REVIEW ARTICLE Agricultural Reviews, Volume 45 Issue 1: 96-102 (March 2024)

Diversity of Traditional Grain Legumes of Himalayan Region of Uttarakhand: A Review

Madhulika Pandey[1], Nirdesh Kumar[2]

10.18805/ag.R-2362

ABSTRACT

Due to distinct agro-climatic, geological and edaphic characters in hilly region of Uttarakhand owing the large genetic diversity of crop species, vegetation and indigenously developed land races. Due to less water and other external inputs requirement traditional legume crops are well suited to rainfed condition of hilly region of Uttarakhand. These traditional legume crops are rich in taste, odour, colour, nutritional values, medicinal and soil fertility enhancement characteristics. But due to increased population pressure, changed food habit, lack of innovative agricultural technology, environment conservation policies and increased market forces a shift from traditional to modern intensive agriculture system during the past few decades resulted in decline in area and production of traditional legume crops. For increasing the area and production (61.18 thousand ha and 53.63 thousand ton) of traditional legume crops, a suitable long-term strategies and management practices for strengthening the distribution facilities for produce and availability of market for conservation of traditional legume crops needs to be worked out in the state.

Key words: Cereals, Crop rotations, Cropping pattern, Genetic diversity, Traditional legume crops.

Uttarakhand state is also known as “Devbhoomi” due to its scenic beauty, temples and religious places. In Central Himalayan region, agriculture is main occupation and provides livelihood security to the major proportion of rural population. Nearly 80% land of Uttarakhand is hilly and more than 85% agricultural land is rainfed (Nautiyal and Datta, 2018). Himalayan region of Uttarakhand is characterized by distinct agro-climatic, geological and edaphic characters. The variation in altitude and climate owing to large genetic diversity of crop species, vegetation, indigenously developed land races, cropping pattern and crop rotations. In Himalayan region, wheat, rice, maize, millets, barley, few species of pulses, oilseeds, potato, *Ramdana* (Amaranth), *Kuttu/Ugal* (Buckwheat) *etc.* are important cash crops. However, Uttarakhand has more area under millets and pulses. There are many cultivated species and varieties of legumes like *Rajma* (Kidney bean), *Lobia* (Black-eyed peas), *Bhatt* (Black Soybean), *Gahat* (Horse Gram), *Naurangi* (Cowpea), *Urad* (Black Gram), *Mung* (Green Gram), *Arhar/Tur* (Pigeonpea), Masoor (Lentil), *Lobia* (Black-eyed peas), *Rains* (Adjuki beans) and *Raiyas/Bhotia* (Rice bean) by the farming communities. The productivity potential of pulses in Uttarakhand is high as compared to the national average as mentioned in Table 1.

Importance of legume

The legumes or pulses belong to the family Fabaceae, sub-family Papilionaceae. Legume crops include important grain, pasture and agro-forestry species and play significant role in providing agricultural, food, nutritional and livelihood security to the hill farmers. Legume crops are used for human, animal consumption, cultivated as ornamental crops, living fences and wind breaks. It is also used as fuel-woods, timber, paper production, oil production, sources of chemicals and medicines (Lewis *et al*., 2005). Legumes consumed as food grain and vegetable (leaves and pods) are valued for their nutrient-rich products (Dixon and Sumner, 2003). In India, frequency of pulses consumption is much higher than any other source of protein, which indicates the importance of pulses in their daily food habits. About 89% persons consume pulses at least once a week, while only 35.4% persons consume fish or chicken/meat at least once a week (IIPS, ORC Macro, 2007). Its stems, leaves, mature and immature pods and seeds can be used as animal feed due to its high-protein content (Asif *et al*., 2013). All cultivated legumes directly supply biologically fixed nitrogen and indirect source of manure based nitrogen inputs to maintain soil productivity (Giller and Cadisch, 1995). Peoples *et al*., 2009 reported that a well developed nodulated root system with effective Rhizobia produced about 30 to 40 kg of N per tonne of biomass produced. In rotation with cereals, legumes provide a source of slow-release nitrogen that contributes to sustainable cropping systems. The improvement in the

[1]Institute of Medicinal and Aromatic Plants, VCSG Uttarakhand University of Horticulture and Forestry, Mehalchori, Gairsain-246 431, Uttarakhand, India.
[2]G.B. Pant University of Agriculture and Technolgy, Pantnagar-263 145, Uttarakhand, India.

Corresponding Author: Madhulika Pandey, Institute of Medicinal and Aromatic Plants, VCSG Uttarakhand University of Horticulture and Forestry, Mehalchori, Gairsain-246 431, Uttarakhand, India. Email: pandey.madhulika@hotmail.com

How to cite this article: Pandey, M. and Kumar, N. (2024). Diversity of Traditional Grain Legumes of Himalayan Region of Uttarakhand: A Review. Agricultural Reviews. 45(1): 96-102. doi: 10.18805/ag.R-2362.

Submitted: 31-08-2021 **Accepted:** 04-06-2022 **Online:** 20-09-2022

production of these crops will therefore contribute substantially to better human nutrition and soil health (Popelka *et al*., 2004).

Legume cropping in Himalayan region of Uttarakhand

In hilly region of Uttarakhand farmers practiced low input agriculture spend almost nothing on improved seed, organic fertilizer, irrigation and pest control measures *etc.* The cropping pattern in Himalayan region is built around three crop growing seasons *viz*. *Chaumas or Baskat/Kharif* (Rainy Season) (Mid-June to October), Hyund or Sheetkal /*Rabi* (Winter Season) (November to February) and *Purior Kharso* /*Jayad* (March-Mid-June). In Uttarakhand most of the agricultural land under the rainfed condition (85%) and only about 15% area irrigated (Maikhuri *et al*., 1996). In irrigated land wheat and paddy are the major crops and in rainfed condition various traditional crops like *Mandua* (Finger millet), *Cholai* (Amaranth), *Kuttu/Ugal* (Buckwheat), *Cheena* (Proso millet), *Jwar/Bajur* (Sorghum), *Bhangjee*ra (Perilla) and various legume crops *Rajma* (Kidney bean), *Lobia* (Black-eyed peas), *Bhatt* (Black Soybean), *Gehat* (Horse Gram), *Naurangi* (Cowpea), *Urad* (Black Gram) and *Mung* (Green Gram), *Arhar/Tur* (Pigeonpea), Masoor (Lentil) are cultivated and hence they play a vital role in conserving crop diversity in hilly region of Uttarakhand (Table 2).

Table 1: Productivity (Kg/ha) of major crops (2019-20).

Crop	India	Uttarakhand
Rice	2566	2493
Wheat	3314	2667
Maize	2881	1824
Total coarse cereal	1836	1250
Gram	1021	563
Total pulses	776	877
Rapeseed and mustard	1349	907
Total oilseeds	1187	970
Total food grain	2206	2168

Source: Agricultural Statistics at a Glance 2021, Department of Agriculture, Cooperation and Farmers Welfare.

In irrigated condition farmers take 2 to 3 crops per year. Most of the grain legumes are cultivated under rainfed condition. Indigenous cropping system involves the sowing of legumes as mixed crop with traditional non-legumes like *Jhangora* (Barnyard millet), *Mandua* (Finger millet), *Cholai* (Amaranth), *Kuttu/Ugal* (Buckwheat), *Cheena* (Proso millet) *etc.* into a single terraced field. This system of sowing of mixture of multiple crop seeds into a single terraced field during in the *kharif/chaumasa* or monsoon season is locally known as "*Barahnaja*". The term indicates that about 10-12 crops are grown together into a single terraced field which enables the farmers to supply different kinds of foods, maintaining crop biodiversity, restore soil fertility (by the use of leguminous plants), reduces the infection of pests and pathogen and to obtain maximum and diverse yield on per unit area basis (Ghosh and Dhyani, 2004).

For hilly farmer's cultivation of traditional legume crops play an important role in providing agricultural, nutritional and livelihood security. It is considered as an integral part of traditional cropping system for building up the soil fertility. Cultivation practices of legumes are easy and do not require much inputs, labour and attention like another crops. Production potential of legume crops is directly depends on the climatic condition in hilly region of Uttarakhand. Due to less water requirement legume crops are well suited to rainfed condition in comparison with another cereal and oilseed crops. These Himalayan traditional legume crops

Table 2: Major cultivated traditional legume crops of Uttarakhand.

Botanical name	Common name	Local name	Altitude ranges (m asl)
Cajanus cajan	Pigeon pea	*Arhar/Tor*	Up to 1200 m
Canavalia gladiate	Sword bean	*Sema/Sem*	Up to 1500 m
Cicer arietinum L.	Chick pea/Gram	*Chana,*	Up to 1500 m
Glycine max L.	Soybean	*Soya bean/ Bhatt*	500-1500 m
Glycine soja	Wild soybean	*Kala bhatt*	500-1500 m
Lens culinaris	Lentil	*Masur*	Up to 1500
Macrotyloma uniflorum	Horse gram	*Gehat*	Up to 1000 m
Phaseolus lunatus	Lima bean/Butter bean	*Vilaiti Sem/ Sunta*	Up to 1600 m
Phaseolus vulgaris	French bean/Common bean	*Razma/Cheemi,*	Up to 3000 m
Pisum sativum	Pea	*Matar*	Up to 2000 m
Vicia faba	Broad bean/Faba bean	*Bakla/Kalamatar*	Up to 1500 m
Vigna aconitifolia	Moth bean	*Bhringa*	Up to 2000 m
Vigna angularis	Adzuki bean	*Rains/Guruns*	Up to 2000 m
Vigna mungo	Black gram	*Urd*	Up to 3000 m
Vigna radiata	Green gram	*Mung/Pessana*	Up to 1200 m
Vigna umbellata	Rice bean	*Bhitia dal/ Naurangi*	Up to 1500 m
Vigna unguiculata	Cow pea	*Sonta, Lobia*	Up to 2500 m

Source: Pande *et al.,* 2016.

have high ecological, economic potential and thrive well in adverse environmental conditional with low external inputs (Maikhuri *et al*., 1996). There are many land races of traditional legume crops as described by various authors mentioned in Table 3.

These traditional legume crops are also play an important role in cultural and traditional life of the local communities of Himalayan region of Uttarakhand. These traditional legume crops are used for preparing the traditional dishes *viz. fana, bhatwani, chainsa etc.* during marriages, festivals and other auspicious occasions (Table 4). These traditional legume crops are grown for their taste, odour, colour, nutritional values and for their medicinal and soil fertility enhancement characteristics.

Genetic erosion of traditional legume crops

Due to low external inputs and less water requirement traditional legume crops are well suited to rainfed condition of Himalayan region of Uttarakhand but during past few decades due to climatic, cultural and socio-economic changes in local farming communities area under cultivation of pulses is continuously declining which ultimately affects productivity potential of traditional legume crops. Farmers in hilly regions experience low productivity potential and resource use efficiency due to short growing season, small land holdings, moisture stress, poor soil conditions, remoteness, inaccessibility, poor production, post-production management, lack of market development and entrepreneurship. All these natural and socio-economic constraints have led to under-utilization of resource bases in the hills. Maikhuri *et al*. (2001) also reported a variety of changes in traditional Himalayan agro-ecosystem due to increased population pressure, lack of innovative agricultural technology and environment conservation policies for Himalayan region. Due to change in food habit and increasing market forces a shift from traditional to modern, intensive agriculture system has been observed in Himalayan region (Palni *et al*., 1998). All these factors are together responsible for loss in traditional legumes crop diversity in hilly region. Maikhuri *et al*. (1997) also reported that being as an important component of hill agricultural system and economy, legume production showed a stagnancy or decline since past few decades. Decline in legume crop diversity is a collective consequence of following various factors:

- Weather uncertainties/climate change is the major reason for decline in legume crop cultivation. Being as a rainfed crop, the production of pulses much affected by adverse climatic condition as compared to cereals. So the farmers in hilly region give more emphasis to paddy cultivation in irrigated/rainfed land.
- Yield potential of traditional legume crops is very low as compared to improved cereals varieties and also in adverse climatic condition farmers get about 3 to 4 times higher yield from cereal crops than the traditional legume crops.
- Changes in food habits is the another main cause for decline in legume crop cultivation. Due to changed food habits, consumption of traditional legume crops is considered as a sign of backwardness which leads to a decline in interest towards traditional legume crop cultivation. Maikhuri *et al*. 2001 also reported the replacement of *Macrotyloma uniflorum* (Horse Gram by kidney bean, wheat and potato owing to changed food habits and increased market demand for potato and kidney bean.
- Traditional legume crops are much susceptible to abiotic constraints like water logging and frost as compared to cereals.
- Traditional legume crops are much susceptible to biotic stress like pest, diseases and wild animals as compared to cereals and it is also one of the important reasons to decline in traditional legume cultivation in hilly region.
- Unavailability of seeds of suitable improved high yielding cultivars for hilly region of Uttarakhand.
- Lack of improved production technology for pulse production in small/marginal undulated land holdings in hilly region.
- Low profitability.

Table 3: Land races of traditional legume crops as described by various authors.

Crop	Land races/ varieties
Gehat (*Macrotyloma uniflorum*.)	*Rat gehat*, *Garua gehat*, *Kaw gehat*, *Bhangrail gehat* (based on seed colour)
Naurangi (*Vigna umbellata*)	White, Green, Black, Pale yellow (based on seed colour)
Chana (*Cicer arietinum* L.)	*Chhota chana*, *Bara chana* (based on seed size)
Bhatt (*Glycine max* L.)	*Bhatt* (creeping Stem, seeds red, white and mottled), *Safed bhatt* (seeds with black streak), *Soriya bhatt* (creeper, largest seed), *Bhangrail bhatt* (slightly seeds reddish colour seeds), Kaw/Black bhatt (seed black, compressed (*Glycine soja*), *Thangri bhatt* (plant erect)
Matar (*Pisum sativum* L.)	*Thuli matar* (larger seeds), *Kanyu matar* (seeds round small: *Pisum sativum* var. arvense)
Masur (*Lens culinaries* Medik)	*Kali masur*, *Rati masur*
Urd [*Vigna mung* (L.) Hepper]	*Kukuriyans* (cultivated up to 2000 m), *Mans* (cultivated above 2500 m)
Razama (*Phaseolus vulgaris* L.)	*Thumari razama* (dwarf plant), *Lagili Razama* (climber plant)
Sonth [*Vigna uniguiculata* (L.) Walp.]	*Hul sunth* (larger seeds), *Nani sunth* (smaller seeds)

Source: Pande *et al*., 2016.

Table 4: Major cultivated traditional legume crops and its uses.

Crop	Botanical description	Sowing time	Harvesting time	Uses
Arhar (Pigeon pea)	Pigeon pea is a perennial shrub, 1-4 m tall but mostly cultivated as annual crop. Leaves are trifoliate; compound with relatively narrow and hairy leaflets. Flowers are yellow or purple in colour, 4-12 mm long, mostly axillary but sometimes terminal. The pods are 3-6 cm long usually constructed obliquely between the seeds.	February-March	November	Whole seeds are cooked and use as *dal* and dry leaves, stem are good source of fodder for cattle.
Chana (Chick pea)	Plant is branched, erect, annual and 25-30 cm tall. Leaves are impair pinnate with 9-15 pairs of ovate leaflets margin. The flowers varying with serrated in colour from white to pink are usually born singly. The pods are small (3×2 cm) but in fated and contain one or two seeds which are angular with a prominent beak and small helm at the anterior end.	Middle of October	April-May	Whole seeds are cooked as and use as *dal* and on the occasion of festivals/ remonies used by peoples as *chole*.
Bhatt (Soybean)/ *Kala bhatt* (Wild soybean)	It is fast growing, erect, sub erect or trilling annual herb up to 50-70 cm height. Leaves and stem are covered with downward pointed reddish brown hairs. The leaves are large trifoliate. The flowers are small, yellow and clustered at the top of short hairs peduncle.	June-July	September-October	It is the important cash crop in hills and are used for preparing the traditional dishes *viz. fana, bhatwani, chainsa etc.*
Masur (Lentil)	Plant is much branched, erect, pubescent, annual herb with a slender angular stem. Leaves are pinnate bearing 5-7 pairs of ovate leaflets, ending in the points have terminal tendrils. The flowers are born singly or in cluster of two or three at the tip of flowering branches. The pods are short rarely longer; contain only two lens shaped seeds.	September	February-March	Immature seeds eaten directly. Dry seeds cooked as whole or split and used as *dal*. Dry leaves and empty pods are used as cattle fodder.
Gehat (Horse gram)	Plant is cylindrical, sub erect, 30 - 40 cm high. Leaves are trifoliate being membranous and filose with entire margins. Flowers are borne in bunches in axillaries racemes. The pods are sickles shaped, about 1.2-5cm broad, articulated with persistent style. Each fruit contains 5-7 seeds, which are small, flattened, rhomboidal, 3-6 cm long, variously colour from brown to red, black or matted.	July last or August	November	It is largely consumed as whole seeds. It is the important cash crop. Local peoples believe that the boiling soup of *gehat* is very useful for blast of rocks instead using blast.
Vilaiti Sem (Lima bean)	It is pubescent annual herb, 10-30 cm in height. Due to its mat like spreading habitat it is also known as mat bean. Leaves are trifoliate, each leaflet being subtended by a pair of small stipule. Small flowers are grouped on long hairy axillary peduncle. They are small (2.5-5×0.5 cm) nearly	June-July	October	It is used as *dal* and on the occasion of festivals/ ceremonies local people prepared a famous dish *i.e.* "*sunta pakori*".

Table 4: Continue...

Table 4: Continue...

	with short curved beak and are covered with stiff hairs or bristles. Each pod containing 4-9 small seeds, which are, more or less cylindrical, rectangular up to 5 mm long.			
Razma (French bean)	It is erect or twinning annuals with small white or coloured flowers, trifoliate leaves and slender pods.	June-July	October	Young unripe and dried ripe seeds are used as *dal*. Dry leaves, stem are good source of fodder for cattle.
Matar (Pea)	Pea plant is climbing or trawling annual with a slender hallow stem (about 1.5 m tall). The leaves are pinnately composed with three pairs of leaflets terminated by branched tendrils. Pods are swollen, compressed straight or slightly curved, each of which contain 2-10 seeds.	December	June	Immature seed used as vegetable and the mature seed may be split and prepared in various forms of consumption.
Rains (Adzuki bean)	It is a bushy annual usually 30-40 cm tall, determinate, late maturing with trifoliate leaves and short, axillary inflorescence having 6-12 clustered pale yellow flowers. Generally, it shows an erect growth habit, Pods are generally cylindrical with 4-12 seeds. Seeds are diverse colour ranging from red, white, black, gray seed mottled with black to white seed mottled with red.	March	September-October	Dried seeds are cooked as whole or used in soups.
Urd (Black gram)	It is fast growing, erect, sub erect or trailing herb up to 0.8 m in height. Leaves and stems are covered with long, reddish hairs. Leaves are larger, trifoliate, each leaflets is being ovate lanceolate. Flowers are small, yellow and clustered at the top with short penduncle. Pods are narrow, cylindrical, septate between the seed, erect or sub erect (4-7×0.6 cm) covers with long ferocious and possess short hooks beaks. Each pod contains 6-10 seeds with square or flat ends up to 4 mm long. Seeds are black in colour.	June-July	September-October	Seeds is consumed as dal (whole, split, husked, de-husked) or parched.
Mung (Green gram)	Plants are erect or sub erect, much branched, annuals m in length. Leaves are trifoliate and compound. Flowers occur in clusters of 10-20 long peduncles axillary racemes. Pods are grey or brown when mature, measuring 5-10× 0.4-0.6 cm and contain 10-15 small seeds.	September-October		It is consumed either whole or split, after decapitation. It is said to be easily digestible.
Naurangi (Rice bean)	It is sub erect or twining herbs covered with spreading white hairs. Pod compressed 4× 2cm and 8-12 seeded glabrous.	June-July	October	Seeds are frequently cooked with rice.

Source: Chauhan and Bisht, 2016.

- Unavailability of market linkages and entrepreneurship.
- Lack of post-production management for traditional legume crops.

Strategies for conservation and management of traditional legume crops

There is need to develop a suitable strategies and management practices to increase the area, production and productivity per unit area, strengthening the distribution facilities for produce and availability of market for conservation of traditional legume crops. For timely production, out-sourcing and distribution of pulses, a long-term strategy needs to be worked out to meet the deficit in the demand and supply of pulses in the state. For this a policy has been proposed by State Agriculture Department, Uttarakhand in 2001. Policy much focused on to increase the research experimental trial on traditional legume crops viz. Urd (black gram), *Mung* (green gram), Bhatt (soybean)/ Kala bhatt (wild soybean), Rains (Adzuki bean), Naurangi (Rice bean) and Gehat (horse gram) and to develop scientific crop cultivation and management practices to increase productivity and decrease the cost of production of white soybean. The only short coming of this policy is that much emphasis was given on scientific cultivation of white soybean as compared to other traditional legume crops. There is needed to take more steps towards enhancing the production of other traditional legume crops of Uttarakhand. To enhance the production potential and to conserve the traditional legume crop diversity following steps should be considered:

- There is a strong need to reorient crop-specific and region-specific research approaches and cultivation practices along with the changing socioeconomic, agro-ecological and climatic conditions.
- At village level attempts should be made that the farmers continued the farming of traditional legume crops in remote isolated, marginal and waste land which may help in conservation of traditional legume crop diversity.
- Diversification in existing cropping system through the introduction of traditional legumes as intercrops and catch crops will be helpful to meet out the needs of farming family as well as to improve livelihood.
- In-depth research need to be focused on yield enhancement of traditional legume crops in rainfall deficit areas with specific strategies to maximize the use of available water.
- Yield improvements in traditional legume crops can be done by developing and introducing new varieties having traits like high yield, resistant to drought and disease-pest, increased water and nutrient use efficiency.
- There is an urgent need to motivate and changing the mindset of the farmers by facilitating the platforms to demonstrate the benefits of traditional pulse cultivation to farmers as less remunerative, tasty, rich in nutrition and also possesses medicinal properties as compared to cereal crops.
- There is need of placing of innovative marketing strategies to ensure that farmers are able to get remunerative prices for their produce and also find the possibility of marketing of traditional legume crops to be explored by proper campaigning in urban market.
- For strengthening the resource and infrastructural base, there is need to make regular funds availability to pulse growing farmers and government must incorporate the traditional legume crops in public distribution systems (PDS), which will increase the interest of the people towards these crops.
- At village or community level small co-operatives/contract farming of pulses must be adopted from where collection, processing of raw pulses from a particular area and direct approach to market is need to be encouraged to provide supplementary employment and additional income to farmers/villagers.
- Traditional legumes are important parts of the daily diet in hilly region, so an innovative approach to develop a new taste for the consumers by blending and value addition *etc.* to make the product more attractive and to meet out the nutritional security of the state population.
- Hill agriculture is women folk based, so empowering them through technical training, development of leadership and organization skills can led to successful outcomes from implemented strategies.
- Reviving the Dal milling industry and providing value addition at the farm gate by the installation of improved small *dal* mills and allied accessories at village level.
- *In-situ* conservation in their natural habitat is the most appropriate measure for conservation of traditional legume biodiversity in Himalayan region of Uttarakhand (Nautiyal *et al*., 2005).

FUTURE PROSPECTS

In future there is considerable scope to increase the area and production of traditional legumes in Uttarakhand state.

- Collection, screening, genetic cataloguing, conservation and use of important traditional legumes through conventional and molecular mean need to be undertaken.
- Production of seeds of traditional legume crops in such a participatory mode to ensure that quality seed is easily available to the farmers.
- Standardization of organic farming package and practices for various traditional pulse crops.
- Weather and pest forecasting system need to be strengthened to warn the farmers prior to incidence of diseases and pests to traditional legume crops in the region.
- Rural connectivity, transportation and other infrastructure need to be strengthened so that the farmers are easily able to sell their produce to nearby market.
- State extension system need to be strengthened to train and educate the farmers about the various farmers friendly government schemes such as *Fasal Bima Yojna*, *Kisan* Credit Card *etc.*
- The state government needs to take a policy decision to modify the present land tenure system and launch the various schemes to the banking sector to make the easy credit availability to small and marginal farmers.

There is considerable potential to increase the area sown to grain legumes and to improve their yields in Finland.

CONCLUSION

Due to variation in altitude and climatic condition, mix diversity of plants and crop species are found in hilly region of Uttarakhand. However due to commercialization, changed food habits and concern for monetary gain, farmers in hilly region focused on growing of selected crop species such as rice, maize, potato, wheat, chickpea *etc*. Amplification of "More Production" approach for few selected crops species resulted in declining the productivity of traditional legume crops. Traditional Himalayan pulses are cheapest source of protein, better for human nutrition and soil health, therefore it is important to increase the area and production of traditional legume crops to increase balanced diet among the socially and economically poor peoples. Advanced multidisciplinary approach to integrate the production technology, dissemination, utilization and support systems for transfer of improved technology to get a sustainable and efficiently productive cropping system, to provide the nutritional and economic security to the people without losing the wealth of traditional legume crops in Himalayan region of Uttarakhand.

Conflict of interest

All authors declared that there is no conflict of interest.

REFERENCES

Asif, M., Rooney, L.W., Ali, R. and Riaz, M.N. (2013). Application and opportunities of pulses in food system: A review. Critical Reviews in Food Science and Nutrition. 53: 1168-1179.

Chauhan, P.S. and Bhisht, S. (2016). Legumes diversity in Chamba block, district Tehri Garhwal (Western Himalaya) with reference to their economic importance and yield. International Journal of Food Science and Nutrition. 2: 15-20.

Dixon, R.A. and Sumner, L.W. (2003). Legume natural products: Understanding and manipulating complex pathways for human and animal health. Plant Physiology. 131: 878-885.

Ghosh, P. and Dhyani, P.P. (2004). *Baranaaja*: The traditional mixed cropping system of the central Himalaya. Outlook on Agriculture. 33: 261-266.

Giller, K.E. and Cadisch, G. (1995). Future benefits from biological nitrogen fixation: An ecological approach to agriculture. Plant and Soil. 174: 255-277.

International Institute for Population Sciences (IIPS) and Macro International. (2007). National Family Health Survey (NFHS-3), 2005-06: India: Volume I. Mumbai: IIPS. 2007.

Lewis, G., Schrire, B., MacKinder, B. and Lock, M. (Eds.) (2005). Legumes of the World. Royal Botanical Gardens, Kew Publishing, UK. pp. 112-135.

Maikhuri, R.K., Rao, K.S. and Semwal, R.L. (2001). Changing scenario of Himalayan agroecosystem: Loss of agrobiodiversity, an indicator of environmental change in Central Himalaya, India. The Environmentalist. 2: 23-39.

Maikhuri, R.K., Rao, K.S. and Saxena, K.G. (1996). Traditional crop diversity for sustainable development of Central Himalayan agroecosystem. International Journal of Sustainable Development and World Ecology. 3: 8-31.

Maikhuri, R.K., Semwal, R.L., Rao, K.S., Nautiyal, S. and Saxena, K.G. (1997). Eroding traditional crop diversity imperils the sustainability of agriculture system in Central Himalaya. Current Science. 73: 777-782.

Nautiyal, R. R. and Datta, R. (2018). Development Dynamics of a Himalayan state. pp. 97.

Nautiyal, S., Shibasaki, R., Rajan, K.S., Maikhuri, R.K. and Rao, K.S. (2005). Impact of land use changes on subsidiary occupation: A case study from Himalayas of India. Environmental Informatics Archives. 3: 14-23.

Palni, L.M.S., Maikhuri, R.K. and Rao, K.S. (1998). Conservation of the Himalayan Agroecosystems: Issues and Priorities. In: Eco-regional Cooperation for Biodiversity Conservation in the Himalaya. UNDP, New York. pp. 253-290.

Pande, P.C., Awasthi, P., Bargali, K. and Bargali, S.S. (2016). Agro-biodiversity of Kumaun Himalaya, India: A review. Current Agriculture Research Journal. 4: 16-34.

Peoples, M.B., Brockwell, J., Herridge, D.F., Rochester, B., Alves, R., Urquiaga, S., Boddey, R.M., Dakora, F.D., Bhattarai, S., Maskey, S.L., Sampet, C., Rerkasem, B., Khans, D.F., Hauggaard-Nielsen, H. and Jensen, B.S. (2009). The contributions of nitrogen-fixing crop legumes to the productivity of agricultural systems. Symbiosis. 48: 1-17.

Popelka, C., Terryn, N. and Higgins, T. (2004). Gene technology for grain legumes: Can it contribute to the food challenge in developing countries? Plant Science. 167: 195-206.