

PROSPECTS AND POTENTIAL OF BUCKWHEAT (*Fagopyrum spp*) PRODUCTION IN NEPAL: A REVIEW

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ABSTRACT

Buckwheat is one of the important but underexploited crop of Nepal. It ranks 6th position as a staple food crop and is cultivated from Terai to mid hills and mountains. It is cultivated as summer crop in mountains, autumn and spring crop in mid-hills and winter crop in Terai and inner terai. The major buckwheat producing districts of Nepal are Mustang, Humla, Dolpa, Mugu, Kalikot, Jumla, Rukum, Rolpa, Jajarkot, Kavre, Dolakha, Solukhumbu, Okhaldhunga and Taplejung. It is considered as a short duration, eco-friendly, drought tolerant, wider adoptive and rainfed loving crop with minimal requirement of plant nutrients, tilling, plant protection measures and other management practices. It plays an important role in the food and nutritional security of the people living in remote rural areas. Two buckwheat species; *Fagopyrum. esculentum* (Mithe phaper) and *Fagopyrum. tataricum* (Tite phapar) are cultivated in Nepal. It can withstand against various kinds of biotic and abiotic stresses and fit well in various multiple cropping systems. The area, production and productivity of buckwheat in Nepal during fiscal year 2021/022 is 13875 ha, 15917 tons and 1.15 tons ha⁻¹, respectively. Several factors such as frost, drought, lack of high yielding varieties, lodging, self-incompatibility, female sterility, indeterminant growth habit, shattering is responsible for low yield. To increase the area, production and productivity of buckwheat in Nepal, immediate attention should be given by the researchers, development workers, local governments, and policy makers by developing and advocating location specific scientific interventions and policies.

Key words: *Biology, Landraces, mountain, nutritive value, shattering*

INTRODUCTION

Buckwheat (*Fagopyrum esculentum* Moench) is an annual herbaceous ancient dicotyledonous crop plant belongs to family poligonaceae with diploid chromosome number (2n=16). The crop is called as a pseudocereal (a crop with an end use like a cereal which does not have tillering capacity as like other cereals and is not comes under grass family) and underutilized crop, poor man's crop, and neglected crop in Nepal (Baniya, 1995). It plays an important role in the food and nutritional security of the people living in remote rural areas in the Himalayan region. The top ten buckwheat producing countries in the world in 2020 are Russia, China, Ukraine, USA, Brazil, Japan, Kazakhstan, Belarus, Tanzania and Nepal (Tridge, 2022).

There are 20 buckwheat species known to be the members of genus *Fagopyrum* (Shao *et al.*, 2011) including five species namely *F. esculentum*, *F. tataricum*, *F. cymosum*, *F. gracilipes*, and *F. megacarpum* have been available in Nepal (Sharma and Jana, 2002, Joshi, 2008). Among them, the main cultivated two species are *F. esculentum* and *F. tataricum* (Ohsaki *et al.*, 2001). *F. esculentum* Moench is called common buckwheat / Japanese buckwheat / sweet buckwheat (Mithe Phapar in Nepali) while *F. tataricum* L. Gaertn is called bitter buckwheat (Tite Phapar in Nepali). Buckwheat species are cultivated for their grain-like seeds which are notable for their exceptional nutritive values compared to rice and wheat (Popovic *et al.*, 2014). It is an important source of carbohydrates, protein, fibre, K, Ca, Mg, Na, Mn, Zn, Se, and Cu. Grain also contains rutin, flavonoids, pyridoxine, riboflavin and many amino acids, which have beneficial effects on human health, including lowering

both blood sugar and lipid levels (Sharma and Jana, 2002). It has balance amino acids, mineral compound, high content of lysine, fibrous materials, vitamins and bioflavonoid rutin (De Francischi *et al.*, 1994, Ikeda *et al.*, 2005). However, due to a high content of crude fibre and tannin, the true digestibility is below 80% (Ahmad *et al.*, 2018). The rutin, quercetin and polyphenols are potent carcinogens against colon and other cancers. Act as antioxidant of ascorbic acid that can trigger diabetes, cardiovascular diseases besides hypertension (Ahmad *et al.*, 2018).

Buckwheat is cultivated to serve as food for human consumption, animal feed as well as for medicinal purpose. It is short duration crop having photo periodically insensitive in nature. It can be cultivated under low input conditions year-round if temperature and moisture is favourable in different agroecological zones. It suits very well for different cropping systems such as sole cropping, intercropping, cover cropping, catch cropping, double cropping etc.

Buckwheat is considered as a sixth staple food crop after rice, wheat, maize, finger millet and barley, representing an important food crop in remote mountain areas in Nepal. It is cultivated in all parts of Nepal from the altitude of 60 m in Terai to 4500 m above sea level (Joshi and Ghimire, 2015). It is cultivated in more than 61 districts of Nepal (Sherchand, (2001), mostly at high altitude of western and mid-western regions (Luitel *et al.*, 2017). The total area, production and productivity of buckwheat in Nepal in fiscal year 2021/022 is 13875 ha, 15917 tons and 1.15 tons ha⁻¹, respectively (Ag. diary, 2022).

Out of best two cultivated species, *F. esculentum* is generally grown in Terai and mid-hills while *F. tataricum* is in mountain areas using different cropping pattern (Joshi, 2008). In mountain areas, the *F. tataricum* is generally grown in upland, whereas in Terai and Inner Terai, *F. esculentum* fits in rainfed lowland under Rice-Buckwheat-Maize crop rotation (Sharma and Jana, 2002). The Bitter buckwheat (tataricum type) has relatively wider adaptability compared to common buckwheat. It can be grown in marginal land, and can withstand the poor, less fertile, and acidic soils with nutrients, moistures, and heat stress condition (Luitel *et al.*, 2017), which is prevalent to hilly area of Nepal. Buckwheat is cultivated as summer crop in mountains (> 1700 m asl), autumn and spring crop in mid-hills (600–1700 m asl), and winter crop in Terai (below 600 m asl) (Atreya and Shakya, 2000). There are a lot of opportunities and advantages to grow buckwheat in all seasons (summer, autumn, winter, and spring) in different agroecological zones of Nepal (Ahmad *et al.*, 2018). The major buckwheat producing districts of Nepal are Mustang, Humla, Dolpa, Mugu, Kalikot, Jumla, Rukum, Rolpa, Jajarkot, Kavre, Dolakha, Solukhumbu, Okhaldhunga and Taplejung district (Luitel *et al.*, 2017).

The grain production potentiality and number of available landraces of *F. tataricum* is higher as compared to *F. esculentum* in Nepal. However, most of the buckwheat farmers are not preferred the Tataty buckwheat because of more bitterness and difficulty in producing flour after dehulling (Luitel *et al.*, 2017). A number of traditional buckwheat cultivars / landraces grown in western Himalayan region of Nepal is given in Table 1.

Table 1. Name of Buckwheat landraces grown in western mountain region of Nepal

<i>Fagopyrum esculentum</i>		<i>Fagopyrum tataricum</i>			
Chendrung	Ghode	Bharule	Dhesu	Tensya teta	Thin kunde tite
Bisam	Tote	Dalle,	Dhop	Techhung	Tuchi
Gulio	Bahramase	Dhahasur,	Ghamre	Tasung	Thou
Madane	Batule	Dhau	Gharelu	Tar	Murali
Mithi	Chhendrak	Chiniya	Gore	Tan	
Mithe	Phape	Jhoumle	Jamdalo	Tabre	
Ogale	Thulo	Tite	Jhaumre	Spangre	
Seto	Sathiya	Bhalu	Kalo kise	Rani tite	
Seychun	Seyekar	Bhadre	Seto kise	Pranah	
Ghabre	Ghode	Barkhe	Kamre	Lekhari	
Jhusile	Kalo	Oule	Chuchche	Khumbeli	

Source: Luitel *et al.*, (2017)

ORIGIN AND DISTRIBUTION

It is reported that the original centre of buckwheat is in South China before 4000–5000 where large number of buckwheat genetic resources are still available (Gondola and Papp 2010). The exact place of origin of common buckwheat is considered as Yunnan province and in between Yunnan and Sichuan provinces of China (Ohnishi, 2010). The Buckwheat genetic

resources were distributed in the world mainly from central Asia especially in the south-western China (Zhou *et al.*, 2018). Buckwheat is distributed to Europe through Russia and spread to North America through immigrants (Campbell, 1997). It is cultivated in Asian countries like China, India, Mongolia, North Korea, far eastern Russia, Japan, Nepal and Bhutan (Farooq, *et al.*, 2016). It has been grown in almost all the temperate region and countries of the world.

Cultivation of buckwheat was started in Nepal from Vedic times. Wild species of buckwheat have been found in wild stage in Nepal. So the origin of buckwheat may be in mountainous region of Nepal too. In Nepal buckwheat is mainly cultivated as summer crop in mountains (> 1700 m asl), autumn and spring crop in mid-hills (600–1700 m asl), and winter crop in Terai (below 600 m asl) (Atreya and Shakya 2000).. The major buckwheat producing districts of Nepal are Mustang, Humla, Dolpa, Mugu, Kalikot, Jumla, Rukum, Rolpa, Jajarkot, Kavre, Dolakha, Solukhumbu, Okhaldhunga and Taplejung district (Luitel *et al.*, 2017). The total area, production and productivity of buckwheat in Nepal in fiscal year 2021/022 is 13875 ha, 15917 tons and 1.15 ton ha⁻¹, respectively (Ag. Diary, 2022).

TAXONOMIC CLASSIFICATION

Kingdom: Plantae, Sub kingdom: Viridiplantae, Super division: Embryophyta, Division: Tracheophyta, Subdivision: Spermatophytina, Class: Magnoliopsida, Super order: Caryophyllanae, Order: Caryophyllales, Family: Polygonaceae, Genus: Fagopyrum, Species: esculentum

Source: (ITIS,n.d.)

Biology of Buckwheat plant

Buckwheat is an annual herbaceous plant with free branches, reddish stem, shallow taproot and fine lateral roots producing a root system that is about 3-4% of the weight 0.9 - 1.2 m in depth (Mushtaq *et al.*, 2018). The leaf is simple, petiolate, ovate triangular, large heart shaped that vary in size (2-8cm) and arrangement. Plant can grow from 0.6 - 1.5 m in height and can produce several erect branches. Stems vary in colour from green to red and brown at maturity. The main stem is grooved, succulent and smooth except at the nodes. Stems are hollow and the plant is subject to breakage by high winds and hail. The fruiting structure is an axillary or terminal racemes with densely clustered flowers with no petals. The flowers (calyx is composed of five petal-like sepals) that are usually white, pink or dark pink in colour. Each inflorescence consists of 7–9 small flowers with pink, white, or yellow in colour, and flowers are heteromorphous in nature. The fruit is a triangular nut, sometimes prominently winged. Seeds are wide at the base and triangular to almost round in cross section. Seed colour may be brown, grey brown or black while size varies according to variety. The seed is comprised of a thick outer hull and an inner groat. Buckwheat has an indeterminate growth habit (Mushtaq *et al.*, 2018). So the crop does not mature uniformly. Stems become reddish brown at maturity. Plants will begin to blossom 5 to 6 weeks after sowing and will mature in 80 to 90 days. It requires cross pollination to produce seed, so insect pollinators are essential for effective fertilization and seed set. Seeds are generally triangular but vary with varieties.

ECONOMIC IMPORTANCE

Buckwheat is one of the ancient, domesticated crops of Asia, Central, and Eastern Europe among underutilized or minor crop that has been used as a staple food especially in arid regions of the world (Farooq *et al.*, 2016). It has got worldwide importance because of the presence of important bioactive constituents like rutin, vitexin, orientin, isovitexin, quercetin, and isoorientin. Other essential components such as fagopyritols find vast potential for glycemic control in type II diabetics, treatment of celiac disease, positive cardiovascular effects, prevention of gall stones, and several hormone-dependent tumors (Campbell, 1997).

Buckwheat is used mainly as an items of food like thick porridge (dhindo), noodles, pancakes, buckwheat pakoras, gluten-free beer, whiskey, local beer (Jaand), roasted flour (satu), tea, shochu, biscuit, cakes, fresh and dried vegetables etc. The flour of buckwheat is used to prepare different food items singly or by mixing flour of other cereals like wheat, barley and finger millet. The green and dried stover can also be used as fodder for livestock and green manures also. Buckwheat flower contain high amount of nectar, which is a major source of honey. Buckwheat contains an alkaloid rutin which is better for building and strengthening weak capillary to prevent or reduce haemorrhage (bleeding disease) and diabetes (Campbell, 1997). The major food items prepared from the buckwheat in Nepal are listed in Table 2.

Table 2. Nepalese food items prepared from Buckwheat

Food items					
Roasted grain	Phuraula	Jam	Macaroni	Pickle	Pakauda
Porridge	Puri	Fresh vegetables	Soup	Noodle	Tea
Bread (Roti)	Puwa	Dried vegetables	Ryale roti	Sel roti	Vinegar
Pancake	Haluwa	Biscuit	Chhyang	Bhat (rice)	
Lagar	Mithai	Raksi	Alcohol	Sausage	
Dheshu	Cakes	Salad	Satu	Dorpa dal	

Source: Joshi, (2008).

Buckwheat is a multifarious crop and perform multitude functions such as a green manure crop, smother crop to suppress weeds, nutrient conserving crop, trap or gourd crop, cover crops and as land reclamation crop (Babu *et al.*, 2018).

MAJOR OPPORTUNITIES IN NEPAL

Buckwheat is a short duration (mature within 10-12 weeks) and a climate resilient crop with the ability to grow in less fertile and marginal soils and fits well in intensive cropping systems in mid-hills and terai regions of Nepal as a catch crop (Baniya *et al.*, 2000). It has good scope to meet the ever-increasing food demand of rapidly expanding population in hill, mountain and terai areas of Nepal under changing climatic scenario. It is one of the best suited crops for higher altitudes, where crop growing season is very short. In lower hills and terai areas, it can be grown very well in different cropping pattern due to its short duration nature and can grow in moisture stress conditions (Luitel *et al.*, 2017). Buckwheat is drought-tolerant crop and can be grown in less fertile, marginal upland in different agroecological zones in different season within a year. The use of buckwheat in multiple cropping and crop diversification is an important practices to combat climate change and for enhancing the profitability and farmer's income (Joshi, 1999). It is considered a reliable and sustainable crop having multifarious use for supporting the livelihoods of millions of hill people under changing climatic conditions in the future (Tolani *et al.*, 2016).

The demand of buckwheat in Nepal is increasing annually due to its multiple uses, which is not fulfilled from the Nepalese production. The buckwheat is imported from different countries like India, China, USA etc annually. In case of high hills like Mustang, Manang, Dolpa, Mugu, Solukhumbu etc where buckwheat is a major summer crop, there is still potentiality to increase its production and productivity. Buckwheat can contribute significantly to meet the food demand of that area where transport of food grain from other parts of the country is too expensive. Buckwheat is short duration crop and its flowering period is about 30 days, which is much useful to beekeepers to produce quality honey. Commercial organic honey production in different parts of Nepal is increasing annually. Its demand has been increasing from the urban areas because of balanced amino acids and minerals as well as free from cholesterol, which is a preferred diet in urban areas.

Buckwheat is cultivated throughout the Himalayan region of Nepal, but western Himalayan region has more diversity. In the mountain area, the bitter buckwheat (*F. tataricum*) is common and grown in barley-buckwheat crop rotation in lower areas (2000-3000m), while in high altitude areas (above 3000m) only tartary buckwheat is grown as a single crop in a year (Sharma and Jana, 2002). In high hill, buckwheat is grown in summer

months. April–May is the optimum sowing time in areas above 2000m asl, while in mid hills, buckwheat is usually sown in autumn (Oct-Nov) and spring season (Feb-March). The crop is grown only in subsistence farming and is now considered to be an endangered crop species in Nepal. Majority of the traditional varieties have been grown by local farmers in Himalayan regions while in hills and terai region, some released varieties are also be grown. In the recent year, Hill Crop Research Program (HCRP), Dolakha has started buckwheat varietal improvement program and released few varieties.

Buckwheat in mid hills has very high significance to stabilize the production in autumn season where finger millet could not be grown and in spring season where wheat could not be grown. These lands are less fertile and otherwise would have been left fallow. So, the generation of technology from HCRP, Dolakha in terms of variety and management practices could contribute considerably to buckwheat production and thus helps to sustain the hill farming. This crop can support agri-tourism industries in hills and mountain areas like Mustang (along Kali Gandaki River), Manang, Mugu, Dolpa, Solukhumbu districts where international and national tourists are trekking every year and pancake prepared from common buckwheat is the most favourable item among the tourists. So, common buckwheat also has high potentiality to prepare number of food dishes to attract tourist.

In Terai and Inner Terai areas of Nepal, farmers can grow buckwheat easily just after harvesting of rice in rainfed lowland followed by maize harvesting in upland. The expansion of area is dependent upon the situation of market and price rate of buckwheat which is directly influenced from open boarder. If government can provide assured market to the farmers, buckwheat area can increase rapidly. It has high export potentiality especially in Japan and Bangladesh. The buckwheat flour use in baby food industry, noodle industry and making sweets cannot be underestimated. However, it needs a strong government policy which can bring significant positive change in farmers economy.

MAJOR PROBLEMS

The demand of buckwheat flour is increasing in national market in Nepal, which has been imported from India, China and other countries annually. It is minor and underexploited crop, and the government has given less priority for its development. Major problems faced by the buckwheat producers and traders are listed as under:

- There are no organized marketing facilities for buckwheat. The common buckwheat is purchased by middlemen from the farmers at low price, prepare flour and sold at higher price in the market.
- The young peoples are leaving their villages to urban area or in abroad for employment, education and business opportunities and the leftover rural people are old age and children. The people who are still inhabit in the villages are engaged in business and government jobs like teacher and other, who are not interested to spend their time in agriculture, so that the uplands and marginal lands are left fallow in hilly areas. Similar trends are also reported in other buckwheat growing countries like China and India (Cai and Chan 2009).
- The fooding habit of the villagers is also changing these days. Their food base become narrow and restricted to rice-based products like cooked rice, bitten rice, puffed rice etc. People are less aware about the nutritional superiority of buckwheat useful to all age group of the people.

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- The buckwheat is mainly used for preparation of thick porridge, bread, roasted grain, green leafy vegetables and brewing products like Chyang and local beer (raksi especially in ethnic family). To change the fooding habit of the people and increase the demand of buckwheat, value added products like noodles, bakery items, groats, sprouts, malt, tea etc. can be prepared, which is very less practiced in Nepal.
 - Very less attention is given for buckwheat improvement program by the government sectors. Germplasm collection, varietal development, crop management practices, post-harvest management, marketing etc. are different priority sectors for research and development. Maximum exploitation of local landraces collection, evaluation, selection, breeding program should be continued through research stations and universities.
 - Buckwheat farmers are suffering from a problem of seed shattering especially during harvesting time. Research station should give priority to develop the varieties, which have no shattering problem during harvesting.

FUTURE DIRECTIONS

- It is expected that a good diversity of buckwheat genetic resources occurs in Nepalese Himalayan region and hence crop specific missions need to be undertaken to collect the diverse and unexploited germplasm, characterization and documentation for the future use.
- The buckwheat crop can be grown from Terai to high hills and mountains in different seasons in Nepal. It is a good candidate crop which can be used in sustainable diversification and intensification programs in different agro-ecological conditions.
- Buckwheat is multifarious crop with its high-quality protein, carbohydrate, minerals and lipids source for the farmers inhabited in remote hill and mountain areas, where there is limited access to transport and supplying of quality food materials. Hence, it can serves as a very good nutrition supplement superfood to the children's and women in the remote areas.
- Although, the Tartary buckwheat has good medicinal value with wider adoptable habit, but its demand in the international trade is less due to its bitterness and poor palatability. The evaluation of existing germplasms is necessary to eliminate the bitterness from this species.
- Dehulling in tartary buckwheat is very difficult due to tightly adhering hull. So, a suitable hulling machine should be designed or introduced for commercial cultivation in Nepal.
- Buckwheat is a good candidate crop for rainfed ecosystems, organic farming and zero-budget farming in hill and mountain farmers of Nepal. It can withstand against various kinds of biotic and abiotic stresses and fit well in various multiple cropping systems.
- Most of the young peoples are migrated from hills and mountains to urban areas and abroad for their education and employment. The cultivated land especially upland is left fallow now a days. The immediate attention of researchers, developers, local governments, and policy makers is required for developing and advocating location specific scientific interventions and policies for this crop. Government should manage funds for cultivar development, crop management practices and on more industrial and pharmaceutical uses.

CONCLUSION

Buckwheat is native and very important crop of Nepal ranked 6th position as staple food crop. It is underexploited and less prioritised crop of Nepal grown from terai to Himalayan regions in different seasons. The high hill districts like Mustang, Humla, Dolpa, Mugu, Kalikot, Jumla, Rukum, Rolpa, Jajarkot, Kavre, Dolakha, Solukhumbu, Okhaldhunga and Taplejung are major buckwheat producing districts in Nepal. It is number one candidate crop suitable to grow in rainfed ecosystem, in marginal land with minimal requirement of moisture, tilling, chemical fertilizers etc. It is short duration crop fitted in high altitude areas of Nepal. Mainly there are two species such as *Fagopyrum esculentum* and *F. tataricum* cultivated in Nepal. *F. esculentum* is popular in lower hills and terai regions. The area and productivity of Buckwheat in Nepal is less compared to developed countries, which may be due to the use of local landraces, crop lodging, frost damage, self-incompatibility, shattering, no use or less use of improved varieties with improved package of practices (POP) etc. It is multi advantageous crop with balanced nutrient and has medicinal value also. The researchers, development workers, university professors, policy makers and local government should give attention for advocating location specific scientific interventions and policies for its area expansion and increase crop yield in the future.

CONFLICTS OF INTEREST

The author declared that there is not any conflicts of interest.

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