CHAPTER 3

Health and nutritional aspect of underutilized high-value food grain of high hills and mountains of Nepal

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3.1 Introduction

Among the numerous plant species found in nature, approximately 120 are cultivated for human consumption as food (Adhikari et al., 2017). Worldwide-abundant edible plant species are neglected and/or underutilized; however, they are a potential source of nutrients for human beings, for example, energy, fiber, protein, fat, vitamins, and many other vital micronutrients essential for quality human life. These food grains are called as forgotten or underutilized foods, which are domesticated plant species that have been used for human or animal food, fiber, fodder, oil or medicinal properties, but have decreased in importance over time in terms of global production and consumption systems. In the modern context, only three grain crops—rice, wheat, and maize—are abundantly used grains and are responsible for supplying more than half of the dietary energy supply for the human body (FAO, 2009). However, through the lens of sustainability and food and

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nutrition security of people of Nepal, these three crops are not adequate and are hard to procure for many people of hilly areas too. Among 17 of United Nation's Sustainable Development Goals (SDG), Goal 2, "*end hunger, achieve food security and improved nutrition and promote sustainable agriculture*" is directly related to the fundamental rights of human beings that are ensured by all nations. This is also closely related to Goal 3, which is "*ensure healthy lives and promote wellbeing for all at all ages*." Thus to achieve SDG nos. 2 and 3, it is necessary to promote the consumption of those underutilized food crops that are local, sustainable, and nutrient-dense and are beneficial for human life of all ages. The genetic resources of these underutilized crops are vital for sustaining agriculture and adapting to climate change because many of these species are well adapted to stressful environmental conditions especially of high hills and mountainous areas (Padulosi et al., 2012).

Nepal is famously categorized into three ecological regions: mountains, hills, and the *Terai*. Climate, landscape, geography, resources, and socioeconomic development are distinctly varied among these three ecological regions. The mountain region accounts for 35% (51,817 square kilometers) of the total land area and ranges in altitude from 4877 to 8848 m above sea level, where 7% of the total population of Nepal reside (Government of Nepal, 2012). Occupying nearly 42% of the total land area, the hill region ranges from 610 to 4876 m above sea level, is thickly populated where about 43% of the total population of the nation resides. Due to hill and high hill topography, the terrain is rugged, uneven, and hard for farming and easy access to other developmental means; however, it is also known as a very fertile part consisting of areas such as *Kathmandu*, *Dhading*, and *Pokhara*. The *Terai* region is plain and covers 23% (34,019 square kilometers) of the total land area. It has highly fertile land where nearly 50% of the population lives (ibid).

The national household food security percentage of Nepal is only 48.2, and in rural areas it is about 38.8. The severely food-insecure households are about 10% (NDHS, 2016). The mountain region of Nepal suffers with high food insecurity, where only 38.4% of households are considered as food secure compared to *Terai* where similar data is around 51%. In total, the severely food-insecure households in mountain regions are about 13.8% compared to 9.2% of the *Terai* region. Province-wise, the Karnali Province has the lowest level of food security where only 22.5% of households are food secure and severely food-insecure households are about 17.5% (ibid).

Except for the high hill region, other regions (hill and *Terai*) are surplus in major cereals. Among 16 high hill districts such as *Taplejung*, *Sankhuwasabha*, *Solukhumbu*, *Dolkha*, *Sindhupalchowk*, *Rasuwa*, *Manang*, *Mustang*, *Dolpa*, *Mugu*, *Humla*, *Jumla*, *Kalikot*, *Bajura*, *Bajhang*, and *Darchula*, 12 districts, except *Sankhuwasabha*, *Solukhumbu*, *Dolkha*, *and Sindhupalchowk*, have a food deficit situation. Nepal is in a food surplus situation at the national level. It is positively indicated that food security can be achieved by balancing the cereal distribution system within the country. However, this is not indicative of nutrition security in the nation. There is a need for production and utilization of various traditional/local grains including diversified foods including pulses, vegetables, fruits, eggs, milk, fish, and meat in cereal-based diets for nutrition security. So,

certainly, there is a need for the promotion of underutilized food grains in the country for sustainable nutrition security (NDHS, 2016).

3.2 Historical overview

In the past, the Nepalese household food plate consisted of many different edible food grains and plant species in the high hill region. However, due to continuous changes in technology and commercialization of local food systems, food habits, policy priorities, and exposure to various media along with the movement of people, traditional crops are largely neglected and/or underutilized today (Adhikari et al., 2017). In this region, millets, sorghum, buckwheat, barley, and beans are some of the grains mostly considered as underutilized, and these were habitually used by community from large areas of high hills and mountains. However, these grains continue to be cultivated and consumed by minor localities because of habituation and health benefits. After decades of negligence, many researchers and nutritionists are promoting these underutilized grains as good food for health and nutrition security in place of rice, which has now become a staple for most people. Mostly, tourism sectors are promoting these foods as local and nutritious in their cuisine that provides an opportunity for income generation and expresses a typical identity through food.

Nepalese farmers have historically grown several species of food crops including many varieties of millet, barley, and buckwheat. These food crops were primarily consumed by the growers, and remaining was sold in the local market for income generation. Even today, these food crops are major sources of nutrition for many communities in Nepal. Yet, people are shifting toward rice as their main staple food instead of high-value food grains such as barley, buckwheat, or other millets.

3.3 Cultural value

Food has always been an expression of love, affection, happiness, and sorrow. It is also a means of welcoming guests and respecting them. Traditional food systems are now being recognized as a cultural identity of the Nepalese. It is a powerful medium of conservation of the local ecosystem and traditional local food. Local people's skills and knowledge have transferred over time, and new generations are eagerly modernizing these skills acknowledging the culture and tradition of the society/place/ethnicity. For example, buckwheat noodles are excellent food for young as well as aged persons in the mountainous areas of the Hindukush region including Nepal. Similarly, *dhindo*,[1] *roti*, *pakoud*, and cakes made by buckwheat and millet flour are in demand even in good modern restaurants in the name of traditional cuisine. *Satu*[2] prepared by barley

[1] Soft porridge made by flour cooked in hot water.
[2] *Satu* is prepared by roasting and grinding barley and adding sugar, cardamom, and cinnamon powder.

flour is considered as a sacred food and especially offered to God *Bishnu* (during the festival of Sakranti) and Siva (on the day of *Akcchyaya Tritiya*, a religious auspicious day) with juices. Barley and buckwheat are taken as holy food by pure vegetarians, priests, and common people even during fasting, and this reflects the sentiment of connectivity with health, land, tradition, and acknowledgment of their own produce. Culturally, millet is considered as inferior food grain and hardly used by traditional higher caste people: *Brahmin* and *Chhetri*. However, now there is no such taboo for millet, and they are equally being used by all.

3.4 Value addition on nutrition security

With respect to food and nutrition security, Pearl S. Buck (2018) stated that "A hungry man cannot see right or wrong. He just sees food."[3] Previously, our focus was only on food rather than its quality or diversification to address overall food and nutrition security. Asia and Pacific Region have 79 million children, or one child in every four below the age of five, suffering from stunting and 34 million children are wasted, while 12 million suffer from severe acute malnutrition with drastically increased risk of death (FAO, 2018). More than half of the world's malnourished children live in Asia and the Pacific. It is also home to the fastest growing prevalence of childhood obesity in the world. This paradox is attributed to the nutrition transition with children increasingly exposed to cheap and convenient unhealthy processed foods rich in salt, sugar, and fat but poor in essential nutrients. This double burden of malnutrition sees undernourished and overweight children living in the same communities and households, and it can even occur in the same child (FAO, 2018).

Nepal Living Standard Survey (2011) found that 38% Nepalese live with less than the minimum daily requirement of calories required for a healthy life. However, a significant disparity prevails between ecological zones, development regions, and rural–urban divisions. Compared to 24% of *Terai*, the population living with insufficient calorie intake is higher, that is, 36% and 38% in hilly and mountainous areas respectively. Disparity is evident in the extent of incidences of low-calorie intake among various landscapes and provinces[4] ranging from 24% in Province 1%–36% in Karnali Province. By provinces, the two western provinces—Karnali and Province 7—are more calorie-deficient compared to the other four provinces, 1, 2, 3, and *Gandaki*. Thus hilly and mountainous areas of the western parts of Nepal are worst hit by food insecurity and insufficient calorie intake.

[3] Quotation drawn from the site https://www.pinterest.com/pin/365213851007853526/visual-search/?x=16&y=16&w=530&h=530.

[4] The Constitution of Nepal (2015) has declared the provision of seven provinces in Nepal.

Nepal is struggling to reduce a very high rate of child malnutrition (36% and 27% of children under five are stunted and underweight, respectively—NDHS, 2016) since decades. About 17% of Nepali women belonging to the reproductive age group have chronic energy deficiency with a body mass index[5] of less than 18.5, and 41% of them are anemic. Similarly, women and children also suffer from vitamin and mineral deficiencies that can be emphasized by the fact that vitamin A deficiency is the cause of deaths of approximately 6900 children in Nepal each year. Nearly 21% of children are born with low birth weight reflecting gestational malnutrition (ibid). Diabetes and cardiovascular disease prevalence are serious and show an increasing trend. Iodine deficiency in pregnancy causes more than 200,000 babies a year in Nepal to be born mentally impaired and intelligence quotients that are 10−15 points lower than those who are not deficient.

The proportion of food-insecure households in the mountain areas of Nepal is significantly higher than in the plains and in comparison to the national level. In mountain areas, 59.5% households are food insecure and in hills 52.8%. Similarly, the consequences of food insecurity in the form of child stunting, wasting, and underweight are also very high: in mountains—52.9%, 10.9%, and 35.9%; and in hills—41.1%, 10.6%, and 26.6%, respectively (Rasul et al., 2019). The growing trend of consuming refined white rice replacing high-value grains is affecting the health of people of these regions, especially children and women. The result of the household survey 2016/17 (Government of Nepal, 2018) has indicated that Nepalese consume 3.5 kg of millet, 0.1 kg of buckwheat, and 0.1 kg of barley per year in comparison to 86.8 kg of rice. These data draw serious attention for making every effort to encourage the production and consumption of high-value grains in a systematic way to reduce undernutrition in these high hills and mountain regions. Below is a brief discussion regarding some of the underutilized high-value food grains of Nepal, which are significant for their nutrition and health.

3.5 Millet (*Pennisetum glaucum*)

Millets are small-seeded grains, originated in Africa and grown extensively in Africa, Asia, India, and Near East as a staple grain. There is evidence of the cultivation of millet in the Korean Peninsula around 3500−2000 BCE a very ancient religious book *Yajurveda* has mentioned about millets and indicates that production and consumption of this grain was an indigenous practice especially in the Asian region (around 4500 BCE). Before the Green Revolution, millets made up around 40% of all cultivated grains (contributing more than wheat and rice). However, since the revolution, the production of rice has doubly increased and wheat production has tripled so

[5] Body mass index (BMI): BMI=weight(kg)/height $(m)^2$.

millets were less valued for production. There are many types of millets produced in the globe; however, here, only popular varieties of millets that are cultivated in relation to hills and mountain regions of Nepal are discussed.

3.6 Finger millet (*Eleusine coracana*)

Finger millet (*Ragi*) is the fourth most important crop of Nepal after rice, maize, and wheat in area and production. It occupies an average of 7.9% (268,050 ha) of the total area covered by cereal crops and accounts for 3.3% (308,488 mt) of total cereal production (MoAD, 2015). It has been cultivated from Kachorwa (Terai, 60 m) of *Bara* district (Amgai et al., 2004) to Burnouse of Humla district (High Hill, 3500 m) in Nepal with cultivation records in all 77 districts. The major production districts of millet are *Khotang*, *Sindhupalchok*, *Baglung*, *Syangja*, *Kaski*, *Gorkha*, and *Sindhuli*. It is an important crop in terms of food and nutrition security of Nepal, especially for both mid-hill and mountain areas. Nepal produced a total of 306,704 tons of millet in the year 2017, of which 77% was from hill districts and 20% from mountain districts (Factfish, 2018).

In the mid-hill agroecosystem, the crop is important for different traditional food uses and is strongly associated with a maize-based cropping system. Finger millet is important for human food and animal feed and is included in various cropping patterns. In addition, the crop is widely tailored to marginal lands in high hill with cold stress and also well adapted to lands where low fertile and dry soils are the general characteristic stresses. Its cultivation has been found with low infestation of crop pests and diseases. So, this millet grain can be stored for years without any losses by pests and insects; that is why it is a suitable and preferred food grain in famine/drought-prone areas. It is especially valued for filling specific niches or needs because it often succeeds in stressful situations where other crops generally fail to grow.

After rice, finger millet is another crop that produces grain for human consumption and straw for cattle fodder. Several food preparations are made from finger millet. The most commonly eaten varieties are a semiliquid cooked item *khole*,[6] a thick porridge locally known as *dhindo* and *roti*.[7] Other improved but modern look-alike food items can be made with millet flour such as pancakes, cake, cookies, noodles, and super flour (MoAD, 2013). Finger millet is also popular for making fermented beverages—beer and local alcohol among certain communities of the country. As much as one-fourth of the total production of finger millet in Nepal goes into fermented alcoholic beverages *raksi*.[8] Finger millet is one of the most important food crops of the

[6] Finger millet flour cooked in water adding salt or sugar.
[7] Thick or thin bread cooked in flat iron pan.
[8] Alcoholic drink locally made by millet.

economically suppressed but physically hard-working people. It is appreciated by the people because it is digested slowly (apparently due to its rather high fiber content) and thereby furnishes energy for hard work throughout the day after being eaten as a single morning meal (Seetharam et al., 1986). The harvest residue of finger millet particularly green, as well as dry straw, is extensively used for animal feeding.

Finger millet is tasty, mildly sweet with a nut-like flavor, highly nutritious, nonglutinous, and is good for health. Finger millet is an excellent source of fiber, calcium, iron, manganese, and methionine—an amino acid lacking in the diets of hundreds of millions of the poor who live on starchy foods such as cassava, plantain, polished rice, and maize meal (FAO, Statistics, 2005 Data). Finger millet provides 320 kcal, 7.0 g protein, 11.2 g of fiber, 364 mg of calcium, and 4.2 mg of iron per 100 g. It also provides other vitamins and minerals (Longvah et al., 2017). Different from myth, millet is not an acid-forming food and therefore is soothing and easy to digest. In fact, it is considered to be one of the least allergenic and most digestible grains available, and it is considered as hot grain that helps to keep the body warm in cold weather. Consuming millet helps to keep skin healthy, reduces wrinkles, discoloration, and pigmentation, keeps bones healthy, helps in weight management (Railey, 2019a,b), and is a heart-healthy choice, which acts as a cofactor for more than 300 enzymes. The seeds are also rich in phytochemicals, including phytates, which is believed to lower cholesterol and is associated with reduced cancer risk (ibid).

Due to so-called modernization and attraction toward refined processed foods, millets are looked down upon as "coarse grains," though their ancestors lived on them. Food habit is changing and many valuable traditional grains such as finger millet, which are far better than refined grains are utilized less. As a result, millet production has been reducing over the years (315,067 mt. tons in 2012 to 306,704 mt. tons in 2017) (Fact fish, 2018).

3.7 Chino (*Panicum miliaceum*)

In high hills and mountainous areas of Nepal, *Chino* (*Proso* Millet) is considered as a second-most important crop of the millet group from the food security point of view. However, it ranks third after pearl millet and foxtail millet in total global millet production (about 5×10^6 tons of grain per year). Literature shows that this grain was grown first as a domestic crop in Northern China at least 10,000 years ago (Liu et al., 2016). Later, around 3000 years ago, it was introduced as a cereal in Europe. Now, it is cultivated as a staple grain in several locations such as the high belt of Afghanistan, Bhutan, China, India, Nepal, and Pakistan as well as in Central Asia. It is comfortable for farmers to not wait longer for harvesting because of its short cycle (60−90 days) of growing and maturation. It grows well in many varieties of soil and climatic conditions and can be cultivated in altitudes up to 3500 m (Baltensperger,

2002). The crop has a climate-resilient capacity and could survive in low water and nutrient requirements, allowing it to be cultivated at a wide range of altitudes, even on marginal land where other cereals can hardly survive (Lagler et al., 2005).

Chino grain is being utilized for many local food varieties such as *bhat* (boiled), *kheer* (sweet pudding cooked in milk), *dhindo* (porridge), roti (pancake and flatbread), and *raksi* (locally produced alcohol). In Nepal, *proso* millet is grown in 1900 ha with a productivity of 0.81 t/ha (DoA, 2017). Major districts producing *proso* millet are Mugu, Dolpa, Humla, Jumla, Kalikot, Bajura, and Jajarkot (Ghimire et al., 2017). It is considered as a healthy and nutritious food because of its nutritional composition with 11% protein (significant amounts of essential amino acids, particularly those containing sulfur, methionine, and cysteine), 4.22% fat, 72.9% carbohydrate, 1% fiber, and 3.25% minerals such as iron, calcium, and phosphorus (Ministry of Agriculture Development, 2013). Being gluten-free and easily digestible, it is considered as a perfect food for gluten-intolerant people. *Chino* millets are rich in micronutrients such as niacin, B-complex vitamins, vitamin B_6, and folic acid (Hulse et al., 1980; Pathak, 2013). This grain contains a good amount of lecithin, which provides brilliant support to the health and normal functioning of the nervous system by helping to reestablish nerve cell functions, regenerate myelin fiber, and intensify brain cell metabolism. Although nearly unknown for urban habitat, now it is considered as the crop of the future in the context of climate change with great potential to cope with food insecurity in remote areas of the country.

3.8 Kaguno (*Panicum italicum*)

Kaguno falls under the millet family and is popularly known as Foxtail Millet. It is a gluten-free grain and the second-most commonly grown species. It is one of the oldest cultivated millet of Nepal generally grown in high hill areas. Characteristically, it has a low water requirement, although it does not resist drought conditions well due to a shallow root system. *Kaguno* is preferred by hill and high hill people due to its short growing season, higher yield potential, disease resistance, and attractive panicles that could be considered as an important genetic resource to develop climate-resilient varieties to cope with the adverse effects of climate change (Ghimire et al., 2018). Its maturation time is almost 65–70 days. This millet can be planted when it is too late to plant most other crops. It is a gluten-free grain, and the structure is very similar to rice paddy. In Nepal, it is used as a food grain and is cultivated in high hills and mid hills mainly in the districts of the *Karnali* Province and *Kaski and Lamjung of Gandaki* provinces. There is a practice of cultivating *Kaguno* as a monocrop in *Ghanpokhara* whereas *Karnali* province farmers cultivate it as a mixed crop together with finger millet. Currently, the trend of cultivation and production of *Kaguno* is decreasing all over

Nepal. Farmers find the process of weeding and postharvest handling to be more tedious. Shortage of labor has demotivated farmers to grow this grain.

Kaguno is very easy to consume any time of the day either as a snack or staple food. Young/immature panicles can be roasted and consumed. Indigenous people carry it as travel food while going for wild honey hunting, which is one of the unique features of Nepal, especially among the *Gurung* community (Gurung, 2016). Popular dishes of *Kaguno* are *bhaat*, *kheer* (porridge cooked in milk), *selroti* (deep-fried bun-like product made by mixing *kaguno* flour with ghee and sugar), and *raksi* (local liquor, made by mixing with finger millet).

Kaguno is highly nutritious and superior to rice and wheat grain. This grain has a low glycemic index with high fiber content with hypoglycemic and hypocholesterolemic action that is extremely beneficial for preventing cardiovascular diseases and diabetes. Despite its importance for local food security and nutrition, little research has been done in foxtail millet making it a neglected and underutilized species from a research and development perspective (Hariprasanna, 2016). As per the food composition table (MoAD, 2012), *Kaguno* has 12.3% protein, 60.9% carbohydrate, 4.3% fat, and 3.3% minerals. It is also a rich source of micronutrients.

3.9 Buckwheat (*Fagopyrum esculentum*)

In the series of important staple food grains of Nepal, buckwheat comes sixth after rice, wheat, maize, finger millet, and barley. It is cultivated widely on marginal land of 61 out of 77 districts of Nepal ranging from 60 to 4500 m altitude such as *Rukum*, *Rolpa*, *Jajarkot*, *Dolpa*, *Humla*, *Jumla*, *Dolakha*, *Solukhumbu*, *Mustang*, *Kalikot*, *Kavre*, *and Okhaldhunga* districts. *Karnali* zone is popularly known for abundant cultivation of this grain. Basically, it is a summer crop of hills (high altitude >1700 m), autumn and spring crop in mid-hills (600−1700 m), and winter crop in *Terai* (Luitel et al., 2017). In recent times, it has been grown extensively in some *Terai* districts such as *Chitwan*, *Jhapa*, and *Nawalparasi* for commercial purposes especially for green vegetables that have very high demand due to flavonoid (rutin) content. It can resist the poor, infertile, and acidic soil, as well as nutrients, moisture, and heat stress with wider adaptability so its cultivation is easy for farmers. These rare characteristics of buckwheat show great potential as a future crop for food security among food-deficit areas of Nepal. Buckwheat is cultivated in 10,510 ha area with a production of 10,355 tons/year and a yield of 0.983 tons/ha (ibid).

Popularly known as a poor man's crop, buckwheat is taken as an alternative cereal grain for the habitat of high hills ensuring food security year-round. Due to the short duration of cropping and easy adaptation to various climatic situations, buckwheat is considered as an imperative food grain. There are many varieties of buckwheat found in Nepal such as *Barule*, *Bharule*, *Chuchche*, *Chode*, *Kalo*, *Seto*, *Tilkhude*, *Tite*, *Tote*

Phaper, *Batule*, *Bharule*, *Mithe*, *Murali*, and *Tilkhunde*. Sweet buckwheat varieties are generally grown in mid-hill and *Terai*, but Tartary buckwheat varieties are grown in higher altitudes. Buckwheat is a drought-tolerant crop and requires approximately 100 mm rain for its whole cropping life. Although buckwheat is a short duration crop, its flowering period is more than 30 days, which is very useful for bee-keepers to collect good quality honey. The productivity buckwheat varies from district to district and also depends upon the type of local variety (Luitel et al., 2017).

Buckwheat is a pseudocereal/minor food, or cash crop but it is one of the major staple food crops for the high mountainous region of Nepal. Buckwheat is a multipurpose crop and has been cultivated for its use as staple food, animal feed, vegetable, soup, beverage, and medicine. All parts of buckwheat plants are used in a variety of ways. The leaf contains rutin, which is an important pharmaceutical product used as tea brew and to treat hypertonia; flowers that bloom for about a month produce good quality nectar for honey; grain is the staple food; hulls of grain are used for making pillows; straw is good source feed for livestock; and green plants are used as green manure.

Many food items prepared from buckwheat are popular in Nepal such as *dhindo* (thick porridge), *roti* (bread), *momo* (dumpling), *lagar* (very thick bread), *dheshu* (bread thicker than *lagar*), fresh vegetables, dried vegetables, *chhyang or jaand* (local beer), *raksi* (alcohol), salad (leaves), pickle (fresh and dry leaves), soup, *ryale roti*, noodle, *sel roti*, *bhat* (rice), sausage, *dorpa dal*, tea, vinegar, jam, macaroni, biscuit, cakes, *mithai* (sweet), *haluwa*, *puri*, *puwa*, *bhuteko Phapar* (roasted grain), *satu*, *phuraula*, porridge, and *pakauda*. Nepalese from mountainous regions prefer *dhindo* than other items because of its specific sticky taste (Luitel et al., 2017).

Common buckwheat is mostly used as bread pancake, which is a delicious item for the tourists in the trekking root of Mustang. Thick porridge prepared by mixing the flour of bitter buckwheat with *Uwa* (Oat) or finger millet (in the ratio of 1: 3) is the common food of poor people in the hilly area. Buckwheat has a superior nutritional value because of balanced amino acids and high mineral content. Hundred grams of buckwheat provides 343 kcal along with 12.5% protein, 29% dietary fiber, and 4.7 mg iron. Similarly, it contains significant amounts of micronutrients, that is, riboflavin, vitamin B_6, magnesium, phosphorous, and potassium, which is essential for our bodily function (Alvarez-Jubete et al., 2010). It is an excellent source of lysine that is typically deficient in cereals. Due to its therapeutic value, buckwheat is now in demand, especially in urban areas. Rutin is an important bioactive component present in buckwheat that works as a strong antioxidant and can fight inflammation and protect the heart and brain. It also reduces bruising and vein issues (Ana Aleksic, 2018). Buckwheat diet is suitable for most of the noncommunicable diseases that have preventive action especially on leg edema, high blood pressure, high cholesterol, and cardiovascular disease.

Traditionally, buckwheat flour paste is applied as a curative treatment for wounds and burns, and its semicooked flour is used orally to cure cold, cough, jaundice, and

fever. Similarly, fresh flour is used for dandruff treatment as well as for stopping hair fall, curing pimples, and skin scratches. Similarly, tender twigs and leaves of wild buckwheat are used in dysentery, pneumonia, and cholera. It is believed that soaked buckwheat flour is harmful to internal worms. Buckwheat grain flour is given regularly to goat and sheep in the hill and high hill areas. This grain is considered as a holy food, so Nepali Hindus prefer to eat food made from buckwheat during the fasting period or for religious activities (Ana Aleksic, 2018).

3.10 Barley (*Hordeum vulgare*)

Barley (*Jau* in Nepali language) is considered as an important crop culturally; however, its consumption as food grain is very low in Nepal. Barley is cultivated in approximately 26,000 ha (<1.5% of the total cultivated area for grain) of land, which is a very small area for food grain. Moreover, 40% of hill and 37% of mountainous area is under barley cultivation (Basnyat, 2015). It is cultivated starting from the low land of *Terai* at an altitude of around 4300 m (in *Dingboche* on the route to Everest). However, at higher altitudes, only barley grows successfully rather than buckwheat. It has an amazing quality of growing in high altitudes under extreme weather conditions. Barley tolerates poorer soils and lower temperatures better than wheat. In 2017, the barley yield for Nepal was 11,147 mt/ha. Although the yield of barley in Nepal fluctuated substantially in recent years, it increased through 1968–2017 ending at 11,147 mt/ha in 2017 (World Data Atlas, Grando and Macpherson, 2005).

The barley-growing season depends upon the geography of Nepal. Barley is grown as a winter crop in the hilly areas, whereas in the mountainous areas, barley is planted during spring. Barley that is grown as a winter crop matures earlier than wheat (at least a month), which allows plenty of time for planting a summer crop such as maize, rice, or buckwheat. In alpine climates, barley is grown as a spring crop that takes up to 10 months for maturation. Barley is valued not only as a grain, but its straw is preferred as a livestock feed, and the value of this straw is equal to that of the grain in areas where livestock feed is very limited. In the past, this crop had much economic value because it was traditionally traded with Tibet for salt.

Due to a massive impact of climate change and people's preferences, barley yields are declining gradually both in the hills and in the mountains. If we observe the consumption pattern, of total consumption, 70%, 16%, and 14% is consumed by mountainous, hilly, and *Terai* people, respectively. A naked type of barley, which is locally called *Uwe or Karu*, is cultivated extensively in mountainous areas and is valued as a highly nutritious food (Khadka).

Barley has nutritional benefits that provide both physical and spiritual sustenance to the people/especially of Nepal. It is considered as a rich source of vitamins B and micronutrients. It has plenty of fibers and therefore is very good for stomach muscle

health and bowel movement, and it regulates blood glucose levels. There is also some evidence that consuming barley over a long period may help to decrease blood cholesterol.

Mostly people eat barley in the form of bread (*roti*), *satu* (prepared by roasting and grinding), and barley water during illness. In the Nepalese community, *satu* is offered especially to the God Vishnu and Shiva during the holy days of *Sakranti* and *Akcchaya Tritiya*. It is utilized as a livestock feed, for malt and for preparing foods. The roasted grains are coffee substitutes mostly used by hill and high hill people. This grain is beneficial not only for its nutritive value but also as a remedy for certain diseases. It is common knowledge that barley can be effective in the treatment of diabetes, stomach and colon issues, and kidney problems. It is also taken as a high-calorie food.

Nowadays, in many villages of the Himalayan region, instant noodles have replaced the eating of *Tsampa* (roasted barley) as a staple diet or snack especially among the younger generations. It is higher in rural areas than in cities mainly due to the ease of preparation and impression of having good food. However, for certain social occasions, such as gatherings for marriages and funerals, barley preparations are preferred. This grain is considered holy and is an essential offering to God during worship/*pooja*.

3.11 Future prospects

All high-valued grains mentioned previously that are widely cultivated in high hills and mountainous areas are valuable from the nutrition and food security context. Various studies have shown that low-quality diets are responsible for undernutrition, especially protein, calorie, and micronutrient deficiencies, which are high among mountain and high hill people. This situation could be improved through massive production and promotion of these high-value grains along with local but modified recipes. Similarly, these grains are climate-resilient and easy to store; however, more storage facilities and minimization in aflatoxin that is standardized by Food Standard[9] of Government of Nepal and Food Law could be a good action to improve the food security level of those areas of Nepal.

Moreover, more research on aflatoxin content in traditionally stored millets, buckwheat, and barley is needed for food safety and health for its wide promotion and use. Besides, nutritive value analysis is another important action highly recommended for better utilization of those grains by reducing local myths and negative fads. Identification and use of easy but smart postharvesting technology are also essential for better promotion of these grains. Similarly, improved storage facilities and safety measures against the climate as well as pest rodents and processing technology need to be addressed as an institutional priority for future prospects.

[9] Government of Nepal, Food Standard, Published in Nepal Gazette 2057.10.23.

3.12 Conclusion

Due to climate change and the need for sustainable development, traditional food grains such as millet, barley, and buckwheat are becoming an integral part of the food system of high hills and mountain areas. The cultivation and consumption of traditional food crops, however, are facing decreasing trends. Industrial farming patterns tremendously promote three grains—wheat, maize, and rice responsible for providing more than half of the global dietary energy supply, which is the cause for underutilization of many valuable grains despite their high nutritional and traditional value.

Low priority for local food grains, increased choices and easy access to ready-to-eat foods, and low awareness about nutritional needs and their sources have reduced the use of these valuable grains, and they are on the verge of disappearance. Farmers need to be motivated through policy and programming for cultivating and consuming these high-valued grains. Massive awareness campaigns with local and modern recipes originally made up of barley, buckwheat, and millets need to be initiated to protect and promote these underutilized food grains. These food grains not only supplement the necessary nutrients to improve the nutritional status of the people but can ensure household food security for more days. Moreover, one of the major attractions of tourism sectors is traditional food varieties with local grains and products, which has provided tremendous opportunities for encouraging more production and consumption. Hence, advanced technology for easy postharvest activities and advanced research for minimizing the attack of pests and aflatoxin contamination are also seen as future prospects of these food grains.

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