

CLIMATE, DISTRIBUTION AND CROPPING PATTERN OF FINGER MILLET IN NEPAL: A REVIEW

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ABSTRACT

Agriculture is main profession of 65% population in Nepal. The main component of agriculture is cereal crops which include paddy, wheat, maize, finger-millet, buckwheat, barley, naked barley, Proso millet and Foxtail millet. Finger millet is cultivated in all 75 districts from 85m to 3130m asl especially in marginal land of hills and high mountains. Gandaki, Bagmati, Sagarmatha and Lumbini zones have maximum area of finger millet cultivation. In Nepal, finger millet is cultivated in 271183 hectares of land and produced 304104 metric ton with average yield of 1.121t/ha in 2014. The production of finger millet was insufficient and the country imported 1311t annually. The cultivation area and production analysis of finger millet from 1990 to 2014 show that there is not significant increase in production. Finger millet-Fallow-Fallow, Finger millet-Barley-Fallow are common cropping pattern in high hills; Maize-Finger millet-Fallow, Maize/Mustard-Fallow in mid-hills is main cropping pattern and generally grow in marginal land having low productivity as mono-crop in Terai. There are 33 local landraces of finger millet and Okhale-1 which is cultivated in several districts is only recommended variety. Seventy eight percentage of total finger millet produce is utilized to prepare liquor/alcohol and remaining is used to make porridge, breads, sweet.

Keywords: Cereals, Eleusine, cultivation, liquor, production

1. INTRODUCTION

Nepal has unique topography and climate, the range of elevation varies from 60m to 8848m within a distance of 150-240km. This uniqueness leads to global attraction towards varied

ecosystem and biodiversity in short land belt as well as diversity in agriculture. The country has 125 caste/ethnic communities in different ecological regions with their 123 different languages (CBS, 2011). Each community has own system of culture and agricultural practices. Agriculture contributes 36% to Nepal's gross domestic product (GDP) and involves 65% population directly. The major components of agriculture are cereals, legumes, cash crops, fruits, vegetables and livestock. The cereals crops growing in Nepal include paddy, wheat, maize, finger-millet, buckwheat, barley, naked barley, *Chino* (Proso millet), Kaguno (Foxtail millet), etc. Among them paddy and wheat are considered as major cereals in Terai and maize in hill and mountain region. The finger-millet, buckwheat and barley are grown in marginal land of hills and mountain. The Cereal crops contribute 12.5% to GDP and share of finger millet is 0.46% (MOAD, 2012). Finger millet is considered as poor man crop in Nepal though it has been growing in every part mainly of hilly regions.

Till date intensive research on finger millet has not been done except some qualitative agromorphological characteristics analysis, varietal taste and release (BK *et al.*, 2001; Mandal *et al.*, 2005; Baral *et al.*, 2014, Amagai *et al.*, 2014). Information regarding this crop in Nepal are also scarce besides some of the paper presentation in conference, seminars, workshops; symposium, etc. Distribution, cropping pattern and other related information including local landraces and productivity of finger millet has not been properly reviewed.

2. MATERIALS AND METHODS

This study is basically based on secondary information. The secondary information were collected from Ministry of Agriculture development, Nepal, web-based information, several proceedings published from Hill Crop Research Station, Kabre Dolakha and Nepal Agricultural Research Council, (NARC), Department of Agriculture in Nepal.

3. RESULTS AND DISCUSSION

3.1 Finger millet:

Eleusine coracana (L.) Gaertn (family: Poaceae), (Synonyms: *Cynosurus coracana* subsp. *africana* (Kenn.-O'Byrne) Hilu & de Wet, *Eleusine coracana* var. *alba* Korn., *Eleusine coracana* var. *tocussa* (Fresen.) Franch., *Eleusine coracana* var. *stricta* (Roxb.) Nees, *Eleusine coracana* var. *fusca* Korn., *Eleusine coracana* subsp. *coracana*, *Eleusine coracana* var. *alra* Korn.) is known as African finger millet, Caracan millet, Koracan (English); Kodo (Nepali), Ragi (India), Kuracan (Srilanka), Fingerhirse (German), wimbi (Swahili), Bulo (Uganda), Telebum (Sudan) (Bhattarai, 2014, <http://www.feedipedia.org/node/721>,). Cultivated form of finger millet is *Eleusine coracana* subsp. *coracana* and wild form of millet is *Eleusine coracana* subsp. *africana*.

3.2 Biology:

Eleusine coracana is herbaceous annual plant with erect and clump stem reaching the height up to 0.6m -2m. The flattened stem is covered by hairy leaf sheaths. The periphery of ligule is covered by short hairs. The leaves are narrow, grass-like and capable of producing many tillers and nodal branches. The leaf lamina is about 60 cm long mostly folded upward along the midrib. The inflorescence is raceme type and consists of 4-7 unbranched axes along which the spikelets are arranged. The fertile spikelets (the clustered units of flowers and bracts typical of grasses) are sessile and comprise 3-9 fertile florets. The upper and lower glumes (empty bracts that enclose the florets) are of different sizes, the lower glume is 2-5 mm long and has 1-3 veins running through it. The upper glume is 3.5 mm long, with 5-7 veins. The lemma (the outer bract which encloses the flower in a spikelet) of the fertile floret is 4mm long and lance-shaped (lanceolate) and three-veined and pointed (acute) at the apex. The sterile florets resemble the fertile florets, although they are underdeveloped. The flower contains 2 fleshy wedge-shaped lodicules (small structures at the base of the stamens). The fruit is a small and round caryopsis (a fruit in which the seed is fused to an outer wall), 1.5-2.5 mm long, dark-brown in colour and exposed at maturity (www.kew.org/science).

3.3 Description:

An annual grass of robust tufted and tillering from Poaceae family and have been cultivated for grain since time immemorial. The inflorescence of finger millet is panicle with 4-19 finger-like spikes which look like fist after maturation so it is called as finger millet. Each spike bears up to 70 alter spikelets having 4-7 seeds. The seed bearing pericarp is free from the kernel and can easily be removed from the seed coat (Heuze and Tran, 2015). Seed sowing and seedlings transplantation time vary from the end of May to July, harvesting from September to November in Nepal depending upon the local landraces, altitude and regions (eastern, central and western as well as Terai, mountain and high mountains)(Ghimire, 2015).

3.4 Distribution

Eleusine coracana (L.) Gaertn. is one of the most important crops of millet group considered to have been domesticated in the beginning of the iron age in Africa, may be in Uganda or Ethiopia (Anonymous, 1996; <http://world-crops.com/finger-millet>) and at present it has been cultivating in most of drier places of Africa and Asia with highest production. It was introduced to the South East-Asia and the Indian sub-continent about 3000 years ago (Heuze and Tran, 2015). It is primarily grown in arid regions of Eastern and Southern Africa, north and central Europe; Southwestern and northwestern pacific (www.kew.org/science),Japan, Australia, India, Indo-China, Malaysia, Bhutan, Pakistan and Nepal (Pokhrel, 2014) and also grown in colder parts of

world like Northern Ireland in summer season (Vauze and Tran, 2015). Globally nineteen countries including Nepal are major finger millet producing countries (Zimbabwe, Zambia, Vietnam, Uganda, Tanzania, Sri Lanka, South Africa, Russian Federation, Nigeria, Malawi, Kenya, India, Ethiopia Eritrea, China, Burundi, Bhutan and Nepal) and 36 countries have some cultivation with minor production but at least holding gene pools (ICIRISAT, 2012).

In Africa, finger millet is generally grown in between the elevation of 1000-2000 m and in Himalaya region reached up to 3000m, best suited crop of 23°C temperature with annual rainfall from 500-1000 mm but also withstand much colder and hotter condition. Finger millet cannot withstand flooding but somehow for water logging condition (Dida and Devos, 2006). Finger millet is well grown in fertile well drain sandy to sandy loam soil but adapted to various soil condition with average pH of 5-7 (Dida and Devos, 2006). Finger millet has very high vegetative, floral and seed morphological variations (Hilu and de Wet, 1976) and has good adaptability in wide range of geography due to C4 photosynthetic nature (Holt, 2000).

In Nepal, it has been growing in all 75 districts (Ghimire, 2015) and is considered as the fourth staple food crop after rice, wheat and maize in term of cultivation area (271183 ha) production (304105 t/yr) and yield (1121 kg/ha) (Sina, 2004; MOAD, 2014) as well as for uses.

Due to its wide adaptability it has been cultivated in diverse agro-ecological condition ranging from low land Terai (85 m asl, Kachorwa village, Bara district) to foothills of Himalaya (3130 m asl, Borounse village, Humla district in Nepal) (Humagain and Krishna, 1998; Amagai *et al.*, 2004; Baral *et al.*, 2014). Cultivation of finger millet is necessary part of farming system in mountain terrain where agriculture land is limited and food deficit is an issue (Subedi *et al.*, 2009). About 9% of total cultivated area of Nepal is shared by finger millet of which 75% of cultivation lies in mid-hills (1000- 1800 m asl) and account 4.2% of total cereals production in country (Upreti, 2002). According to Baniya *et al.*, 1990 Frequency distribution analysis of local landraces of finger millet was found highest in 1660 m asl in western development region.

Geographically, maximum area of finger millet cultivation lies in western development region (Prasad, 2005) and Gandaki, Bagmati, Sagarmatha and Lumbini zones are the major finger millet producing constituencies in the country (Adhikari, 2005; MOAD, 2014). It has been successfully cultivated up to an altitude of 2200 m above sea level in monsoon season (Bhattarai, et al., 2014), although local landraces have been cultivated in between 300-3130 m asl (Upreti, 2001). It is also grown in some marginal land in Terai but in negligible quantities due to limited area of marginal land (Rajbhandari and Bhatt, 2008). Therefore, finger millet is grown in diverse ecological regions of the country. Small seeds of finger millet can be stored for many years safely without insect damage which may be the important risk avoidance strategy in drought prone area of the country (Pokhrel, 2014).

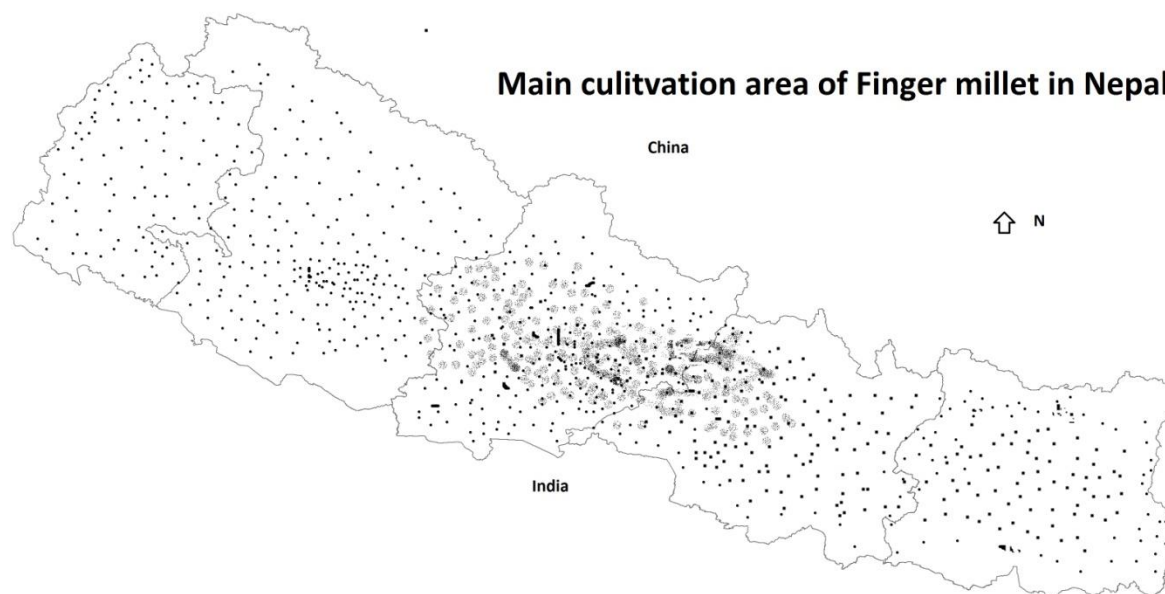


Figure 1: Main cultivation area of Finger millet in Nepal

3.5 Production

In the global context of production of millet, African continent share more than 55% and produce about 2 - 4.5 million ton annually. The remaining product comes from Asian continent especially from India and Nepal which share 50% and 8% of total Asian finger millet production respectively (Vauze and Tran, 2015).

Though finger millet is considered most labor intensive crop, 76% of cultivated land in hills occupies finger millet, followed by 20% in mountain and 4% in Terai (MOAD, 2012). Among five development regions of Nepal Western Development Region is main area of finger millet production, followed by Eastern, Central, Mid-western, and Far-western development regions (Pokhrel, 2014).

Finger millet is cultivated in 271183 ha of land and produced 304104 metric ton with an average yield of 1121kg/ha in 2014. This production of finger millet does not meet the demand of the country and the records of the last 10 months (September, 2015- July, 2016) showed 1311 metric tons of finger millet with worth of about 34 billion Nepalese Rupees (ca 330 million US dollar) imported in Nepal. (June-20, 2016; Kantipur daily News paper, Nepal). The time series data of Statistical information on Nepalese Agriculture, 2013/14 on cultivation area, production of finger millet's trend analysis shows that both area and production remain slightly increased from 2000

to 2012 AD thereafter decreasing (Fig-2) that may be due to several reasons like unfavorable weather condition, lack of labors, interest of farmers, increasing remittance as well as the opportunity of foreign employment. Similarly, trend analysis of yield (Kg/ha) of finger millet showed that highest yield was recorded in fiscal year 1992/93 with 1173 kg/ha which is slightly greater than the year of 1990/91 (1153kg/ha), thereafter yield remain decreasing and increasing order and become least yield in fiscal year 2006/07 (1074kg/ha) again after 2007 yield of finger millet increased and reached to 1121kg/ha in fiscal year 2011/12 (Fig-3).

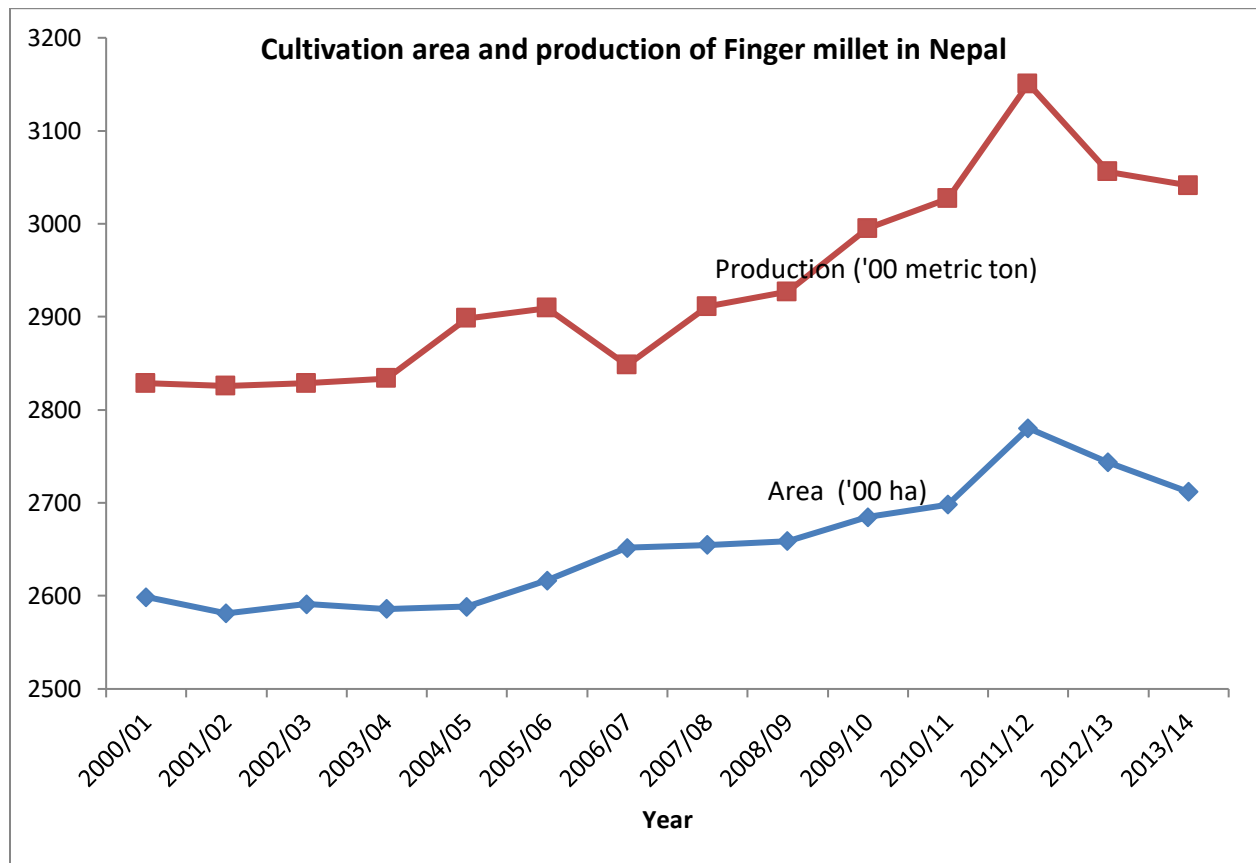


Figure 2: Trend analysis of cultivation area and production of finger millet from 2000-2014 in Nepal

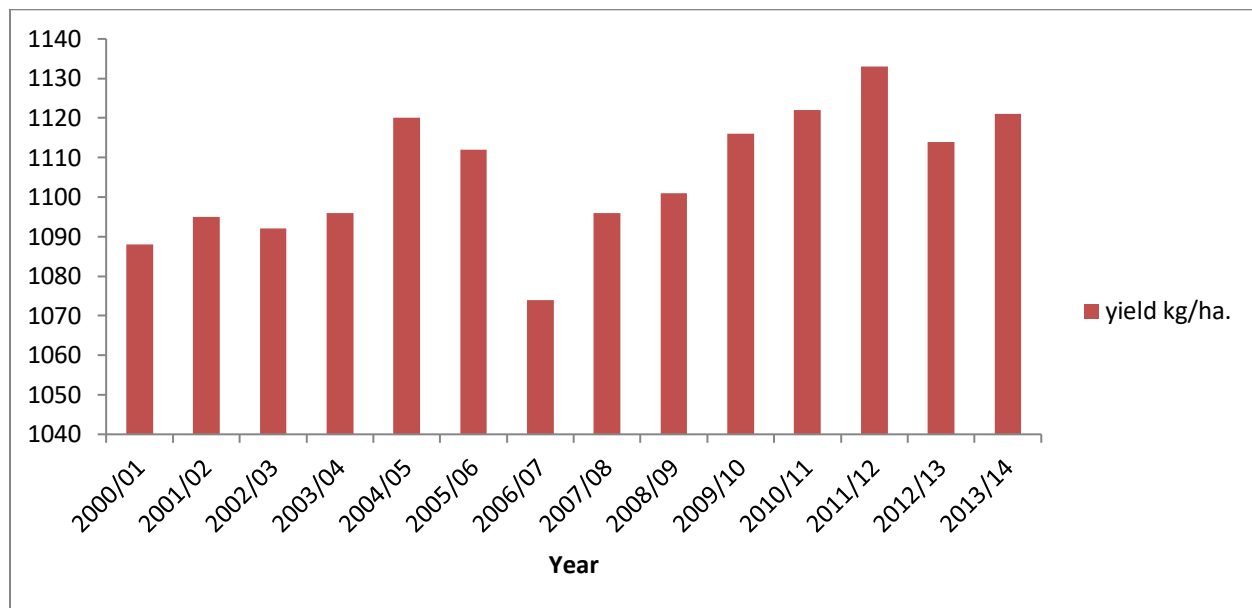


Figure 3: Trend analysis of yield (kg/ha) of Finger millet from 2000-2014 in Nepal

3.6 Cropping pattern

Production of crops depends on cropping pattern and local environment, type of land, use patterns of land, productivity of soil, willingness of farmers, indigenous knowledge and available technology (Bhandari and Devkota, 1998). Cropping pattern of Nepalese agriculture vary with physiographic condition, agro-ecological zones and inputs. Paddy-wheat-maize pattern is dominant in Terai while maize-wheat in mountain and Maize-potato is dominant in high Himalaya (MOAD, 2012).

Mostly finger-millet is grown in marginal land where other crop cannot be grown. It is one of the main crops in mid-hills where finger millet is generally grown as a relay crop under maize. Maize/millet is a dominant cropping system (Upreti, 2001; BK, *et al.*, 2001; Acharya, *et al.*, 2001, Shrestha, *et al.* 2001; Upreti, 2003,) in mid-hills of eastern and central parts of the country, it grows as mono-crop in western parts (Prasad, 2005). In high hill farmers have been practicing mixed cropping with soybean and proso millet (*Panicum miliaceum* L.) (Upreti, 2001as). Eighty five percent of finger millet is grown as inter-crop with maize (Subedi, 1990) in hills there as variability of agro ecological condition exists there which makes single variety of crop to perform well in wider area in term of yield and to fit in cropping pattern (Mandal, *et al.* 2005). It is also grown as spring crop in irrigated lower foot-hills and river valleys. It is grown as mono crop in Terai, lower river valley and far western mid-hills and as mixed crop with other millet or niger or legumes in high hills. Comparatively more area in mid-hills is in cultivation under

maize/ finger-millet cropping system. In Terai, the finger millet is grown usually in sandy soil where water cannot be impounded for paddy cultivation. So finger millet is the crop of marginal land and commonly cultivated with low external inputs (Upreti, 2001b). Upreti 2001 documented the cropping system in different elevation range of Nepal (Table-1)..

Table 1: Cropping system at different elevation of Nepal (modified after Upreti, 2001)

SN	Physiographic region	Cropping system	Remarks
1	High hill	Finger millet-wheat or Barley-Beans -2 years	Rainfed
		Rice-Fallow-Fingermillet-Barley-2 years	Irrigated
2	Mid hill	Maize/millet-fallow- 1 years	Late maturing
		Maize/millet-Barley or Mustard- 1years	Early
3	Foot hill	Maize/millet-fallow	
		Maize-millet – 1 years	
4	Lower river valley	Rice-Finger millet- 1 years	Less area
5	Terai (Marginal land)	Fingermillet-fallow-1 year	
		Fingermillet-Rice-1 year	

However, Bhandari and Devkota 1998 listed the cropping pattern of cereal in Nepal have grouped based on irrigated, partially irrigated and fallow land from Terai to high Himalaya regions of Nepal. In Terai, there are twenty six types of cropping patterns in irrigated land, twenty four in partially irrigated land and twenty seven in upland. Similarly, twenty three types in irrigated land, sixteen in partially irrigated land and twenty seven type in upland of mid-hills and eleven types in irrigated land and twelve in partially irrigated land in high hills.

3.7 Diversity of landraces of finger millet in Nepal

Finger-millet diversity is very high in mid hills where most of them have been cultivated under maize/millet system. In different conditions specific finger millet landraces have been growing in different niche under various cropping pattern. For example, early maturing millet varieties have been growing in maize/millet-barley (*Hordeum vulgare*) or mustard cropping system; late maturing finger millet with considerably high yielding is common under maize/millet–fallow system. Farmers in different agro ecological conditions are maintaining diversified finger-millet landraces fitted for their specific cropping pattern (Upreti, 2001a). Shakya, *et al.* (1991) had compiled the local landraces of finger millet from different regions of Nepal (Table-2).

Similarly, various local landraces of finger millet adopted in different altitudinal gradients and ecological condition of the nation under various cropping system that helps to make overall farm

production sustainable and stable. Rai and Shakya (2005) have recorded the local landraces with productivity from the study in Dolakha, Nuwakot and Kaski districts depending upon local landraces, soil types (Table-2).

**Table 2: Local landraces of Finger millet in different region of Nepal
(modified after Rai and Shakya, 2005)**

SN	Physiographic Region	Landraces	Remarks
1.	Eastern High hills	<i>Mudke, Nangkatuwa, Bhalu Nala*</i> , <i>krei, Kanchhi kodo</i>	*Early planting, old variety
2	Midwestern High hills	<i>Kalo kodo, Rato kodo</i>	
3	Eastern Mid hills	<i>Jangali, Titile, Kalo Kodo, Lure, Dalle, Pandure, Seto kodo, Bagare, Jhumke, Nangkatuwa</i>	
4	Eastern Mid hills (Dolakha and Nuwakot district)	<i>Mudki, Pahelo, Bhursi, Chauri</i>	Yield ranges from 2.5-3.5t./ha. depending upon soil type
5.	Western Mid-hills	<i>Karantee, Dalle, Nala, Baghjung, Okhale-1, Archale, Jhyape, Urchho, Kalobhunde, Ramjali, Bhachuwa, Seto Urchho,</i>	
6.	Lekhanath and Pumdibhumdi, Kaski district	<i>Kalo dalle, Seto Samdi koto, Jhamre, , Kalo Jyape, Seto jyape, Dude kodo</i>	Yield range from 3-4 Mt./ha depending upon local varieties and improved
7.	Far western Mid-hills	<i>Thulo kodo*</i> , <i>Seto kodo, Jhalare, PES176, Kali, Lokhare</i>	*Late variety
8.	Eastern Terai	<i>Mudke, Pangdur, Ashauge, Nangkatuwa</i>	
9.	Western Terai	<i>Jhapre, Dalle</i>	
10.	Far and Mid Western Terai	<i>Barbatel</i>	Late variety

Source: Shakya *et al.*, 1991; Rai and Shakya, 2005.

3.8 Importance of Finger millet

Finger millet grains are rich than rice, maize, wheat, sorghum in protein, sulphur containing amino acids, calcium, iron, methionine, manganese, fat and minerals (Pokhrel, 2014; ICRISAT, 2004; Reed, 1976; Baral, 2014). Finger millet cultivation supports livelihoods of hill farmers in Nepal and forms main diet as breakfast. In Terai region of Nepal, it is used to make *haluwa* (sweet), *roti* (bread) and *Chokha* (powder paste). It has been consumed in the form of thick porridge (*dhindo*). In past, it was used as good diet for new mothers and growing children but now alternate ready foods have replaced it. Poor people used to prefer it as a good source of nutrients. In Nepal, it is regarded as the poor man's food and people with higher status in the society hesitate to use it for food. These days Kodo's *dhindo* is become popular in touristic areas. Seventy to eighty percent of total finger millet produce in the country is utilized to prepare liquor/alcohol (*Jand/Chhang/Raksi*) (Rajbhandari and Bhatta, 2008; Bhattarai *et al.*, 2014). In some communities like Gurung, Mager Rai prepare liquor from finger millet, it is essential for their ritual ceremony.

Finger millet is considered safe diet for the patient of diabetes, obesity and hypertension (Wuresh, 1994), a prefer food for pregnant women and also used to treat the diarrhea problems of animals (Rana *et al.*, 2000). Finger millet and its parts have been used as folk medicine to treat diuretic, vermifuge, diaphoretic as well as to cure the leprosy, liver diseases measles, pleurisy, pneumonia, small pox (Duke and Wain, 1981, Baral *et al.*, 2014). The finger millet straw constitutes about 61% of total digestible nutrients so it makes very good fodder than that of pearl millet, wheat or sorghum (Anonymous, 1996)

4. CONCLUSION

The finger millet is an important crop in Nepal and its cultivation, production and productivity should be increased to meet the growing demand and address food scarcity.

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