuring food security of the country. It may be noted that Indian agriculture mostly includes marginal and small farmers, having land holdings of less than 1 and 2 hectare respectively. As per agricultural census 2010-11, out of 138.35 million operational holdings, small and marginal holdings account for 117.61 million which is 85% of the total operational holdings. Therefore these marginal holdings are important for improving agricultural productivity, food security and economy of the country. However, there are several agricultural challenges faced by marginal farmers such as low quality soil, scanty rainfall, irregular landforms, seasonal employment, non mechanized farms, and poor rural infrastructure. These

challenges could be dealt with the strategy of crop diversification which includes identification of the region specific crops suitable for growing in marginal lands and shifting from less remunerative crops to the more remunerative ones. Under this strategy, farmers try to grow several crops in their agricultural holdings depending upon the geo-climatic conditions of the region which improves income by generating year round employment. There are many traditional underutilized minor crops which are rich source of essential nutrients and could be a potential candidate for crop diversification by having promising commercial value and high adaptation to the marginal lands. In the present article, the potential of *Amaranthus* as a candidate for crop diversification is highlighted and briefly discussed.

Crop diversification: Need and benefits

In India, there is a need for crop diversification as Indian agricultural holdings have a large share of marginal farmers and many parts of

India have observed a high number of farmer suicides owing to the low farm income and seasonal unemployment. Diversified cropping pattern help the farmers with the agricultural risks of harvest loss and price shocks, thus making farming more resilient and sustainable economic activity. In the recent years, a shift from the traditional specialized cropping to the high value diversified cropping system have been witnessed due to the issues related to monoculture farming such as declining profitability, degradation of soil health, lower fertilizer response and production. Government of India implemented Crop Diversification Programme in Punjab, Haryana and Western UP to diversify paddy fields with hardy and less water requiring crops of pulses, oilseeds, cotton, and agro-forestry plantation.

Diversified agro-ecosystems can be achieved through increased structural diversity, crop rotations, polycultures including non crop vegetation, genetic diversity in the monocultures,



Fig. 1. Crop diversification in marginal lands

Source: Adapted from Innovative initiatives for farmers development and issues of crop diversification, Dr Shankar Chatterjee, International journal of research, 2017.

agro-forestry and mixing landscapes. These types of diversification benefit the farmers by disease and pest suppression, increased production stability and climate change buffering.

Furthermore, diversification results into the environmental benefits of improved soil and water conservation with better nutrient retention. Thus, crop diversification is a productive way to build resilience and enhance agro-ecosystem health in the agricultural system.

Crops for diversified agro-systems

During the post independence era of India, the challenge to prevent the food scarcity and attain nutritional security for the vast population led to reliance on the foodgrain crops. Around 40-50% of total arable land is under cultivation of only 3 major crops *viz.* wheat, maize and rice. Reliance on the few major staple crops has various economic, nutritional and ecological risks which would lead to reduced yield and crop failures due to reduced resilience to biotic and abiotic stresses. The diversification into other crops could result into more flexible agriculture system by mitigating these economic, ecological and nutritional risks. There are several underutilized minor crops, known as development opportunity crops (DOCs) which are grown for

food, forage, oil and medicines for local consumption and have good adaptation to the marginal lands. These crops have the potential to contribute to the food security and lead to improved sustainability of the agro-systems.

One such crop is *Amaranthus* spp. which is characterized by high nutritional value and its adaptation to the marginal lands. Amaranthus is a hardy, stress tolerant crop and can be cultivated with minimal external inputs. It is a drought resistant crop with short growth cycle and therefore can be used efficiently for crop diversification on marginal lands.

Amaranthus: Physiology and cultivation

Grain *amaranth* is native to central and South America and during 15th century it underwent significant migration to Asia. It became popular among hill tribes in India, Nepal, Tibet, China and Pakistan. At present grain *amaranth* is cultivated in 17 states of India as shown in Figure 2. *Amaranth* is not a true cereal but considered as a pseudo-cereal like buckwheat and quinoa. Approximately 60 genera are known all over the world but only few species are used as vegetable, grains, forage and ornamental plant. The major grain producing species are *A.*

Development Opportunity Crops (DOCs)

DOCs are undervalued and neglected crops that are already cultivated but are underutilized regionally and globally. These are restricted to local production and consumption, owing to unrecognized nutritional value and poor consumer awareness. These traditional crops are grown for food, fodder, oil, traditional medicine and fiber. These crops play a key role in survival of local communities and have ethno-botanical and medicinal value. DOCs have good adaptation to marginal lands and provide valuable nutritional element to local population that generally lack in the staple crops. These crops have the potential to contribute to food security, income generation and culinary diversification. There are many underutilized plant species in India some of which include wild potatoes (*Ipomoea batata*), wild melon (*Cucurbita* spp.), *Amaranthus* spp. buckwheat (*Fagopyrum esculentum*), cowpea (*Vigna unguiculata*), quinoa (*Chenopodium quinoa*), millets, plum (*Ziziphus mauritiana*), jojoba (*Simmondsiaceae schneider*), wood apple (*Aegle marmelos*) and karonda (*Carissa* spp.).

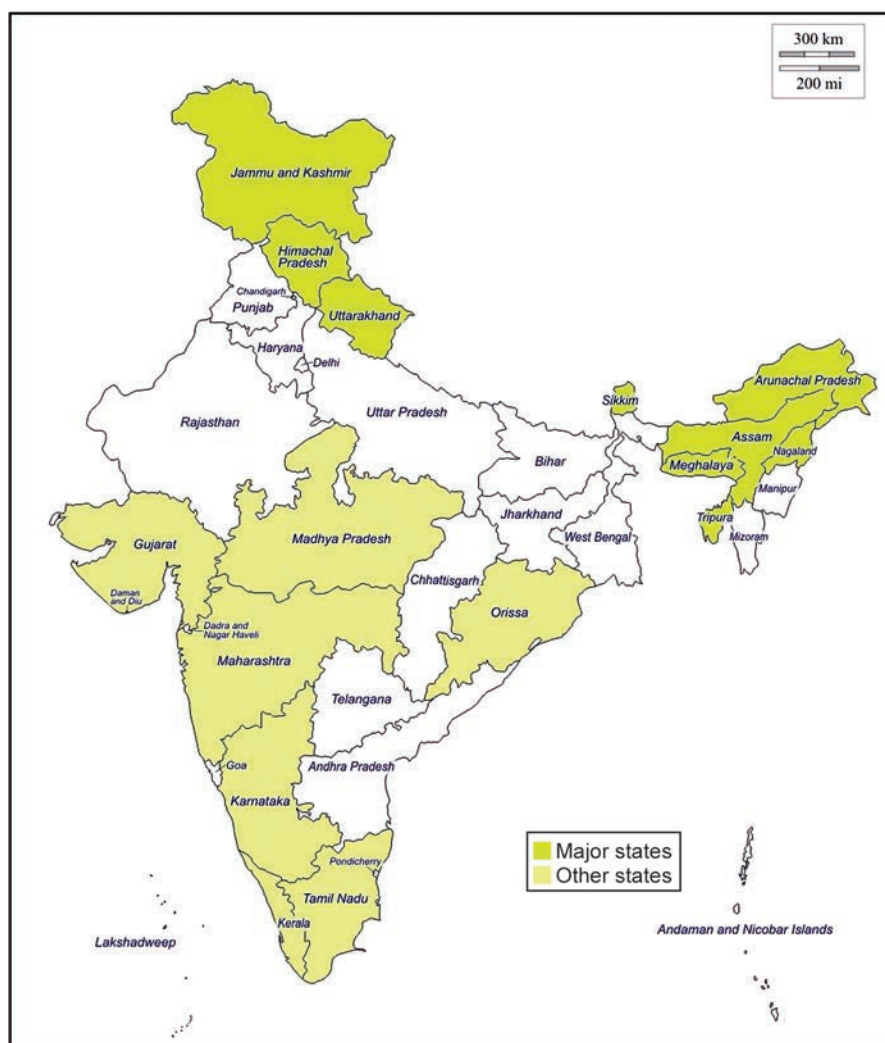


Fig. 2. Cultivation and distribution of grain *amaranthus* in India
Source: Grain *amaranthus*: the future food crop, NBPGR

caudatus (Inca wheat) *A. cruentus* (Purple amaranthus) and *A. hypochondriacus* (Prince's feather) whereas vegetable species include *A. lividus*, *A. blitum* and *A. tricolor*. In India *amaranthus* is widely cultivated for both grains and greens in highly diverse areas from tropical lowlands to the elevation of 3500 m in the Himalayas. In South Indian hills *amaranthus* is not grown as a pure crop but generally mixed with *ragi*. In North Indian hills the crop is sown at the onset of monsoon but in South India it is grown throughout the year. The yield of *amaranthus* seeds is highly variable and depends upon species, genotype, environmental conditions, soil physical and chemical properties, fertilizer input, plant density etc. Usually grain yield may range from 0.5 t/ha to 2.5 t/ha on dry-weight basis (dwb). This large variability in yield presents opportunities for the

selection of regionally targeted cultivars which could be used for diversifying fields.

Amaranth is an annual, herbaceous C4 plant having improved photosynthetic efficiency under high temperature and water deficient conditions as compared to the C3 crops which makes it an ideal crop

under abiotic stress conditions. The water requirement for growing *amaranthus* is 40-60% less than that required for the other grain crops. Under extremely dry conditions, plant may temporary wilt but revives completely after receiving water. Moreover *amaranthus* can be grown as a monoculture or can be intercropped with bean, pepper, maize and squash. *Amaranthus* is also tolerant to nematodes and therefore can be used in rotations to reduce nematode population for the succeeding crops. These characteristics make *amaranthus* an interesting choice for crop diversification on the marginal lands.

Amaranthus: Benefits and utilization

Nutritional benefits: *Amaranth* is a popular superfood worldwide and possesses a high nutrient value. The seed coat of the *amaranth* grain is thin and smooth with its germ and perisperm highly rich in fat and starch respectively. Due to the high nutritional value of the grain, it is considered as a natural mixture of cereals and legumes. The amino acid composition of *amaranthus* seeds is very close to the levels recommended by WHO for healthy diet. Also the combination of maize flour and *amaranthus* in 50:50 ratio matches the ideal score of 100 on the scale of nutritionists. The following table records the nutritional composition of *amaranth* grain and leaves.

Amaranthus grain is gluten free which contributes to its globally increasing popularity. Today approx. 0.5% of world population has gluten intolerance and therefore the demand

Table 1: Comparison of grain *amaranthus* with other cereals (on 100 gm dwb) and leaves (g/100 g of fresh leaves)

	Amaranth grain	Wheat	Maize	Sorghum	Amaranth leaves	Spinach
Crude protein (g)	11–18	14	10	12.7	2.5–3.5	2.9–3.2
Lipids (g)	7–8.5	1.7–2.5	4–5	4	0.31–0.50	0.3–0.4
Carbohydrates (g)	65–70	75–77	80–82	72	4–6	3.5–4.3
Iron (mg)	7–15	2.5–3.3	2–3	3.4	2.3–3.2	2.7–3.1
Calcium (mg)	160–212	33–35	5–7	13	215–260	90–99
Vitamin C (mg)	4–7	0.0	0.0	0.0	43–55	28–51
Energy (Kcal)	365–370	370–390	390–410	339	27–53	23
Starch (g)	48–68	-	-	70.1	-	-
Crude fiber (g)	6.5–9	2–3	3–4	8.5	-	2.2
Ash (g)	2.8–3.8	1.9–2.2	1.5–1.8	1.7	-	-

Source: USDA nutrient database

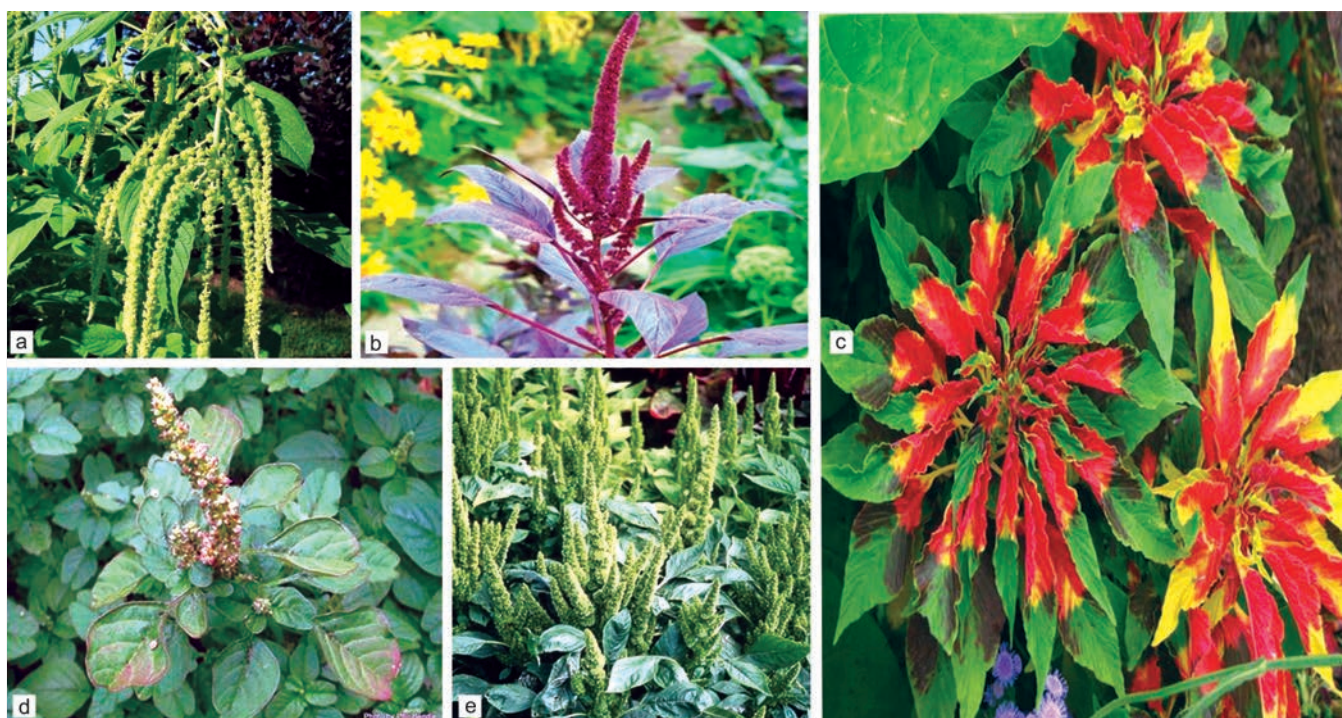


Fig 3. *Amaranthus* spp. a) *A. caudatus*, b) *A. cruentus*, c) *A. tricolor*, d) *A. lividus*, e) *A. hypochondriacus*

of gluten-free high nutritional products is increasing constantly. *Amaranth* grains are rich in amylopectin (93-95%) with high water binding capacity, low gelatinization temperature and freeze-thaw stability. These traits make utilization of *amaranthus* high in food and beverage industry. Grain *Amaranth* flour is used as a raw material for bakery production. *Amaranth* grains are also used to produce a few alcoholic beverages as well. Popped seeds are used in cereal muesli, candies and are often mixed with honey or jaggery to prepare *laddoos*. *Amaranth* flour is also used to make *chapattis* and porridge. The high content of lysine, arginine and histidine increase the utility of *amaranthus* seeds to be used in baby food and as a supplement to treat malnutrition.

Economic benefits: *Amaranth* grain is very extraordinary in its oil content. It has a distinctive composition of unsaturated fatty acids and considerably high content of squalene. Squalene has a preserve function for skin and hair against sun and radiation and has wide application in cosmetic industry (face cream, shampoos, sunscreens, etc.). Therefore *amaranth* oil and the extracts from its inflorescence (mainly

rutin) are used in cosmetics which enhance the economic value of the crop. The bright colored inflorescence can be used to prepare red, yellow and green dyes which could replace synthetic dyes and can be used as a natural colorant in food, beverages and medicines.

Medicinal benefits: Different parts of the *amaranthus* plant have high utility in medicine where traditional medical practices are quite prevalent.

The few applications includes cold and cough remedy, diuretic, treatment of urinary infections, gastric issues, diarrhea, measles, excessive menstruation, ulcerated mouth, and high blood pressure. It can also be applied externally to treat vaginal discharges, skin problems, nosebleeds and wounds. Due to these properties, *amaranthus* may have wide application in pharmaceuticals industry and needs further research

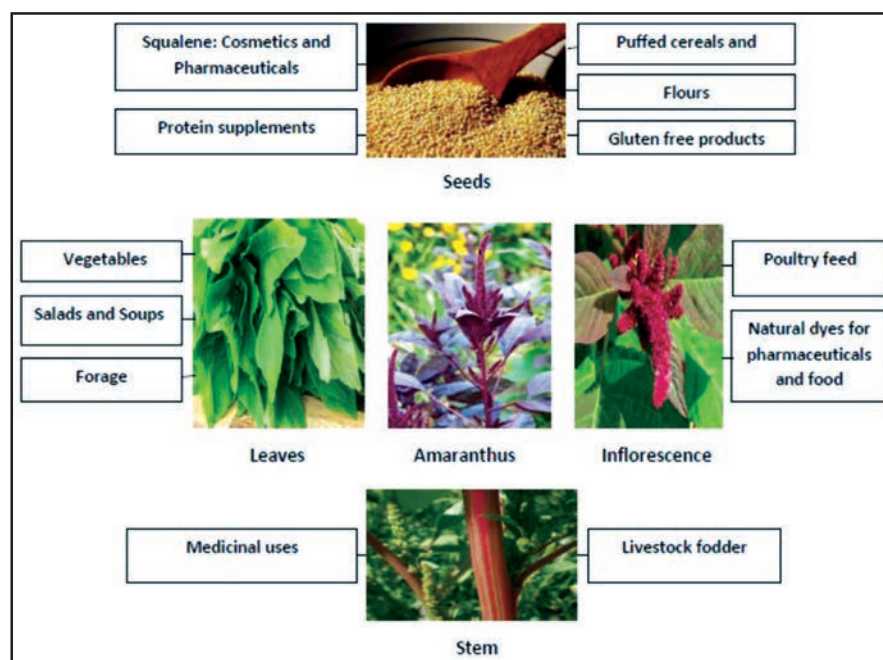


Fig. 4. Utilization of *Amaranthus* plant

on *amaranth* compounds with potential medicinal uses.

Environmental benefits: *Amaranth* is also an excellent option for feeding livestock due to the high content of dietary fiber, ash and protein. *Amaranth* can be intercropped with maize which would continue the forage supply in the dry season and increase the land use efficiency. *Amaranthus* can also be utilized as vegetative cover in mountains having low soil fertility therefore reducing soil erosion in hilly region. *Amaranthus* is an attractive source of biomass because of its high yield under marginal conditions. It could be grown on waste land unsuitable for food production and have the ability to detoxify the polluted soil which eliminates the competition with food producing land. Some *amaranthus* species can also be explored as a potential

bioenergy crop e.g. *A. retroflexus* possess 70-95% of the calorific value of the wood, thereby reducing the dependence on non renewable source of energy.

Due to the above mentioned attributes and the ability to broaden the food base, *amaranthus* can increase the income of marginal farmers as significant economic benefits could be reaped by developing value added *amaranth* products. Therefore *amaranthus* should be explored and used maximum for the diversification of the farmlands.

SUMMARY

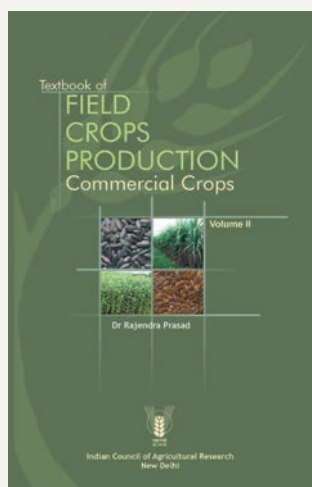
Crop diversification aims at enhancing plant productivity, quality, nutritional value, soil health and building crop resilience to pests, diseases and environmental stresses. *Amaranthus* species is an attractive

option to be exploited for crop diversification due to the various attributes of the crop. It has wide application in food, pharmaceutical and cosmetic industries which help in withstanding price fluctuation and increasing income of marginal farmers. *Amaranthus* cultivation reduces the dependence on the off farm inputs and contributes to the food security of the farmers. Further due to the small size, grains are not prone to post harvest injury which makes them easy to transport. Great scope exists to exploit this plant for crop diversification and an urgent need is required to develop cost effective processes for value added products in India.

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Textbook of Field Crops Production – Commercial Crops

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TECHNICAL SPECIFICATIONS

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