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RESEARCH ARTICLE

A DETAIL EVIEW ON STATUS AND PROSPECT OF MAIZE PRODUCTION IN NEPAL

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ABSTRACT

Maize ranks second after rice in terms of both production and area coverage in Nepal. Maize being the principal staple food for majority of people and source of animal feed, cultivated from March to May depending upon distribution of rainfall. Although maize area and production has shown a steady increase in recent years, its productivity has been low (2.67t/ha). Despite the many efforts made to increase the maize productivity in the country, the results are not much encouraging. This paper was prepared after intensive review of all the information obtained from all available resources to analyze the production of maize and reason for decrease in productivity of maize. The research work conducted in several periods has shown numerous reason such as insect pest, disease, weeds, biotic stress, lack of labour, unavailability of improved seed, poor extension and research Programme and frequent occurrence of drought and many more. Therefore, in order to streamline the future direction of maize production in Nepal, an attempt has been made in this paper to highlight the present status and future prospect with key pathways for increasing the productivity of maize.

KEYWORDS

Maize Production, Productivity, Significant, Constraints, Adaption strategies

1. INTRODUCTION

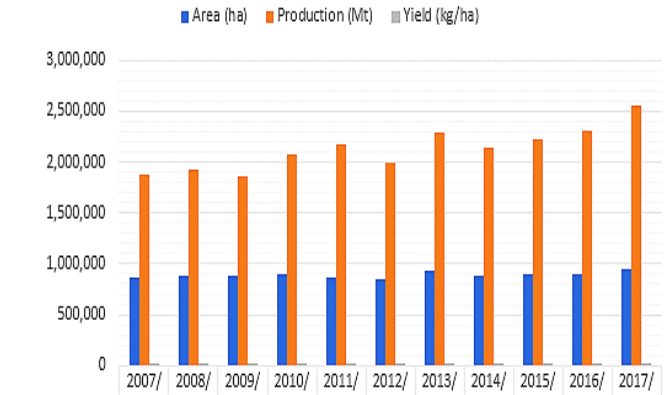
Maize (*Zea mays*) is the second most important staple crop after rice in terms of area and production in Nepal (Kandel et al. 2017; MOAD 2017/18). Maize is the major traditional cereal crop grown for food, feed and fodder. Maize demand has been constantly growing by 5% annually in last decades. Per capita maize consumption in Nepal was 98g/person/day (Ranum *et al*., 2014). At present, maize cultivation area in Nepal is 954,158 ha with a total production of 2,555,847 metric tons/ha and productivity of 2.67 t/ha (MOAD 2017/18). It contributes about 25.02% of total cereal production, 6.88% in Agriculture Gross Domestic Product (AGDP) and 3.15% in Gross Domestic Product (GDP) (Pandey and Basnet 2018; MOAD 2014/15).

In Nepal maize is grown in sub-tropical to cool temperate climates. It is cultivated as food, feed and fodder on slopping *bari* land (rainfed upland) in the hills. Maize is grown under rainfed conditions during the summer (April-August) as a single crop or relayed with millet later in the season. In the terai, inner-terai, valleys, and low-lying river basin areas, maize is also grown in the winter and spring with irrigation.

More than two third of the maize produced in the mid hills and high hills is used for direct human consumption at the farm level.

1.1 Status of Maize Area, Production and Productivity

The area, production and productivity of maize are slowly and constantly increasing since 2007 in Nepal (Figure 1). However, the production of maize is low as compared to other developed nation. Maize contributes 24.93% in total edible cereal grain production in Nepal. In Nepal mid hill, terai and high hill occupies 72.85, 17.36 and 9.79% of total maize cultivation area respectively (MOAD 2014).



	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
Area (ha)	870,166	875,428	875,660	906,253	871,387	849,635	928,761	882,395	891,583	900,288	954,158
Production (Mt)	1,878,6	1,930,6	1,855,1	2,067,5	2,179,4	1,999,0	2,283,2	2,145,2	2,231,5	2,300,1	2,555,8
Yield (kg/ha)	2,159	2,205	2,119	2,281	2,501	2,353	2,458	2,431	2,503	2,555	2,670

Figure 1: Maize production trend in Nepal. Source: (MOAD, 2017/18)

Maize yield level in Nepal at present is much below than potential yield 6.7 t/ha (on station experimental yield), attainable yield of about 5.7 t/ha (on farm with improved practices) and national yield of 2.67 t/ha (Figure 2). There are various biotic and abiotic yield limiting factors in maize of which diseases and poor crop management are important ones.

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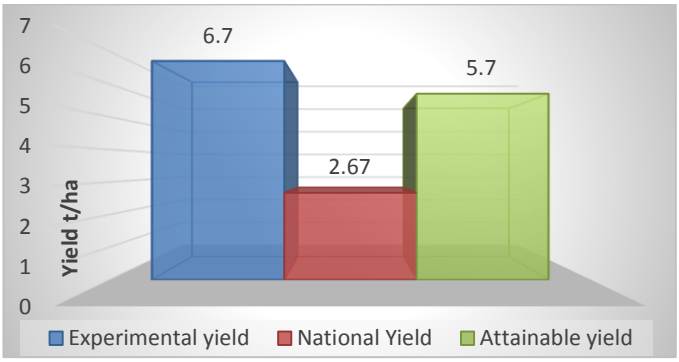

Figure 2: Yield gap of maize in Nepal (NMRP, 2014)

2. Major Constraints to Maiaze Production

2.1 Biological Constraints

(Insect, Pest and Disease in Maize Field and Store)

Smut (*Sphacelotheca reiliana*) and turcicum blight (*Helminthosporium turcicum*) in the eastern and midwestern/ far-western midhills and high hills; ear rot in the central/western and mid-western/far-western midhills; stalk rot in the mid-western/far-western midhills, terai, and high hills; and downy mildew (*Perona sclerospora spp*.) and leaf firing in the terai were important diseases mentioned by farmers. Banded leaf and sheath blight (*Rhizoctonia solani*) was increasing in severity and prevalence in all environments. Turcicum leaf blight is ubiquitous in hill environments and can cause severe losses if the variety does not have good genetic resistance.

Similarly, gray leaf spot disease is emerging as problematic during rainy season in the hills. White grubs (*Phyllophaga spp*. and *Cyclocephala spp*.), stem borers (*Chilo partellus*), and termites (*Microtermes spp. and Macrotermes spp*.) were major maize field insects in all agro-ecologies. Army worms (*Spodoptera spp*., *Mythimna spp*) and cutworms (*Agrotis spp*. and other species) were also major problems in all agroecologies except the eastern mid hills. Blister beetle was a major problem in the central/western and mid-western/ far-western midhills and the terai, and field cricket a serious pest in the eastern and mid-western/far western mid-hills and high hills. Aphid (*Rhopilosiphum spp*.), locust, red ant, and tassel beetle were also reported by farmers. Weevils (*Sitophilus* spp.) and Angoumois grain moth (*Sitotroga cerealella*) were major problems in stored grain (Paudyal *et al*., 2001) throughout the country.

2.2 Crop Management and Soil Fertility Constraints

2.2.1 Weed Infestation

Weeds, being hardier in nature compete with maize plants for nutrients, water, sunlight and space during entire vegetative and early reproductive stages of maize, they transpire a lot of valuable conserved moisture and absorbs large quantities of nutrients from the soil and their relative density plays a significant role in reducing the yield of crop. The loss caused by wees in maize ranges 40 -70 % (Mandal, 2000) and yield loss depend on type of weed flora and its severity. At ARS Pakhribas (eastern mid hill of Nepal) experimental result showed weedy environment resulted yield reduction up to 70% in maize (Mishra, 2004).

Table 1: Common weeds associated with maize.

Scientific name	English name	Local name	Weed type
Cynodon dactylon	Bermuda grass	Dubo	Narrow leaf weeds
Echinochloa colonum	Jungle rice	Sama jhar	
Eleusine indica	Goose grass	Kode jhar	
Sorghum halepanse		Banchari	
Amaranthus sp.	Amaranthus	Latte jhar	Broad leaf weeds
Solanum nigrum	Night shade	Kaligedi	
Ageratum conyzoides	Goat weed	Gandhe jhar	
Chenopodium album		Bethe	
Cyperus rotundus	Nut sedge grass	Mothe	Sedge

Source: Research gate

2.2.2 Soil Fertility

With the increase in population, industrialization, modernizations, urbanization, deforestation and land pollution are increasing day by day. Among important recent changes, reduction in livestock, forest degradation, reduced land availability and stall feeding of cattle led to reduction in manure. High cost, non-availability at key time, lack of knowledge of use and no updated recommendation on the dose of fertilizers are also main reason behind low soil fertility and productivity.

2.2.3 Water Management

The total irrigated area in Nepal is only about 1331521 ha (MOAD, 2014). More than two thirds of the maize is produced in the mid hills and high hills during summer season and is mostly grown under rainfed condition. Delay in monsoon during planting, uneven distribution of rainfall and prolonged drought during crop season may affect the crop yield adversely. Water stress due to drought is probably the most significant abiotic factor limiting plant and also crop growth and development (Khalilli *et al*., 2013). The very limited area under winter and spring maize in Terai is irrigated.

2.2.4 Socio-economic

Maize is predominantly grown in the mid hills and the farm sizes are also quite smaller compared to Terai region. Maize farming is considered as subsistence farming in Nepal. It is regarded as a staple food of hill people. Staple commodities such as rice, wheat, potato and vegetables have higher commercialization rates (30-50%) than maize and fruits (15-25%) (ADS, 2014). The productivity is adversely affected by the shortage of agricultural labor. Due to an inadequate policy intervention for prioritization of agriculture research, NARC, is suffering from inadequate operational budget as a consequence maize research is also being affected.

2.3 Input Supply Constraints

The problems associated with availability of quality maize seeds differ between agro-ecologies. In the eastern to western midhills farmers are not able to get improved

maize varieties of their choice. Hybrid yield 20 -30% more than OPVs but unavailability of location specific maize hybrids is one of the major causes of low productivity. National Maize Research Program (NMRP), Rampur, has registered and released seven maize hybrids but they are not suitable for all agro-climatic region of Nepal. The SRR for maize is also very low (<10%).

The farmers of the high hill and mid hill are deprived of quality seeds and fertilizers due to;

a. Remoteness of the area (no developed infrastructure).

b. Lack of awareness and demand of modern inputs.

c. Lack of purchasing capacity of farmers because of high piece of input supply.

2.4 Institutional Constraints

Although the District Agricultural Development Office (DADO) has offices in the district headquarters and satellite offices at the service center, it has not been able to provide sufficient services to farmers, especially in remote hills. Farmers of the remote hill are not in access to National Maize Research Programme (NMRP, Rampur, Chitwan) regarding research activities and production technology. The NGOs are more inclined towards production of cash crops such as vegetables and fruits.

NMRP have modest facilities of land for research and seed production, disciplinary and multidisciplinary research projects funded by Nepal Agricultural Research Council (NARC), some scientific and technical staffs, and laboratories. It also works in collaboration with International Maize and Wheat Improvement Center (CIMMYT) and ICRISAT, the international CGIAR organizations. In particular, NMRP is incessantly suffering from inadequate research funds and no fixed term research staffs, lack of motivational schemes for the research staffs including exposure visits and training, poor technology delivery mechanisms, and inadequate system-based research. Disciplinary laboratories like soil, seed, entomology, plant pathology, plant breeding and Agri-mechanization are not in full operation.

2.5 Information Constraints

Lack of information is most acute for farmers in the High hills and remote areas of the midhills. Many farmers in these areas did not know which

improved varieties are suitable for their farms and where to obtain them. Lack of knowledge of improved crop management practices including spacing, fertilization, and choice of variety are other problems. Farmers, in many instances, could not identify insect pests, diseases, and nutritional deficiencies in their crops and had no knowledge of pesticides that could be used for their control. In most locations improved technology was beyond the reach of the farming community because of their unavailability and high price.

2.6 Environmental Stresses

Environmental stress such as high temperature, chilling, irregular pattern of rainfall, water logging, salinity, toxicity also reduces the production of maize. They cause growth inhibition, morphological changes, affects photosynthesis activity and biochemical mechanism. These stresses adversely affect the plant performance by disrupting the cellular functions and metabolic activities. Similarly, drought stress is also one of the most serious environmental stress affecting the productivity, quality and quantity of the maize.

2.7 Market Facility

Because of the underdeveloped marketing system, poor market infrastructure, and shortage of inputs, excess maize production is not easily disposed of at an attractive price. This has indirectly slowed the pace of adoption of new technologies. Annual requirement of maize seed in Nepal is 19,552 MT. Prevalence of farmers saved seed and OPVs. Contribution of the formal sector to this demand is 15 % (2932 t). Companies contribute10% and balance 90% are produced by cooperatives, DADOs, NARC and CBSPs. Three varieties viz., Rampur Composite, Manakamana-3 and Arun-2 (constitutes 81% of the total source seed production of 75 t). Growing trend of hybrid maize in Nepal – open border. About 1500 t (both formal and informal) of maize seed imported worth NRs 1 billion. Hybrids developed by NARC are yet to be commercialized and Low capacity of private sector and limited market development activities.

3. Adoption Strategies for Improving Maize Production

Drought stress impairs many physiological processes. The stressful There are tremendous opportunities to increase the maize production there by narrowing down the wider yield gap and horizontal expansion in winter season. The conventional maize production system needs to be converted into modern, resource use efficient and climate smart under the pretext of stagnant productivity as a result of limited area expansion, low yield potential of the existing genotypes, imported hybrid seed, declining soil fertility, and emergence of new pest species, labor and water. Therefore, the research should focus on utilizing the latest tools of plant breeding for the development of stress resilient maize genotypes, hybrid seed production effort, climate smart, and resource conserving agro-techniques like conservation agriculture.

3.1 RECOMMENDED STRATEGIES

Following strategies can help in better production of maize:

3.1.1 Varietal Selection

Farmers should select the appropriate crop variety depending upon their farm ecological climate and environment. NMRP has released some recommended varieties for different ecological region which are given in Table 2. National Maize Research Program (NMRP), Rampur, has registered and released seven maize hybrids but they are not suitable for all agro-climatic region of Nepal. Promising NMRP hybrids: RML-32/RML-17, RML-4/RMl-17, RML-86/RML-96, RML-95/RML-96. Hybrid yields 20–30% more than open pollinated variety.

Table 2: Some recommended varieties of maize

Production Area	Recommended Varieties
High hills (>1500masl)	Ganesh-1, Ganesh-2, Kakani Yellow
Mid hills (>1000masl)	Manakamana-1,2,3,4,5&6, Makalu-2, Khumal yellow
Foot hills (spring maize)	Rampur composite, Arun-1,2,3,4 and 6
Inner Terai	Rampur composite, Janaki, Arun-2
Terai (winter maize)	Hetaunda composite, Rampur composite, Sarlahi seto

Source: (NMRP, 2015)

3.1.2 Better Crop Management Practices

Better crop management practices like conservation tillage, land preparation, Insect Pest Management (IPM), nutrient and herbicides application, pre- and post-harvest management helps to increase the production of maize. Conservation tillage in maize reduced the impact of drought by lowering soil temperature and surface evaporation, hence increased grain yield.

- In case of conservation tillage in maize, Atrazine herbicide (pre-emergence) application of Atrazine (50%WP) @ 1.5kg ai. /ha within 24 hours of planting and Pendimethalin 30% EC @ 6ml/liter of water i.e 550 litres/ha within 48 hours of direct seeding reduces wees infestation and helps in better development of crop.
- Tank mixture of Atrazine and Glyphosate (Atrazine @ 0.75kg a.i./ha + Glyphosate @2.5 ml/liter of water) or Atrazine (Atrazine @1.5kg a.i./ha as pre-emergence) + one hand weeding at 40 days after seeding during spring season maize is better for higher grain yield and net economic return.

3.1.3 Soil Fertility Management

- To date general recommendation of fertilizer for maize in Nepal is 120:60:40 NP2O5K2O kg /ha. Follow proper rate of fertilizer dose i.e., **Spring and Kharif maize**: 120:60:40 kg NPK/ha, **Rabi maize**: 150-180: 60:40 kg NPK/ha, **FYM**: 10-15 t/ha.
- Full dose of phosphorus and potassium along with 1/3-1/2 dose of Nitrogen should be applied as basal dose during final land preparation before sowing. Remaining 2/3-1/2 dose of N should be applied as side dressing (for wider spacing crops) in two equal splits as;
  - first split dose at 'knee high stage' (35-45 DAS)
  - Last split dose at tasseling stage (55-65 DAS)
- For zinc deficient soil, 20-25 Kg ZnSo4/ha during final land preparation and thoroughly mix into the soil is recommended for better crop growth and development.

3.1.4 Plant Protection

- For Gray leaf spot (GLS) disease the resistant/tolerant varieties such as; Manakamana-3, Manakamana-5, Manakamana-6 (for mid-hills) & Ganesh-1 & Ganesh-2 for high hills Rampur Composite & Sarlahi Seto should be cultivated.
- Chemicals such as Bayleton (triademeform) @2g/kg seed helps to control heat smut. Similarly, seed treatment with Apron 35 SD (metalaxyl) @3g a.i./kg seed is effective for the control of downy mildew.
- For maize stem borer management, a commercial mixture of Chloropyriphos 50% and Cypermethrin 5% spray can be performed.
- Maize grains should be treated with 5% dust of malathion and 2-3 tables of Aluminium phosphide (Celphos) per metric ton found to protect against storage pests. In the case of botanicals, Bojho (20 gm/Kg seed) found effective control to maize weevil.

3.1.5 Research Priorities

To alleviate the constraints of maize production, both varietal development and crop management research need to be implemented in an integrated approach. Research efforts should be targeted to address both yield potential and on-farm yields by reducing the impacts of abiotic and biotic constraints. So, the following actions are needed to address such problems:

- Development of stress (drought, heat, cold, low nutrient and high density) resistant high yielding hybrids and open pollinated varieties of maize for different production ecologies
- Provision of subsidy to genuine farmers and loan at low rate of interest
- Application of modern tools of breeding like Marker-Assisted and Genomics for the fast track and precision breeding program in collaboration with CIMMYT and other concerned organizations

- Source seed production and distribution system throughout the country
- Low-cost resource conserving production technologies
- Development of quality protein maize for nutritional enhancement
- Flow of information and knowledge to the farmers.
- Mize research areas:
  - Varietal development
  - Soil fertility management and agronomy
  - Plant pathology and entomology
  - Seed production technology
  - Technology update

4. Conclusion

The attainable yield of maize is 5.6 t/ha but the national average yield is only of 2.67 t/ha. Thera is huge yield gap which can be fulfilled with the help of better crop management, adequate use of manure and fertilizers, supply of quality seeds, advancement in technologies and machineries, continuous research and extension activities, development of infrastructures in hills, flow of information, awareness and so on. With the increasing population, higher production of maize and other cereal crops can minimize the food insecurity in the nation as well as all over the world. Feed industry and poultry farms has huge demand of maize. Out of total maize that was used in feed production, 87% of the maize was imported from India each year by feed industries. Similarly, the poultry feed and animal feed demand are also increasing over recent years. This shows big scope to increase domestic production of maize. Nepal has potential to produce different varieties of maize because of its adverse climate diversity. Hence, there is tremendous scope to increase area, production and productivity of maize in Nepal.

References

Acharya Y, Ghimire Y, Upadhayay N and Poudel B., 2019. Assessing Migration and Remittance status and its Effect on Maize Production in Nepal. Journal of Nepal Agricultural Research Council. 5: 88-95, DOI: https://doi.org/10.3126/jnarc.v5i1.23814

ADS, 2014. Agriculture Development Strategy (ADS). Ministry of Agricultural Development Singhdurbar. Kathmandu, Nepal.

Bhandari, G.S., Thapa, R.B., Giri, Y.P., Manandhar, H.K., Jha, P. K., 2019. Farmers' Perception on Climate change and Maize cultivation in relation to insect diversity across the altitudinal gradient of Nepal. Journal of Agriculture and Forestry University Chitwan. 3: 85-97

Govind KC, Karki B Tika, Shrestha Jiban, Achhami B Buddhi., 2015. Status and prospect of maize research in Nepal. Journal of Maize Research and Development. 1(1):1-9 DOI: 10.5281/zenodo.34284.

Jakhar D.S, Singh R., 2015. Biotic stress response in Maize (Zea mays L.). Journal of Biotechnology and Crop Science, 4(4): 47-51

Kafle, B., 2010. Determinants of Adoption of Improved Maize Varieties in Developing Countries: A Review. International Research Journal of Applied and Basic Sciences, 1(1), 1–7. https://doi.org/10.1111/j.1477-9552.2004.tb00115.x

Kandel B.P., 2020. Status, prospect and problems of hybrid maize (Zea mays L.) in Nepal: a brief review. Genet Resour Crop Evol. 68: 1-10.

Kandel B.P., Poudel A., Sharma S., Subedi M., 2017. Correlation and path coefficient analysis of early maize genotype in western hill of Nepal. Nepal J Agric Sci 15:119–124

Karki, T.B., Gadal, N., & Shrestha, J., 2014. Studies on the conservation agriculture-based practices under maize based (Zea mays L.) based system in the hills of Nepal. Int.J. Curr. Microbiol. App. Sci 3(10), 990-1002.

Khadka, B.B., & Shah, S.M., 1967. Preliminary list of plant diseases recorded in Nepal. Nepalese Journal of Agriculture, 2, 47-76.

Khalili, M., Naghavi, Aboughadareh, M.R., & Rad, H.N., 2013. Effects of drought stress on yield and yield components in maize cultivars (Zea mays L.). International Journal of Agronomy and Plant Production. 4,809 -812.

Lamichhane, J., Timsina, K.P., Ranabhat D.B. & Adhikari, S., 2015. Technology adoption analysis of improved maize technology in western hills of Nepal. Journal of Maize Research and Development, 1, 146-152.

Manandhar, G., 1997. 25 years of maize research in Nepal (1972- 1997). Nepal Agricultural Research Council, National Maize Research Program, Rampur, Chitwan, Nepal.

Mandal, R.C., 2000. Weeds, Weedicides and weed control principles and practices. Agro botanical publisher, Bikaner, India.

Mishra, M., 2004. Studies on weeds management in maize crop in the eastern hills of Nepal. In: Proceeding of the 24th National Summer Crops Research Workshop, 2004. NARC. Pp. 180-181.

MOAD., 2014. Statistical Information on Nepalese Agriculture, Ministry of Agricultural Development, 2014.

MOAD., 2014/2015. Statistical information on Nepalese Agriculture. (2014/2015). Agri-Business Promotion and Statistics Division. Ministry of Agriculture and Development. Singhadurbar, Kathmandu, Nepal.

MOAD., 2017/2018. Statistical information on Nepalese Agriculture. (2017/2018). Agri-Business Promotion and Statistics Division. Ministry of Agriculture and Development. Singhadurbar, Kathmandu, Nepal.

MOAD/CBS., 2016. Food and Nutrition Security: A Status Report. Reported by Ministry of Agricultural Development and Central Bureau of Statistics to the Food and Agricultural Organizations, Nepal.

Nayava J.L, PhD and Gurung Dil Bahadur, PhD., 2010. Impact of climate change on production and productivity: A case study of maize research and development in Nepal. The Journal of Agriculture and Environment. Vol:11

Neupane, S., Karn, R., Khanal, P., Karki S, Sah SK (2019) Performance of maize hybrids in spring season at Sonpur Dang, Nepal. Field Crop 2(4):21–27. https://doi.org/10.5376/fc. 2019.02.0004

NMRP., 2013. Registered maize Varieties in Nepal Up to 2013. Published by Government of Nepal/ Nepal Agriculture Research Council/National maize Research Program, Rampur,

NMRP., 2015. Characteristics of maize Varieties Developed and Released in Nepal (1966- 2015). Published by Government of Nepal/ Nepal Agriculture Research Council/National Organizations, Nepal.

Pandey G., Basnet S., 2018. Objective's agriculture book at a glance. Kapil Group & Company Pvt. Ltd., Budhanilkantha, Kathmandu, Nepal pp 28–29

Paude, P., Matsuoka, A., 2008. Cost efficiency estimation of maize production in Nepal: a case study of the Chitwan district. Matsuyama 790-8566, Ehime, Japan

Paudel P., Shrestha Arjun Kumar, Matsuoka Atsushi., 2009. Socio-economic Factors Influencing Adoption of Fertilizer for Maize Production in Nepal: A Cast Study of Chitwan District. The 83rd Annual Conference of the Agricultural Economics Society, Dublin

Paudyal, K.R., Poudel, S.K, 2001. Impact of public and private sector maize research in Nepal. In: Impact of Public and Private Sector Maize Breeding Research in Asia (1966–1999). CI MMYT, Mexico, D.F., pp. 66–80.

Paudyal, KR, JK Ransom, NP Rajbhandari, K Adhikari, RV Gerpacio and PL Pingali., 2001. Maize in Nepal: Production Systems, Constraints, and Priorities for Research. Kathmandu: NARC and CIMMYT.

Poudel, N.S., Khanal, K., 2018. Viral Diseases of Crops in Nepal. Int. J. Appl.

Sci. Biotechnol., 6 (2), Pp. 75-80.

Ranum, P., Pena-Rosas, J.P., & Garsia-Casal, M.N., 2014. Global maize production, utilization and consumption. Annals of the New York Academy of Sciences, 1, 1312·

Santa BBK, Shrestha J., 2014. Effect of conservation agriculture on growth and productivity of maize (Zea mays L.) in Terai region of Nepal. World 2(4):168–175

Sapkota D., Pokhrel S., 2010. Community based maize seed production in the hills and mountains of Nepal: A review. Agronomy Journal of Nepal, l 1:107–112.

Shrestha, J., & Timsina, K.P., 2011. Agronomic Performance and Economic Analysis of Maize (Zea mays L.) under Different Plant Geometry and Nitrogen Rates in Chitwan, Nepal. Nepalese Journal of Agriculture Science, 9, 5-13.

Slideshare.net, Maize market development in Nepal. [accessed July 1 2021] https://www.researchgate.net/publication/319526853

Subedi S, Ghimire Y.N, Devkota D., 2017. Socio-economic assessment on maize production and adoption of open pollinated improved varieties in Dang, Nepal. Journal of Maize Research and Development. 3(1):17-27, DOI: http://dx.doi.org/10.3126/jmrd.v3i1.18916

Subedi S., 2015. A review on important maize diseases and their management in Nepal. Journal of Maize Research and Development, 1(1):28-52. DOI: 10.5281/zenodo.34292.

Timsina K.P., Ghimire Yuga Nath, Lamichane Jeevan, 2016. Maize production in mid hills of Nepal: from food to feed security. Journal of Maize Research and Development 2 (1): 20-19.

Timsina, K.P., Shivakoti, G.P., & Bradford, K.J., 2015. Supply Situation of Vegetable seeds in Nepal: An analysis from policy perspective. Nepalese Horticulture, 10, 26-36.