Productivity and Preferences of New Potato Varieties and their Relationships in Five Districts of Bhutan

Pradeep Rai[b], Yadunath Bajgai[b], Tshering Lhadon[b], Lobzang[b], Sangay[b]

ABSTRACT

Potato (Solanum tuberosum L.) is one of the widely cultivated horticultural commodities in Bhutan. Over the years yields of potato at national level have stagnated due to degeneration of seeds and lack of appropriate varieties in the country. To address the yield stagnation issue, two potato varieties (Yusi Maap and Nasphel Kewa Kaap (NKK)) were introduced in recent years. To understand crop productivity and farmer's preferences of the new varieties this study was conducted in Bumthang, Chukha, Gasa, Haa, and Wangduephodrang districts from 2017 to 2018 using the field demonstration trials and participatory varietal selection method. Desiree, the popular variety was used as a control. On an average across years and dzongkhags, mean yields of the NKK and Yusi Maap were 10.4 and 10.5 tons/acre, respectively. Hence, yields of Yusi Maap and NKK were approximately 30% higher in comparison to Desire, which was 7.30 tons/acre on an average across the years and dzongkhags. Being one of the oldest varieties, Desiree consistently showed lower productivity compared to other two varieties due to seed degeneration and quality deterioration. Although the productivity difference between NKK and Yusi Maap is minimal (0.10 tons/acre) the preference votes of Yusi Maap was 1.3 times that of NKK indicating the higher level of preferences for Yusi Maap. There was positive significant relationship (P=0.02) between the potato productivity and the farmer's preference suggesting that higher productivity attracted more votes and lower productivity attracted lesser votes. Further higher productivity is also seen as a means to earn cash income for the household to achieve food security in terms of household's consumptions through the sale of potatoes. The findings provide a sound scientific basis to guide program implementers and policy-makers in terms of potato research and development at the national level.

Keywords: *Potato productivity; Farmer's preferences; Potato varieties*

1. Introduction

Potato (*Solanum tuberosum* L.) is considered as the fourth most important crop in terms of food consumption after wheat, rice and maize. According to Roder, Nidup, and Chettri (2008), the origin and cultivation of the crop dates back to as early as 8000 years ago in the high lands of South America. Later in the 16th century, Spanish explorers brought this magnificent plant to European continent merely as a botanical curiosity. However, within short span of time it spread

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throughout Europe providing cheap and abundant food alternative especially to workers of the industrial revolution. Eventually it gained popularity and became one of the most preferred food crops in Europe and gradually spread to other parts of Asia (Roder et al., 2008). Currently, potato is grown on an estimated 19 million hectares of farmland globally and its production stands at 378 million tons (Devaux et al., 2020). Although potato cultivation has been associated with developed countries historically, there is a shift towards developing nations in recent times with India and China surpassing and leading global productivity (Campos, 2020). Simultaneously, with progress in crop science potato crop is increasingly becoming more and more relevant in addressing the food and nutrition security and climate change impacts popularly in global south (Raymundo et al., 2018). Current breeding efforts through development of bio-fortified potato varieties have found to be supplementing various vitamin needs, mineral content, micro nutrition delivering high content of Fe, vitamin C and Zn and fight against hidden hunger and disease like anemia (Campos, 2020). Further, given its easy management and wider adaptation ability, potato crop has evolved as one of the most successful food crops for the entire world in terms of consumption (Devaux et al., 2020).

In Bhutan, potato was first introduced by Scottish explorer, George Bogle during one of his expeditions in the year 1774 (Roder et al., 2008). The members of the expedition planted the crop at their halting places while travelling from Buxa Duar through Chapcha to Thimphu. However, the authors also mentioned potato could have also reached Bhutan prior to his arrival because it was also found widely cultivated in northern India and in close proximity of Bhutanese southern border. It was only after late 1960s and early 1970s that Bhutan initiated formal potato development program through the assistance and support of the Swiss Agency for Development and Cooperation (SDC) (Roder et al., 2008). Although potato was newly introduced in the 60s, its cultivated areas exponentially increased by 10-20%, every year. The exceptional increase in adoption rate was accorded to farmer's own self-interest and introduction of relevant potato varieties. The important factors contributing to rapid adoption was attributed to market growth, improved road accessibility and access to improved potato varieties. Other factors relating to its rapid adoptability could be due to the crop's relatively longer shelf-life compared to other vegetables. Amongst other varieties introduced, the Dutch variety Desiree was found to be, by and large, widely accepted by the farmers due to its yield and superior agronomic performances during the early years of potato farming in the country (Roder et al., 2008, Roder, 2004). To improve potato industry, the Royal Government of Bhutan then initiated several intervention measures, primary amongst them being the introduction of potato auction yard through the Food Corporation of Bhutan (FCB) in 1980 (Roder, Nidup, & Wangdi, 2007). Since then, the concept of downhill movement of potato seed quality began in the country. According to RSD (2020) the present harvested area under potato cultivation is estimated at 10,342 acres out of total cultivated area of 189,499. 37 acres in the country.

The crop which was once commonly grown as a homestead vegetable is now one of the most widely cultivated, traded and consumed crops in Bhutan (Bajgai et al., 2018). Due to its

physiological considerations, cultivation of potato as a commercial crop is mainly concentrated at elevations between 1500-3000 masl. Nonetheless, given its wider adaptation capacity and easy management, it is also found cultivated in areas as low as 200 masl - mostly covering the southern dzongkhags of Bhutan - as winter crop for self-consumption (Roder et al., 2008). Potato is not considered as a staple crop yet in Bhutan, however, 21% of the total farming households depend on potato farming for their daily livelihood comprising 34,000 households of the total 1, 63,001 households in Bhutan (RSD, 2017; NSB, 2017). The income received from the sale of potato by farmers directly help purchase household items, food essentials and render livelihood support. Further, Bajgai et al. (2018) reported that the revenue generated through export of potato amounting to Nu 797 million in 2016 was one of the highest among horticulture commodities in the country. Similarly, RSD (2020) revealed that potato alone generated a revenue of Nu 709.81 million through the export of 30,277.08 MT in 2019, surpassing the combined revenue earned through the sale of vegetables and pulses at Nu 169.15 million only.

Although potato farming significantly contributes to national revenue and livelihood support, there is a declining trend in potato productivity as observed over the decades mainly due to lack in diversity of desired potato seed varieties and degeneration in seeds of the existing varieties (Bajgai et al., 2018). According to FAO (2014) the productivity of potato in Bhutan stood at 8.9 t/ha whereas the neighbouring countries like Bangladesh, India and Nepal reported yields of 19.3, 22.9 and 13.7 t/ha, respectively which is comparatively higher than that of Bhutan's. Owing to this and given the opportunities for expansion of cultivation area and increase productivity, the National Potato Program with the Department of Agriculture released potato clone accession CIP 393077.159 as Nasphel Kewa Kaap variety (NKK) in 2014 and accession number CIP 392797.22 as Yusi Maap in 2017. These clones were imported from the International Potato Centre (CIP) to generate higher yielding and better varieties as an intervention to address the stagnation issue of potato productivity. Following their release, the new varieties were demonstrated through field trials in major potato growing dzongkhags of Bhutan with the intention of transferring the new varietal technology to the farmers.

However, within a short span of time since the release of these varieties, Yusi Maap gained huge popularity and there is an overwhelming demand from growers in the country. Against this backdrop, this paper attempts to understand as to why farmers are interested in the newly released Yusi Maap potato variety as compared to other varieties and, also determine farmers' preferences of the released variety. The missing information sought would help design appropriate planning and interventions for researchers and relevant stakeholders in the future to enhance potato industry in the country. The objectives of this paper are:

1. Compare the productivity of the newly released potato varieties of Yusi Maap (YM) and Nasphel Kewa Kaap (NKK) with the existing commonly grown and popular variety Desiree in Bumthang, Chukha, Gasa, Haa and Wangdue over three years period from 2017 to 2019.

2. To assess the farmer's preference of the three varieties through participatory selection procedure in the aforementioned five dzongkhags from 2017 to 2019.
3. To determine the relationship between the productivity and the farmers preference votes.

2. Materials and Method

2.1. Description of the Research study Area

The National Potato Program (NPP), National Centre for Organic Agriculture (NCOA) – Yusipang, in collaboration with the dzongkhags/geogs disseminated newly released potato varieties to major potato growing parts of the country as part of its continuous evaluation and production assessment program. In 2017 potato field demonstration trials were set up in the main potato growing dzongkhags of Trashigang, Mongar, Pemagathsel, Bumthang, Paro, Chukha, Thimphu, Gasa, Haa and Wangdue. The idea was to disseminate growing technology to growers involving them throughout the growing season. However, yield and farmer's preferences were assessed consistently over three years from 2017 to 2019 in Bumthang, Chukha, Gasa, Haa, and Wangduephodrang dzonkghags only. Therefore, only these five dzongkhags were considered for the paper. The demonstration sites selected in consultation with geog agriculture extension staff and local government officials. The site was in a single household in a village and in the following year the demonstration was selected in another village according to suitability of the crop. Each demonstration site was provided with 50 kg seeds of the new two varieties (Yusi Maap and NKK). Desiree was provided only if the locally grown seeds were degenerated. Suphala fertilizer, irrigation pipes and other equipment were provided during the demonstration.

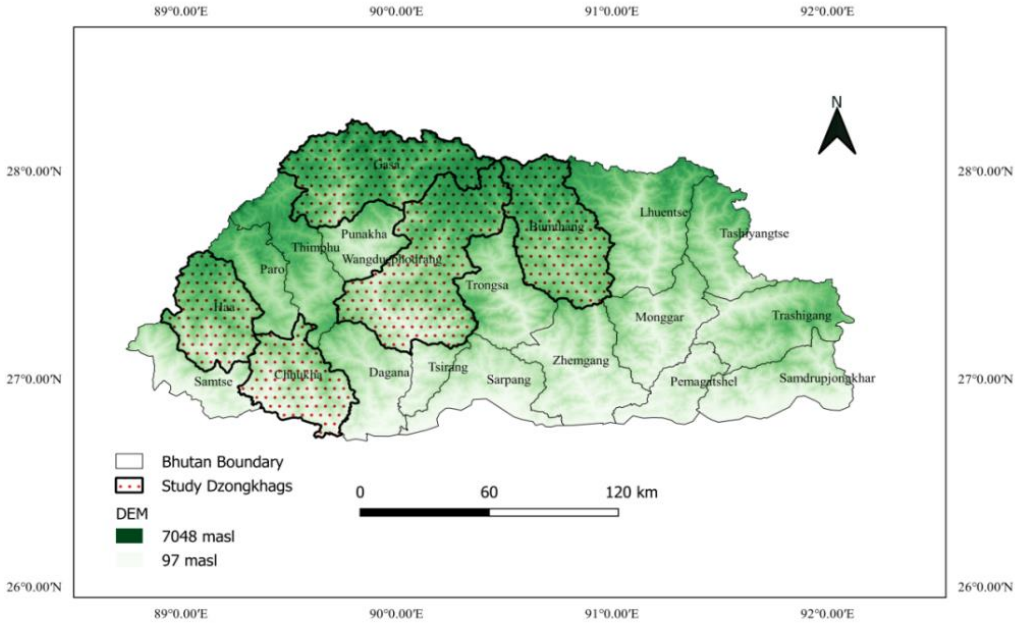

Figure 1. Location of potato demonstration dzongkhags.

2.2. Description of the major Agro-ecological zone for potato farming in Bhutan

There are six major agro-ecological zones identified in Bhutan (described in Table1). Depending on these agro-ecological zones, there are three major dominant land use categories and cropping patterns identified in Bhutan (NSSC, 2010). According to Katwal and Bazile (2020), the major cropping systems under different agro-ecological zones are:

1) Potato, wheat and apple-based farming in Kamzhing (dry land) under cool and warm temperate zone wherein other crops such as vegetables, mustard and buckwheat are rotated or intercropped in orchards.
2) Maize based cropping system predominates with cereals such as millets, buckwheat followed by vegetables, legumes and oilseeds in dry and humid subtropical areas and in warm temperate zones *Kamzing* (dry land).
3) In the terraced wetland (Chhuzhing) under warm temperate zone, farmers mostly grow a single crop of high-altitude irrigated rice with some farmers rotating peas, potato, oat and wheat as fodder after rice.

Based on these prevailing agro-ecological zones, majority of the farmers practice self-sustaining, integrated agricultural production system where they grow a variety of crops under different farming practices and rear livestock to meet their food security (Katwal et al., 2015). Owing to the topography dominated by high mountains and deep valleys there is huge variation in the micro-climate which calls for location specific crops and varieties (Katwal et al., 2015). Accordingly, within these given agro-ecological zones, potato farming is specifically spread and mainly concentrated in the warm temperate to temperate region as a semi-commercial farming undertaking. The concentration in these regions can be attributed due to the favorable conditions available during the crop's morphological and physiological development (Roder et al., 2008).

Table 1. Major agro-ecological zones of Bhutan.

Major Agro-ecological Zones	**Altitude (masl)**	**Temperature (degree Celsius)**		**Mean Rainfall (mm)**	**Geographical area (%)**
		Max	**Min**		
Alpine	3600.1 - 7500	12.0	-1.0	<670	28.56
Cool Temperate	2600.1 - 3600	20.0	1.0	650-850	23.89
Warm temperate	1800-2600	26.0	1.0	650-870	18.61
Dry Subtropical	1200.1- 1800	29.0	3.0	870-1200	13.11
Humid Sub tropical	600.1-1200	33.0	5.0	1200-1500	10.23
Wet Subtropical	94. - 600	35.0	12.0	2500-5500	5.60

Adapted from RSD (2017)

Table 2. Land use categories and major cropping pattern.

Major Agro-ecological Zones	Altitude (masl)	Land use types		Major crops (Cropping pattern)
		Kamzhing (dry land)	**Wetland (Chhuzing)**	Horticulture/Plantation
Alpine	3600.1 - 7296	Pasture	Absent	Absent
Cool Temperate	2600.1 - 3600	Barley-fallow, Potato-Turnip	Absent	Apple
Warm temperate	1800-2600	Potato-Buckwheat, Potato-Turnip, Wheat/Barley-Buckwheat, Potato-Wheat/Barley, Vegetables- Wheat	Rice- Fallow, Rice-Potato, Rice- Peas, Rice- Wheat	Apple, Walnut, Pear, Peach, Plum
Dry Subtropical	1200.1-1800	Maize and Potato, Maize and Soybeans, Maize and Mustard, Maize and Barley, Maize and fodder Oat, Maize and Buckwheat, Chilli- fallow, Vegetables and Wheat	Rice- wheat, Rice-Mustard, Rice- Chilli, Rice- Vegetables	Apples, Pears, Peach, Kiwi, Large Cardamom
Humid Sub tropical	600.1-1200	Maize- Maize, Maize-beans (Rajma), Maize-Millet	Rice-Fallow, Rice-Mustard	Citrus, Large Cardamom
Wet Subtropical	94. - 600	Maize- Mustard, Maize- Maize, Maize-Grain Legumes (Black Gram, rice bean, broad beans) and Maize and Millet	Rice- Fallow, Rice-Maize, Rice-Wheat, Rice-Sesbania	Arecanut, Mango, Avocado, Banana, Litchi

Adapted from Katwal and Bazile (2019)

Table 3. Description of three potato varieties under demonstration trials in five Dzongkhags.

Name of Potato Variety	Accession no and year of release	Characteristics and Agro-ecology
Desiree	CIP800048 & 1988	-Red skinned, relatively high yield potential, -Agro-ecological/elevation: 1000-2000 meter above sea level (masl), -130-140 days to maturity
NasphelKewaKaap (NKK)	CIP393077.159 & 2014	-High yielding, pink eye and resistant to late blight - All agro-ecologies -160-180 days to maturity
Yusi Maap (YM)	CIP392797.22 & 2017	-High yielding, red skinned, moderately resistant to late blight, high content of micro nutrient of Ca, Zn and Fe; Mid and high altitudes; 130-140 days to maturity

Table 4. Physical appearance of different potato varieties.

Name of Varieties	Plant Physical Appearance	Tuber appearance
Desiree		

Nasphel Kewa Kaap (NKK)		
Yusi Maap (YM)		

2.3. Data Collection and Analysis

Purposive sampling technique was employed for identification of households where field demonstration sites were located. The households were identified in consultation with local government officials at the geog level including the Dzongkhag Agriculture Officers (DAOs) and Geog Agriculture Extension Officials (GAEO). Both primary and secondary data were used in this paper. Primary data on yield of potato varieties were collected from those households that were involved in cultivating and demonstrating the newly released potato varieties from 2017 to 2019. Primary data of preference votes on potato varieties were generated from the demonstrations and training programs organized at the sites in all five dzongkhags. Participatory Variety Selection (PVS) was employed at harvesting stages in all the sites. While collecting the information, gender-responsive voting methodology developed by the International Centre for Potato (CIP) was also employed. In the process of voting, both men and women were given six numbers of corn seeds and bean seeds, respectively. Each farmer (male and female) participant cast three votes for the most desired varieties/clones. Similarly, votes were cast for the second best with two votes and the third with only one vote depending on the physical appearance of the different varieties displayed (Haan et al., 2019). Votes were cast based on farmer's preference on the basis of yield, tuber sizes and distribution, tuber color, perceived marketability, resistance to late blight and nutrient content of the potato variety. The varieties receiving maximum numbers of total votes determined the best variety.

Secondary data on trends in potato production and export value from 2012 to 2017 in Bhutan were obtained from the www.moaf.gov.bt (DoA, 2012, 2013, 2014, 2015, 2016, RSD, 2017) and

www.mof.gov.bt (DRC, 2014, 2015, 2016, 2017, 2018). The information collected both from primary and secondary data were organized systematically. In order to analyze the relationships between the productivity of different varieties of potato with that of votes cast by the farmers, Pearson's correlation was employed while variation in the productivity was analyzed and derived through the use of standard deviation and standard error of each variety from each dzongkhag. Similarly, comparative yield assessment of three potato varieties, viz. Yusi Maap, Nasphel Kewa Kaap (NKK) and Desiree were carried out and produced in the form of graph through R software Version 3.6.6 as well as Microsoft Excel version 2010. A total of 947 farmer participants were involved in the study that spanned from 2017 to 2019 comprising of five main potato growing dzongkhags (Figure 1).

3. Results and Discussion

Figure 2 presents the overall total potato production scenario in the country from 2012 to 2017. The total production remained fairly stable with the lowest production recorded at 43,000 tons and highest at 57,223 tons over these years. However, the export value earned and the quantity produced did not directly correspond due to the prevailing price differences determined by market forces that in turn was subject to variation in the production in the neighboring states of India. In 2014, the price of Bhutanese potato at the FCBL auction yards was particularly high due to the slightly lower production in neighboring Indian states which thereby increased the demand for Bhutanese potatoes. In some years prices dropped, indicating the decrease in demand as a result of the high productivity in neighboring Indian states. This indicates the dependency on the vagaries of external markets where prices are beyond the country's influence and control, thus adversely affecting potato growers and their livelihood.

There is the need to explore assured market for long term sustainability of potato farmers. Earlier study carried out by Roder et al.(2007) also emphasized the urgent need to develop clear road map to benefit potato farmers as well as the nation. Although majority of the farmers practice subsistence farming, potato has singularly transformed Bhutanese agriculture from subsistence to emerging market-oriented farming, supporting livelihoods of a large number of farmers, especially living at elevations between 1500-3000 masl (Roder, 2004). The analysis reveals that production has been fairly stable over the span of six years indicating the slightly stagnated nature of potato productivity.

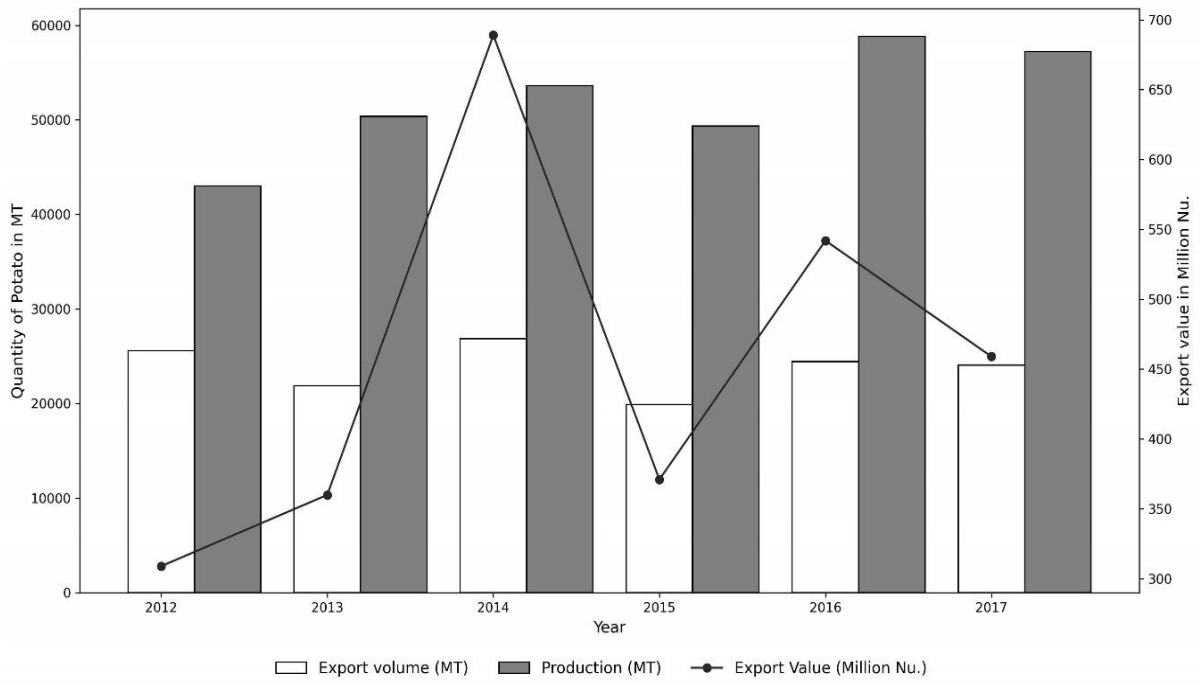

Figure 2. Trend in potato production and export from 2012 to 2017 in Bhutan.

The comparative mean productivity of three different potato varieties (Desiree, Nasphel Kewa Kaap and Desiree) in five potato growing dzongkhags (Bumthang, Chukha, Gasa, Haa and Wangdue) over the three years from 2017 to 2019 is presented in Figure 3. On an average, across the dzongkhags mean yields of NKK and Yusi Maap were 10.42 and 10.52 tons/acre, respectively. The mean yield difference was as minimal as 0.10 tons/acre between these two new potato varieties whereas Yusi Maap showed slightly higher average yield than NKK**.** However, Desiree variety yielded 7.30 tons/acre on an average across dzongkhags and over the years. Being one of the oldest varieties, Desiree consistently showed lower productivity compared to the other two varieties (Figure 3). Even though Desiree was a popular variety in the past, overall crop performance of YM and NKK in terms of yield was about 30% higher. Standard deviation values for Desiree showed greater variation compared to other two varieties particularly in 2017 indicating lower yield stability. As stated by Thomas-Sharma et al. (2015), the lower productivity in potato varieties could be due to the degeneration of seed quality and inadequacies in timely seed replacement, further aggravated by accumulation of pathogens and pests in the planting materials. They further observed that small scale farmers mostly from developing world continues to plant seed tubers acquired through informal seed systems that is either produced on-farm or acquired from neighbors or local markets. Similarly, Bajgai et al. (2018) also reported that the yield of Desiree variety and other old varieties have consistently shown stagnation in productivity over the years due to limited availability of superior potato seed quality and as a result of degeneration in the quality of seed potato.

However, this is also an indication of the opportunities for the National Potato Program to augment and explore potato production through diversifications of desired potato seeds. The consistency in better performance in productivity by the two new varieties is due to their fairly new genetic seed composition and vigor which is comparable with the current productivity reported in neighboring countries like Bangladesh, India and Nepal (Bajgai et al., 2018). According to the author, although, NKK showed similar comparative productivity trend to that of Yusi Maap in the past studies, the acceptability of this variety by the farmers was however, lower when compared with Yusi Maap. This is attributed to the NKK being a white-skinned variety fetching market prices lower than Yusi Maap. Generally, growers prefer red-skinned variety like Yusi Maap because consumers prefer them and are higher in demand (Roder et al., 2007). Moreover, red-skinned varieties are offered higher prices by the buyers at the FCBL auction yards in Phuentsholing, Gelephu and Samdrupjongkhar. A study carried out in Nepal also found that farmers were less receptive to white varieties even if they were high yielding (Upadhyay, Ghimire, Acharya, & Sharma, 2020).

Unlike Yusi Maap, NKK possesses higher resistance to late blight disease and thereby has the potential to address food and nutrition security and improve livelihood of farmers in the country (Bajgai et al., 2018). Similarly, the analysis of mean productivity of three varieties across all the five research study sites at dzongkhag level (Figure 4) also show the similar performance pattern with Desiree's performing consistently lower than the two varieties. The overall mean productivity difference of Desiree from that of NKK was 3.7 tons/acre, and 3.12 tons/acre lower than that of Yusi Maap. And analysis between the newly released varieties, NKK and Yusi Maap found the average yield difference as only 0.052 tons/acre when compared across five dzongkhags from 2017 to 2019. Based on the current yield trend and market price if we could replace all existing Desiree variety with Yusi Maap, our national productivity will increase by 30.6% with corresponding increase in revenue generated through export as well. The scenario is similar for NKK variety. Further, due to its high adaptive capacities and easy management, there is huge opportunity to increase production through staggered cultivation practice. Staggered cultivation in the three agro-ecologies of low-altitudes, mid-altitudes and high-altitudes has the potential to supply potato to the country for most part of the year.

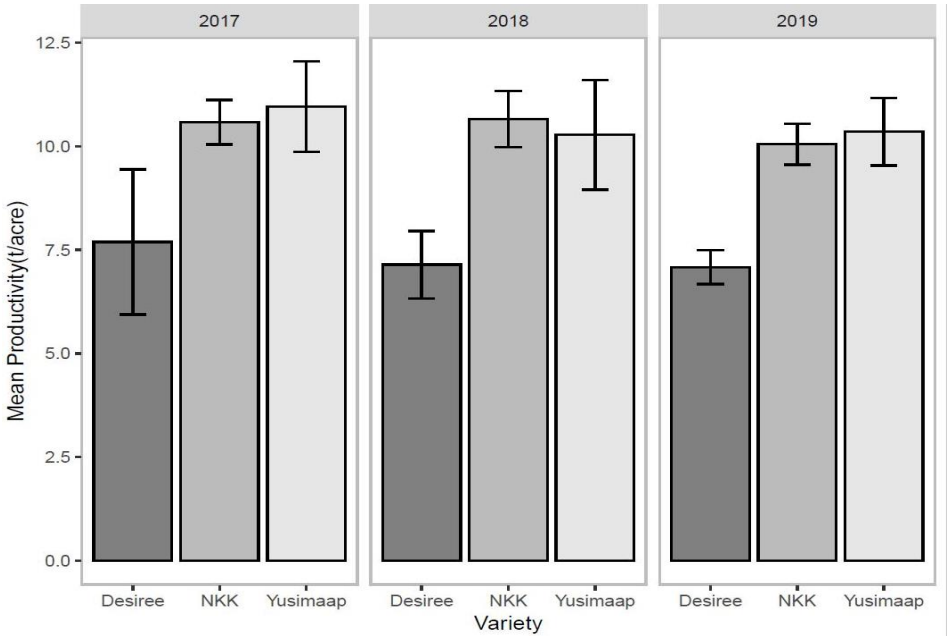

Figure 3. Mean yield of three potato varieties from 2017 to 2019 across five dzongkhags. Error bars show SE of means calculated for each year.

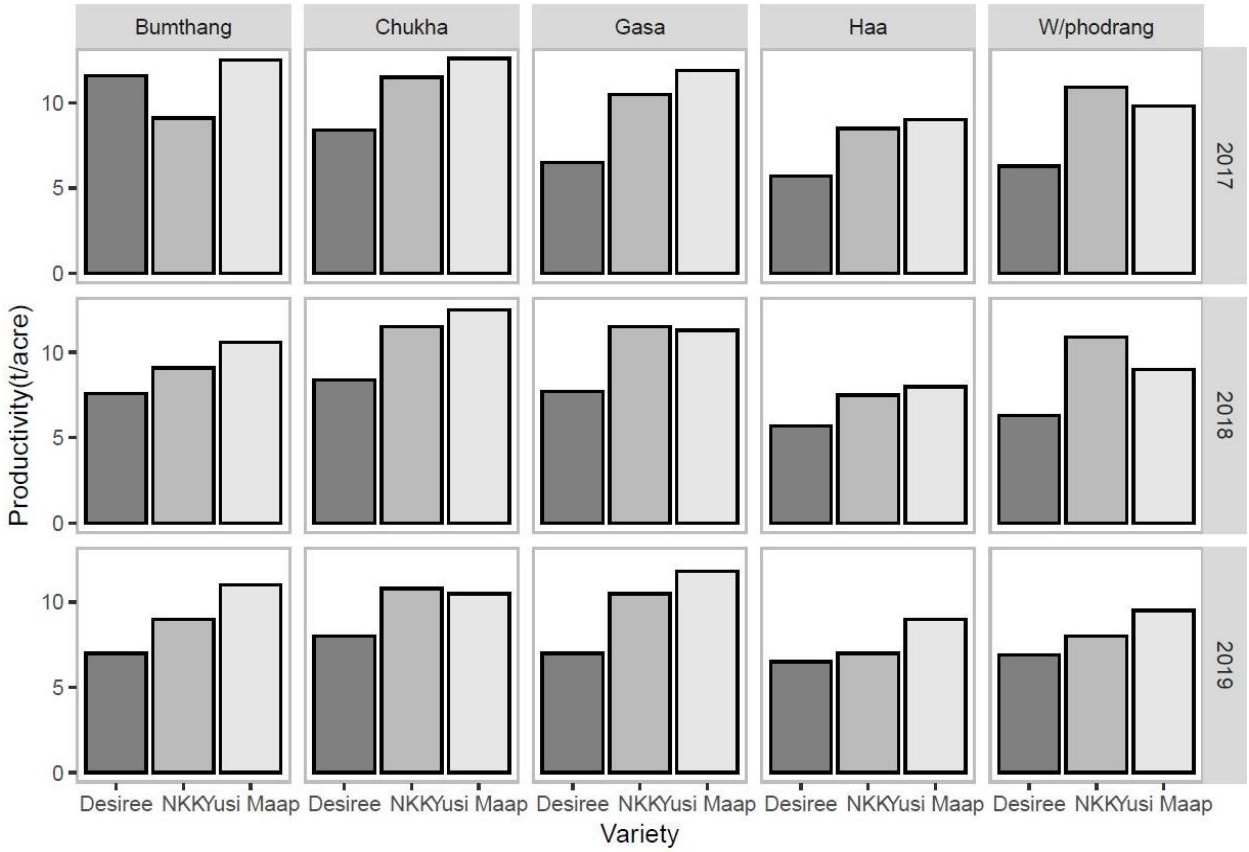

Figure 4. Dzongkhag-wise yield of three potato varieties from 2017 to 2019.

Similarly, Figure 5 explains the preference votes cast by farmers for the three potato varieties in the five research study sites from 2017 to 2019 following participatory varietal selection methodology (Haan et al., 2019). The data represents votes cast by both male and female farmer participants who took part in the field day-cum-training program organized at the demonstration sites. Both the new potato varieties received higher number of votes in comparison to the old variety Desiree in all the three years. In 2017, Desiree received only 473 total votes whereas NKK received 676 and Yusi Maap received the highest total votes of 849. Similarly, in 2018 the total votes for Desiree was 494, NKK 703 and 927 for YM. In the following year (2019), Desiree received 400, NKK 492 and YM 668 votes. Across the sites and years, Desiree received 79 and 37% less votes in comparison to Yusi Maap and NKK, respectively. In stark contrast, although the productivity difference between NKK and Yusi Maap is minimal (Figure 3), the preference votes for Yusi Maap was 1.3 times that of NKK, clearly indicating Yusi Maap is preferred the most. This reflects farmer's preference for red-skinned variety due to better marketability as red-skinned varieties are preferred by consumers as well as by the bidders at all the FCBL auction yards (Roder et al., 2007). Likewise, a study conducted in Nepal also reported thatfarmers were more receptive to new red potato varieties than white-skinned ones, and that adoption rate was found to be low for white-skinned than red skinned varieties (Upadhyay et al., 2020). With the similar agro-ecological environment between Bhutan and Nepal, our farmers seem to have a similar tendency with regards to adoption of new technologies. Additionally, a study carried out by (Bajgai et al., 2018), also found report that red variety Yusi Maap was found to be more receptive by the farmers as compared to NKK although it has similar productivity potential.

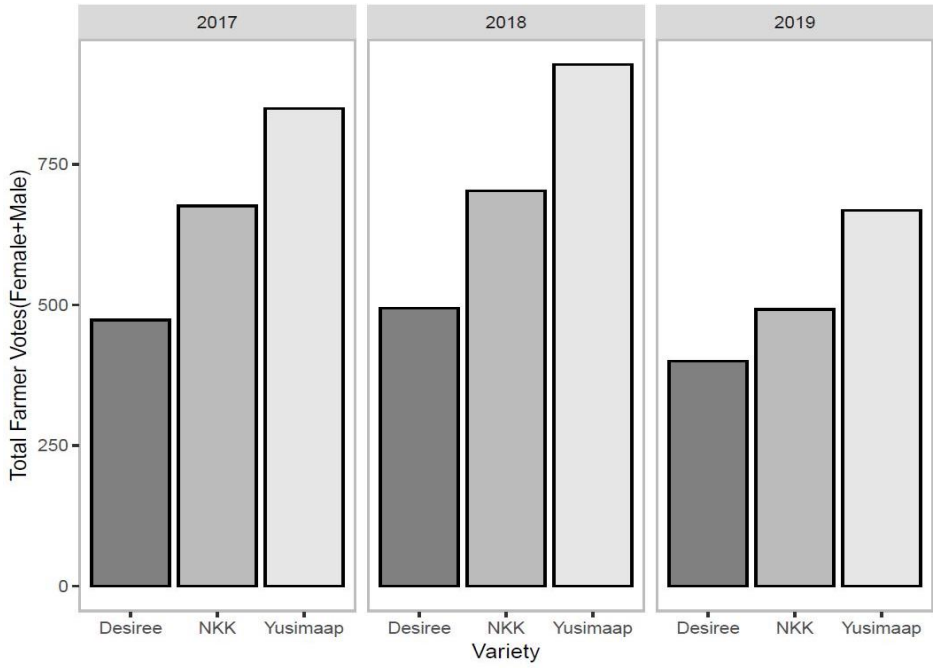

Figure 5. Preference votes casted by farmers (Female and Male) during the participatory varietal selection (PVS) process over the choice of potato varieties.

Statistical relationship between the yields and preference votes was tested. To determine the relationship Pearson's correlation analysis was performed. The correlation model between potato productivity and the farmer's preference votes showed significant association (R= 0.35, P=0.02) indicating potato productivity is positively related to the number votes cast for the three potato varieties (Figure 6). In other words, the higher the potato productivity, the higher is the preference votes cast, meaning higher productivity attracted more votes and lower productivity attracted lesser votes.

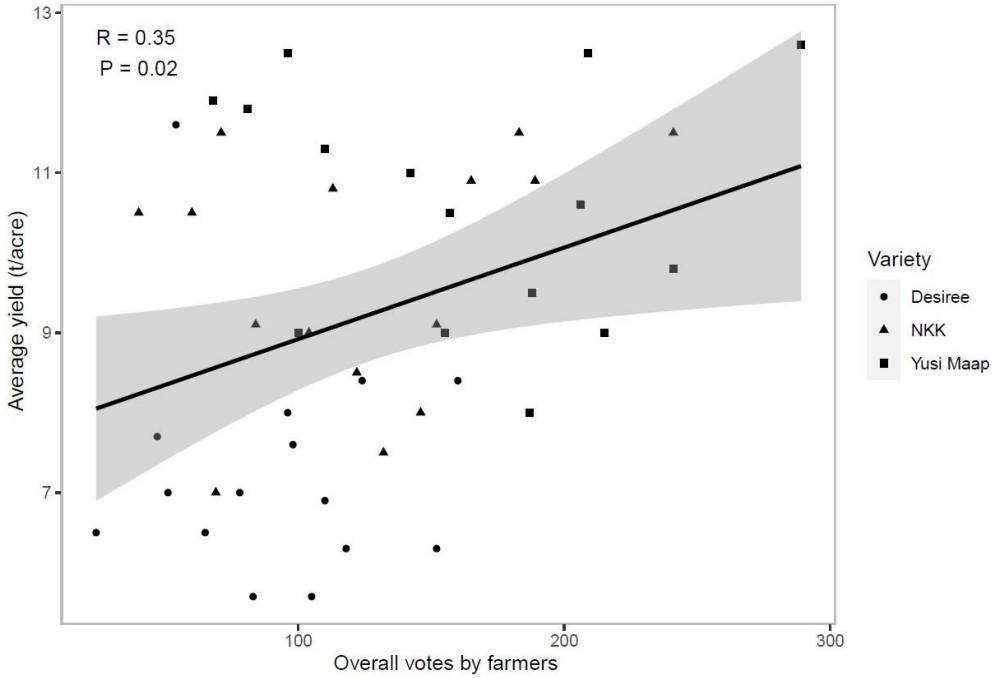

Figure 6. Relationship between the farmer's preference votes and yields of three potato varieties in five districts from 2017 to 2019.

Bajgai et al. (2018) in their study on farmer's selection criterion that included 1) high yielding, 2) oblong shape, 3) floury texture, 4) medium and uniform size, 5) high nutrients content 6) scab resistant 7) chipping quality, ranked from 1 being highly preferred to 7 being the least preferred found the highest number of votes were cast for the highest yielding varieties/clones and the least for the chipping varieties. Further, the study revealed that even if the varieties possess other important attritubes like chipping qualities, farmers would still first prefer high yielding varieties amongst other in general. This could be due to the concerns of feeding their family first which principally reflects the importance of the food availabilty both in quantity and quality amongst farmers in the global south unlike their northern counterparts who normally opt for easy, fast and nutrtitive food (Devaux et al., 2020). Moreso, the higher productivity in potato is also seen as the direct and most certain means to earning cash income, and an importance parameter in assuring household food security.

4. Conclusion

In summary, the study showed that, mean yield of Desiree is consistently lower than that of the NKK and Yusi Maap. Yields of Yusi Maap and NKK were approximately 30% higher in comparison to Desiree. Being one of the oldest varieties, Desiree consistently showed lower productivity compared to other two varieties due to seed degeneration and quality deterioration. Across the sites and years, Desiree received 79% and 37% less votes in comparison to Yusi Maap and NKK, respectivly. Although the productivity difference between NKK and Yusi Maap was minimal (0.10 tons/acre), the preference votes for Yusi Maap was 1.3 times that of NKK indicating the higher level of preferences for Yusi Maap because of its marketable appearance. Although farmers' preference could also be related to colour, marketability, resistance to late blight, tuber sizes , empirically this study found a positive significant relationship between the potato productivity and the farmer's preference votes suggesting that the higher productivity attracted more votes and lower productivity attracted lesser votes. The findings of this study is likely to provide a sound scientific basis to guide program implementers and policy-makers in terms of potato recearch and development in Bhutan.

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