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CEREAL IMPORT AND CONSUMPTION PATTERNS IN NEPAL – ANALYSIS OF RICE, WHEAT, MAIZE, AND MILLET: A REVIEW

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ABSTRACT
This article examines the import and consumption patterns of four major cereal crops in Nepal, namely rice, wheat, maize, and millet. Using data from various sources, including the Ministry of Agriculture and Livestock Development (MoALD), Food and Agricultural Organization (FAO) and scholarly publications, we analyze the quantities of these cereals imported into Nepal, their major sources, and the factors driving import trends. We also explore the consumption patterns of these cereals, considering factors such as regional variations, seasonality, and cultural preferences. Finally, we discuss the challenges and opportunities associated with cereal import and consumption in Nepal, highlighting the significance of this issue for the country's food security and overall well-being. Our findings suggest that Nepal remains heavily dependent on cereal imports to meet domestic demand, and that the consumption patterns of these cereals vary considerably across the country. We conclude with some policy implications and recommendations for enhancing Nepal's cereal industry, promoting self-sufficiency in cereal production, and improving the nutritional status of its population.

KEY WORDS
Eleusine, import*, Oryza,* production, *Triticum*, *Zea*.

The primary cereal crops in Nepal are rice, maize, and wheat, which are the country's main cash crops with 91.31 and 96.67 percent of the total area and production of cereal, respectively (MoALD, 2021; Prasad, et al., 2019). Paddy (*Oryza sativa* L.) is the most important cereal, CH-45, Parwanipur-1, IR24, Chandina, Laxmi, Bindeswari, Malika, Chaite-2, Chaite-4, and Chaite-6 are some of the varieties of paddy that are grown in Nepal. Maize (*Zea mays* L.) is the second most important cereal, Rampur Yellow, Khumlal Yellow, Kakani Yellow, Hetauda Comp., Rampur Comp., Sarlahi Seto, Janaki, Arun-2, Manakamana-1, Rampur-2, Ganesh-2, Arun-1, Rampur-1, Makalu-2, and Ganesh-1 are some of the varieties of maize that are grown in Nepal. Wheat (*Triticum aestivum* L.) is the third most important cereal, NL30 and HD 1982, UP 262, Lumbini and Triveni, Vinayak, Siddhartha and Vaskar, Nepal 297, Nepal 251, BL 1022, Annapurna 1 are some of the varieties of wheat that are grown in Nepal. Paddy and wheat are grown in the valley, tars, Terai, and irrigated lands in mountain; while maize is mid-hills of the country (Bhandari, 2012). Millet (*Eleusine coracana* L.) is a relatively minor cereal in terms of area. Despite having importance, Nepal is not able to become self-sufficient in terms of cereal crop production.

RESULTS AND DISCUSSION

Rice consumption demand is getting high as a huge non rice consuming community is also shifting to rice consuming. From 1990/91 to till 20221/22, the gross national production of paddy is increased by nearly 150%. Additionally, during the civil war period from 1996 to 2006 there was a massive movement from village to town area in search of security and peace. 1.8 million of people migrated in those ten years (Mosaic, 2017). Due to the labor shortage the agriculture land were left barren and uncultivated which had a direct impact on Nepalese economy (Lokendra, 2019). The shift from rural to urban areas has impacted crop cultivation in Nepal, with many people abandoning their traditional practices in favor of modern lifestyles. As a result, there has been a significant shift in food habits, with rice becoming a more popular choice than traditional crops like millet and maize. While there have been many advances in the development of new rice varieties in recent years, the demand for this staple food remains high in Nepal, particularly in the mountainous and Himalayan regions where food culture is rapidly changing. To meet this demand, imports of rice have been increasing steadily in recent years, with major importing countries including India, Thailand, Bangladesh, Japan, and Myanmar. Despite the increase in rice imports, however, there is still a need to improve local cultivation practices to ensure that the demand for this vital food source can be met sustainably in the long term (MoALD, 2023; NRB, 2021). In the figure there is a quadratic model between the import weight of rice and price, meaning that the price of rice is increasing as the demand is increasing (NRB, 2021). The rice import quantity and value is increasing at the rate of 24.48% and 38.11% while population growth is 1.68% (Choudhary et al., 2021).

The increasing demand for rice in Nepal has resulted in a situation where local production is unable to meet the country's needs, leading to a reliance on imports. While there have been significant improvements in the development of new rice varieties, the production of rice locally is still insufficient to meet the rising demand. This can be attributed in part to the migration of people from rural to urban areas, which has led to a decline in traditional agricultural practices. Moreover, unpredictable weather patterns and natural disasters can further exacerbate the shortage of rice production. In such scenarios, there is a lack of proper management of food items during disaster management, which can result in severe food shortages and hunger. This highlights the need for better disaster management strategies that consider the importance of food security and the need for sustainable agricultural practices.

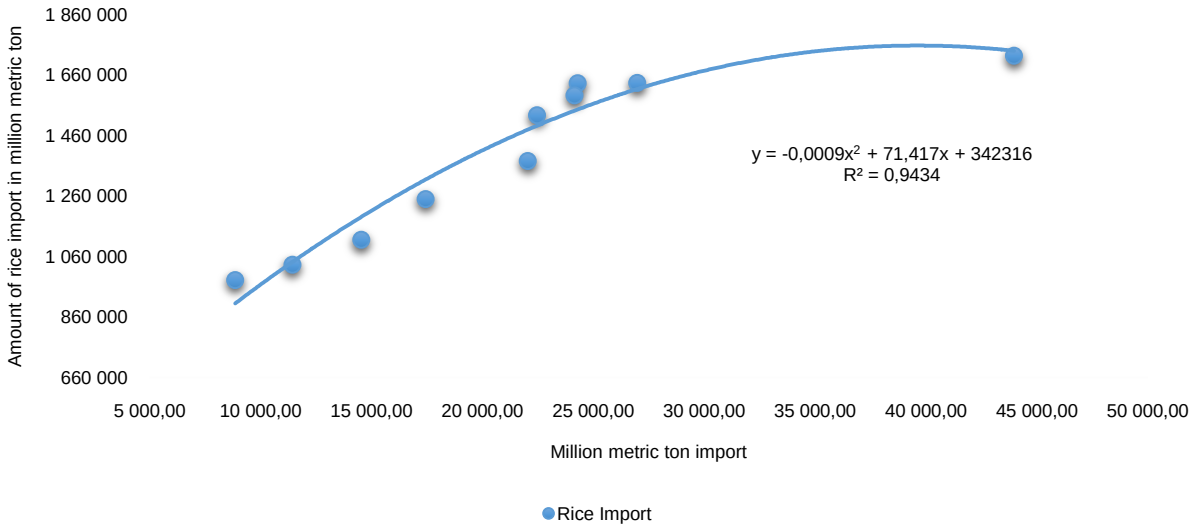


Figure 1 – Correlation between amount of rice import and values from 2010/11 – 2019/20

To address the gap between demand and supply of rice in Nepal, it is crucial to promote sustainable agriculture practices and encourage farmers to cultivate a diverse range of crops. This can help reduce the country's reliance on rice as the primary food source, which in turn can help ensure greater food security. Additionally, there is a need to improve local storage and distribution systems to ensure that food reaches those who need it most during times of scarcity. In conclusion, the increasing demand for rice in Nepal has led to a situation where local production is unable to meet the needs of the country. This has resulted in a reliance on imports, which can be unsustainable in the long run. To ensure greater food security, it is crucial to promote sustainable agricultural practices, improve local storage and distribution systems, and develop better disaster management strategies that prioritize the importance of food security.

Table 1 – Production of rice (MoALD, 2022)

Year	Production ('000 MT ton)	Productivity
1990/91	3.500	2.4
1991/92	3.222	2.28
1992/93	2.584	2.04
1993/94	3.495	2.41
1994/95	2.906	2.12
1995/96	3.578	2.39
1996/97	3.710	2.45
1997/98	3.640	2.41
1998/99	3.709	2.45
1999/00	4.030	2.59
2000/01	4.216	2.7
2001/02	4.164	2.74
2002/03	4.132	2.67
2003/04	4.455	2.85
2004/05	4.289	2.78
2005/06	4.209	2.71
2006/07	3.680	2.55
2007/08	4.299	2.77
2008/09	4.523	2.9
2009/10	4.023	2.71
2010/11	4.460	2.98
2011/12	5.072	3.31
2012/13	4.504	3.17
2013/14	5.047	3.39
2014/15	4.788	3.36
2015/16	4.299	3.15
2016/17	5.230	3.5
2017/18	5.151	3.51
2018/19	5.610	3.76
2019/20	5.550	3.8
2020/21	5.621	3.82

Table 2 – Varieties of rice cultivated in Nepal (Bhattarai, 2017)

S.N.	Variety	Year of Release	Origin	Days of Maturity	Yield (Mt/ha)	Recommended domains
Spring Season						
1.	CH-45	1966	China	118	3.5	Terai, inner Terai
2.	Parwanipur-1**	1973	IRRI	135	4.0	Terai, inner Terai
3.	IR-24**	1975	IRRI	135	3.8	Terai, inner Terai
4	Chandina**	1977	Bangladesh	128	3.8	Terai, inner Terai
5.	Laxmi**	1979	IRRI	135	4.5	Terai, inner Terai
6.	Bindeswori	1981	India	128	4.0	Terai, inner Terai
7.	Mallika**	1982	Bangladesh	128	4.0	Terai, inner Terai
8.	Chaite-2	1987	IRRI	125	4.8	Terai, inner Terai
9.	Chaite-4	1987	IRRI	118	4.5	Terai, inner Terai
10.	Chaite-6	1991	Nepal	123	4.8	Terai, inner Terai
11	Hardinath 1	2004	Srilanka	110	5.0	Terai, Inner Terai
Main Season						
1.	Taichung-176	1966	Taiwan	144	7.9	Mid-hills and valley
2.	Chainung-242	1966	Taiwan	144	7.3	Mid-hills and valley
3.	Tainan-1	1966	Taiwan	144	6.6	Mid-hills
4.	Chainan-2	1966	Taiwan	143	7.8	Mid-hills
5.	IR-8**	1968	IRRI	138	4.0	Terai
6.	IR-20**	1970	IRRI	153	4.0	Terai
7.	IR-22**	1972	IRRI	146	3.5	Terai
8.	Mansuli	1973	Malaysia	155	3.5	Terai, inner Terai
9.	Jaya**	1973	India	130	4.3	Terai
10.	Durga**	1979	India	130	4.3	Terai,innerTerai

11.	Janaki	1979	Srilanka	135	4.5	Terai inner Terai
12.	Sabitri	1979	IRRI	140	4.0	Terai, inner Terai
13.	Himali	1982	IRRI	149	6.4	Mid-hills
14.	Kanchan	1982	IRRI	143	7.6	Mid-hills
15.	Khumal-3	1983	India	130	6.5	Mid-hills
16.	Khumal-2	1987	Nepal	142	5.6	Mid-hills
17.	Khumal-4	1987	Nepal	144	6.3	Mid-hills
18.	Makwanpur-1	1987	Srilanka	150	4.8	Terai, inner Terai
19.	Barkhe-2**	1987	Indonesia	148	4.3	Terai, inner Terai
20.	Khajura-2**	1987	India	140	3.8	Mid-western Terai (Banke)
21.	Ghaiya-2	1987	India	113	3.4	Terai, inner Terai
22.	Palung-2	1987	Nepal	172	6.1	High hills
23.	Khumal-5	1990	Nepal	154	6.7	Mid-hills
24.	Khumal-7	1990	IRRI	146	7.0	Mid-hills
25.	Khumal-9	1991	IRRI	148	6.7	Mid-hills
26.	Chhomrong local	1991	Nepal	164	4.2	Eastern and western high hills
27.	Radha-7	1991	Nepal	148	3.5	Terai, inner Terai (rainfed)
28.	Radhakrishna-9	1991	Nepal	150	3.8	Terai, inner Terai (irrigated)
29.	Radha-4	1995	IRRI	125	3.2	Mid-western and Far-western Terai
30.	Radha-11	1995	India	148	4.0	Central Terai (rainfed)
31.	Radha-12	1995	India	155	4.6	Eastern Terai (irrigated/rainfed)
32.	Machapuchhre-3	1997	Nepal	174	5.0	Mid-hills and high hills (semiirrigated)
33.	Khumal-6	1999	7.8	155	7.8	Kathmandu Valley and equivalent areas
34.	Rampur Masuli	1999	5.7	135	5.7	Central and western Terai, inner Terai, and foothills (irrigated and semiirrigated)
35	Manjushree-2	2002	Nepal	149	8.3	Kathmandu Valley
36	Khumal-11	2002	Nepal	144	7.7	Kathmandu Valley
37	Chandannath-1	2002	Jhingling-78 (China)	191	6.0	High altitudes (Jumla)
38	Chandannath-3	2002	Yungen-1 (China)	191	6.0	High altitudes (Jumla)
39	Loktantra	2006	IRRI	130	3.6	Terai, Inner Terai, Mid-hills (3000 ft)
40	Mithila	2006	IRRI	145	5.0	Terai
41	Ram dhan	2006	Nepal	133	4.9	Terai, Inner Terai
42	Barkhe 3004	2006	India/IRRI	157	3.9	Terai, Inner Terai
43	PokhreliJethobudho	2006	Nepal	185	2.7	600-900 mslPokhara Valley
44	Khumal – 8	2006	Nepal	158	9.8	Terai, Inner Terai, Mid-hill
45	SunauloSugandha	2008	UK	115	3.8	Terai, Inner Terai
46	Ghaiya – 1	2010	IRRI	115	3.6	Terai,InnerTerai, Midhills
47	Lalka Basmati	2010	Nepal	150	3.5	Central and Eastern
48	Hardinath-2	2010	*Indonesia*	125	3.1-4.2	Terai, Inner Terai
49	Tarahara-1	2010	IRRI	113-125	4.2	Terai and Eastern Terai
50	Khumal – 10	2010	Nepal	145	4.5	Mid-hills
51	Khumal – 13	2010	Nepal	145	4.5	Mid-hills
52	SukhhaDhan – 1	2011	IRRI	125	2.5-3.6	Terai, Inner Terai, River basin
53	SukhhaDhan – 2	2011	IRRI	125	3.3-3.5	Terai, Inner Terai, River basin
54	SukhhaDhan – 3	2011	IRRI	125	3.2-4.2	Terai, Inner Terai, River basin
55	Barkhe – 2014	2011	IRRI	125	3.5	Terai, Inner Terai, River basin
56	Swarna Sub-1	2011	IRRI	150	4.5	Terai
57	SambhaMasuli Sub1	2011	IRRI	150	4.5	Inner Terai
58	Lekali Dhan - 1	2014	Nepal	158	4.07	1500-2600 msl, high hill
59	Lekali Dhan - 3	2014	Nepal	152	3.9	1500-2600 msl, high hill
60	Sukkha Dhan - 4	2014	IRRI	118-125	2.7-4	Unirrigated area of Terai and inner Terai and mid hill 500 msl
61	Sukkha Dhan - 5	2014	IRRI	125	3.2-4.2	Unirrigated area of Terai and inner Terai and mid hill 500 msl
62	Sukkha Dhan - 6	2014	IRRI	120-125	3-4	Unirrigated area of Terai and inner Terai and mid hill 500 msl

***: Foreign Varieties introduced in Nepal*

Table 3 – Import trend of rice (NRB, 2021)

Fiscal Year	Rice Imports (in million Nepalese Rupees)	Rice Imports (in metric tons)
2010-2011	8,854.2	980,872
2011-2012	11,434.6	1,031,913
2012-2013	14,547.2	1,115,023
2013-2014	22,048.5	1,375,141
2014-2015	17,438.3	1,249,192
2015-2016	24,292.7	1,631,886
2016-2017	24,157.4	1,591,427
2017-2018	22,468.8	1,526,373
2018-2019	26,979.3	1,633,436
2019-2020	43,976.6	1,722,879

Wheat is one of the most important cereal crops in Nepal, and it is widely consumed throughout the country. However, Nepal is not self-sufficient in wheat production, and the

country relies heavily on imports to meet its domestic demand. According to data from the Food and Agriculture Organization (FAO), Nepal imported a total of 1,760,000 metric tons of wheat in 2020, up from 1,620,000 metric tons in 2019 (FAOSTAT, 2021). Further, as for sources of wheat imports, it is reported that Nepal imports wheat mainly from India and sometimes from other countries like Russia, Ukraine, and Australia (Adhikari, 2021). The majority of wheat imports to Nepal come from India, which shares a long land border with Nepal. In recent years, there have been some disruptions to wheat trade between the two countries due to political tensions and border closures. Wheat imports from other countries, such as Australia and Canada, have also increased in recent years as Nepal seeks to diversify its sources of wheat (Adhikari, 2021).

There are a number of factors that contribute to Nepal's reliance on wheat imports. These include low levels of wheat productivity, limited availability of land suitable for wheat cultivation, and a lack of investment in agricultural research and development (Bista et al., 2013; Rasul 2016). In addition, changing dietary habits and increasing urbanization have led to a shift away from traditional cereal crops like maize and millet, and towards more wheat-based diets (Dixon et al., 2020). Wheat production in Nepal has increased slightly over the past decade, from 1.56 million metric tons in 2010 to 1.72 million metric tons in 2020. However, this level of production is still not sufficient to meet the country's domestic demand, which has led to increasing imports of wheat over the same period. Further, the price of wheat imports can be volatile and is influenced by factors such as global supply and demand, transportation costs, and currency exchange rates. In 2020, the average price of wheat imports to Nepal was around $263 per metric ton (FAOSTAT, 2021).

Despite the challenges associated with wheat production in Nepal, there are efforts underway to increase domestic production and reduce the country's reliance on imports. For example, the government of Nepal has implemented a number of policies aimed at promoting domestic wheat production, including subsidies for fertilizer and seed, as well as investments in irrigation and other agricultural infrastructure (Ministry of Agriculture and Livestock Development, 2022). In addition, there are a number of ongoing research projects aimed at improving wheat productivity and developing new wheat varieties that are better adapted to local conditions (Bista et al., 2013). Despite these efforts, wheat imports are likely to remain a significant part of Nepal's food system in the foreseeable future (Krupnik et al., 2021).

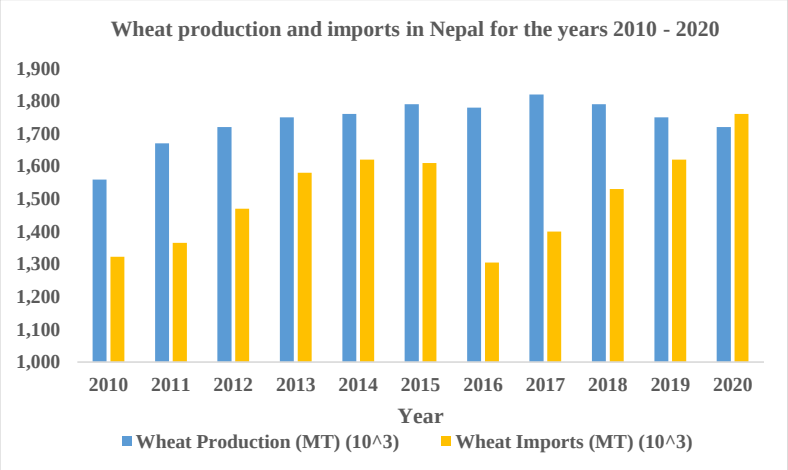


Figure 2 – Figure showing wheat production and imports in Nepal for the years 2010 to 2020 (Data source: FAOSTAT, 2021).

Wheat is a major staple food in Nepal, with a long history of consumption. It is the second most consumed cereal after rice, and its per capita consumption has been steadily increasing over the past decade (Kumar et al., 2020; Campbell et al., 2014). According to Kumar et al. (2016), and Sudo et al. (2006), wheat is mostly consumed in urban areas, particularly in the form of bread, whereas rural areas tend to rely more on rice. This trend is

partly due to the greater availability of wheat-based products in urban areas and the perception that these products are more modern and desirable (Angdembe et al., 2019; Dixon et al., 2020). However, there is growing concern about the potential health impacts of excessive wheat consumption, particularly as it has been linked to non-communicable diseases such as diabetes and obesity (Gyawali et al., 2015). To address this issue, some researchers have suggested promoting the consumption of traditional Nepalese cereals such as finger millet and buckwheat as a more sustainable and healthier alternative to wheat (Ramashia et al., 2019; Joshi et al., 2007).

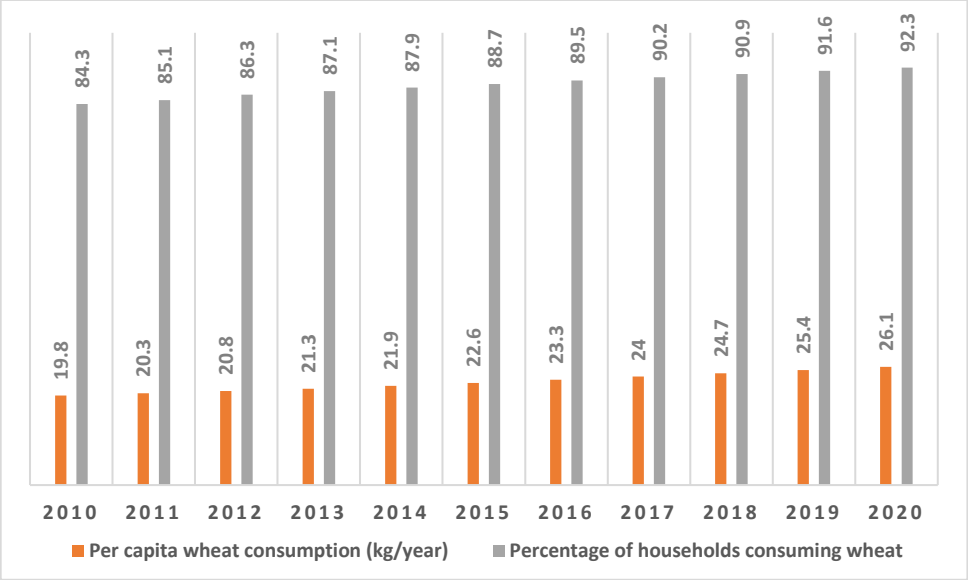


Figure 3 – Illustrates the per capita wheat consumption and percentage of households consuming wheat in Nepal from 2010 to 2020 (Data source: Ministry of Agriculture and Livestock Development, 2022)

Table 4 – Varieties of wheat produced in Nepal

S.N.	Varieties	Descriptions	Reference
1.	NL-297	This is a wheat variety developed by Nepal Agricultural Research Council (NARC) and is suitable for cultivation in the mid-hills of Nepal. It is a high-yielding variety with good resistance to diseases and lodging.	(Pandey et al., 2017)
2.	BL-4341	This is a wheat variety developed by International Maize and Wheat Improvement Center (CIMMYT) and released in Nepal in 2017. It is a high-yielding, disease-resistant variety that is suitable for cultivation in the Terai region of Nepal.	(Prasai, 2016)
3.	Gautam	This is a wheat variety developed by NARC in collaboration with CIMMYT. It is a high-yielding variety that is suitable for cultivation in the Terai and mid-hill regions of Nepal. It is resistant to foliar leaf blight, heat tolerant, stay green, and has wide adaptation.	(Timsina et al., 2018)
4.	Vijay	This is a wheat variety developed by NARC and is suitable for cultivation in the mid-hills of Nepal. It is a high-yielding variety with good resistance to Ug99 rust, tolerant to terminal heat, suitable to harvest using combined harvester.	(Timsina et al., 2018)
5.	WK-1204	This is a wheat variety developed by National Agriculture Research and Development Fund (NARDF) in Nepal. It is a high-yielding variety with good resistance to rust and other diseases.	(Timsina et al., 2018)
6.	NL-297	This is a wheat variety developed by NARC and is suitable for cultivation in the Terai and mid-hill regions of Nepal. It is a high-yielding variety with good resistance to diseases and lodging.	(Pandey et al., 2017)
7.	Bhrikuti	It is suitable for Terai. Also, it is high yielding, drought tolerant, resistant to leaf and stripe rust.	(Pandey et al., 2021)

In addition, efforts are underway to improve the quality and availability of domestic wheat products and promote the consumption of locally produced wheat (Ministry of Agricultural Development, 2015). Per capita wheat consumption in Nepal has steadily increased over the years, from 19.8 kg per year in 2010 to 26.1 kg per year in 2020, indicating the importance of wheat in the Nepalese diet. Moreover, over 84% of households consume wheat each year, highlighting its consistent high consumption rate. In conclusion,

while wheat remains an important part of the Nepalese diet, there is a need to diversify the consumption of cereals for both health and sustainability reasons. This includes promoting the consumption of traditional cereals and improving the availability and quality of domestic wheat products, as well as addressing broader socio-economic and cultural factors that influence dietary choices (Campbell et al., 2014). Further research is needed to explore the potential health and environmental benefits of promoting alternative cereal consumption in Nepal.

Maize (*Zea mays*), is the major staple cereal crops cultivated universally in terms of production volume and traded crops after wheat (Erenstein et al., 2022). Maize production contributes to food security and plays a major role in promoting the transformation in global agrifood system (Grote et al., 2021). Agriculture is central to the national economy of Nepal where 60.4% population are engaged on it (MoALD, 2020/21). In context of Nepal, the contribution of agriculture to national GDP is 25.8% with an increment rate of 2.64% per year (AITC, 2020/21). Cereal crop shares about 8.24% of national GDP (MoALD, 2020/21) thus ensuring the food and nutritional security of Nepal. Rice, maize and wheat mainly come up with the better production performance of cereal crops where maize ranks secondly after rice with 6.83% contribution in agriculture GDP in the fiscal year 2020/21.

Maize contributes 12% to the global production of primary crops in 2020 with 1.2 billion tonnes production (FAO, 2021), whereas in Nepal maize is cultivated under the area of 97976 ha with a total production of 2999733 tons. Comparatively yield of maize production in Nepal is less than global record due to inadequate supply and inefficient use of inputs, disease infestation and poor crop management practices. Agriculture economic growth is slowing sharply with reduction in yield, marketing and profitability (Sapkota et al., 2018). The annual growth rate for the demand of maize is 5% over the past decades which indicates high possibility of import of maize if its production remain constant/reduced (Sapkota & Pokhrel, 2013). There is a gap between the production and satisfaction of consumers demand and this may be due to the lack of research and problems in seed production sector, supply of quality seeds (Khanal et al., 2020).

Maize as a crop has multiple uses and mainly grown for human consumption, livestock and poultry feed, seed and food (Kandel et al., 2021). Ghimire et al. (2019) found changes in the pattern of maize utilization and suggest adopting the appropriate technologies development strategies to meet the changing needs. According to Timsina et al. (2016) more than 86% maize production has been utilized for human consumption in the hills and 80% production of Terai for livestock feed 10% each for human consumption and industries. Moreover, in the hills and mid-hills 60% of maize grains is used for animal feed, 25% for food, and 3% for seed while remaining 12% of its production was marketed (Ghimire et al., 2019).

Table 5 – Contribution of maize grains to Nepalese diet on a daily basis (Giri et al., 2017)

Year	Kcal/capital/day	%
2002	336	14.93
2003	347	15.42
2004	344	15.29
2005	357	15.87
2006	357	15.87
2007	379	16.84
2008	380	16.89
2009	370	16.44
2010	362	16.09
2011	354	15.73
2012	346	15.38
2013	342	15.20

Per capita maize consumption in Nepal was 98 g/person/day (KC et al., 2015; Ranum & Pe, 2014) thereby bringing change in the food preference (Ghimire et al., 2019) which varies from place to place and depends on the food habits of people (Timsina et al., 2016). Maize has great nutritional significance, also known as the “Queen of Cereals” (Murdia et al.,

2016). According to Ranum & Pe (2014), maize contains nearly 72% starch, 10% protein, 4% fat with an energy density of 365 kcal/100gm. It also contains 2.7% fiber, 66.3% carbohydrate, 1.5% minerals (Calcium, Phosphorous, Iron), and Vitamins (A, B, E) (Joshi et al., 2016).

Murdia et al. (2016) overlook the health benefits of the maize consumption and identified as the important ingredient in diet of the people. Maize has many benefits such as prevents constipation, lung cancer, age related vision loss, also boost memory, maintain normal growth, kidney function and bone health, regulates heart rate, lowers cholesterol, diabetes and hypertension. Therefore, these benefits may highlight the increasing interest of consuming more quantity of micronutrient and protein rich food in the recent daily diet of the people in comparison to the past years (Timsina et al., 2016).

Above table 5 shows the contribution of calories in regular diet of Nepalese from 2002-2013 which was invariable (Giri et al., 2017).

Beside these, there is also rise in the demand of byproducts of this commodity by the consumers (Murdia et al., 2016). Considering the multiple uses of maize, it has been widely used as breakfast cereals, snacks, bakery items, corn flour, cooking oils, popcorn (Erenstein et al., 2022; Gwirtz & Garcia-casal, 2014). In addition to its uses, maize starch is used in the textile, food, pharmaceuticals and paper industries (Murdia et al., 2016).

With the increase in demand of meat and eggs, low investment with high profit in less time period is leading rise in interest for poultry business these days (CBS, 2073). In addition to this, different projects and programs provide and boost development activities for poultry and livestock (Ghimire et al., 2019).There are 21956 number of total poultry farm in Nepal (CBS, 2073) and high livestock densities as compared to the available land resource. Thus, there is a shift of maize from food to livestock and poultry feed (Ghimire et al., 2019).The percentage share of cattle, buffalo, goat/sheep, pigs and poultry to the livestock population has marginally increased (Upadhyay et al., 2017). Maize silage is used as the major forage component which increases the production performance of cattle with its high nutritive value. According to Singh et al. (2019), 40t of silage was produced and marketed daily in Nepal and mostly used by the commercial dairy farmers. Chaudhary et al. (2013) underlies the importance of maize as fodder because of its high palatability, nutritive value, fast growing habit and high yielding crop.

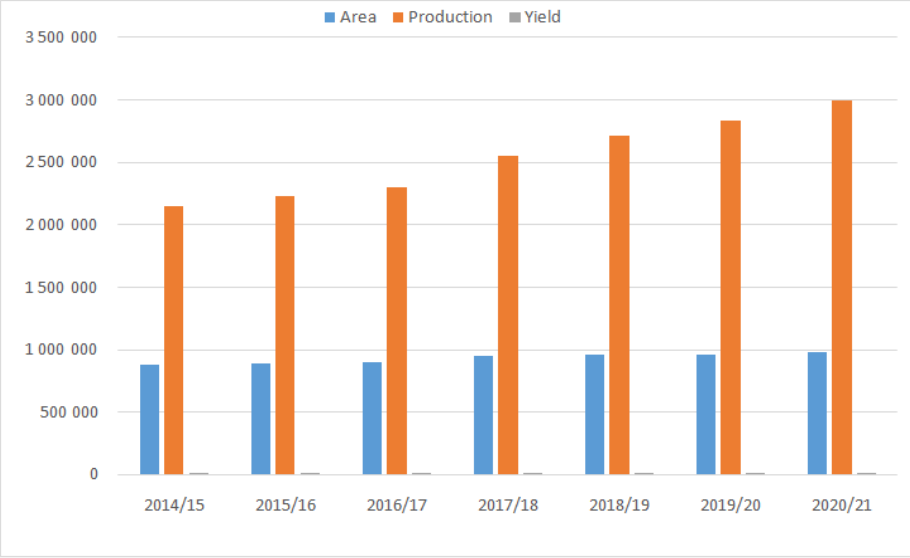


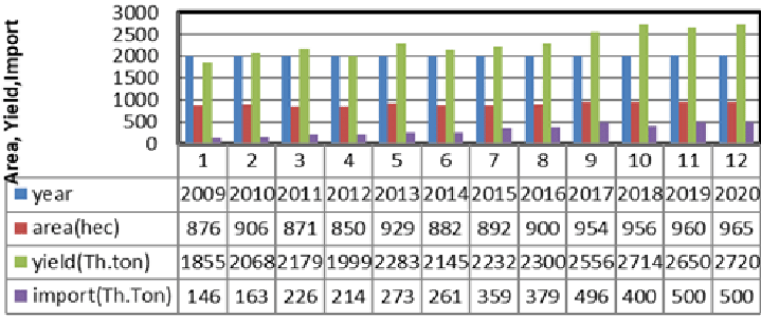
Figure 4 – Maize production trend in Nepal. Source: (MoAD 2020/21)

Maize is the second most grown cereal crop in both sub-tropical to cool temperate climate (Thapa, 2021). Since, the area and production is found to be increased since 2015-2021 but still lacking to meet the demand growth (Dhakal et al., 2022). Small and fragmented land, limited use of improved technologies, unavailability of hybrid maize varieties,

inadequate use of quality fertilizer contribute to food insecurity and challenges to the production (Gairhe et al., 2018; Kandel, 2021) where climate also acts as a crucial role in determining the production and productivity of the crops (Sarkar, 2014). The amount of maize seed imported was 12537809 kg with the import value of Rs 851618 in the year 2020/21 (MoALD, 2020/21) The total seed requirement of maize in the fiscal year 077/78 was 23941 metric tons but the seed supply was only 3210 metric tons with the seed replacement rate 13.41% (SQCC, 2021). This 13.41% also reflects lack of improved seed supply to the farmers which is comparatively low to the neighboring nation as mentioned in the study (Adhikari et al., 2019).

Nepal's agro-food imports is quite at frightening situation with worth Nepali Rs. 243 billion in the 2020 fiscal year (Adhikari et al., 2021). In Nepal trade deficit amounted to around 14.21 billion U.S. dollars (MOF, 2021).Nepal mainly depends on India and China imports to meet the domestic demand (Giri et al., 2017). India becomes the highest trading partners by both volume and valued followed by China, Bangladesh, USA and SAARC region. However, a positive balance of trade is observed with Bangladesh.

There is increase in need of livestock and poultry feed with the establishment of feed industries which requires high proportion of maize produced in the country (Ghimire et al., 2019). Katel et al. (2020) reported that there is requirement of 6.46 million mt feed to run the existing poultry industries in Nepal. Therefore has to depend on imports despite of increase in the production and productivity (Khadka, 2021). Moreover, feed industries prefer high quality maize even though it is expensive than the local maize which eventually increases relies on import from neighbor countries (Singh et al., 2019). According to Ghimire et al. (2019), annual growth rate of maize import was 30.5% in the recent years.



	1	2	3	4	5	6	7	8	9	10	11	12
year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
area(hec)	876	906	871	850	929	882	892	900	954	956	960	965
yield(Th.ton)	1855	2068	2179	1999	2283	2145	2232	2300	2556	2714	2650	2720
import(Th.Ton)	146	163	226	214	273	261	359	379	496	400	500	500

Figure 5 – Cultivation area, production & import outline of maize in Nepal

The import data given in the figure 5, state that there is a yield gap between the demand and supply (Khadka, 2021). Nepal rank 108th position out of 141 Global Competitive Index which determine poor export performance.

Besides the constraints in production and heavily dependency on the other countries, Nepal has high potential to increase maize production by adopting the improved technologies and uplift export performance. Value added products of maize have great potential in the domestic as well as global market. Development, value addition and commercialization of maize products in required time and quantity can meet the internal consumption.

Millet gets its name from the French word "mille," which means "thousand," and a handful of millet can contain up to 1000 grains (Shahidi & Chandrasekara, 2013). Millet refers to a group of small-grained, warm-weather annual cereals in the grass family. These crops are naturally drought tolerant. Millet is widely grown for food and fodder all over the world. Millets are important crops in semiarid tropical areas and are native to many parts of the world. Millets have been a staple in parts of Asia and Africa for centuries (Wadmare, et al., 2022). A millet crop includes grasses like finger millet (*Eleusine coracana* (L.) Gaertn), pearl millet (*Pennisetum glaucm* L.), foxtail millet (*Setaria italica* (L.) P. Beauvois), kodo millet (*Paspalum scorbiculatum* L.), bahiagrass (*Paspalum nota-tum Flugge*), little millet (*Panicum sumatrense* Roth ex Roem. & Schult.), proso millet (*Panicum miliaceum* L.), barnyard millet (*Echinochola crusgalli* (L.) P. Beauv), guinea grass (Chandra et al., 2016). Because of their

higher resistance to pests and diseases, good adaptability to a wide range of environments, and good yield, millets are important but underutilized crops in tropical and semiarid regions of the world. Additionally, they have a short growing season, can withstand high salinity, can withstand drought, require few inputs during growth, and are significant crops for feeding a growing global population and diminishing water resources (Seetharam, et al., 1990). Finger millet's potent antioxidant potential and enhanced signal perception may be responsible for its resistance to droughts. Finger millet can be grown in challenging conditions due to its hardiness without significantly affecting its general productivity. In developing countries, millet grains have a great deal of potential for processing into foods and beverages with added value. Additionally, since millets don't contain gluten, they are suggested for people with stomach (abdominal) conditions (Wadmare, et al., 2022).

Table 6 – Different millet varieties' distribution in Nepal (Gyawali, 2021)

S.N.	Type	Nepali	Scientific Name	Distribution
1.	Finger millet	Kodo	*Eleusine coracana* L. Gaertn.	Khotang, Baglung, Sindhupalchowk, Sindhuli, Kaski, Gorkha, Syangja
2.	Foxtail millet	Kaguno	*Setaria italica* L. P. Beauv	Mugu, Kalikot, Hulmla, Jumla, Bajhang, Bahira, Dolpa, Lamjung, Gorkha
3.	Proso millet	Chino	*Panicum miliaceum* L	Mugu, Dolpa, Humla, Jumla, Kalikot, Bahira, Jajarkot, Ramechhap, Kavre
4.	Pearl millet	Bajra	*Pennisetum typhoides* (Burm.f.) Stapf and C.E. Hubb	Rarely found in Nuwakot and far western Terai
5.	Little millet	Kutki sama	*Panicum miliare* Lam	Rarely found in the far western region
6.	Kodo	Kodo	*Paspalum scrobiculatm* L.	Gorkha, Lamjung, Tanahun, Dhading.

Table 7 – Recommended varieties of millet with maturity days, and recommended area for production (Gyawali, 2021)

S.N.	Variety	Maturity days	Recommended area
1.	Ookhla 1	154- 194	Mid-hills, high hills
2.	Dalla 1	125- 151	Terai, inner terai and mid hills
3.	Kabra millet	167	900–1900- meter area of mid-hills
4.	Sailing millet	155	1300–2200- meter area from the western too far western area of hills and high hills.
5.	Kabra millet	153	700–1800- meter area from the western too far western area of hills and high hills.

One of the most significant small grains, finger millet [*Eleusine coracana* (L.)] is an annual herbaceous plant that is tetraploid (2n=4x=36 AABB) and evolved from a natural cross between *Eleusine indica* (AA) and *Eleusine floccifolia* or *Eleusine tristachya* (BB). It is also known as Ragi or Mandua (Varsha et al., 2009; Jagati et al., 2021). The seed head, which resembles human fingers, is where the name of the plant comes from. After sorghum, pearl millet, and foxtail millet, the crop is currently ranked fourth in importance among the millets on a global scale. It is grown in more than 25 nations, mostly in Asia (India, Nepal, Malaysia, China, Japan, Iran, Afghanistan, and Sri Lanka) and Africa (Ethiopia, Eritrea, Mozambique, Zimbabwe, Namibia, Senegal, Niger, Nigeria, and Madagascar) (Chethan & Malleshi, 2007). The fourth-largest crop in Nepal plays a significant role in the country's agriculture, particularly in the mountainous remote regions where they serve as important, stable food crops for low-income communities with subsistence farming systems (Dharmaraj & Malleshi, 2011). It matures in between 100 and 130 days and is better adapted to acidic soils in areas with higher rainfall (600 to 1,200 mm). One of this millet's key characteristics is its adaptability to various agro climatic conditions, which contributes it to have the highest productivity among all millets. The crop has a C4 photosynthetic pathway, which allows it to withstand a variety of abiotic stress conditions (Bastola et al. 2015; Opole et al. 2018). Grain is grown between February and August, with the harvest taking place in either June or January. Finger millet grains are grown in Nepal, Sri Lanka, Bhutan, and the Indian Himalayan regions (Adhikari, 2012; Jideani, 2012). Along with South Carolina in the US, the grain is also grown in Taiwan, China, and (to a lesser extent) Japan (Mathur, 2012). It is primarily grown in mid-mountainous regions and is regarded as a neglected, underutilized crop of the poor (Luitel, et al., 2020). Finger millet is considered a poor man's crop because

of its long-lasting strength and ability to be stored safely for many years without being infested by insects or other pests.

Finger millet has a high nutritional content, especially for calcium, iron, and manganese as well as essential amino acids, and is significantly rich in protein, dietary fiber, minerals, and micronutrients such as riboflavin, thiamine, leucine, isoleucine and trypsine inhibitory factors (Jagati, et al., 2021). Because they are less susceptible to pests, they can be stored for longer (Gull et al. 2015), and are crucial for the food and nutritional security of the regions where they are grown (Luitel, et al., 2019). Additionally, finger millet has numerous medicinal qualities, including hypoglycemic, hypo cholesterolemic, and anti-ulcerative effects and antioxidant properties (Chamoli, et al., 2018).

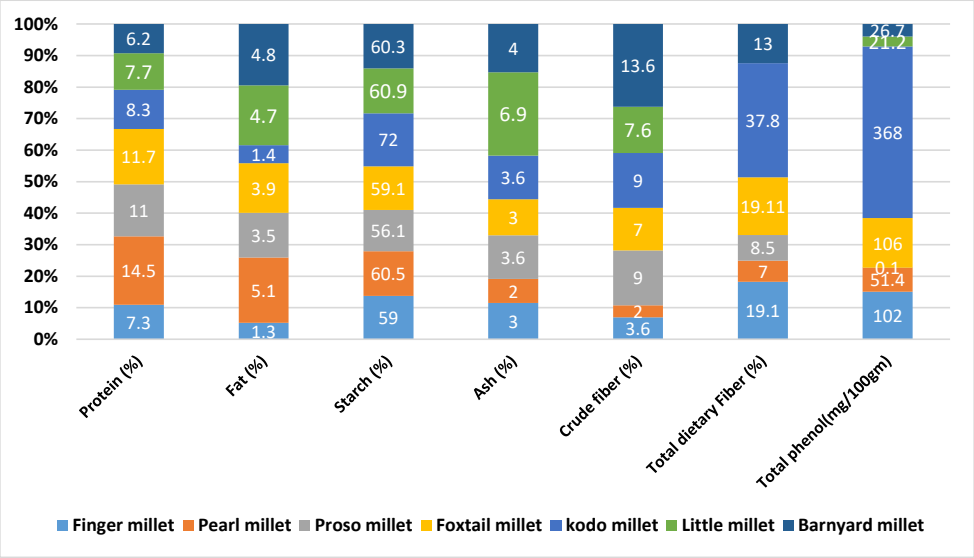


Figure 6 – Representation of finger millet nutrient composition with other minor millet (Jagati et al., 2021)

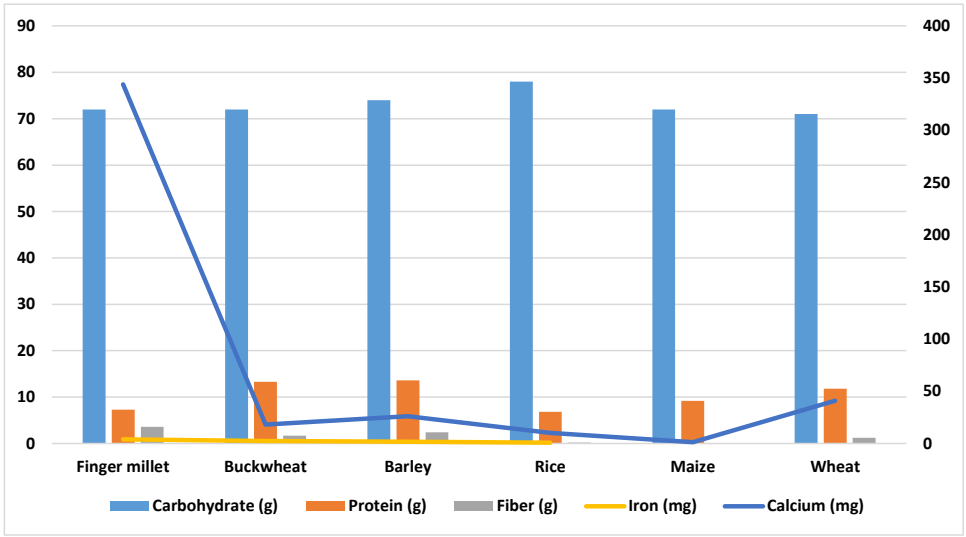


Figure 7 – Amount of Nutrients per 100 grams raw grain values of cereals crops (Jagati et al., 2021)

Now that it has been abandoned and underutilized, finger millet is emerging as a crop with significant potential for use in functional foods and high-value health foods (Dhami, et al., 2019). Despite the many advantages of underutilized crops, production and productivity are not rising due to numerous obstacles. Compared to other cereals, these crops require more labor during the transplanting, weeding, harvesting, threshing, and grinding processes. Additionally, the crop is regarded as "food of marginalized communities" or "low status food".

There is a lack of knowledge among the populace regarding the nutritional value and health advantages of these crops (Gautam & Subedi, 2022). In the hills of Nepal, finger millet has the potential to enhance resource management while also serving as a staple food, weaning food, or a cash crop that offers opportunities for income generation (Raj, 2012).

Table 8 – Import and Export trend in Millet (Gautam and Subedi, 2022)

Fiscal Year	Millet Imports (in metric tons)	Millet Exports (in metric tons)
2013-2014	1182.5	39.8
2014-2015	896.3	36.4
2015-2016	1550	18.8
2016-2017	1216.7	24.9
2017-2018	1283.1	16.4
2018-2019	2910.3	38.8
2019-2020	2172.6	0
2020-2021	1909.4	1.8

The table shows an increasing trend of millet export in Nepal. A sharp increase in the import of millet was seen between the years 2018 to 2019. A large amount of millet imported from India goes for making liquor while only a small amount goes for consumption as food and feed. The import value of millet to Nepal has been increasing at 14.62% per annum (Gairhe et al, 2021). On the other hand, the export of millet has been decreasing over the years. The highest export was seen in the year 2018-2019 with a sharp decline in just another year.

Table 9 – Area production and Yield of different cereals crops (Gyawali, 2021)

	Paddy			Maize			Millet			Wheat		
Year	Area	Production	Yield	Area	Productior	Yield	Area	Productio	Yield	Area	Productior	Yield
2011/12	1,531,493	5,072,248	3.31	871,387	2,179,414	2.50	278,030	315,067	1.13	765,317	1,846,142	2.41
2012/13	1,420,570	4,504,503	3.17	849,635	1,999,010	2.35	274,350	305,588	1.11	759,843	1,882,220	2.48
2013/14	1,486,951	5,047,047	3.39	928,761	2,283,222	2.46	271,183	304,105	1.12	754,474	1,883,147	2.50
2014/15	1,425,346	4,788,612	3.36	882,395	2,145,291	2.43	268,050	308,488	1.15	762,373	1,975,625	2.59
2015/16	1,362,908	4,299,079	3.15	891,583	2,231,517	2.50	266,799	302,397	1.13	745,823	1,736,849	2.33
2016/17	1,552,469	5,230,327	3.37	900,288	2,300,121	2.55	263,596	306,704	1.16	735,850	1,879,191	2.55
2017/18	1,469,545	5,151,925	3.51	954,158	2,555,847	2.68	263,497	313,987	1.19	706,843	1,949,001	2.76
2018/19	1,491,744	5,610,011	3.76	956,447	2,713,635	2.84	263,261	314,225	1.19	703,992	2,005,665	2.85
2019/20	1,458,915	5,550,878	3.8	957,650	2,835,674	2.96	262,547	320,953	1.22	707,505	2,185,289	3.09
2020/21	1,473,474	5,621,710	3.82	979,776	2,997,733	3.06	265,401	326,443	1.23	711,067	2,127,276	2.99

The cultivation area of millet goes on decreasing years by year. Despite of this the production is highest in the year 2020/21 with the production of 326,443 Metric ton.

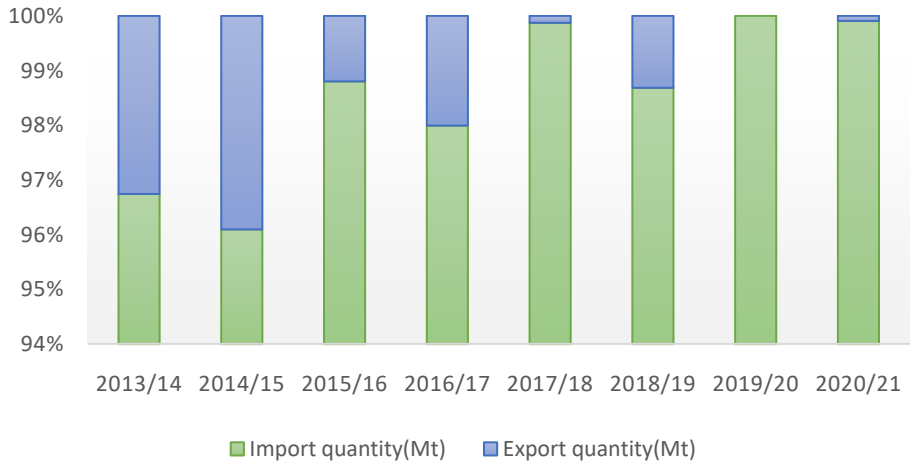


Figure 8 – Import and Export quantity of millet (Gairhe, et al., 2021)

The amount of millet import showed a sharp upward trend from 2013/14 to 2020/21 than export quantity. The majority of the finger millet imported comes from India.

CONCLUSION

In conclusion, our analysis of cereal import and consumption patterns in Nepal highlights the significant role played by rice, wheat, maize, and to a lesser extent, millet in the country's food system. Despite being major cash crops and staples, Nepal is not able to produce enough cereal to meet its domestic demand, which necessitates the need for imports. Our study shows that the import trends for these cereals vary over time and across sources, with India being the largest supplier of rice, wheat, and maize to Nepal. We also found that consumption patterns of these cereals vary across the country, reflecting differences in cultural preferences, dietary habits, and socioeconomic factors. For example, rice is the most widely consumed cereal in Nepal, while maize is more prevalent in the mid-hills. While cereal imports are important for ensuring food security, they can also pose challenges, such as price volatility and supply disruptions. Therefore, it is important for Nepal to develop a more robust and sustainable cereal industry that promotes self-sufficiency in production and reduces reliance on imports. This can be achieved through various means, such as improving the efficiency of agricultural practices, enhancing infrastructure and storage facilities, and promoting the cultivation of diverse and climate-resilient crops. Overall, our study underscores the need for a holistic and integrated approach to addressing cereal import and consumption patterns in Nepal. This requires the involvement of various stakeholders, including policymakers, farmers, traders, and consumers, who can work together to ensure that Nepal's food system is sustainable, equitable, and resilient in the face of current and future challenges.

AUTHORS' DECLARATION AND CONTRIBUTION

The authors declare no conflicts of interest. All authors contributed equally in all stages of the preparation of this manuscript. Similarly, the final version of the manuscript was approved by all authors.

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