



Review Paper

Field evaluation and nutritional benefits of finger millet (*Eleusine coracana* (L.) Gaertn.)

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Abstract: Finger millet (*Eleusine coracana* (L.) Gaertn.) is an important crop used for food, forage and industrial products. High diversity of finger millet exists in the mid hills of Nepal. Out of 15 species reported in the world, three of them namely *Eleusine coracana*, *E. indica* and *E. aegyptica* are found in Nepal. The substantial variations in finger millet genotypes were reported in previous studies for their agro morphology, nutrient composition, stability and economic analysis. This study covers the production status, morphological evaluation, economic and health benefits. Finger millet has a wide ecological and geographical adaptability and resilience to various agro-climatic adversities; hence it is highly suited to drought condition and marginal land and requires low external input in cultivation. Nutritionally it is

superior to major cereal crops and rich source of micronutrients such as calcium, phosphorous, magnesium and iron. It has several health benefits. This study will help the researchers to get information on finger millet. It may serve as information source for farmers, researchers and stakeholders who are involved in finger millet research and development.

Keywords: Finger millet, variability, nutritional and health benefit

INTRODUCTION

Finger millet [*Eleusine coracana* (L.) Gaertn.] is a tetraploid ($2n=4x=36$ AABB) species evolved from the natural crossing of *Eleusine indica* (AA) x *Eleusine floccifolia* or *Eleusine tristachya* (BB). It was originated about 5000 years ago in east Africa (possibly Ethiopia) and was introduced into India, 3000 years ago

(Upadhyaya et al., 2006). In terms of area and production, finger millet (*Kodo*) is the 4th most important crop of Nepal after rice, maize and wheat. 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 t) of total cereal production (MoAD, 2015). It has been cultivated from Terai; Kachorwa (85 masl) of Bara district (Amgain et al., 2004) to High Hill: Burounse (3150 masl) of Humla district (Baniya et al., 1992) in Nepal with cultivation records in all 75 districts. The major production districts of Nepal for this crop are Khotang, Sindhupalchok, Baglung, Syangja, Kaski, Gorkha and Sindhuli. It is considered very important in terms of food and nutrition security in both mid hills and mountains. A total of 237,862 t (77%) of finger millet produced was from hill districts followed by 61,417 t (20%) from mountain districts. Area and production of finger millet has slightly increased over last 25 years but the productivity is static or even decreased. Sherchan (1989), mentioned that in mid hill agro-ecosystem, finger millet is important for different traditional food use values and is strongly associated with maize-based cropping system. Nutritionally finger millet is known for its high fiber content (3.6%), calcium (0.38%) and phenolic compounds (0.3-3%) (Devi et al., 2011). Kumar et al. (2016) describes some health benefits by antipyletic, antitumoric, atherosclerotic, antioxidant and antibacterial effects. In drought-prone areas, this is a basic food cultivation and is considered an important component of food safety worldwide.

Human daily basis consumption of food were rice, maize, and wheat in Nepal. The ratio of cultivation and consumption of that food crop was increasing annually, whereas these crop does not provide ample nutrition for pregnant women and children. However, underutilized crop like: finger millet, Buckwheat, Proso millet, and Amaranths which contain high nutrition value are in the looming stage. If such production trend of major crops spike, it would threat the food basket of Nepal. This review assesses the overall value of Finger millet, so that it can be an informative paper to every viewer. The purpose of this review article was to provide information about finger millet and this information will help in the research and development of millet.

Production status of finger millet

Nepal has diverse climate, topography and altitude variation which make diverse in crops. Finger millet (*Elusine corocana* (L.) Gaertn.) ranks 4th in the world among mostly grown cereals after the sorghum, pearl millet and foxtail millet and 4th in Nepal in term of area of Nepal has diverse climate, topography and altitude which make diverse in crops. In the world, it ranks 4th among mostly grown cereals after the sorghum, pearl millet and foxtail millet and also in Nepal it ranks 4th in case of area of cultivation (263,596 ha), total production (3,06,704 t) and productivity (1.16 t/ha) after paddy, maize and wheat (MoAD, 2016/17). Its production in the world accounts for 30.73 million ton, out of which 11.42 million ton is produced in India accounting for 37% of total world production (<http://www.fao.org>). It is an annual hardy cereal crop grown in the

tropical, subtropical areas of world. Finger millet produced about 3.736 thousands of metric tons in world and mostly producing countries were India, China, Uganda and Nepal. Nepal is rich in finger millet genotypes, grown upto 3150 m (Upreti, 1999). About 790 accessions have been collected from various parts of Nepal (Gupta et al., 2000) and large diversity within *Eleusine coracana*, two wild species, *E. indica* and *E. aegyptica*, were found (Baniya, 1999). It's productivity has depend on wide range of environments and growing conditions, from South India to

throughout the middle-elevation areas of Eastern and Southern Africa (ICRISAT 2004). Major finger millet producing zones in Nepal are Gandaki, Bagmati, Sagarmatha and Lumbini (Adhikari, 2005). Baniya et al. (1992) mentioned that the diversity of finger millet in Nepal is rich at both varietal and population levels and this diversity could be used for variety improvement.

the foothills of the Himalayas in Nepal (Hunsigi and Krishna, 1998) and

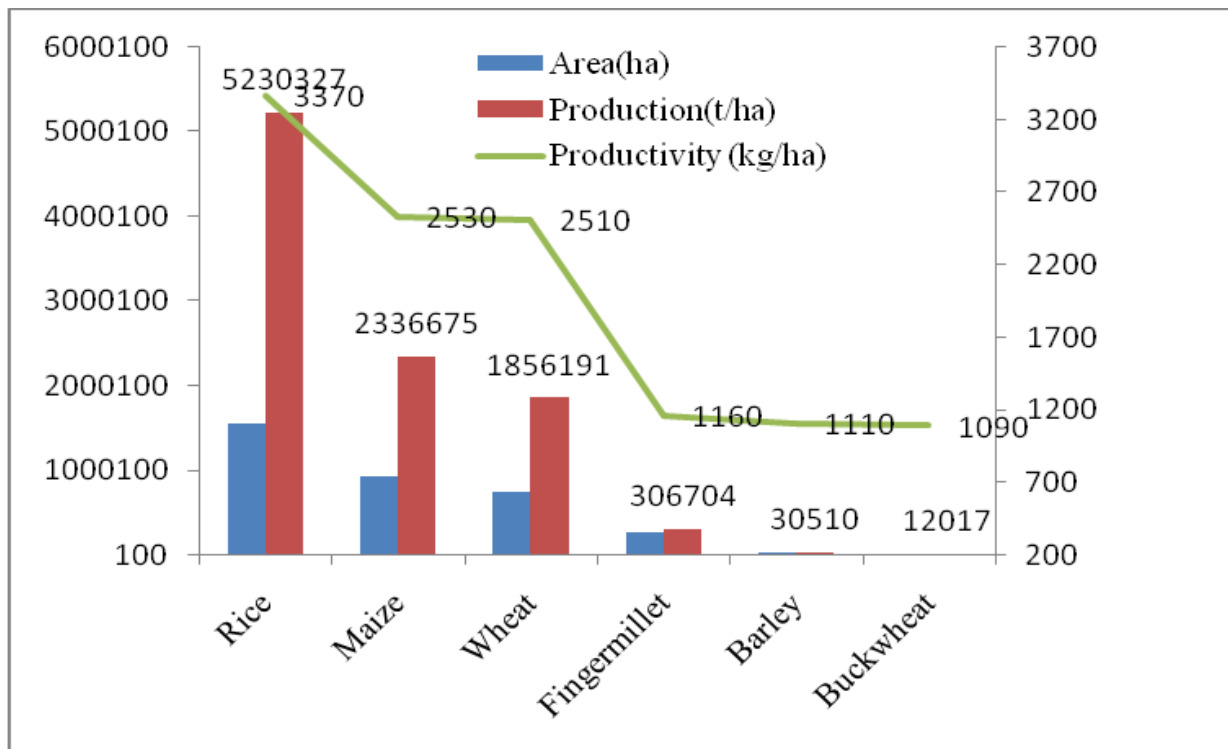


Fig 1: Present status of major and minor cereals in Nepal (MoAD, 2016/17)

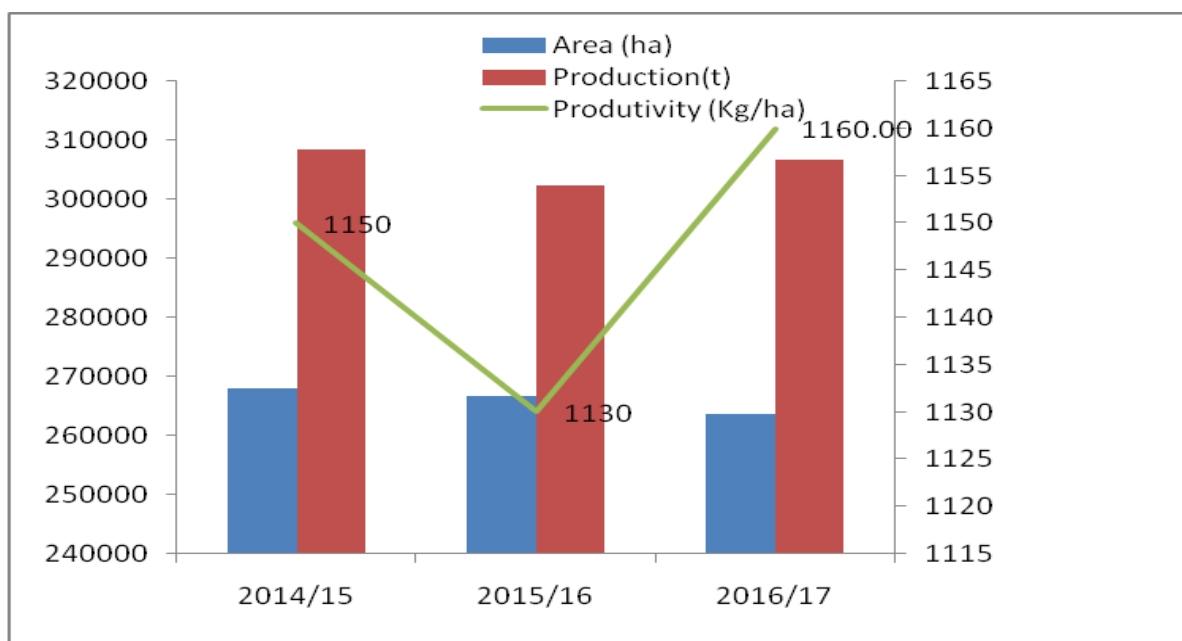


Fig 2: Area, production and productivity of Finger millet in Nepal (MoAD, 2016/17)

Field evaluation works on finger millet

Genetic resources

Nepal has diverse eco-geographical niches that led to the diversification in the finger millet. It is widely grown in Nepal from the terai region (80-90 m) to the hilly regions (upto 3000 m). Finger millet occupies a variety of niches in the rainfed farming systems of the mid hills growing as a summer crop between April and November. The highly diversity of finger millet exist in the mid hills of Nepal. 15 species of finger millet had been reported in the world and out of them three; *Elusine coracana*, *E. indica* and *E. aegyptica* were found in Nepal (Baniya, 1999). The land races of finger millet found from different topographic regions of Nepal Viz. Jhapa (12), Sindhuli (9), Tanahu (15), Nawalparasi (4), Dang (2), Doti (9) and Humla (3) (Subedi et al., 2009). Farmers generally maintained a large number of land races of finger millet, which possessed different maturity periods,

adaptation to soil or climatic conditions, and qualities desired for food, alcohol and fodder use. Different maturity periods were found useful in spreading out of the peak labor demand, and extending the period when fresh fodder could be provided. Villagers which reported highest millet yields and most extensive finger millet production in eastern and western mid-hills, also possessed highest number of millet land races (27) while the far western mid and high hills, villages that reported the lowest millet yields also possessed the fewest land races (3-11) (Upreti et al., 1991). Tiwari (1999) reported that 24 finger millet farmer's varieties (land races) which showed extreme variability existence in those areas in the research conducted in Kaski district by LIBIRD during the year 1999. The inter- and intra-population variation found in these landraces could be useful for finger millet improvement. Amgain et al. (2004) mentioned that the landraces of

central terai could serve as the gene pool for earliness in maturity and yield purposes for terai condition.

Table 1: Varietal status of Finger millet in Nepal

Crop	Name of Varieties	Origin	Released Year (AD)	Maturity Days	Recommended Domains	Grain Yield (t/ha)
Finger millet	Dalle-1	India	1980	125	Inner terai to mid hill	3.3
	Okhle-1	Nepal	1980	154	Mid- hills	3.3
				194	High-hills	
	Kabre Kodo-1	Nepal	1989	167	Mid-hills	2.3
	Kabre Kodo-2	India	2015	152	Mid-hills	2.5
Sailung Kodo-1	India	2015	155	High-hills	2.4	

Morphological variation

Morphological traits govern quantitative traits. Various studies have shown a large variation in quantitative characters. Differences in agro climatic conditions affect the variability of morphological features. Various morphological features affect the action of the millet. De Wet et al. (1984) found that the inflorescence morphology was associated with the grain yield and is used by farmers to distinguish between varieties complexes. The growth habit showed a marked variability of the millet's finger. Bezaweletaw et al. (2006) mentioned that the growth habit of the documented type was more dominant in the whole region, followed by the type of prostate, which may have resulted from its ability to eliminate weeds in the initial phase of growth and good position under stressful conditions. The diversity of ear shape also contributes to performance. Genetic variation through molecular markers has been emphasized in several cereal crops. The pattern of genetic variation was closely related to geographical distribution. Important

features of finger millet, i.e. the color of seeds (white, red orange and brown) determines the quality and. Farmers prefer to dark color with high yield and resistance to adverse environmental conditions, such as low soil fertility, although they receive less money compared to white and red seeds (Kefyalew and Ensermu, 1989). The morphological traits studied, with the exception of open, straight, compact and fist-shaped ears, and the color of white grain were exceptionally unique in one region. This can be attributed to the exchange of germplasm (gene flow), which makes regional boundaries irrelevant (Bezaweletaw et al., 2006). Upadhyaya et al. (2007) showed that 63.5% was accession to green plants from 909 accession: 92.8% of types are straightened in the habit of growth: it changes in the average height of the plant, average time up to 50% of flowering, length and width of the average inflorescence, the average panicle effort varies between 90-104 cm, 65-81 days, 88-104 mm, 55-103 mm and 75-110 mm,

respectively. The diversity of morphological features showed that there is a variety that directly affects the yield of millet. Amgain et al. (2004), found greater variability in population level in all quantitative traits, and similarly, a larger polymorphism was observed in 11 qualitative characters (the shape of the ear followed by the number of grains) and the number of the rudder, finger length, finger width and grain yield at significant load.

Variation and heritability

For the determination of heritability and variability in the finger millet, few researches had been done. The phenotypic, genotypic and environmental variability indicate the amount and occurrence of diversity within and between finger millet genotypes. Phenotypic variability expressed by a genotype or a group of genotypes in any species can be partitioned into genotypic and phenotypic components. Variability in genotypes make, how much it adaptive and possess the characters. The characters in genotype, when regenerated after each generation make how much it is heritable. Bezaweletaw et al. (2006) reported that genotypic variability among genotypes was not influenced by environmental condition in characters such as days to heading, finger width, finger length, and days to maturity, culm thickness and grain yield per plant. But these characters showed large variation in phenotypes. He also recorded high broad sense heritability for grain yield, indicating possibility of genetic advance from selection. Similarly, John (2006) reported high genotypic and phenotypic coefficients of variation for number of productive tillers per plant,

number of fingers per head and total dry matter production. He also reported high heritability coupled with high expected genetic gain for productive tillers, fingers per head, test weight, total dry matter and harvest index. Sumathi et al. (2007) reported high broad sense heritability for different parameters viz days to 50% flowering, days to physiological maturity, plant height, number of tillers, number of fingers per ear, finger length, 1,000 grain weight and grain yield per plant.

Correlation among traits

Correlation between traits is a decisive factor in the selection process and breeding programs that directly affect the genotype, the environment and their interaction. The phenotypic correlation between traits indicates the observed dependence, and the genotypic correlation reflects the genetic composition and origin. There are two reasons for the correlation between characters, genetic and environmental, and the genotype correlation is mainly caused by pleiotropia (a gene affecting more than one form), although the association may also cause transient correlation, especially in populations of different strains (Falconer, 1989). Cauvery (1993) reports that the correlation of grain yield with efficient soil cultivation and harvest index is positive and highly significant at both phenotypic and genotypic levels. They also found a positive correlation between straw yield and grain yield. Amgain et al. (2004) observed that the crop/plant was negatively correlated with flowering and maturing days. However, he correlated positively with the tiller/ plant, the number of leaves, the length of the flag leaves, the

width of the flag leaves, finger width, number of grains/finger and finger, and reported that deviations in these traits led to intramedullary deviations and inter population of crab grass. Similarly, Shanthappa (1979) observed that productive shoots, head length and harvest index were positively and significantly related to grain yield. According to Dhagata et al. (1972) yield correlated positively with yield and ripening time. Mahudeswaran and Murugesan (1973) observed that grain yield correlates positively and significantly with productive shoots. Harinarayana et al. (1989) described a positive correlation of grain yield with plant growth, productive shoots, fingers per head and head length. Exhaustive study of 4,000 germplasm of the pig's finger, Rama Krishna et al. (1996) showed that the grain yield is positively related to the plant height, efficient shoots, toes on the head and finger length. Grain yield had a positive and very significant relationship with all the studied traits, except plant height, days up to 50% flowering and days to maturity, as reported by Satish (2003). Bezawetraaw and others (2006) found that the millet yield per plant significantly correlated with days and maturity. However, thanks to the analysis of the path coefficient, it was found that the start days had a high positive direct impact on the crop per plant, and the days until maturity had a very high negative direct effect. He also informed that the yield per plant correlates positively with the productive tiller, the number of grains per finger and the mass of grain 1000 and the number of fingers.

Genotype × Environment interaction

The genotypes show variable phenotypic expression among each other at different environmental condition leads to effect in response to selection. The G × E directly influence the adaptability and stability of genotypes. Low G × E shows the stability of the genotype over the high range of environment and which genotype exploits high range of environment is adaptable and stable in response of yield. Mishra et al. (2009) reported that significance differences in grain yield of fifteen late duration finger millet genotypes in three environmental conditions over three years. He also concluded that AMMI model of analysis of variance in grain yield showed higher G × E interaction than Genotype (G), and Environment (E). Similarly, Kempanna et al. (1971) reported G × E interaction for different traits like, number of days to heading, tiller number and yield in twenty-two varieties of finger millet in three environmental conditions

Health and nutritional benefits

Finger millet grains contain higher amount of proteins, oils and minerals than the grains of rice, maize or sorghum (Reed et al., 1976). Vadivoo and Joseph (1998) mentioned finger millet grains contain 13.24% moisture, 7.6% protein, 74.36% carbohydrate, 74.36% carbon, 1.52% dietary fiber, 2.35% minerals, 1.35% fat and energy 341.6 cal/100g. It is a rich source of micronutrients such as calcium, phosphorus, magnesium and iron. Cysteine, tyrosine, tryptophan and methionine are the right spectrum of amino acids found in finger millet protein (Rachie, 1975). The increase in global temperature leads to climate changes that

directly affect crop production and increase people's hunger and malnutrition around the world. Therefore, food can be stored in this case for the public. The latest estimates published by the FAO in October 2010 shows that 925 million people are malnourished. Some 578 million people are from the Asia-Pacific region, and most children suffer from malnutrition, which leads to various diseases and ultimately death. Estimated mortality rates due to a nutritional deficiency are somewhat similar for diarrhea (61%), malaria (57%), pneumonia (52%) and measles (45%) (Black et al., 2003). Malnutrition, as measured by the inhibition of growth, affects 32.5% of children in developing countries, a third of them (De Onis et al., 2000). Finger millet

can be ground and cooked into cakes, puddings or porridge. In addition to this grain is made into fermented drink or beer in Nepal and in many parts of Africa. In central terai of Nepal, it is used as tiffin, for making *haluwa*, *roti* and *chokha*. It is also believed that this is a good diet for pregnant women and for treatment of animal diarrhea (Rana et al., 2000). In South India pediatricians recommended finger millet based food for infants six months and above because of its high nutritional content especially iron and calcium. Similarly, in northwest of Vietnam, finger millet is used as medicine for women when they give birth.

Table 2: Comparison of nutritional values of finger millet and other cereals

Crops	Amount of Nutrients per 100 gram raw grain				
	Carbohydrate(g)	Protein (g)	Fiber (g)	Iron (mg)	Calcium (mg)
Finger millet	72	7.3	3.6	3.9	344
Buckwheat	72	13.3	1.7	2.3	18
Barley	74	13.6	2.4	1.7	26
Amaranthus	68	9.4	2.2	5.2	37
Foxtail millet	66	12.3	8	2.8	31
Proso millet	73	12.5	2.2	3	14
Sorghum	72	8.5	1.6	11.2	22
Potato	23	1.6	0.6	0.5	10
Rice	78	6.8	0.2	0.7	10
Maize	72	9.2	-	-	1.2
Wheat	71	11.8	1.2	5.3	41

Source: Nutritive value of Nepali Foods: National Nutritional Program 2061, Nutritive Value of Indian Foods, NIN, 1993. Millets: Future Food and Farming, India.

CONCLUSION: Finger millet is one of future smart food crop of Nepal. It is hardy in nature and can be grown in the drought condition. This crop is rich in nutrient for

health benefit. The diversity of finger millet was found in previous studies. Mostly people are concerning to develop only handful cereals crops like maize, wheat, rice etc in these days may cause

food insecurity within few years because of increase in population of world and depletion of area of production. Exploration and evaluation of diversity among these genotypes would be of great significance for in situ conservation and finger millet breeding programs. The commercial production of finger millet should be done for minimizing hunger and poverty and maximizing food and nutritional security.

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REFERENCES:

Upadhyay H.D., Gowda C.L.L., Pundir R.P.S., Reddy V.G., and Singh S. (2006). Development of core subset of finger millet germplasm using geographical origin and data on 14 quantitative traits. *Genetic Resources and Crop Evolution*, 53, 679-685.

MoAD. (2015/16) Statistical Information on Nepalese Agriculture, 2014/015. Ministry of Agricultural Development, Nepal

Amgain R.B., Joshi B.K., Shrestha P., Chaudhry B., Adhikari N. P., and Baniya B.K. (2004) Intra- and interpopulation variation in finger millet (*Eleusine coracana*

(L.) Gaertn) landraces grown in Kachorwa, Bara, Nepal. Sthapit, B.R.; Upadhyay, M. P.; Shrestha, P. K.; Jarvis, D.I. (Eds.). Conference paper: On-farm conservation of agricultural biodiversity in Nepal. Volume 1: assessing the amount and distribution of genetic diversity on-farm. *Proceedings of the second national workshop*, Nagarkot, Nepal, 25-27 August, 2004

Baniya B.K., Riley K.W., Dongol D.M.S., and Sherchand K.K. (1992) Characterization of Nepalese hill crops landraces (Barley, Buckwheat, Finger millet, Grain Amaranth, Foxtail, Proso and Barnyard millets). NARC-IBPGR, Kabre, Dolakha, Nepal, 162.

Sherchan K.K. (1989) Importance, genetic resources, varietal improvement of finger millet in Nepal. In: Small Millet in Global Agriculture (A Seetharam, KW Riley and G Harinarayan, eds). Oxford and IBH Pub. Co. Ltd. New Delhi., 85-92.

Devi P.B., Vijayabharathi R., Sathyabama S., Malleshi N.G., and Priyadarisini V.B. (2011) Health benefits of finger millet (*Eleusine coracana* L.) polyphenols and dietary fiber: A review. *J Food Sci Technol*, 51(6), 1021–1040.

Kumar A., Metwal M., Kaur S., Gupta A.K., Puranik S., Singh S., Singh M., Gupta S., Babu B.K., Sood S., and Yadav R. (2016) Nutraceutical value of finger millet [*Eleusine coracana* (L.) Gaertn.], and their improvement using omics approaches. *Frontiers in Plant Science*. DOI:<http://dx.doi.org/10.3389/fpls.2016.00934>.

MoAD (2016/17) Agriculture Diary. Agriculture information and communication center, Harihar Vawan, Nepal.

Upreti R.P. (1999) Status of millet genetic resources in Nepal: Wild relatives of cultivated plants in Nepal. Pp. 78-82 *in* Wild relatives of cultivated plants in Nepal (R. Shrestha and B. Shrestha, eds.). Proceedings of National conference on wild relatives of cultivated plants in Nepal, 2–4 June 1999, Kathmandu. Green Energy Mission (GEM), Kathmandu, Nepal

Gupta S.R., Upadhyay M.P., and Dongol D.M. (2000) Nepalese germplasm catalogue 2000. Agriculture Botany Division, NARC, Khumaltar.

Baniya B.K. (1999) Some wild relatives of amaranth, barley, buckwheat and finger millet of Nepal: Wild relatives of cultivated plants in Nepal. Pp. 90-101 *in* Wild relatives of cultivated plants in Nepal (R. Shrestha and R. Shrestha, eds.). Proceedings of National conference on wild relatives of cultivated plants in Nepal, 2–4 June 1999, Kathmandu. Green Energy Mission (GEM), Kathmandu, Nepal

Hunsgi G., and Krishna K.R. (1998) Science of field crop production; Finger millet. New Delhi Oxford and IBH publishing Co Pvt. Ltd, 132.

ICRISAT. (2004) Finger millet. <http://www.icrisat.org/web/ASP/mainsection.asp/> (assessed: 15 July, 2019)

Adhikari R. K. (2005) Economics of underutilized crop: A case of finger millet

from Peri urban area of Pokhara valley, Thesis, M.Sc. Ag., Tribhuvan University, IAAS, Rampur, Chitwan, Nepal.

Baniya B.K., Riley K.W., Dongol D.M.S., and Sherchand K.K. (1992) Characterization of Nepalese hill crops landraces (Barley, Buckwheat, Finger millet, Grain Amaranth, Foxtail, Proso and Barnyard millets). NARC-IBPGR, Kabre, Dolakha, Nepal, 162.

Baniya B.K. (1999) Some wild relatives of amaranth, barley, buckwheat and finger millet of Nepal: Wild relatives of cultivated plants in Nepal. Pp. 90-101 *in* Wild relatives of cultivated plants in Nepal (R. Shrestha and R. Shrestha, eds.). Proceedings of National conference on wild relatives of cultivated plants in Nepal, 2–4 June 1999, Kathmandu. Green Energy Mission (GEM), Kathmandu, Nepal

Subedi A., Maharjan S.K., Silwal S., Devkota R., Upadhyay D., Pandey S., and Bhandari B. (2009) Community-based Biodiversity Management in Nepal: Site Selection Report. Local Initiatives for Biodiversity, Research and Development (LI-BIRD), Pokhara, Nepal.

Upreti R.P., Shakya P.B., Vaidya S., and Riley K.W. (1991) A study of finger millet in Nepal: Importance, Nutrition, Utilization and farming systems in a Socio Economic and Ecological context. IDRC library, Ottawa, Canada.

Tiwari P.R. (1999) Farmers' Varieties and Agricultural Sustainability in Kaski, Nepal. LI-BIRD Nepal.

Amgain R.B., Joshi B.K., Shrestha P., Chaudhry B., Adhikari N. P., and Baniya B.K. (2004) Intra- and interpopulation variation in finger millet (*Eleusine coracana* (L.) Gaertn) landraces grown in Kachorwa, Bara, Nepal. Sthapit, B.R.; Upadhyay, M. P.; Shrestha, P. K.; Jarvis, D.I. (Eds.). Conference paper: On-farm conservation of agricultural biodiversity in Nepal. Volume 1: assessing the amount and distribution of genetic diversity on-farm. *Proceedings of the second national workshop*, Nagarkot, Nepal, 25-27 August, 2004

De Wet J.M.J., PrasadaRao K.E., Brink D.G., and Mengesha M.H. (1984) Systemic evolution of *Eleusine coracana* (Graminea). *Amer. J. Bot.* 7, 550-557.

Bezaweletaw K., Sripichit P., Wongyai W., and Hongtrakul V. (2006) Genetic variation, heritability and path-analysis in Ethiopian finger millet (*Eleusine coracana* (L.) Gaertn) landraces. *Kasetsart Journal, Natural Sciences.* 40, 322-334.

Kefyalew A., and Ensermu R. (1989) Initial Results of Informal Survey Bahir Dar Mixed Farming Zone. No. 5. Institute of Agricultural Research. Addis Ababa, 31.

Upadhyaya H.D., Gowdaand C.L.L., and Reddy V.G. (2007) Morphological diversity in finger millet germplasm introduced from Southern and Eastern African *Journal of SAT Agriculture Research*, 3(1). ejournal.icrisat.org.

John K. (2006) Variability and correlation studies in quantitative characteristics of

finger millet (*Eleusine coracana* (L.) Gaertn.). *Agricultural Science Digest* ,26, 166-169.

Sumathi P., Joel A.J., and Muralidharan V. (2007) Genetic variability in the hybrids of finger millet [*Eleusine coracana* (L.) Gaertn.]. *Crop Research*, 33, 192-194.

Falconer D.S. (1989) Introduction to quantitative genetics (3rd ed.). Longman Scientific and Technical London and co-published in USA with John Wiley and Sons, NY

Cauvery M. B. (1993) Variability for fodder yield, it's components and grain yield in Indian and African collection of finger millet. *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Bangalore, India.

Shanthappa M. B. (1979) Inheritance studies in *Eleusine coracana* Gaertn Crosses. *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Bangalore, India.

Dhagat N. K., Pathak G.L., Srivastava P.S., and Joshi R.C. (1972) Correlation and genetic variability in ragi (*Eleusine coracana* G.). *Jawaharlal Nehru KrishiVishwaVidyalay Research Journal*, 6,121– 124.

Mahudeswaran, K., and Murugesan M., (1973) Correlation and path analysis in *Eleusine coracana* G. *Madras Agricultural Journal*, 60, 1287–1291

Harinarayana C., Shewall T.T, Gaikwad A.C., and Harper P.N. (1989) Variability

for components of yield in Maharashtra, Sikkim and Malawi collections of finger millet. In: Finger millet Genetics and Breeding in India. Proceedings of National Seminar, University of Agricultural Sciences, Bangalore, 1983, 119- 123.

Ramakrishna, M. B., Gowda B.T.S., Katti M., Seetharam A., Mantur S.G., Viswanath S., Channamma K.A.L., Krishnappa M., Vasanth K.R., Krishnamurthi B., and Jagadeeswara K.(1996) Evaluation of finger millet germplasm. *Germplasm Catalogue 1*. Small Millets Project Co-ordination Unit, UAS-KAR, Bangalore., 33-35.

Satish D. (2003) Studies on genetic diversity based on productivity and variability for quality traits in finger millet (*Eleusine coracana* Gaertn.). *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad, India.

Mishra R.C., Das S., and M.C. Patnaik M.C. (2009) AMMI Model Analysis of Stability and Adaptability of Late Duration Finger Millet (*Eleusine coracana*) Genotypes. *World Applied Sciences Journal*, 6, 1650-1654.

Kempanna C., Vijayamma R., and Setty M.V.N.(1971) The impact of genotypic environmental interactions on the components of variation and other genetic parameters in *Eleusine coracana*. *Maharashtra Journal of Agricultural Sciences*, 5, 295-301.

Reed C. F. (1976) Information summaries on 1000 economic plants. USDA, USA.

Vadivoo A.S., and Joseph R. (1998) Genetic variability and diversity for protein and calcium contents in finger millet (*Eleusine coracana* (L.) Gaertn) in relation to grain color. *Plant Foods for Human Nutrition Dordrecht* 52, 353-364. Department of Botany, Avinashilingam Institute for Home Science and Higher Education for Women, Deemed University, Coimbatore, TN, 641 043, India.

Rachie K. O. (1975) The Millets: Importance, Utilization and Outlook. International Crops Research Institute for the Semi-Arid Tropics, Hyderabad, India., 63.

Black R.E., Morris S.S., and Bryce J. (2003) "Where and why are 10 million children dying every year?" *Lancet*. 361, 2226-34.

De Onis M., Frongillo E.A., and Blossner M. (2000) "Is malnutrition declining? An analysis of changes in levels of child malnutrition since, 1980." *Bulletin of the World Health Organization*. 2000, 1222–1233.

Rana R.B., Rijal D.K., Gauchan D., Sthapit B.R., Subedi A., Upadhyay M.P., Pandey Y.R., and Jarvis D.I. (2000c) *In situ* crop conservation: Findings of agro-ecological, crop diversity and socio-economic baseline survey of Begnas ecosite, Kaski, Nepal. NP working 2/2000. NARC, LI-BIRD and IPGRI.