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RESEARCH ARTICLES

Effect of age and number of seedlings in productivity of *Tilki* rice in Dang, Nepal

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ABSTRACT

The growth, yield and yield attributing characters of Tilki rice landrace was evaluated under different age and number of seedlings hill $^{-1}$ at Dang, Nepal from June to September, 2019. The experiment was laid out in factorial design with two different age of seedlings: a)20-day and b) 30-day as main plot factor and four different number of seedlings: 1, 2, 3 and 4 hill $^{-1}$ as sub-plot factor with three replications. The results revealed that highest plant height (79.7cm) at the time of harvesting , LAI (0.17), panicle length (23.5 cm), number of grains per panicle (101.8), effective tiller per hill (9.9), non-effective tiller per hill (1.03), total tiller per hill (10.9), test weight (29.2g), economical yield (2.09 ton/ha), biological yield (5.28 ton/ha) and harvest index (39.34%) were recorded by 20-day of seedlings. Regarding the number of seedlings effective tiller per hill and harvest index were non-significant. Highest plant height (79.6 cm), test weight (28.9 g) and LAI (0.17) were recorded in 1 seedling per hill. Longest panicle length (24.11 cm) and more number of grains per panicle (100.48) were also recorded in 1 seedling per hill. Highest number of non-effective tiller (1.7) and total tillers per hill (11.08) in four seedlings per hill were recorded. Highest economical yield (2.21 ton/ha) and biological yield (5.43 ton/ha) were recorded in 2-seedling per hill. The interaction effect of age and number of seedlings per hill showed non-significant relation with all the growth, yield and yield attributing parameters except non-effective tiller per hill and LAI.

Key words: Rice, variety, seedlings, LAI, HI,

INTRODUCTION

Rice (Oryza sativa L. var. Indica) is the most important cereal crop in agriculture and economy of Nepal. It shares about 20% to the agricultural gross domestic product (AGDP) and accounts about 53% of the total food grain production and covering more than 50% of the agricultural land area (NARC, 2007). Rice is grown in 1.55 million ha of cultivable land with 71% in terai and 24.9% in inner-terai, and 4.1% in Hills and Mountains (MOAC, 2008) amounting 4.30 million ton of rice grain with an average productivity of 2.9 ton\ha (FAO, 2010). It is the main diet of Nepalese people and meets more than 50% of their total calorific requirements (NARC, 2007). It is one of the most important cereal crops of Nepalese agriculture and economy. It is grown in all agro-ecological zones from Terai plains (59 masl at Musaharnia of Dhanusa district) to high hills up to 3050 masl (Chhumchure in Jumla district) including valleys and foot hills of Nepal. Lowland rice contributes 91% where as 9% of the rice is grown upland condition (aerobic rice or upland rice or Ghaiya).

Seedling age and number of seedling per hill are one of major factor that influences the tillering capacity, growth and development, which ultimately influences the yield and yield contributing characters. Number of seedling per hill is an important factor for successful of rice production as it influenced on tiller formation, solar radiation interception, total sunshine reception, nutrient uptake, photosynthesis rate and several physiological phenomena and ultimately affects the growth and development of rice plant. Higher number of seedling per hill causes intra competition between the plants and sometimes causes gradual shading and lodging leads higher straw yield instead of grain yield and lower number of seedling may leads lower number of tiller and finally lower yield. Thus, it is necessary to determine the optimum number of seedling per hill to get optimum grain yield per unit area.

Similarly, age of seedling for transplanting is another important factor, affects the yield of rice because it, directly influences the tillering capacity, yield attributing characters and ultimately yield. Over aged of seedling tends the degeneration of primary tiller buds which ultimately reduce the number of tiller production. Bozorgi et al. (2011) also state that older seedling reduce the general performance of crop and finally reduce the yield of crop. Hence, this experiment was under taken to identify the optimum age and number of seedling per hill.

MATERIALS AND METHODS

Field experiment was conducted at Fulbari municipality of Dang district during June to November 2019 to study the effect of age and number of seedlings per hill in Tilki rice landrace. Geographically, it is located at Latitude 28° 07' 24.00" N and Longitude 82° 17' 26.40" E with an altitude of 725 masl. The average maximum and minimum temperature during cropping season were 31.32°C and 23.32°C respectively and the total rainfall was 134.38 mm during rice growing period (June to September 2019). The experimental site was silty loam with pH

6.6, soil organic matter 1.46%, available N, P, K were 0.1%, 45 kg ha^{-1}, and 190.8 kg ha^{-1}, respectively.

The experiment was laid out in factorial design keeping combination of two different ages of seedlings viz. 20-day and 30-day old seedling as main plot factor and four numbers of seedlings per hill i.e. 1, 2, 3 and 4 seedlings per hill as sub plot factor and each replicated thrice. The individual plots and replication were separated by 0.5 m. The area of each individual plot was 0.75 m^2. Dry nursery bed was prepared for raising the seedlings and 20 and 30 days old seedlings were transplanted with various numbers of seedlings in puddled field in 15 cm x 10 cm planting geometry. The fertilizer dose of 100:50:50 kg NPK ha-1 was applied from urea (46% N), DAP (18% N and 46% P_2O_5) and MOP (60% K2O). Half dose of Nitrogen and full dose of P and K were applied at the time of transplanting as basal dose and remaining N was applied in two split dose at vegetative stage (40 DAT) and panicle initiation stage (60 DAT). Manual weed management was done after 25 DAT and frequent irrigation was done depending upon necessity.

After 30 DAT different biometrical observations like plant height, number of tiller per hill was recorded. For plant height, five hills were selected from each plot and tagged it for taking plant height and number of tiller per hill in different phase of the crop. The height of each tagged plants was measured at 15 days interval till full maturity stage. Plant height was determined by measuring the distance from the soil surface to the tip of the leaf before heading and to the tip of the panicle after heading. The mean height of ten plants is expressed as plant height of each plot. Similarly, after physiological maturity different yield and yield attributing characters like effective tillers per hill, non-effective tillers per hill, total tillers per hill, panicle length, number of grains per panicle, thousand grain weight (g), grain yield and straw yield were recorded from unit plot. The grains and straws are sun dried and converted to ton/ha at 14% moisture content. The biological yield and harvest index were calculated by using the following formulae.

Biological yield = Grain yield + straw yield
Harvest index = (grain yield / biological yield) x 100
Collected data were analysed statistically using R-program with Agricola.

RESULTS AND DISCUSSION

Effect on plant height

There was high significant difference in plant height at the time of harvesting due to the age of seedlings .Tallest plant height (79.69 cm) was observed in 20-day old seedling whereas shortest plant height (67.73 cm) was observed in 30-day old seedling. The transplanting of young aged seedling get sufficient time to root establishment with less transplanting shock at this stage which ultimately resulted better nutrient uptake which stimulate cell division and causing stem elongation. Kim *et al*. (1999) observed that 10-day old seedlings had more

vigorous stem elongation and higher tillering ability compared with 15 and 40-days old seedlings. Gani *et al.* (2002) reported that young seedlings (7 or 14 days old) performed better than 21 days old seedlings.

Table 1. Effect of age of seedlings, number of seedlings per hill and their interaction on Biometric characters

Treatment	Plant height (cm)	LAI
Age of seedling		
X	79.69[a]	0.17[a]
deY	67.73[b]	0.14[b]
LSD (0.05)	4.74***	0.01***
No. of seedling		
S_1	79.65[a]	0.17[a]
S_2	74.71[ab]	0.15[bc]
S_3	70.96[b]	0.14[c]
S_4	69.51[b]	0.15[b]
LSD(0.05)	6.70*	0.01***
Interaction		
$X \times S_1$	86.56	0.18[ab]
$X \times S_2$	80.60	0.16[b]
$X \times S_3$	76.16	0.14[c]
$X \times S_4$	75.43	0.19[a]
$Y \times S_1$	72.73	0.017[ab]
$Y \times S_2$	68.83	0.13[c]
$Y \times S_3$	65.76	0.14[c]
$Y \times S_4$	63.60	0.12[c]
S.Em. (±)	5.41	0.01
LSD(0.05)	NS	0.02**
CV (%)	7.35	7.49
Grand mean	73.71	0.15

Note: Data subjected to square root transformation; figures in parentheses are transformed value. CV: Coefficient of variation, LSD: Least significant difference, S.Em: Standard error. Mean separated by LSD and columns represented with same letter are non-significant at 5% level of significance,* significant, *** highly significant, NS-non significant.

The effect of number of seedlings on plant height was found to be significant. The tallest plant height (79.65cm) observed when 1 seedling per hill was transplanted while the shortest, i.e. 69.51 cm was found when transplanted with 4 seedlings per hill. Gupta (1996) found that transplanting of 1 seedling per hill

significantly increased plant height, than the higher number of seedlings per hill. The plant transplanted with 3 and 4 seedlings showed at par plant height The plant height when transplanted with 2 seedlings per hill was found to be at par with 3 seedlings per hill, 4 seedlings per hill as well as with 1 seedling per hill.

The different interactions of age and number of seedlings showed non-significant differences on plant height.

Effect on LAI

The effect of age of seedlings on LAI was found to be statistically highly significant. The plant transplanted at 20 days after sowing had greater (0.17) leaf area index than when transplanted at 30 DAS (0.14). Hussain et al. (2012) also observed that, 14 ages of seedlings produced more LAI and dry matter as compare to 21 days old seedlings.

LAI was observed greater (0.178) in the plant that was transplanted with 1 seedling per hill and lesser (0.014) in the plant transplanted with 4 seedlings per hill which concludes there were highly significant differences in LAI value when seedlings were transplanted with different numbers per hill. Also, LAI was at par in the plant transplanted with 3 and 4 seedlings per hill. When transplanted with 2 seedlings per hill, LAI result was at par to the plant transplanted with 1 seedling per hill and also to 3 seedlings per hill.

The interaction result showed that LAI value was greater (0.19) in the plant which was transplanted with 20-day old seedling and 4 seedlings per hill while the lowest was in the plant which was transplanted with 30-day old seedling and 4 seedlings per hill (0.12).

Effect on panicle length

The panicle length showed significant differences when transplanted with different aged seedlings. Panicle length was longest, i.e. 23.55cm in 20-day old seedling transplanted plant and shortest, i.e. 22.37 cm in 30-day old transplanted plant. The longest panicle produced by early planting might be due to availability of more time for better development of plant parts which might result in the better development of yield attributing characters. Similar results have been reported by Singh *et al.* (2004).

Significant difference was found in the plants transplanted with different number of seedlings per hill. The longest panicle length, i.e.24.11cm was found in 1 seedling per hill transplanted plant while the shortest panicle length, i.e. 21.92cm was found in 4 seedlings per hill transplanted plant. The lower number of seedling per hill gave the longest panicle and the increase in number of seedling per hill decreased the length of panicle. It might be due to competition for soil, nutrient and light which are necessary for growth and development of rice plant. The panicle length of 2 seedling transplanted plant was at par with 1

seedling transplanted plant and that of 3 with 4. Non- significant result was found on panicle length in interaction (A×N).

Table 2. Effect of age of seedlings, number of seedlings per hill and their interaction on yield attributing characters

Treatment	Panicle length(cm)	No. of grains/panicle	Effective tiller/hill	Non-effective tiller/hill	Total tillers/hill	Test weight (g)
Age of seedling						
X	23.55[a]	101.82[a]	9.9[a]	1.03[a]	10.94[a]	29.22[a]
Y	22.37[b]	89[b]	9.3[b]	0.84[b]	10.22[b]	25.68[b]
LSD (0.05)	0.71**	3.11***	0.22***	0.07***	0.21***	0.79***
No. of seedling						
S1	24.11[a]	100.48[a]	9.45	0.43[d]	9.9[c]	28.88[a]
S2	23.18[ab]	94.06[b]	9.81	0.66[c]	10.65[b]	27.10[b]
S3	22.63[bc]	92.71[b]	9.66	1.03[b]	10.7[b]	26.50[b]
S4	21.92[c]	94.38[b]	9.46	1.616[a]	11.08[a]	27.32[b]
LSD (0.05)	1.01**	4.40**	NS	0.10***	0.30***	1.12**
Interaction						
X×S1	24.69	104.83	9.70	0.36[f]	10.10	29.77
X×S2	24.01	102.43	10.23	0.80[d]	11.03	28.98
X×S3	22.41	98.46	9.90	1.20[d]	11.10	28.59
X×S4	23.11	101.56	9.76	1.76[a]	11.53	29.57
Y×S1	23.53	96.13	9.20	0.50[ef]	9.70	28.00
Y×S2	22.35	85.70	9.40	0.53[e]	10.26	25.23
Y×S3	21.43	86.96	9.43	0.86[d]	10.30	24.40
Y×S4	22.15	87.20	9.16	1.46[b]	10.63	25.08
S. Em (±)	0.81	3.55	0.25	0.08	0.24	0.91
LSD (0.05)	NS	NS	NS	0.15***	NS	NS
CV (%)	3.53	3.72	2.66	9.27	2.31	3.31
Grand mean	22.96	95.41	9.6	0.93	10.58	27.45

Note: Data subjected to square root transformation; figures in parentheses are transformed value. CV: Coefficient of variation, LSD: Least significant difference, SEm: Standard error. Mean separated by LSD and columns represented with same letter are non-significant at 5% level of significance,* significant, *** highly significant, NS-non significant

Effect on number of grains per panicle

Number of grains per panicle was also highly significantly different when transplanted with different aged seedlings. The number of filled grains was determined by the suitable age of seedling because younger seedlings were established well than the older one. Plant with 20-day old seedling had more number of grains per panicle (101.82) and the plant with 30-day old seedlings had less number of .grains per panicle (89).

The statistical data showed significant differences in number of grains per panicle as affected by transplanting seedlings with different number per hill. 1 seedling per hill transplanted plant had greater number of grains per plant, i.e. 100.48 and 3 seedlings per hill transplanted plant showed lesser no. of grains per panicle, i.e. 92.71 while 2 and 4 seedlings per hill transplanted plant had at par grains as that of 3 seedlings transplanted plant. The number of seedling per hill also contributed to number of filled grains because transplanting more number of seedling per hill increased the inter and intra plant competition which resulted in decreased number of filled grains per panicle and increased number of sterile spikelet which reduced the number of filled grains per panicle. The interaction between seedling age and number of seedling showed non-significant differences on number of grains per panicle.

Effect on total tillers per hill

The age of seedling during transplanting showed high significant differences in total tillers per hill later. The more tillers (10.94) was observed in the plant with 20-day old seedling and lesser (10.22) in the 30-day old seedling.

The high significant difference was shown by the different number of seedlings transplanted per hill on total tillers per hill. More number of tillers, i.e. 11.08 was shown by 4 seedlings and lower number of tillers, i.e.9.9 was shown by 1 seedling. As there was increase in the number of seedling per hill, tiller number also increased. This result is in conformity with the findings of Nayak *et al.* (2003). Also the number of tiller production increased with increased number of seedlings per hill from one to three, as showed by Cai *et al.* (1991). The 2 seedlings per hill and 3 seedlings per hill had similar tiller numbers with 1 seedling per hill.There was no interaction effect on total tillers due to seedling age and number of seedling per hill.

Effect on effective tillers per hill

There was more effective tiller per hill in the plant of 20-day old seedling, i.e. 9.9 while lesser effective tiller per hill in the plant of 30-day old seedling, i.e. 9.3. Nayak *et al.* (2003) also reported significant reduction in total tillers production with delay in planting. The 15-day old seedlings revealed superiority over the other age of seedlings in respect of effective tiller production reported by Ali *et al*. (2013). The productive tillers might be higher in early planting due to better development of early formed tillers up to reproductive phase of the crop while in case of late planting, unavailability of sufficient amount of

photosynthates as source of energy might result in the mortality of tillers and number of productive tillers could be reduced.

Not any significant differences was found on effective tillers per hill with transplantation of different number of seedlings per hill and with the interaction of age and number of seedlings per hill.

Effect on non-effective tillers per hill
There were large non-effective tillers in 20-day old seedling transplanted plant (1.03) while fewer in 30-day old transplanted plant (0.84).

Greater non-effective tillers was shown by plant transplanted with 4 seedlings per hill, i.e. 1.61 while the lowest was shown by 1 seedling per hill, i.e. 0.43 followed by 2 seedlings per hill (0.67) and then by 3 seedlings per hill (1.03).Non-effective tillers was found to be greater (1.76) in transplanting with combination of 20-day old seedling and 4 seedlings per hill and lesser (0.36) in transplanting with combination of 20-day old seedling and 1 seedling per hill.

Effect on test weight (1000 grain weight)
Test weight was found to be higher (29.22 g) in 20days old transplanted seedling than 30-day old transplanted seedling (25.68 g).Maximum test weight was obtained from plant transplanted with1 seedling per hill (28.88 g) followed by 4 seedlings per hill (27.32g), 2 seedling per hill (27.1g) and minimum from 3 seedlings per hill (26.5 g). There were non-significant differences in the test weight with the interaction of age and number of seedlings.

Effect on economic yield
The 20-day old seedling transplanted plant had greater economic yield, i.e. 2.09 t/ha than 30 days old seedling transplanted plant, i.e. 1.64 t/ha (Table 3). Faruk *et al* (2009) also reported the highest grain yield from 4-week old seedlings. The higher grain yield with early planting might be due to significant increase in effective tillers per hill as well as number of grains per panicle and 1000 grain weight.

According to the data more economic yield (2.2 t/ha) was obtained from the plant transplanted with 2 seedlings per hill while less yield was obtained from plant transplanted with 4 seedlings per hill (1.30 t/ha). Similar result was also observed by Ahmad and Hasanuzzaman (2012) who found the highest grain yield (497 g/m2) in the treatment having combination of two seedlings per hill. Transplanting 2 seedlings per hill showed significant superiority over the other treatments. Increase in grain yield might be due to production of more number of tillers per hill and more number of filled grains/panicle and finally increased in the grain yield. Similar, observation was also reported by Gupta (1996). And, 1 and 3 seedlings transplanted plant gave at par economic yield to that of 2 seedlings. Economic yield showed no significant differences in the interaction of age and number of seedlings per hill.

Effect on biological yield

There was higher biological yield in 20 days old seedling transplanted plant (5.28 t/ha) while lower in 30 days old transplanted plant (4.45 t/ha).The higher straw yield due to young seedling was due to less stem and root injury and easily establishment of seedlings. Also the young seedlings grow luxuriantly with better vegetative growth because of higher rate of photosynthesis. Faruk, *et al* (2009) also reported the highest grain yield from 4 weeks of old seedlings. It is observed that 22 day old seedling recorded the highest straw yield (6.0 t/ ha) and the lowest straw yield was recorded in 36 day old seedling which is statistically similar to 29 day old seedling.

High significant difference was seen in biological yield as affected by number of seedlings being transplanted. The plant transplanted with 2 seedlings per hill gave more biological yield (5.43 t/ha) followed by 3 seedlings (5.18 t/ha) per hill, 1 seedling per hill (5.03 t/ha) and least by 4 seedlings per hill (3.805 t/ha).Biological yield showed no significant differences with the interaction of age and number of seedlings per hill.

Effect on Harvest Index

Harvest index had non-significant differences when rice was transplanted with different aged seedlings, with different number of seedlings per hill and also with their interaction.

Table 3. Effect of age of seedlings, number of seedlings per hill on economic yield, biological yield and harvest index

Treatment	Economic yield (t/ha)	Biological yield (t/ha)	Harvesting index (%)
Age of seedling			
X	2.090833[a]	5.28[a]	39.34667
Y	1.641667[b]	4.450833[b]	36.495
LSD(0.05)	0.240923**	0.466123***	NS
No. of seedlings per hill			
S1	1.906667[a]	5.038333[a]	37.51
S2	2.211667[a]	5.436667[a]	40.50833
S3	2.043333[a]	5.181667[a]	39.1
S4	1.303333[b]	3.805[b]	34.565
LSD(0.05)	0.340717***	0.466123***	NS
Interactions			
X×S1	2.230000	5.530000	40.27000
X×S2	2.450000	5.873333	41.55000
X×S3	2.390000	5.763333	41.46667
X×S4	1.293333	3.953333	34.10000
Y×S1	1.583333	4.546667	34.75000
Y×S2	1.973333	5.000000	39.46667
Y×S3	1.696667	4.600000	36.73333
y×S4	1.313333	3.656667	35.03000
S.Em. (±)	0.27515	0.376423	3.620614
LSD(0.05)	NS	NS	NS
CV (%)	14.74	7.73	9.54
Grand mean	1.86	4.86	37.92

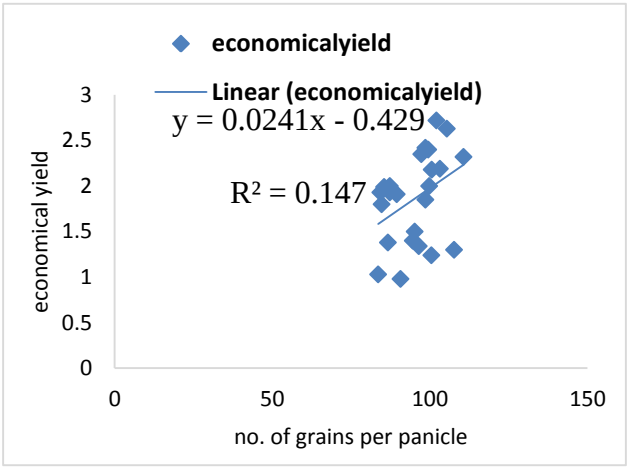

Figure 1. Regression analysis of economic yield with no. of grains per panicle

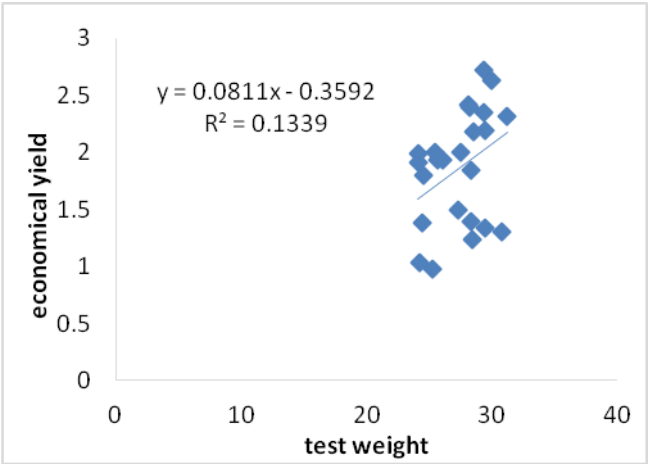

Figure 2. Regression analysis of economic yield with test weight

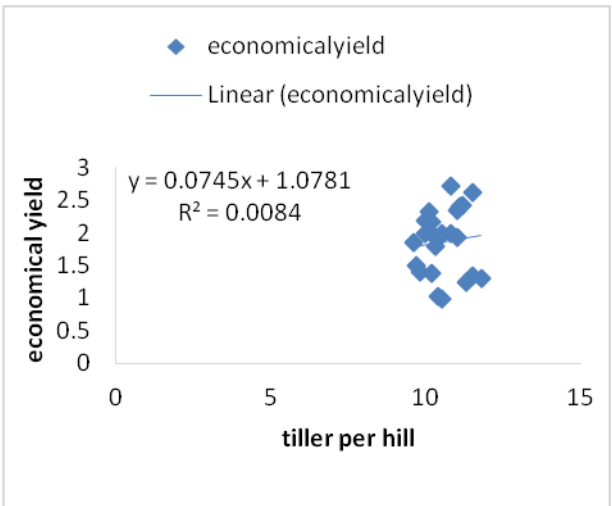

Figure 3. Regression analysis of economic yield with tillers per hill

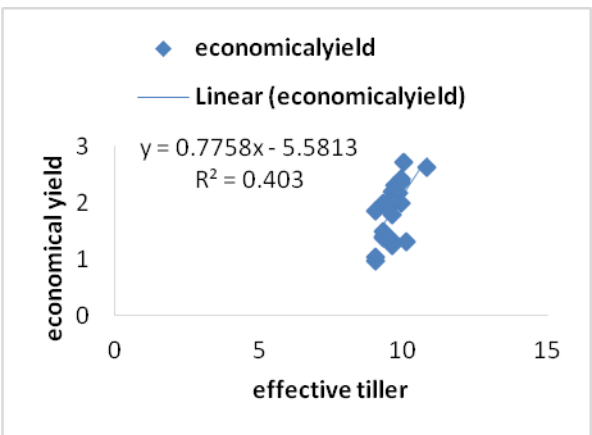

Figure 4.Regression analysis of economic yield with effective tiller

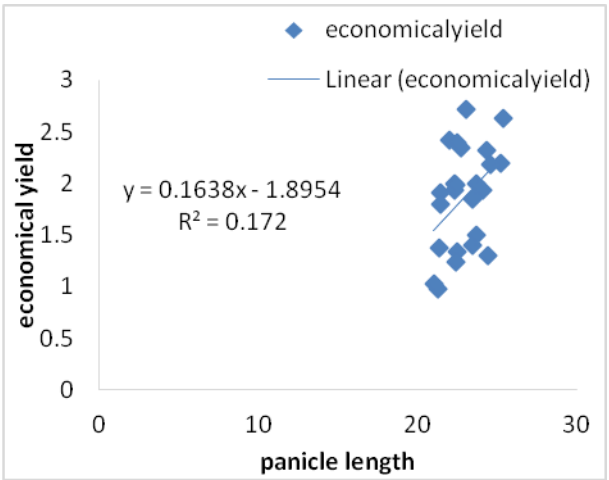

Figure 5. Regression analysis of economic yield with panicle length

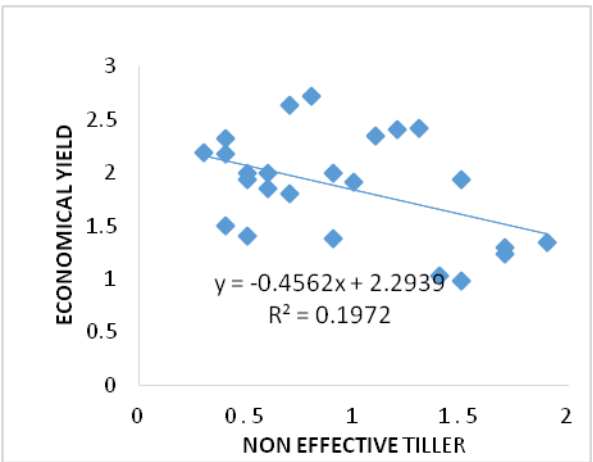

Figure 6. Regression analysis of economic yield with non-effective tiller

Regression analysis of economic yield on yield attributes

Dependence of grain yield on yield attributes, viz. test weight, number of grain per panicle, tillers per hill, effective tiller and panicle length were evident from significant positive correlation with regression functions, accounting for R^2=0.1339, R^2=0.1474, R^2=0.0084, R^2=0.403, R^2=0.172 explained variability in grain yield, respectively (from figure 1 to 5). Expectedly, grain yield showed a

negative correlation with the regression function between grain yield and non-effective tiller, accounting for R^2=0.1972 (Figure 6).

CONCLUSION

Twenty-day old seedlings showed significantly greater value than 30 day's old seedlings. So, the local Tilki variety under Dang condition could give the best yield when 20-day old seedlings are transplanted. The rice cultivation from transplanting 2 seedlings per hill compared to 1, 3 and 4 seedlings per hill gave higher yield.

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Effect of different seed rates on yield and growth of short duration rice varieties under direct seeded condition

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ABSTRACT

An experiment was conducted for two consecutive years to evaluate the effect of different seed rates on yield and growth of short duration rice varieties under direct seeded technique in Regional Agriculture Research Station, Tarahara, Sunsari Nepal. The treatments were two varieties of rice (Sukhadhan-3 and DRR44) and five seed rates (20, 30, 40, 50, 60 kgha^{-1}) which were assigned in split plot design with three replications. The variety treated as main factor and seed rates distributed as sub-plot factor. Both consecutive years, the plant height, tiller per meter square, panicle per meter square, panicle length, filled grains, thousand grain weights were recorded and comparatively better performance was recorded in 40 kg ha^{-1} seed rate condition. In the year 2016, the sowing of 30 kg ha^{-1} seed rate was expensively higher grain yield (4.21 tha-1) followed by sowing of 40 and 60 kg ha-1 seed rate (3.67 & 3.61 t ha^{-1}). Similarly, in the year 2017, the higher grain yield (4.23 t ha^{-1}) was recorded in 50 kgha^{-1} seed rate which was remarkably similar with the sowing of 40 and 60 kgha^{-1} seed rate (4.22 & 4.12 t ha^{-1}) so the study revealed that variety Sukhadhan-3 was higher in grain yield (3.81 & 4.10 t ha^{-1}) over DRR44 variety (3.56 & 3.6 tha^{-1}) and sowing of 40 kgha-1 seed rate was economically best for direct seeded rice techniques in Regional Agriculture Research Station, Tarahara and similar ecological condition throughout the country.

Key words: Direct seeded rice, seed rate and crop yield.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important staple food crop for more than 60% of the global population with the cheapest source of food and energy. It is grown

in 1.3 million hectares area with production and productivity of 4.23 million tones and 3.23 kg ha^{-1} respectively in Nepal during 2016-2017 (MOAD, 2016) which is far below the world average (6.93, 3.96 and 3.77 t ha^{-1}, and 4.64 t ha^{-1} was in China, India, and Pakistan and others respectively (FAO, 2016) . So, there is an urgent need to increase the productivity and the production of rice to feed the national population (Dahal,& Khadka, 2012). It is possible only when we can expand the crop producing areas or increase in yield per unit area. Since horizontal expansion of land is not possible, increasing the yield per unit area is the only means to address the growing population pressure (Mondal, Sarkar, Paul, & Zaman, 2013). This can be achieved by the adoption of improved agronomic practices in rice cultivation. Conventional transplanting methods of rice are labor consuming practices so rice cultivation is getting costly day by day.

Direct seeding is one of the cost and labor saving techniques (Ladha & Kumar, 2011). It reduces cost of production including the land preparation (36%), seedlings raise and transplanting (21%) and the crop harvest (23%) (Hobbs, Singh, Giri, Lauren & Duxbury, 2002) that also reduces the overall NRs. 22021.75 per hectare which is 57.34% lower than the conventional rice farming system in Nepal (Marahatta, 2014). Direct seeded upland rice occupies around 9% of the total area in Nepal (MoA, 2018) which is in increasing trend due the scarcity of water and labors during the planting time. The direct seeded rice has tremendous opportunities in eastern part of Nepal having even more challenges. The appropriate weed management techniques, suitable varieties and optimum seed rate are the major ones. Seed rate has great impacts on plant density and the competitiveness of the crop stand, tiller, time to maturity and yield. Low plant density and improper sowing methods are the limiting factors for obtaining higher yields and have a negative influence on the yield of rice. Optimum plant density is the primary factor for obtaining higher yield in rice (Sivaesarajah et al., 1995). The number of plant per unit area has an impact on plant architecture, modifies growth and development pattern and effects on the production photosynthesis (Abazar et al**.,** 2011). The increase in plant density increases the yield up to optimum limit and thereafter decline in yield takes place (Sivaesarajah et al., 1995). The reason for the reduction in yield is due to the reduction of resources per plant. So the increase in the plant density does not always determine the crop yield, it is also associated with other management factors. If proper management practices for DSR such as weed control, appropriate fertilizer, seed rate, insect/disease management, irrigation and so on are identified, then it can ultimately help the poor farmers to increase yield and income.

This study was carried out with aim to investigate the effect of different seed rates on yield and growth of drought tolerant varieties of rice and also find out best agronomical management practices on drought tolerant rice varieties under rain-fed lowland eco-system in the eastern part of Nepal.

MATERIALS AND METHODS

Study site

Study was conducted during two rainy season of 2016-2017 at Regional Agriculture Research Station, Tarahara, Sunsari, Nepal. The climate of the station is sub-tropical and distribution of land is sandy, silty and sandy loam soil, slightly sandy loam to loamy. It is geographically located at 26º42'16.85" North latitude and 87º16'38.43" East longitude with elevation of 136 m above mean sea level.

Experimental design

The experiment was set up using split plot design with three replications. The two varieties (Sukhadhan 3 and DRR 44) were used in the main-plot and five level of seed rates (20, 30, 40, 50 and 60 kg ha^{-1}) in the sub-plot. The land was well prepared by 2-3 tillage and well leveled.

Seed preparation and sowing

The seed was pre- soaked for 24 hrs and incubated for 36 hrs prior to seeding. The same pre- germinated seeds were sown in continuous lines with the row spacing of 25cm on first week of July 2016 and 2017 respectively. The treatments' sub-plot size was 10 m^2.

Fertilizer application

A recommended dose of fertilizers at 90:30:30 NPK kg/ha was applied where nitrogen was provided through urea, DAP as Phosphorus and source of Potassium was MOP. Half dose of nitrogen was applied as basal along with full doses of phosphorus and potassium. Another half dose of nitrogen was applied in two splits at active tillering and panicle initiation stages.

Weed management

All intercultural operations such as weed control and irrigation were applied as per needed. Pendimethyline @ 1000 ml a.i ha^{-1} was applied to control grasses and sedges in the initial stages of crop followed by one hand weeding and bispyribac sodium 20gm ha^{-1} were applied after one month of planting in all the treatments.

Data recording techniques

During the experimentation, the data was recorded in such a way as average plant height was measured from the base of the stem up to the longest panicle tip in randomly selected 10 hills in each plot. To determine the effective tillers m^{-2}, only the panicle bearing tillers were counted from 4^{th} sample hills and its average was expressed in tillers or panicle m^{-2}. Days to flowering were determined when 50% of the hills in each plot had reached anthesis. Days to maturity were determined when 80% of the hills in each treatment are matured. Panicles after maturity were hand-threshed and the filled and unfilled grains were separated. Total numbers of filled grains and empty grains $panicle^{-1}$ were counted and expressed in grain filling %. Grain and straw yields were determined from the harvested area of 1 m^2 marked in the middle of each sub-

plot to avoid the border effect in each plot. Grain samples were harvested, dried and adjusted to a moisture content of 14% for determining thousand grain weight (TGW) and yield. The straw was sun dried, weighed and expressed in t ha^{-1}.

Data analysis
The data collected were statistically analyzed using STAR software and compared among the different treatments. Treatment means were compared using the least significant difference (LSD) tests; and were compared at $p \leq 0.05$ level of significance.

RESULTS AND DISCUSSIONS

Climatic condition during experimentation

In two consecutive years, the monsoon started from May to September but rainfall pattern was unevenly distributed in 2017 with lower rainfall (1899.2 mm) as compared to 2016 (2262.40mm) within the entire experimentation(from May to October). The rainfall was highly fluctuated in the month of August and September in both year but in 2016, highest rainfall recorded at 590.5 mm which was quite similar to June (589mm). In the case of 2017, the highest rainfall was recorded at 918.2 mm in August, which was far differed than another months. This intense rainfall did not damage the crop because it already attained panicle initial stage (90 days after sowing) that favored growth and development of crop. However, plant population was not optimum -level. Similarly, the maximum temperature ranged from 31.03 to 33.59^0c and minimum temperature from 21.32 to 25.75^0c during the crop growing season in the year 2016 (Figure 1 and 2) but the maximum temperature ranged slightly higher (32.8 to 34.3^0c) in 2017. In both years, the maximum temperature reached above 34^0c in the month of August or September and minimum was recorded below 22^0c in the month of October.

Effect of seeding rate and varieties on crop emergence and maturity under DSR

The crop emergence was significantly influenced by the crop varieties in first year but non- significant (Table1) in second year. The good crop emergence was recorded in sukhadhan-3 and sowing of 50 and 60 kg ha^{-1} seed rate. Better crop emergence was recorded in 2017 as compared to 2016. It might be due to the heavy rainfall at the sowing time that clogged upper soil layer and caused the poor seed germination in 2016. Similar finding supported by Dongarwar *et al. (*2018) & Denup *et al.(*2018) as increased seed rate maintained the plant population in direct seeded rice as compared to low seed rate condition. In the year 2017, the flowering and heading were highly significant among the varieties and seed rate. The earlier heading and maturity were observed in sukhadhan-3 at high seed rate condition. The sukhadhan-3 was matured at 123 days where as DRR44 was at 125 days in 2016 similar pattern followed in 2017,

where Sukhadhan-3 matured at 111 days and followed by DRR44 as 114 days. The higher seed rate encouraged to earlier maturity on both varieties that took around 107 to 123 days but the crop maturated to delay by one week in low seed rate condition. The findings were supported by Aklilu, (2020).

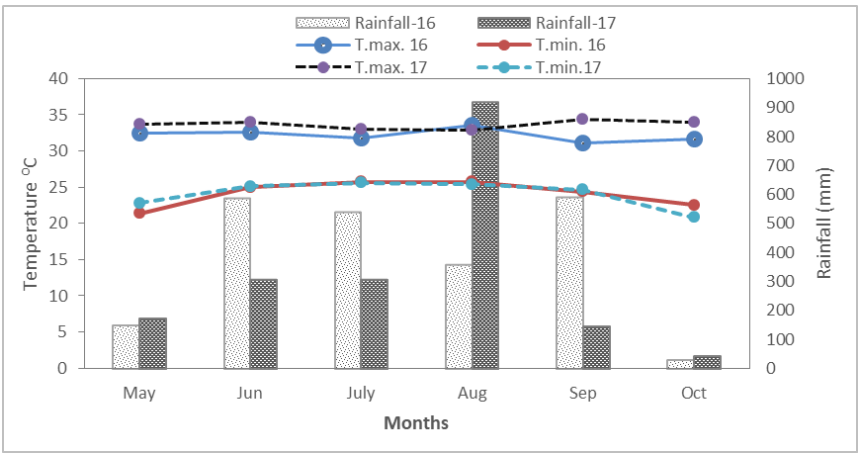

Figure 1. Weather condition during the course of experimentation at RARS, Tarahara, Sunsari, Nepal, 2016 and 2017

Effect of seeding rate and varieties on crop growth under DSR

Overall growth traits of rice were influenced by amount of seed rate under direct seeded condition. Increasing the amount of seed rate that influenced the plant height, grains per panicle, panicle length and effective tillers per meter square (Table 2).

In term of plant height, DRR44 variety attained 127.54 cm, was at its best between two varieties for both years. Among the treatments, the lowest amount of seed rate (20kg ha^{-1}) attained maximum plant height up to 123 cm but lower plant height (121.6 and 120.7 cm) was recorded in sowing of 50 kg ha^{-1} and 60 kg ha^{-1} seed rate respectively. It might be due to the plant get more space in minimum seeding rate condition. Ameen *et al.* (2018) reported the similar findings in Bangladesh. The higher number of tillers m^{-2} was recorded on sowing of low amount of seed that might be attributed to optimum plant population and resulted in comparatively low inter-competition for better resources utilization at tillering stage (Phuong *et al.* (2005) & Chauhan *et al.* **(**2010). Similarly, number of tillers per meter square was maximal in Sukhadhan-3 (around 249.4) as compared to DRR44 (232.7) (Table 2).

Effect of seeding rate and varieties on yield attributes and yields under DSR

Among the seed rate, higher number of grain per panicle were recorded from seed rate of 20 kg ha^{-1}, which was statistically at par with 30 kg ha^{-1} and

significantly higher than 50 and 60 kg ha^{-1} seed however, 30 kg ha^{-1} seed rate recorded the remarkably the number of grain per panicle with 40 kg ha^{-1} seeding condition. The higher seed rate might have more tiller mortality. Similarly, the thousand grain weight and straw yield were not significantly differed among the treatment in both consecutive years.

Table 1. Crop emergence, flowering and maturity influenced due to seed rate and varieties under DSR during wet season 2016 and 2017

Treatments	2016			2017		
	Flowering days	Maturity days	Crop emergence at 12DASm^{-2}	Flowering days	Maturity days	Crop emergence at 12DASm^{-2}
Variety						
Sukhadhan3	93.00 ^{b}	123.00 ^{b}	43.00 ^{a}	88.20^{b}	111.2^{b}	128.8
DRR 44	96.00 ^{a}	125.00 ^{a}	32.13 ^{b}	91.40^{a}	114^{a}	95.9
$LSD_{0.05}$	1.115*	1.09*	8.77*	0.75**	1.10**	Ns
Seed rate (kg ha^{-1})						
20	95.5	124.83	19.50 ^{c}	91.17^{a}	115.0^{a}	60.17^{c}
30	94.33	123.67	27.83 ^{b}	91.00^{a}	114.7a	84.6b^{c}
40	94	123.83	36.33 ^{b}	89.50^{ab}	114.0a	103.2^{b}
50	93.83	123.33	52.16 ^{a}	88.17^{bc}	108.5b	145.7^{a}
60	93.33	123.33	52.00 ^{a}	87.10^{c}	107.5b	168.2^{a}
$LSD_{0.05}$	NS	NS	13.88	1.88**	1.844**	25.24
CV,%	1.53	1.14	30.19	2.36	1.85	18.35

Number of panicle m^{-2} was superior in Sukhadhan-3 (178.13 & 229.9) and sowing of 60 kg ha^{-1} of seed (193.5 & 233.7) in both consecutive years. Longest panicle (25.03 & 27.4 cm) was recorded on sowing of 20 and 30 kg ha^{-1} seed and DRR44 (24.59 & 27.8 cm) (Table 2). Miller *et al.* (1991) found that panicle is a key factor that determines and contributes 89% of differences in yield.

Higher thousand grains weight (24.27) was recorded at seeding of 40 kg ha^{-1} seed which was non-significant among others. Seeding of 30 kg ha^{-1} recorded higher grain yield due to the more effective tillers per panicle in first year. Mahajan *et al.* (2010) reported that 15- 30 kg ha^{-1} seeding rates produced higher grain yield in direct seeded condition. In second year, the higher grain yield was recorded on sowing of 50 kg seed rate which was remarkably similar with sowing of 40 and 60 kg ha^{-1} seed rate.

The similar result was supported by Gill *et al.* (2005) that the seed rate of 50 kg ha^{-1} produced the maximum dry- matter accumulation, leaf area index and even the grain yield under direct seeded condition in Ludiana, Punjab, India. There was no interaction effect among the seed rate and varieties however, Sukhadhan-3 was superior over DRR44 cultivar. Similar finding was reported by Joshi *et*

al., (2018) that the Sukhhadhan-3 produced higher grain yield compared with Hardinath-3 especially under dry direct seeded condition in RARS, Tarahara.

Table 2. The plant height, tillers per meter square, panicle per meter square and panicle length influenced due to seed rate and varieties on DSR during wet season 2016 and 2017

S.N	2016				2017			
Treatments	Av plant height (cm)	Tillers/ m^2	Panicles/ m^2	Panicle Length (cm)	Av plant height (cm)	Tillers/ m^2	Panicles/ m^2	Panicle Lgth (cm)
Varieties:								
SKD-3	111.12 ^{b}	212.86	178.13	23.44 ^{b}	117.7	249.4	229.9	26.1
DRR 44	127.54 ^{a}	198.20	169.33	24.59 ^{a}	126.4	232.7	199.5	27.8
$LSD_{0.05}$	4.806*	NS	NS	0.791	NS	NS	NS	NS
Seed rate (kg ha^{-1}):								
20	120.9	189.33 ^{b}	164.33	25.03 ^{a}	123.0	210.3	192.0	27.4
30	116.8	223.50 ^{a}	174.66	24.50 ^{a}	122.3	229.2	202.8	27.1
40	119.3	211.83 ^{ab}	178.33	23.27 ^{b}	122.9	248.5	212.5	27.1
50	119.53	178.66 ^{b}	157.83	23.68 ^{b}	121.6	260.5	232.7	26.8
60	120.13	224.33 ^{a}	193.5	23.62 ^{b}	120.7	256.7	233.7	26.5
$LSD_{0.05}$	NS	31.73*	NS	1.251*	NS	NS	NS	NS
CV, (%)	5.21	12.61	15.72	4.26	3.35	14.7	12.69	2.52

Table 3. The filled grains, TGW, straw yield and grain yield influenced due to seed rate and varieties on DSR during wet season 2016 and 2017

S.N	Year 2016				Year 2017			
Treatments	Filled Grains $panicle^{-1}$	TGW (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Filled Grains $panicle^{-1}$	TGW (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
Varieties								
SKD-3	99.62^b	23.25^b	3.81	5.45^b	107 ^{b}	23.2	4.1	6.8
DRR 44	114.74^a	24.26^a	3.56	6.54^a	120 ^{a}	23.4	3.6	7.1
$LSD_{0.05}$	11.11**	0.812*	NS	0.921*	6.8*	NS	NS	NS
Seed rate (kg ha^{-1})								
20	126.93 ^{a}	23.90	3.48	5.12	129 ^{a}	23.6	3.13 ^{b}	6.5
30	112.03 ^{ab}	23.69	4.21	5.76	115 ^{ab}	23.4	3.42 ^{b}	6.8
40	97.90 ^{b}	24.27	3.67	6.35	113 ^{ab}	23.3	4.22 ^{a}	7.0
50	101.46 ^{b}	23.70	3.44	6.38	112 ^{b}	23.1	4.23 ^{a}	7.3
60	97.60 ^{b}	23.22	3.61	6.36	99 ^{b}	23.2	4.12 ^{a}	7.3

$LSD_{0.05}$	17.57*	NS	NS	NS	16*	NS	0.4*	NS
CV, (%)	13.39	4.41	3.68	5.99	11.53	3.48	8.97	8.39

CONCLUSIONS

Overall, sowing of 40 kg ha^{-1} seed performed comparatively the higher plant height, more effective tillers per meter square, thousand grain yields, panicle weight, panicle length and grain yield under direct seeded condition in both consecutive years so it will be the economically best practices for Regional Agriculture Research Station, Tarahara and similar ecological condition throughout the country. Similarly, variety Sukhadhan-3 was higher in grain yield (3.81 & 4.10 t ha^{-1}) over DRR44 variety (3.56 & 3.6 tha^{-1}) so it will be the suitable variety for drought prone areas in Nepal.

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Bakery waste as an alternative of maize to reduce the cost of pork production

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ABSTRACT

An experiment was carried out on weaned piglets to investigate the effect of different levels of bakery waste feeding on feed intake, feed conversion ratio (FCR) and growth performance of piglets at Piggery Research Unit of Regional Agricultural Research Station, Tarahara, Sunsari, Nepal from16 Oct 2017 to 12 Feb 2018 for 120 days after adjustment period of seven days. Twenty-four piglets after weaning were allocated into four treatments with 6 replications by using Completely Randomized Design. Four types of experimental diets were composed for piglets. T1: concentrate feed without bakery waste, T2; concentrate feed where 25 % maize was replaced by bakery waste, T3; concentrate feed where 50% maize was replaced by bakery waste and T4; concentrate feed where 75% maize was replaced by bakery waste. Adlib concentrate mixture was given on group basis and was provide twice a day (morning and evening) to the experimental animals. Total feed offered to the experimental piglets was recorded daily in group basis and refusal next morning. The body weight gain of individual piglet was measured in 15 days interval in the morning before feeding. Experiment revealed that at the beginning of experiment, average feed intake was similar for all experimental groups (225 g/piglet/day) but at the end of the experiment feed intake was observed highest in T_3 (1718.98g/ piglet/day) where maize was replaced with bakery waste at the rate of 50 percent. The FCR was noted highest for T4 (1:3.17 kg) followed by T3 and T2 (1:3.19 and 1:3.22 kg, respectively). Both average feed intake and FCR was not significant among diet groups. Similarly, in case of weight gain, the highest body weight gain of experimental piglets was observed for T4 (48.6 kg) whereas body weight gain of T2 and T3 was similar (46 kg). The total weight gain for T2, T3 and T4 was almost similar (37 kg). Both body weight gain and total weight gain was not statistically significant among diet groups. Experiment revealed that maize can be replaced by bakery waste up to 75% without any adverse effect on body weight gain.

Keywords: Pig Bakery waste, feed intake, weight gain, Nepal

INTRODUCTION

Nepal is an agricultural country where more than 60% of people depend upon agriculture. Total contribution of agricultural sector in GDP of Nepal is 32.35%. Among them contribution of livestock sector in total GDP is 30% (MoAC,

2009). The pig population of Nepal is estimated to be 1.33 million with a production of pork 24535 MT per annum. Out of 1.33 million, indigenous pigs constitute 58% of the total pig population while the remaining 42% are exotic or improved breeds (Krishi Diary, 2018).

Pig is one of the oldest domesticated animals. People of certain ethnic groups such as Rai, Limbu, Magar, Tamang etc. prefer to keep pigs for festivals and ceremonial purposes. Initially production and consumption of pig is confined with some ethnic groups. But now-a-days due to urbanization and commercialization, production and consumption of pork is increasing. It is also getting popular due to its short crop cycle, high benefit and easy feeding habit and is based on agricultural by-products and kitchen wastes.

A pig enterprise contributes in many ways to improve the livelihood of poor and vulnerable small-scale farmers. Pork and other pig products provide high value animal protein; the meat is easy to dress and has superior curing and storage qualities. Additional income is earned from the sale of piglets and importantly from their products. The low startup costs and small investment required for building and equipment are recovered fairly quickly as slaughter can take place at about six to eight months from birth, pending on breed and feed availability. Pig production a form of livestock keeping that does not necessarily require access to agricultural land and has therefore gained importance in the growing sector of peri-urban and urban small-scale livestock keeping (Dietze, 2011).

Maize is a primary source of energy and about 70-80 percent of maize production is used as a feed ingredient in the world. Feeding constitutes the greatest cost (about 70%) in raising pigs and affects the pig's performance and sustainability of the sector. More than 60% deficiency in concentrate feed sources is a threat to the pig industry, which compete directly with human for grains (NRC, 2011). Feed manufacturers and livestock producers are facing problems as prices of grains and oil cakes are increasing day by day. Therefore, researchers always search for alternate feed resources to replace the conventional ingredients used for the animal production.

To bridge the gap between the requirement and availability of feeds, there is a need to use more and more of non-conventional feeds. The scarcity and prohibitive cost of conventional feed sources aggravated by stiff competition between human and livestock for these feeds as well as insufficient emphasis on production have resulted in the evaluation of alternative and cheap agro-industrial products as source of feed. Bakery waste is a kind of by product which can be used as a high energy feed for animal feeding. These wastes may be fed to other livestock species, but has most often been used as a source of feed for swine (Westrendrof *et el*., 1999). Dried bakery product is a mixture of bread, cookies, cake, crackers, and dough. It is similar to corn in protein and amino acid content (10.8% crude protein, 0.27% lysine, and 0.10% tryptophan) but higher in fat (11%). Similarly, bakery meal is rich in starch because wheat flour is the main ingredient in all bakery products. Because this starch is already thermally processed (cooked), it is highly digestible, and thus, of high nutritive value. As

such, bakery meal is ideal for the diets of young pigs and starter broilers. In general, bakery meal contains about 2981 kcal/kg net energy which compares very favorably with maize at 2672 Kcal/kg net energy (Mavromichalis, 2013).

Dried bakery product may replace up to one-half of the corn in corn soybean meal growing-finishing and sow diets and up to 20% in starter diets (Thaler and Palmer, 2010). Large numbers of bakery factories are operated in the urban and peri-urban areas, and they produce a sizable amount of bakery waste during processing and marketing of the bakery. Waste bakery has no other definite use; it can be economically used in the pig ration, as pig can accept a wide range of feed items. Results from different feeding trials with different classes of animals, i.e., cattle, sheep, goats, pigs, rabbit and chickens indicated that bakery waste is a satisfactory feed ingredient for animals (Paola *et al*, 2008).

There is a paucity of information regarding the use of bakery waste in the diet of pigs. Keeping in view of the above facts, the study was designed to investigate the effect of different levels of bakery waste feeding on feed intake, utilization and growth performance of pigs.

MATERIALS AND METHODS

Experimental site animals

The experiment was conducted on weaned piglets at Piggery Research Unit of Regional Agricultural Research Station, Tarahara, Sunsari from16 Oct 2017 to 12 Feb 2018 for 120 days after adjustment period of seven days. Twenty-four piglets after weaning were allocated into four treatments with 6 replications by using Completely Randomized Design. All experimental animals were drenched with Fenbendazole at the rate of 5 mg/kg body weight against internal parasites at the beginning of the experiment.

Diet composition

The feeds were formulated containing 16% crude protein and metabolisable energy at the level of 2700 Kcal/kg to meet the requirements. All diets were balanced for Lysine, Tryptophan, Calcium and Phosphorous as per the requirements.

Table 1. Diet composition for piglet, kg

S/N	Ingredients	T1	T2	T3	T4
1	Maize	40	30	20	10
2	Bakery waste	0	10	20	30
3	Soybean meal	22.3	22.3	22.3	22.3
4	Rice bran	35	35	35	35
5	Oil	0.5	0.5	0.5	0.5
6	Mineral	0.5	0.5	0.5	0.5
7	Salt	0.5	0.5	0.5	0.5
8	Lysine	0.1	0.1	0.1	0.1
9	Methionine	0.1	0.1	0.1	0.1
10	DCP	1	1	1	1
	Total	100	100	100	100

Nutrient content					
1	Crude protein	16	16	16	16
2	ME Kcal	2700	2700	2700	2700
3	Tryptophan	0.23	0.23	0.23	0.23
4	Lysine	2.21	2.21	2.21	2.21
5	Calcium	0.41	0.41	0.41	0.41
6	Phosphorous	0.79	0.79	0.79	0.79

Experimental diet

Four experimental diets were composed for experimental animal which is presented in Table 2.

Table 2. Experimental diets

Treatment	**Diet**
1	Concentrate feed without bakery waste
2	Concentrate feed where 25 % maize was replaced by bakery waste
3	Concentrate feed where 50% maize was replaced by bakery waste
4	Concentrate feed where 75% maize was replaced by bakery waste

Feeding regime

Adlib concentrate mixture was given on group basis and was provide twice a day (morning and evening) to the experimental animals. The experiment animals had free access to clean drinking water.

Chemical analysis

The samples of feed ingredients were sent to the Animal Nutrition Division, Khumaltar, Lalitpur for proximate analysis. Representative samples from offered concentrate mixture were analyzed for Dry Matter (DM), Crude Protein (CP), Tryptophan, Lysine, Calcium, Phosphorous and energy. The DM was determined by oven drying at 100°C for 24 hrs. Crude protein of the samples was determined using the Kjeldahl method. Similarly, samples of maize, soybean meal and rice bran were sent to Food Research Division, Khumaltar, Lalitpur for Tryptophan and Lysine content analysis. Tryptophan and Lysine was analyzed at the laboratory of Food Research Division, NARC, Khumaltar, Lalitpur as suggested by Hornandez H and L.S. Bates (1969) for Tryptophan and as suggested by Doll H. and B. Koie (1975) for Lysine. Phosphorous and calcium were determined by spectrophotometer and titration methods, respectively.

Data measurement

Total feed offered to the experimental piglets was recorded daily in group basis and refusal next morning. The body weight gain (BWG) of individual piglet was measured in 15-day interval in the morning before feeding.

Data analysis

Data of feed intake and body weight gain (BWG) were analyzed by "One-way Annova" test for every measurement using statistical package SPSS, version 16

RESULTS AND DISCUSSIONS

Chemical composition of feed ingredients

Chemical composition of feed ingredients is presented in Table 3.

Feed intake

Mean daily feed intake of experimental animals was recorded 226.15 g /animal/day in first 15th days which reached 1702.24 g/animal/day at the end of the experimentation (120 days) which was statistically similar ($p>0.05$) among diet groups. At the 15th days of experiment, feed intake of T1, T2 and T3 was noted almost similar (225 g/animal/day) but in T4 it was found slightly more (227.61 g/animal/day). In 30, 45 and 75 days, highest feed intake was observed in T1 (331.1g/animal /day, 690.37g/animal/day and 1157.46 g/animal/day, respectively) and lowest was found in T2 (322.64 g/animal/day, 688.55 g/animal/day and 1150.8 g/animal/day, respectively). However, in 60 days, the highest feed intake was seen in T4 (984.83 g/animal/day) and lowest in T1 (968.52 g/animal/day). Unlike to others, in 90, 105 and 120 days, the highest feed intake was recorded in T3 (1359.33 g/animal/day, 1530.07g/animal/day and 1718.98 g/animal/day, respectively) and the lowest in T4 (1328.54 g/animal/day, 1516 g/animal/day and 1682.47 g/animal/day, respectively). The FCR was recorded higher for T4 (1:3.17kg) followed by T3 and T2 (1:3.19 kg and 3.22 kg, respectively)

Table 3. Nutrient content of feed ingredients in dry matter basis

S/N	Ingredients	DM	CP	ME Kcal	Tryptophan	Lysine	Ca	P
1	Maize	89	9	3300	0.1	0.18	0.289	0.28
2	Soybean meal	89	45	2300	0.65	2.7	0.29	0.65
3	Rice bran	90	12	3300	0.22	5	0.08	1.3
4	Oil	NA	NA	7700	NA	NA	NA	NA
5	Lysine	NA	NA	NA	NA	0.1	NA	NA
6	Tryptophan	NA	NA	NA	0.1	NA	NA	NA
7	DCP	99	NA	NA	NA	NA	0.23	0.18
8	Bakery waste	91.19	17.23	2842.4	NA	NA	NA	NA

Growth performance

Average initial body weight of the experimental animals was 9.4 kg and reached 46.53 kg at the end of experiment. The data revealed that fortnight body weight gain of experimental animals in all experimental period was found non-significant ($p>0.05$). During 15 days of experiment, highest body weight gain was found in T4 (12.6 kg) followed by T3 (11.5 kg), T2 (11.1 kg). Similarly, weight gain was found highest in T4 (15.7, 19.5, 25.8, 32.5, 38.25, 44.4 and 48.6 kg) in all experimental periods (30, 45, 60, 75, 90, 105 and 120 days, respectively) and lowest body weight gain was found in T1 (22.4, 29 and 45.9 kg) in 60, 75 and 120 days, respectively. However, least body weight gain was found in T2 in 30 days (14.1 kg), 90 days (34.2 kg) and 105 days (40.4 kg).

Total body weight gain of T3 and T4 group was similar (37.4 kg) followed by T2 (37 kg) and T1 (36.7 kg). Subsequently, average daily gain of T3 and T4 was similar (311.66 g/day) followed by T2 (308.33 g/day) and T1 (305.83 g/day). This experiment suggested that expensive maize could be replaced with bakery waste from 50 – 70 % without adverse effect on body weight gain and feed intake of piglets.

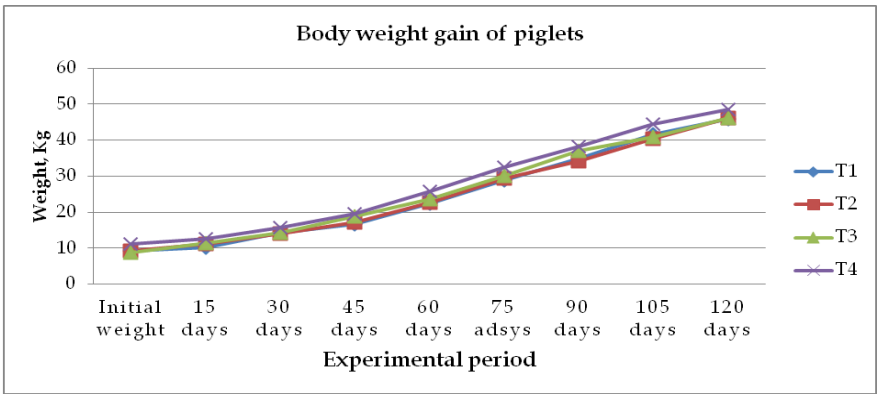

Figure 1. Body weight gain of piglets

Table 4. Feed intake of experimental animals, g (Mean±SD)

TRT	15 days	30 days	45 days	60 days	75 days	90 days	105 days	120 days	FCR
1	225.81 ±1.36	331.1±3 .26	690.37 ±4.5	968.52 ±5.33	1157.4 6±7.12	1330.4 1±8.12	1516.01± 8.34	1708.8 3±9.76	3.24
2	225.75 ±4.26	322.64± 3.8	688.55 ±4.85	984.08 ±5.02	1150.8 ±6.89	1349.2 2±8.34	1525.74± 7.04	1698.7 1±9.41	3.22
3	225.44 ±3.72	327.62± 2.48	690.2± 5.62	977.7± 4.39	1157.4 2±7.55	1359.3 3±6.23	1530.07± 8.61	1718.9 8±9.82	3.19
4	227.61 ±2.86	326.13± 2.01	690.11 ±5.56	984.83 ±6.47	1150.8 3±5.12	1328.5 4±7.75	1516±7.3	1682.4 7±8.99	3.17
Mean	226.15 ±2.28	326.88± 3.94	689.8± 5.34	978.8± 5.19	1154.1 5±6.34	1341.9 5±7.67	1521.96± 7.25	1702.2 4±9.56	3.20
P value	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05

DISCUSSIONS

In Nepal, evaluation of bakery waste on feed intake, FCR and growth performance of pig is not studied so far. Therefore, this experiment was carried out to explore the possible levels of replacement of maize with bakery waste in pig diets. Experiment revealed that at the beginning of experiment, average feed intake was similar for all experimental groups (225 g/day) but at the end of the experiment feed intake was observed highest in T3 (1718.98g/day) where maize was replaced with bakery waste at the rate of 50 percent. The FCR was noted highest for T4 (1:3.17 kg) followed by T3 and T2 (1:3.19 and 1:3.22 kg, respectively). Both average feed intake and FCR was not significant among diet groups.

Table 5. Body weight gain of experimental piglets, kg (Mean±SD)

TRT	Initial weight	15 days	30 days	45 days	60 days	75 days	90 days	105 days	120 days	TWG	ADG
1	9.2±1.69	10.3±1.9	14.3±2.3	16.6±3.44	22.4±4.0	29±4.91	34.8±5.3	41.7±7.08	45.9±7.58	36.7	305.83
2	9.2±1.16	11.1±1.61	14.1±1.95	17.2±2.75	22.6±4.1	29.3±4.41	34.2±5.3	40.4±6.7	46.2±7.12	37	308.33
3	8.7±1.14	11.5±0.75	14.3±0.8	18.7±1.54	23.7±1.3	30.2±1.29	37.1±2.6	40.9±2.83	46.1±3.25	37.4	311.66
4	11.2±2.1	12.6±2.56	15.7±2.7	19.5±3.28	25.8±3.9	32.5±3.75	38.2±4.7	44.4±6.43	48.6±6.51	37.4	311.66
Mean	9.4±3.36	11.26±3.7	14.5±4.2	17.94±6.04	23.4±7.4	30.07±8.26	35.9±10	41.67±12.6	46.53±13.3	37.13	309.41
P value	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05

Similarly, in case of weight gain, the highest body weight gain (BWG) of experimental piglets was observed for T4 (48.6 kg) whereas BWG of T2 and T3 was similar (46 kg). The total weight gain for T2, T3 and T4 was almost similar (37 kg). Both BWG and total weight gain (TWG) was not statistically significant among diet groups. Experiment revealed that maize can be replaced by bakery waste up to 75% without any adverse effect on body weight gain.

Both pig and poultry are non-ruminant animals. Therefore, results of different levels of maize replaced by bakery waste on feed intake, FCR and growth performance of pig and poultry are cited in the discussion parts. Barman *et al.* (2016) conducted an experiment on crossbred piglets by replacing maize with bakery waste at the rate of 0%, 25% and 50% in the diet and they concluded that maize can be replace up to 50% with bakery waste for formulation of economic ration without affecting the growth, FCR and feed cost per kg gain in crossbred piglets.

Manu (2013) conducted an experiment to evaluate discarded biscuits (DB) as an alternative to maize in pig diets. A total of twenty large white starter pigs aged 9-10 weeks with an average initial weight of 16.6 kg were allotted to five groups with four replicates in a Complete Randomized Block Design. They were fed ad-libitum with isonitrogenous diets containing 0%, 10%, 20% and 30% levels of DB replacing similar amounts of maize and representing treatments T1, T2, T3 and T4, respectively. In his experiment, he noted that there were no significant differences in average daily feed intake, average total feed intake, average daily weight gain, average total weight gain and feed conversion efficiency (FCE) values for the four dietary treatments. There was a linear decrease in feed cost as the level of DB increased in the diet, and the cost of gain followed a similar trend. He concluded that DB could constitute as much as 30%

of the diet and replace about 60 percent of the maize in the diet of growing pig without any adverse effect on growth performance and carcass characteristics thereby reducing the competition for maize between humans and livestock.

Kumar *et al* (2014) carried out a trial in order to investigate the effect of bread waste feeding on feed intake, utilization and growth performance of crossbred pigs and to evaluate the economics of bread waste feeding. The study was conducted for a period of 3 months using large white Yorkshire crosses (LWY X Desi) were included in the study. A total of 24 weaned crossbred growing pigs were randomly assigned to four different groups, with six animals in each group. Results indicated that waste can economically supplement up to 50 percent to the diet of crossbred growing pigs.

Olafadehan *et al* (2010) conducted an experiment on laying hens by replacing maize with dried bakery waste at the rate of 0%, 10%, 20% and 30% in the diet and they concluded that could be included at 30% in layers diet which is equivalent to 75% replacement of maize without compromising performance but rather improving it and benefits accruable to farmers. Moreover, they suggested that study on 100% replacement of maize with dried bakery waste; nutrient retention and even amino acid profile of dried bakery waste which could have possibly enhanced performance of the birds should be investigated.

Olafadehan *et al* (2010) conducted another trial to investigate the response of laying hens fed graded levels of dried bakery waste (DBW) as partial replacement of maize in an 8-week experiment using completely randomized design. Sixty-four, 35 weeks old Isa brown layers were divided into four treatment groups of two replicates each consisting of 8 birds per replicate and assigned to four diets were formulated to containing 0% (control), 10, 20 and 30% levels of DBW. Feed intake, body weight gain, protein intake and egg weight did not differ significantly among the dietary treatments. Hen day production was higher ($p<0.05$) in 20 and 30% DBW diets than in 10% DBW and control. Efficiency of conversion feed to eggs was superior ($p<0.05$) in DBW diets as compared with control; even among the DBW diets, it was better in 20 and 30% DBW than 10% DBW. Cost of feed consumed/day and feed cost/dozen egg were lower ($p<0.05$) in DBW diets than the control and least in 30% DBW diet, though 20% DBW diet has an intermediate position between 10 and 30% DBW diets. Savings on feed cost and feed cost/dozen egg were significantly higher with 30% DBW followed by 20 and 10% DBW diets, respectively. Birds fed 30% DBW diets exhibited best performance and the diet was most cost effective.

Shafey *et al*. (2011) studied the effects of replacing corn with extruded bakery waste (BW) in the diet of laying hens on the performance (feed intake, egg production, egg weight, egg mass and feed efficiency) and egg components (albumin, yolk, and eggshell) and characteristics of egg shell (thickness and strength) and albumin (height and Haugh unit) and yolk (height and color) and feed costs of egg production. Six isocaloric and isonitrogenous diets were formulated using 0%, 20%, 40%, 60%, 80% and 100% of BW. The replacement

of corn for up to 100% with BW reduced feed costs with no impairment on the performance, egg component and characteristics of eggshell as well as albumin and yolk height. The feed conversion ratio did not differ significantly among different treatment groups. The replacing with BW reduced yolk color (YC). It is concluded that BW can completely replace corn in laying hen diets without affecting the performances, egg components, egg characteristics of albumen and eggshell and yolk height. Yolk pigment should be added to the diet to improve YC when ≥40% of corn replaced with BW.

Torki and Kimiaee (2011) compared the effects of dietary replacement of maize with bakery by-product (BB) with or without enzyme supplementation on the performance of laying hens and egg quality characteristics. One hundred eighty Hyaline Leghorns were distributed between 30 cages with almost same egg production (EP) level among the cages fed six isocaloric and isonitrogenous diets (ME=2900 kcal/kg and crude protein=15.20 g/100 d diet) with five replicates with six bird each. The experiment was conducted as a 3×2 factorial arrangement of treatments including three replacement levels 0, 50, and 100% of corn with dried bakery by-product replacement and enzyme supplementation (0 and 0.06 g/100 g diet of Hemicellulase®, a commercial β-mannanase –based enzyme product). Replacing dietary corn with BB had no significant effect on egg production (%), except in week 2. Egg production in group of 100% corn replacement in week 2 was lower than the other dietary groups. However, the overall EP for weeks 1-4 was not significantly affected by replacing dietary corn with BB. In addition, FCR was not significantly affected by dietary treatment. Egg weight was affected by dietary corn replacement in weeks 1 and 2; however, no significant difference was found in weeks 3 and 4. Egg quality characteristics were not affected by dietary treatment. Enzyme supplementation had no significant effect on performance of hens and egg quality traits.

Saleh *et al* (1996) conducted a study to evaluate the use of high levels of dried bakery products in diets of broiler chickens and incorporated at levels up to 25% of diets fed to broiler chicken. There were no significant differences in body weight, feed utilization, mortality, feed consumption, or calorie: gain ratio among chicks fed the different dietary treatments.

Al-Tulaihan *et al* (2004) conducted experiment on 250 broiler chicks to evaluate the use of dried bakery waste in the diets of broilers. Diets were formulated to contain 0, 5, 10, 20 and 30 % dried bakery waste were fed to the broiler chicks. These diets were isocaloric isonitrogenous containing 3200 kcal/kg ME with 22% crude protein in the starter diet and 20% protein and 3200 kcal/kg ME in the finisher diet. There was no significant difference in weekly feed consumption among treatment groups. However, cumulative feed consumption showed significant decrease in dried bakery waste fed group. The results provided evidence that inclusion of up to 30% dried bakery waste in the broiler diets had no harm effect on the performance of the birds.

Al-Ruqaie *et al*. (2011) carried out an experiment to evaluate the effects of replacing corn with extruded bakery waste (BW) in corn-soybean diet during the

starter and finisher periods (day to 21 and 22-35 days of age, respectively) on the performance (weight gain, feed intake and feed conversion ratio), nutrient utilization (apparent nitrogen retention and nitrogen corrected apparent Metabolizable Energy (ME), carcass characteristics and cost of feed of broiler chickens. Six isocaloric and isonitrogenous diets were formulated using 0%, 20%, 40%, 60%, 80% and 100 %, respectively. The level of corn in the basal (0 % BW) starter and finisher diets were 53.7 and 62.78 %, respectively. The replacement of dietary corn for up to 100% with BW reduced costs of total feed and feed for the production of a kg live weight with no impairment on the performance, nutrient utilization and carcass characteristics of broiler chickens.

Adeyemo *et al* (2013) conducted a trial for 8 weeks to investigate the effect of dietary biscuit waste (BW) replacing maize (M) on performance and carcass characteristic of broilers. A total of 175-day old marshal broiler chicks was randomly divided into five treatments comprising five replicates of seven birds per replicate. Five experimental diets were formulated as follows; T1: (100% M: 0% BW), T2: (75% M: 25% BW), T3: (50% M: 50% BW), T4: (25% M: 75% BW), T5: (0% M: 100% BW) at both starter and finisher phases. The feed intake (FI) was affected with increasing level of biscuit waste. There were significant differences across the treatments with treatment T1 having the highest value of 2.92 kg for FI and T5 having the least value of 2.51kg while T2, T3 and T4 followed the same trend having the following values of 2.73kg, 2.70kg and 2.61kg, respectively. Average weight gain showed that there were no significant differences across the treatments, the values obtained were 1.13 kg, 1.09 kg, 1.10 kg, 1.12 kg and 1.1 kg for treatments T1, T2, T3, T4 and T5, respectively. Feed conversion ratio showed significant differences ($p<0.05$) as birds in treatments T3, T4 and T5 recorded lower values of 2.47%, 2.37% and 2.33%, respectively while birds on treatment T1 had highest value of 2.60%. The carcass weights expressed as percentages of live weights (LW) did not show any significant differences. The result for breast weights showed significant differences ($p<0.05$) as birds on treatments four (25% M: 75% (BW) and five (0%M: 100% BW) had lower values of 10.05% (LW) and 11.20% (LW), respectively. Surprisingly, birds on T2 (75% M: 25% BW) had the highest breast meat value of 16.75%. The percentage organ weights showed no significant differences between liver, heart and spleen but the gizzard weights were significantly different among the treatments with the control having the highest value of 2.88% (LW). Results indicated that biscuit waste could be used as feed for broilers up to 50% replacement levels for maize at the starter and finisher phases without compromising performance and carcass value of broilers.

Oke and Samson (2013) conducted experiment to determine the effects of partial replacement of maize with bread waste meal on broiler chickens. One hundred and twenty day old Marshall broiler chicks were used in 56 day feeding trial consisting starter phase (0-4 weeks) and finisher phase (5-8 weeks) using completely randomized design to assessed the effect of 0 %, 10 %, 20 % and 30 % inclusion levels of bread waste meal on the performance characteristics, carcass characteristics, sensory evaluation, cost benefit analysis and carcass

characteristics of broilers chickens. Final live weight gain (g/bird) was 1980.6, 1890.4, 1835.2 and 1730.2 in 0%, 10%, 20% and 30 % bread waste meal group, respectively. There was significant effect on body weight gain in the treatment group compared to control. The total feed consumed ranged from 5405.12 g/bird to 5801.60 g/bird, feed conversion ratio ranged from 2.9 to 3.20 and protein efficiency ratio ranged from 1.57 to 1.74. There was significant difference in total feed consumption. The results of cost benefit analysis showed that the feed cost, feed cost/live weight gain were significantly different ($p<0.05$) as well. There were no significant differences observed in dressing percentage, liver, gizzard and heart weight between the different treatment groups. The sensory evaluation results showed that color, juiciness, flavor, texture and overall acceptability were not significantly different. Results indicated that bread waste meal at 0% inclusion supported improved performance while 30% inclusion level reduced cost of production

Ayarinde *et al (*2014) conducted experiment to determine the effect of bread waste on performance and carcass characteristics of broilers at starter and finisher phases. A total of 240 broiler chicks were purchased and allotted randomly into four dietary treatments: T0, T1, T2 and T3 at an inclusion level of bread waste were 0%, 33%, 67% and 100%, respectively with three replicates of twenty birds per replicate. A total of 120 broilers were slaughtered at the end of the 8th week of the experiment and analyzed for carcass parameters. The results obtained at the starter phase of the experiment shows that T2 having (67%) level of inclusion did not show any significant difference on weight gain. However, at the finisher phase, significant difference ($p<0.05$) were obtained on the FCR across dietary treatment with T2 having the lowest mean value (2.08) compared to T1 that recorded highest mean value (2.56). Feed conversion ratio was significant ($p<0.05$) throughout the finisher phase with T1 having highest FCR compared to T_3 that recorded the least value (2.33). The FCR was found to be better in T2 group at starter phase and in T3 at finisher phase. There was significant difference observed in various treatment groups with 67% bread waste showed least feed intake at the starter phase but no significant differences were observed in finisher phase. The bread waste could be used as a replacement for maize in the diets of broilers either partially or completely in order to reduce feed cost and subsequently the cost of production.

Yadav *et al* (2014) conducted a study to compare the efficacy of different level of bakery waste in the broiler ration. The experiment was carried out for 42 days (6 weeks) on 180 broiler chicks. Up to 3 weeks of age there was no significant difference in body weight gain of different treatment groups. However, from 4^{th} to 6^{th} week the gain in body weight in the group maintained on diet, in which 60% maize was replaced by bakery waste was significantly lower as compared to basal diet 20% replacement and 40% replacement. The gain in these three groups was comparable. The results for weekly and cumulative weekly feed consumption showed highly significant differences between treatment groups. The significantly higher consumptions were observed in T4 and T3 treatments groups. During 1^{st}, 3^{rd} and 4^{th} week the FCR in T1, T2 T3 was significantly better than T4 group. From 4^{th} to 6^{th} week of age, FCR of basal diet was

significantly better than the other groups. The FCR for birds feed with 20% and 40% replaced diet was significantly better than the birds feed on 60% replaced diet. The replacement of maize with bakery waste has resulted to lower margin of profit markedly in T4 group. However, in T2 and T3 these was no significant difference therefore it can be concluded that 20% to 40% maize can be replaced without any adverse effect on economy however the percentage of replacement may be decided looking to the cost of maize and its availability.

CONCLUSION

Bakery waste has no other definite use and it is cheaper than maize (maize NRs 40/kg and bakery waste NRs 17/kg). Our experiment revealed that maize can be replaced by bakery waste up to 75% without any adverse effect on feed intake, FCR and body weight gain. Similarly, inclusion of bakery waste in pig diet where it is abundantly available reduces the cost of pork production and contributes in enhancing the livelihood of pig raisers. However, further research should be conducted for cost benefit analysis of pig raising replacing maize with different levels of bakery waste in pig diets.

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Replacement of concentrate mixture with different levels of water hyacinth (*Eichhornia crassipes*) in basal diet on feed intake and production performance of piglets

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ABSTRACT

An experiment was conducted on weaned piglets at Piggery Research Unit of Regional Agricultural Research Station (RARS), Tarahara, Sunsari from 12 Sep to 4 Dec 2019 for 84 days after adjustment period of seven days. Twenty piglets after weaning of 4-6 months age were allocated into four treatments each with 5 replications by using Completely Randomized Design. Four types of experimental diets were composed for experimental piglets. Piglets of T1 (control) group were provided adlib concentrate mixture, 95% concentrate feed + 5% water hyacinth (WH) were given to T2 group, 90% concentrate feed + 10 WH were offered to T3 group, and piglets of T4 group were fed 85% concentrate feed + 15% WH as per their daily requirement. Feed and water hyacinth intake were recorded daily and body weight gain was measured once a week. Experiment revealed that feed and WH intake was highly significant ($p<0.001$) among treatment groups. Highest total body weight gain was obtained in control group (T1) (37.66 kg) followed by T3 (34.91 kg) and T2 (34.25 kg) which was non-significant among diet groups. Similarly, highest average daily gain was observed higher for T1 (control) group (448 g /day) followed by T3 and T2 group (415.59 and 407.73 g/day, respectively). Feed Conversion Ratio (FCR) was observed almost similar in all treatment groups (1:2 kg). Experiment suggested that concentrate mixture can be safely replaced with WH up to 10% without any adverse effect on body weight gain.

Key words: Water hyacinth feeding, pig, weight gain, Nepal

INTRODUCTION

A pig enterprise contributes in many ways to improve the livelihood of poor and vulnerable small-scale farmers. Pork and other pig products provide for high value animal protein, the meat is easy to dress and has superior curing and storage qualities. Additional income is earned from the sale of animals and importantly from their products. This additional income can be used to invest in

farm assets, pay for school fees and medical treatments. Pigs provide income for women, strengthening their role in families as well as in local communities. The sick and disabled can participate in pig raising as it does not require excessive labor and is not too complex in its management. The low start-up costs and small investments required for buildings and equipment are recovered fairly quickly as slaughter can take place at about six to eight months from farrowing (birth), pending on breed and feed availability. Pigs additionally can be considered as a store of wealth and a safety net in times of crisis. The pig, depending on feed and other management aspects, commonly grows rapidly to slaughter age and has a high reproductive rate compared to ruminants, making it a low risk investment with quick returns. Additionally, pig husbandry can be easily integrated with a series of other farming activities within the agricultural and aquaculture sectors. Pig production is a form of livestock keeping that does not necessarily require access to agricultural land and has therefore gained importance in the growing sector of peri-urban and urban small-scale livestock keeping (Dietze, 2011)

Pig farming has been accepted socially and culturally by certain ethnic groups in Nepal. Pig farming trend is changing gradually due to urbanization some commercial and modern pig farming recently started in Nepal. The indigenous pig breeds of Nepal are Chwanche, Hurrah, Bampudke, Pakhribas black and Dharane Kalo Bangur etc. Exotic breeds of pigs such as Hampshire, Duroc and Yorkshire etc. are imported in Nepal since 1957 AD. The pig population of Nepal is estimated to be 1.43 million, and the production of pork is 28214 MT per annum (Krishi Diary, 2019).

Pork consumption has grown tremendously over the years across the Nepal, but production has not responded sufficiently to meet demand. One of the main reasons for rising pork demand is removal of cultural barriers that prevented people from consuming the meat. Most of the people who are growing pigs are overseas migrant workers who have returned home for good. Consumption of pork is going up in the country, as protein intake is continuously increasing due to rise in income level. Today, people of almost every ethnic background consume pork, which is pushing up demand for this meat product (Thapa, 2017).

In swine production, feed alone represent 70-75% of total cost of production. In intensive pig production, pig directly compete with human being for feeding, since conventional fattening is based on the feeding of cereals like maize, wheat, oats, barley etc. along with other protein, mineral and vitamin supplements. Farmers are unable to support costly feeding program because of high cost of cereals and oil cakes. Novel feed ingredients are not traditionally been used for swine feeding. However, these can be used as supplemental ingredients to the basal ration in order to reduce the feed cost. To get profit from swine farming, one has to plan carefully to get maximum feed efficiency from a particular diet. One can easily reduce the feed cost using many locally available novel feed resources. The novel feeds can be used as supplemental ingredients which are

available in large quantities at cheaper rate. Many novel feeds contain anti-nutritional factors which reduce the productivity of animals by hampering the digestibility of nutrients (Ngullie, 2019).

WH has perhaps been a subject of more indecisive study than any other aquatic plant in recent years. Several scientists (Rogers and Davis, 1972; Cornwell *et al*, 1977; Soerjani, 1984) reported that WH has been utilized as livestock feed, bio-fertilizer, sewage purifier and biogas production, paper and fiber (Bagnall *et al*, 1974), and dried hyacinth can be used as animal feed for cows, pigs, goats, etc. (CWSCB, 1982). WH is one such new feed resource for pig which foliage and stem is commonly used as a supplementary feeding for pigs (Le *et al*., 2006 and Jafari, 2010). A maximum inclusion rate of 6–7% (on DM basis) was considered economically viable because of presence of anti-nutritional factors in it (Mako *et al*., 2011).

WH is an invasive aquatic plant in most countries all over the world. It has been recognized for its high nutritional value (Poddar *et al*, 1991). According to an analysis by Abobarkr *et al* (1984), all of the essential amino acids were present at high levels in the leaf protein isolates of water hyacinth. One of the advantages of using WH in pig diets is its lysine content (Abobarkr *et al*, 1984), the first limiting amino acids for pig. WH have a water content of over 90 per cent. The crude protein contains between 10 and 26 percent, but the leaves contain higher levels (about 38 per cent). The mineral content depends directly on the water where the hyacinth grows, but the mean value ranges from 17 to 26 percent. The fibre level averages about 20 percent has made WH interesting for use as fodder to cattle, goats, pigs, ducks and tilapia fingerlings (Tham, 2015; Lareo and Bressani, 1981).

However, published data are limited on its possibility to use for pig diet. Therefore, this experiment was carried out in order to assess the possibilities of replacing concentrate mixture with different levels of WH to a basal diet on growth performance and feed intake of piglets.

MATERIALS AND METHODS

Experimental site and animal selection

An experiment was conducted on weaned piglets at Piggery Research Unit of Regional Agricultural Research Station, Tarahara, Sunsari from 12 Sep to 4 Dec 2019 for 84 days after adjustment period of seven days. Twenty piglets after weaning of 4-6 months age were allocated into four treatments each with 5 replications by using Completely Randomized Design. Experimental piglets were kept in cemented floor in group according to treatment. All experimental animals were drenched with Fenbendazole at the rate of 5 mg/kg body weight against internal parasites at the beginning of the experiment.

Diet composition

Compound feed containing 16% crude protein and metabolizable energy at the level of 2700 Kcal/kg were procured from Sagar Feed Industry, Itahari, Sunsari and water hyacinth was collected in the premises of Piggery Research Unit of RARS, Tarahara and National Buffalo Research Program, Tarahara, Sunsari. The WH plants were harvested lush green using local canoe. The plants were washed clean with the water and packed in plastic bags before taking them ashore. The root and petioles were immediately removed and discarded. After washing, leaves and stem were immediately chopped to an average size of about to 2 cm in length, dried in the shed until crispy while still retaining the greenish coloration and dry matter was achieved 25-30%. The dried WH was thereafter incorporated into basal diet at different levels of inclusion to replace the concentrate mixture weight. All diets were balanced for calcium and phosphorous as per the requirements.

Experimental diets

Four experimental diets as of treatments were thus prepared to feed the experimental animals (Table 1).

Table 1. Experimental diets

Treatments	Diets
1	Adlib Concentrate feed without WH
2	95% concentrate mixture + 5% WH
3	90% concentrate mixture + 10% WH
4	85% concentrate mixture + 15% WH

Feeding regime

Required amount of concentrate mixture and WH was mixed and provided twice a day (morning and evening) in group basis to the experimental animals. The experiment animals had free access to clean drinking water.

Chemical analysis

The samples of concentrate mixture and WH were sent to the Animal Nutrition Division, NARC, Khumaltar, Lalitpur for proximate analysis. Representative samples were analyzed for Dry Matter (DM), Crude Protein (CP), Crude Fibre (CF), Ether Extract (EE) and Ash contents (TA). The DM was determined by oven drying at 100°C for 24 hrs. Crude protein of the samples was determined by using the Kjeldahl method. Ether extract was determined by using Soxhlet apparatus. Total ash content was determined by ashing at 550^0C in muffle furnace for 16 hrs. (AOAC, 1980). Ether extract of the samples was determined using the Van Soest methods (Goering HK and Van Soest, 1970).

Observation recording

Total feed offered to the experimental piglets was recorded daily in group basis and refusal in the next morning. The body weight gain of individual piglet was measured at seven days interval in the morning before feeding.

Data analysis

Data of feed intake and body weight gain were analyzed by One-way Annova test for every measurement using statistical package SPSS, version 16.

RESULTS AND DISCUSSION

Chemical composition of feed ingredients

Chemical composition of feed ingredients is presented in Table 2.

Table 2: Nutrient of feed ingredients in dry matter basis

SN	Ingredients	DM	OM	TA	CP	CF	NDF	ADF	ADL	HC	Cellulose
1	Water hyacinth	18.61	96.69	3.31	13.51	NA	59	28.45	5.35	30.55	23.09
2	Concentrate mixture	89.31	93.48	6.52	24.81	8.32	NA	NA	NA	NA	NA

Note: DM - dry matter, OM - organic matter, TA - total ash, CP - crude protein, CF- crude fibre, NDF- neutral detergent fibre, ADF - acid detergent fibre, ADL- acid detergent lignin, HC - hemicellulose

Feed intake

The feed intake of the experimental animals has been presented in Table 4.

Table 3. Feed intake of experimental piglets, g (Mean±SD)

Parameters	Treatments			
	T_1 (Control)	T_2 (5% WH)	T_3 (10% WH)	T_4 (15% WH)
Water hyacinth intake, g/animal/day	0	53.52±17.38	107.0±34.84	160.53±52.21
CV (%)	0	32.48	32.56	32.52
F value	386.94			
P value	0.000			
LSD	4.97			
Concentrate intake, g/animal/day	1050.23±378.2^{d}	1017.1±330.25^{d}	963.42±312.96	909.7±295.86^{ab}
CV (%)	36.01	32.47	32.48	32.52
F value	2.99			
P value	0.031			
LSD	50.35			
Today dry matter intake, kg	80.64	79.44	75.76	72.44
FCR (DM intake: weight gain), Kg	2.14:1	2.32:1	2.17:1	2.26:1

Table 3 showed that intake of WH was correlated with levels of inclusion. WH intake was increased as per the rate of inclusion level which was highly significant ($p<0.001$) among diet groups. Highest intake of concentrate mixture was noted in T1 (1050 g/day/animal) followed by T2 (1017.1 g/day/animal) and T3 (963.42 g/day/animal) which was significant ($p<0.05$) between T1 and T4 groups and T2 and T4 groups. Feed intake of T3 and T4 groups was noted

insignificant. Similarly, highest FCR (DM intake: weight gain) was observed for T1 (control) group (2.14:1kg) followed by T_3 (2.17: 1kg) and T4 (2.26:1 kg).

Body weight gain

The body weight gain trend of the experimental animals is presented in Table 4.

Table 4: Body weight gain of experimental piglets, kg (Mean±SD)

Parameters	Treatments						
	T_1 (Control)	T_2 (5% WH)	T_3 (10% WH)	T_4 (15% WH)	CV	F value	P value
Initial weight, kg	11.02±0.58	10.75±2.14	10.51±2.12	10.3±1.45	13.58	0.249	0.861
Final weight, kg	48.68±2.36	45.0±6.57	45.42±5.64	42.27±6.34	10.92	1.463	0.262
Total Weight gain, kg	37.66±2.01	34.25±4.35	34.91±4.72	31.97±5.62	13.14	0.854	0.481
Average daily gain, g	448.33±2.39	407.73±4.78	415.59±5.61	380.59±6.69	12.83	1.452	0.267

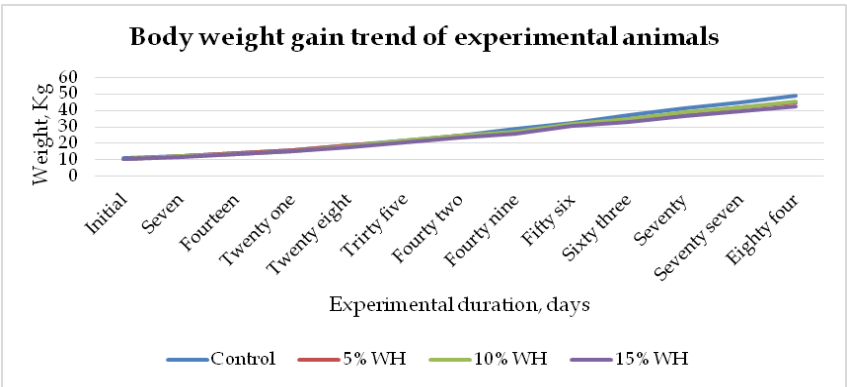

Figure 1. Body weight gain trend of experimental animals

Table 4 showed that initial body weight of experimental piglets ranged from 10-11 kg which was non-significant among diet groups. By the end of experiment, highest total body weight gain was obtained in control group (T1) (37.66 kg) followed by T3 (34.91 kg) and T2 (34.25 kg) which was also non-significant among diet groups. Similarly, highest average daily gain was observed higher for T1 (control) group (448 g /day) followed by T3 and T2 group (415.59 and 407.73 g/day, respectively).

DISCUSSION

The aim of this study was to evaluate the feed intake and growth performance of growing piglets by replacing concentrate mixture with WH at the rate of 0, 5, 10 and 15 percent in their basal diets.

Experiment revealed that there was highly significant ($p<0.001$) effect of replacement of concentrate mixture with WH in different levels on feed and WH intake during entire experimental period. FCR of all experimental groups was almost similar (2:1kg).

Barman *et al* (2015) conducted an experiment on piglets by feeding three types of experimental diets containing WH at the rate of 0, 5 and 10 % by replacing maize and designated as T1, T2 and T3 groups, respectively. In that study they found that there was no difference in DM intake (kg/d) across the groups. Digestibility coefficients (%) of nutrients were similar across the groups except crude fibre digestibility which was reduced significantly in T3 group in comparison to other two groups. The average body weight gain (g/day) was statistically similar across all groups. The feed conversion ratio and cost of production per kg live weight was similar in all the groups. However, feed cost per kg gain was significantly ($p<0.05$) reduced in comparison to T1 (control) group. Moreover, they concluded that WH foliage could replace 5% maize in ration of crossbred grower pigs without any adverse effect on body weight gain.

Ngullie, L (2019) reported that WH foliage is commonly used as a supplementary feeding for pigs in smallholder farms in Asia. It was reported that water hyacinth foliage could replace 5% maize in ration of crossbred grower pigs without any adverse effect on nutrient utilization.

Akankali and Elenwo (2019) conducted an experiment on piglets 24 large white weaner pigs of both sexes with initial live weight of 10-12 kg were randomly allocated to four dietary treatments by using CRD and each treatment replicated thrice with two piglets per replicate. A balance basal diet was formulated with soybean meal (SBM) as the protein source (T1 control), in T2, T3 and T4 SBM was replaced with WH in the levels of 10, 20 and 30%, respectively. Experiment revealed that there was no significant influences of animal studies, growth and performance are important the treatments on average weekly feed conversion indices in evaluating productivity. The growth and ratio (weight: gain) among the treatment group performance indices of the pigs evaluated in the study was non-significant with increasing levels of WH. Similarly, analysis of variance showed the difference between the treatment groups ($p>0.05$) influence of WH on average final weight.

In case of growth performance, this study showed that there was no significant effect of different levels of concentrate mixture replacement with WH on growth performance of piglets from beginning to end of the experiment, however, highest total body weight gain and average daily gain was obtained in T1 (control) group (37.66 kg and 448.33 g/day, respectively) than that of other treatment groups. This could be as a result of fairly adequate crude protein and amino acid profile of WH which was supposedly sufficient enough to cause the possible weight increment. This agrees with the findings of (Peo *et al*, 2001 and Parr *et al*, 1996) who reported that pigs fed diets of protein

concentration varying from 15%-20% CP adequately supplemented with lysine and methionine, gained sufficient weight.

Bohman (2001) reported that pigs fed with 20% crude protein produced weight gains and feed efficiency comparable to those fed 16% crude protein. Moreover, pigs have a unique ability to eat, digest utilize, and covert poor-quality unconventional feed ingredients to high quality meat. The good weight gain of the pigs fed dietary treatments could also be attributed to the presence of non-toxic or non-anti-nutritional factors in water hyacinth which would have inhibited growth. And, this agrees with Gilster and Wahlstrom (1999) who reported that WH contains no toxic or anti-nutritional substance that depresses growth. Also, Perason *et al* (2001) reported that as the particle size of feed containing crude fibre becomes smaller, better weight gains are obtained. The chopping of the WH to small sizes to pass through a 0.5mm screen after drying, could have aided in digestion, utilization of the plant and the consequent good weight gain.

Ajuogu (2019) conducted an experiment to determine the impact of feeding WH-based diets on the organ weights and carcass quality characteristics of weaner pigs. The weaner pigs were fed WH based meal at dietary levels of 0%, 10%, 20% and 30% inclusion Levels to replace SBM in the experimental diets. The result of the organs (Liver heart, kidney, spleen and lungs) and carcass weights revealed no significant difference ($p>0.05$) between the treatment groups and the control. The result of the lean fat deposit and back-fat thickness showed a significant difference among the pigs used in the study. The control diet (0%WH) had the highest fat content and diet IV (30%WH) had the least fat content. Since the lean fat deposit and back-fat thickness are a reflection of the fat deposits in the pig WH produced better (lean fat) pork than Soya bean meal. He concluded that WH had no poisonous impact on organs. Also, SBM has a better significant influence in terms of the fat deposit than water hyacinth.

According to Suharsono (1979), mixing of WH up to 15% into the rations did not significantly affect pig growth and it could reduce the prices of the ration because reducing the amount of concentrate was needed.

A study conducted by Men *et al* (2006) revealed that pig had shown good acceptance for WH and the pigs fed on WH based diets had better carcass appearance than the common diet fed pigs in Vietnam, because, pork exhibited low back-fat and body fat with excellent meat productivity (Choi, 2004 and Kim, 2012). Inclusion of 5-15% of WH biomass in the pig feed did not affect daily gain in feed intake, fat thickness and loin eye area compared to control (Cui *et al*., 2004).

As an animal feed, it has been used fresh. In experiments with pigs in southwest Colombia, fresh water hyacinth was substituted for 20 per cent of commercial

feed without toxicological problems or effects on rate of growth (Lareo and Bressani, 1981).

Ngullie, L (2019) reported that WH foliage is commonly used as a supplementary feeding for pigs in smallholder farms in Asia. It was reported that WH foliage could replace 5% maize in ration of crossbred grower pigs without any adverse effect on nutrient utilization.

Xing *et al.* (2001) investigated the appropriate proportion of WH in pig feed and analyzed the economic benefits. The growing pig reached a standard weight of 90 kg, and the optimal ratio of concentrate to WH was 1:0.5 in the previous period and 1:1 in the later period. Compared with the control group, each pig saved 8184 kg of refined material, resulting in cost savings of 9.95 Chinese Yuan.

Tacio (2009) reported that 5% of water hyacinth in the total diet of pigs leads to significantly weight gains. But feed containing 30 percent of more of hyacinth can reduce weight gain by over 90 percent. These tests showed that water hyacinth as a feed for animals must be used with great care.

CONCLUSION

It can be concluded from this study that one of the real long term, economically viable and environmentally friendly solution to the WH menace was can be utilized it as feed ingredient in swine diets up to 10%. This will help in recycling WH into a useful feed resource, thereby help in reducing cost of feeding. However, further validation of these findings in farmer's field is necessary.

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Value chain analysis of kiwi fruit farming in Dolakha district of Nepal

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ABSTRACT

The study on value chain/market status of kiwi fruit farming was conducted in Bhimeshwor municipality of Dolakha district using random sampling of 40 respondents and 10 stakeholders in October 2019. The study examined information obtained from survey, key stakeholders and from focus group discussions. The findings of the study revealed that kiwi fruit production and marketing is emerging farming enterprises in the study site. Farmers are making a considerable income from kiwi fruit crops, and it is becoming a very attractive agribusiness. Similarly, the market prospectus of kiwi fruit is good, both within and outside the districts. The major constraints of this sector are: unavailability of quality sapling and variety, lack of adoption of appropriate technology, limited access to reliable market information and unorganized market center. Nevertheless, this subsector has many opportunities as well, such as climatic suitability of hilly region, increased demands with attractive price, presence of TFRDC (Horticulture farm of Boach) etc. After a thorough analysis, some intervention strategies are identified for increasing the competitiveness of this subsector, which include kiwi fruit cultivation zoning, strengthening and regulating the existing kiwi nursery farm, training on post harvest handling/entrepreneurship development and provision of crop insurance for kiwi orchards in Dolakha district.

Key words: Kiwi fruit, market, value chain, price n

INTRODUCTION

Kiwi fruit is gaining popularity in Nepal especially in the field of production side. It could be a new fruit to Nepali consumers but in the world context, the kiwi farming had already been started at 16th century. Kiwi, known as a Chinese gooseberry, is a native plant to China. In 1906, New Zealand started massive cultivation of Kiwi fruits. In fact, Kiwi is the nick name used internationally for people from New Zealand. The name derived from kiwi bird which is native to,

and the national symbol of New Zealand. Scientifically, it is known as *Actinidia deliciosa.* The commercial farming of kiwi fruits started universally since 1940. International Centre for Integrated Mountain Development (ICIMOD) is said to be the first doing research work on kiwi fruits in Nepal. Though kiwi plant was first planted in Dolakha district by Swiss during Lamosanghu-Jiri Road Construction Work Period, the commercial farming of Kiwi fruit in Nepal started from Ilam and Kavre district in 2007. Kiwi fruit is well grown in the altitude above the orange growing area and below the apple growing area i.e. the altitude of 1000 to 2400 meter above the sea level. About 40 districts of Nepal are estimated to be feasible for kiwi fruit farming. Till date, kiwi farming has been extended in more than 10 districts. Some of the districts are Ilam, Ramechhap, Sindhuli, Dolkha, Solukhumbu, Kavre, Lalitpur, Kathmandu, Makwanpur, Nuwakot (ICIMOD, 2018).

Dolakha district is located in Bagmati Province in the lower Himalayas region of northern Nepal. This district was one of most affected district by earthquake in April 2015. Agriculture sector was also seriously hit by earthquake resulting loss of livestock and agricultural produces equivalent to millions of rupees. The total area, productive area, production and yield [i]of Kiwi fruit in Nepal are 551 ha, 186 ha, 719 mt and 4 mt/ha respectively while that of Dolakha are 185 ha, 60 ha, 330 mt and 5.5 mt/ha respectively (MOAD, 2016/17). Two main species of kiwifruit are grown throughout the world: *Actinidia deliciosa* and *Actinidia chinensis. Actinidia deliciosa* includes cultivars like Hayward long, Hayward round, Abbot, Allison, Bruno and Monty while *Actinidia chinensis* includes Red Kiwi, Hort 16, Golden Kiwi (Dhakal 2018; Sims, 2011). A value chain consists of all stages of a technical production process as well as of the interaction between these stages. The production process starts at the stage of input supply, than covers production, processing and marketing and ends with the consumption of a certain product. It can be seen as the hard skill of a value chain (Schipmann, 2006). Besides the technical structure, also the actors of a value chain as well as the input-output, and the territorial structure define a value chain (Gereffi, 1994). The value chain describes the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use. Value chain analyses include the study of marketing system, marketing channels, marketing margin, producer's shares and marketing efficiency (Kaplinsky and Morris, 2000). Therefore, value chain analysis approach was used to study the marketing system, marketing channels, marketing margin, producer's shares and marketing efficiency of kiwi fruit farming in Bhimeshwor municipality of Dolakha district.

MATERIALS AND METHODS

Bhimeshwor municipality was purposively selected to assess the situation of kiwi fruit value chain in Dolakha districts of Nepal. The study was conducted in October, 2019. Similarly, 40 farmer respondents and 10 stakeholders were

randomly selected for survey. The study was based on the value chain approach. The methodology of this study included market visits, interactions with stakeholders working in the sector of the kiwi fruit farming, and interactions with traders. The checklist was developed and used for the discussions with traders, focus group discussions (FGD) at pocket levels and concerned institutions. Secondary data from the various sources were reviewed for the study.

Marketing margin and gross margin analysis

Marketing margin is the difference between the farm gate price received by the farmers and the price paid by the consumers. This was calculated by subtracting farm-gate price from retailer price of different markets.

Marketing margin = Retailer price (P_r) *– Farm-gate price* (P_f)

Similarly, Gross margin analysis is the difference between total value product and variable cost associated to particular enterprise. Only variable costs were included for this analysis.

The gross margin was calculated as:

Gross margin = Gross return – Total variable cost

RESULTS AND DISCUSSION

Gross margin calculation

The distribution of costs and gross income at different levels is important in the business of Kiwi fruit farming. The margin calculation is done to show the distribution throughout the various actors as the kiwi fruit move from production to local traders, wholesalers, retail markets, and finally to consumers.

Table 1. The gross margin at different levels

Crop	Farm gate		Traders/Wholesaler		Retailer	
	Price	Margin	Price	Margin	Price	Margin
Kiwi fruit	200	0	225	25	A grade-350 B grade-275	A grade-125 B grade-50

Note: Kiwi fruit qualities were graded on the basis of weight and size of kiwi fruit. Following grading practices are adopted in Dolakha district of Nepal.
For A grade: > 100 grams; For B grade: 70-100 grams; For C grade: <70 grams

Normally A and B grade kiwi fruits were sold from wholesaler to retailer market. C grade kiwi fruits were locally sold to local market's consumer directly by farmers themselves.

Value chain analysis of kiwi fruit

Kiwi fruit is one of the emerging fruit crop grown in Dolakha district. Though some of the private entrepreneurs and cooperatives are cultivating kiwi fruit in commercial scale, kiwi fruit marketing is not organized in a systematic way. Kiwi fruit grown in Bhimeshwor municipality area are consumed within district and outside district. Some quantity of kiwi fruit move to nearby market like

Kathmandu, Kavre, Pokhara, Narayangarh, terai regions etc. Numbers of value chain functions are very few in kiwi fruit value chain. AKC, PMAMP, TFRDC Boach farm, agri section of Municipality/Rural Municipality etc are providing technical support for production of kiwi fruit in the study area. The value chain map of kiwi fruit is presented below:

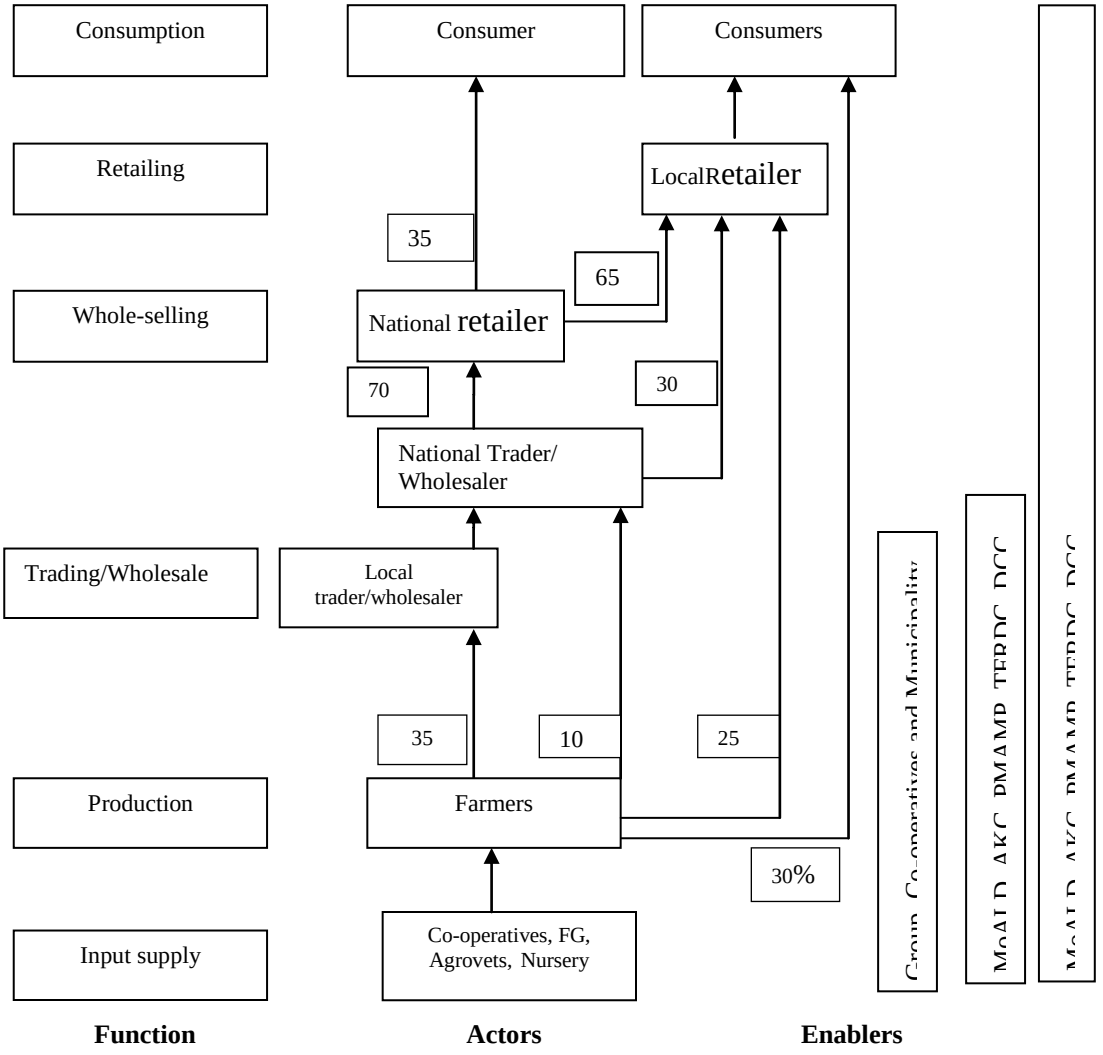

Figure 1. Value chain map of kiwi fruit

Constraints and opportunities

Suitability of climate and soil, first choice of farmer to their fallow land because of its perennial nature and safe from the monkey damage and prioritized crop of

local municipality, Kiwi fruit is one of the emerging fruit crop at Bhimeshwor municipality of Dolakha district. As there is huge potentiality of promoting agriculture in this district, kiwi fruit can be one of the sector to add brick on it.

Constraints

Lack of quality sapling of kiwi plants: Quality sapling is the primary planting material for kiwi fruit farming. As there is no efficient regulating mechanism of fruit's nursery, most farmers were using unauthorized sapling of kiwi fruits.

Lack of good quality mother plant in nursery: Most of the nurseries lack mother plant of kiwi fruit for the production of scion which is very vital for quality kiwi plant production via grafting.

Lack of variety of kiwi plants: Dolakha district has tremendous potential for kiwi fruit production but farmers have no choice on high yielding variety of kiwi fruits.

Lack of technology adoption: Farmers are using the traditional methods of kiwi farming; most of the farmers are unknown about the appropriate training and pruning practices, girdling etc of kiwi plants.

Market information: There is limited access to reliable market information on price, quality, and quantity for farmers and local traders in production pockets.

Unorganized market center: Most of the kiwi fruit markets are not organized and existing markets are focus on apple/banana/orange fruits market.

Lack of irrigation: For better growth and development of kiwi fruits irrigation is utmost.

Labor shortage: Migration of youths has been increasing significantly and is directly affecting the availability of labors in production pockets.

Post-Harvest Losses: Poor post-harvest handling practices regarding sorting, grading and packaging are largely responsible for fetching good price of kiwi fruit. Growers are unable to produce jam, jelly, pickle etc of kiwi fruits in production sites.

Opportunities

Climatic suitability: Dolakha district is very suitable for commercial kiwi fruit farming with specific taste and quality.

Support of input and technical service: Various organizations such as PMAMP, TFRDC (Horticulture farm of Boach), NGOs, and cooperatives and agriculture section of local municipality provide production inputs and technical services to the farmers.

Increased demand: Demand for kiwi fruit is increasing, raising the possibility of export markets to different districts.

Availability of cultivable land, perennial nature of kiwi fruit plants, good keeping quality of kiwi fruits, extension of roads are other opportunities for kiwi farming in Dolakha district.

CONCLUSION

Encouragement and support toward solving the above challenges would contribute to the establishment of thriving kiwi fruit crop market. This would reduce foreign import and improve the market competitiveness of Nepalese products, thereby contributing to the national economy.

AREAS FOR INTERVENTIONS

Kiwi fruit cultivation zoning

- ✓ Training on improve production practices of kiwi farming to growers.
- ✓ Intervention in the sector of technology gap like training and pruning, girdling etc practices in kiwi fruit plants.
- ✓ Opportunity for organic production in the area.
- ✓ Introduction of high yielding variety of kiwi fruits in the production sites.

Strengthen and regulation of existing kiwi nursery farm

- ✓ Provide technical and partial financial assistance towards development of grafted sapling of kiwi plants to nursery owners of Dolakha districts.
- ✓ Make the quality assurance of grafted sapling of kiwi plants.

Training on post harvest handling

- ✓ Training on grading, packaging and quality standards as well as post-harvest handling to farmers.
- ✓ Provide business planning and enterprise development training to traders.
- ✓ Training on post harvest products of kiwi fruits like jam, jelly, wine, candy, pickle should be encouraged.

Provision of crop insurance

- ✓ Heavy hailstorm may cause significant or complete loss of crop. To encourage farmers in kiwi fruit production, crop insurance and minimum price guarantee should be provided.

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Determinants of Seed Replacement Rate (SRR) of Rice in Kanchanpur District of Nepal

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ABSTRACT

The productivity of the rice in Nepal can be increased substantially through the adoption and replacement, at a certain yearly interval, of quality seed. Keeping these points in concern, we attempted to study socio-economic factors affecting seed replacement rate (SRR) of the rice in the Kanchanpur district of Nepal. A pre-tested semi-structured questionnaire was administered among randomly selected 70 rice producers, 35 from the Kanchanpur rice zone, and 35 outside the zone. Face to face interview was scheduled to obtain data from January to March 2019. The average Seed Replacement Rate of rice being 29.64%, the rate was higher in the zone area than outside the zone. Pearson correlation analysis revealed that the education and income of households were contributing to a higher Seed Replacement Rate. Similarly, regression analysis revealed that a unit increase in Seed Replacement Rate can increase up to 22 kilograms yield of rice per hectare. Lack of awareness about seed replacement, farmers' reluctance to farm-saved seed, and high cost of seed were the major problems for seed replacement in the study area. Overall, our study pointed out that expanding the working area of the Kanchanpur rice zone and providing subsidy on seed are immensely indispensable for improving the seed replacement rate of rice.

Key words: Seed replacement rate, quality seeds, regression and correlation.

INTRODUCTION

Rice is the major staple food crop for more than 3.5 billion people in the world. The majority of the Asian, and few American and African countries relied upon rice for staple food. It has contributed 20% of the dietary energy to the world (Gadal et al., 2019). Similarly, being Nepal an agrarian country, the agriculture sector contributes to the highest share to GDP— 26.24% of the total (Prasain, 2020). Further, rice alone contributes one-fourth to the agricultural GDP of the

country (Gauchan et al., 2014). The byproducts of rice—straw and rice husk—also serve as the important feed, fodder, and materials for flooring and roofing of the livestock housing.

Rice, the major staple food crop of Nepal, is cultivated in an area of 1469545 hectares with a production of 5151925 metric tons (AICC, 2019). Despite its immense importance, the productivity of rice in Nepal is much lower than the potential yield (CDD, 2015; MoALD, 2017). This could be attributed to the poor adoption of recommended technologies of rice farming, timely unavailability of fertilizers, a lack of technical support, erratic rainfall, and poor adoption of quality seed (Ghimire et al., 2015; Adhikari et al., 2019). Besides, farmers are switching to other crops due to low profitability in rice farming. Katoky and Barman (2015) reported the poor production was due to poor adoption of quality seed. The seed is a basic input for production as it determines the quality and quantity of production. In addition, commercialization in rice cultivation cannot be achieved without the quality and certified seed. Certified quality seed is free from disease and pest, have higher germination; thus, reduced the seed rate. Besides, the seed not only reduces the cost of seed, lowering the seed rate but also reduces the cost of production (Gauchan et al., 2014). Thus replacing farm-saved seed with improved seed is crucial to increase rice production. Under ideal conditions, seed should be replaced every year for hybrids and every three to four years for non-hybrids (KUBK, 2017). This is essential for maintaining genetic purity and quality seed production. Seed Replacement Rate (SRR) or Seed Replacement Ratio is the percentage of area sown out of the total area of the crop planted in the season by using certified or quality seeds other than the farm-saved seed (Pandey et al., 2017). SRR influences the seed quality by ensuring varietal and physical purity, seed health, and seed vigor (Singh, 2017) and increase the productivity of the crop. Therefore, it is crucial to figure out the extent and socio-economic factors affecting the Seed Replacement Rate.

Previous studies on the adoption of quality seed mainly focused on socio-economic factors affecting the adoption of improved varieties (Saka and Lawal, 2009; Ghimire et al., 2015; Chandio and Yuansheng, 2018; Adhikari et al. 2019). But there is no study, to the date, regarding the effects of socio-economic factors on seed replacement rate (SRR) of major cereals. Further, there is a paucity of study on the relationship between the seed replacement rate and yield of major cereals. Keeping these points under consideration, we made an attempt to study determinants of seed replacement rate of rice in the Kanchanpur district of Nepal.

MATERIALS AND METHODS

Study site: We selected Kanchanpur district, a part of the Sudurpachim Province of the federal republic of Nepal. The district encompasses co-ordinates of 280 38’ to 290 28’ North latitude and 800 03’to 800 33’ East longitude, and altitude of 176-1528 meters from mean sea level. Being seated in a fertile plain, the district has immense climatic potentials for various crop productions, particularly suited for paddy farming. In Kanchanpur, paddy is cultivated in an

area of 48,496 hectares with a productivity of 3.45 M/ton (MoALD, 2017). Due to the commercial production of paddy, more than 500 hectares in a single cluster, the Government of Nepal has declared Kanchnpur as Rice zone under Prime Minister Agriculture Modernization Project (PMAMP) with the mandate to strengthen and expand the area of rice production. We selected Ultakham, Bheemdatta under the Rice zone command area, and Suda and Bedkot outside the fringe of the zone for the study.

Designing of questionnaire

A preliminary study, before the designing of the questionnaire, was conducted to collect various socio-economic, demographic, geophysical conditions of the study sites. A questionnaire was designed based on the field visit and secondary data available on various journals, books, and booklets. 10 paddy growers of Krishnapur and Ultakham were randomly selected for pre-testing of the drafted questionnaire. Based on the feedback of the farmers and experts' suggestions some necessary changes were made and the semi-structured questionnaire was finalized.

Sample size and data collection procedure

A simple random sampling technique without replacement was used to select seventy samples; 35 respondents from the zone area and 35 respondents outside the command of the zone area. Face to face an interview method, Key Informant Survey (KIS) and Focused Group Discussion (FGD) was used to elicit data from respondents from January to March 2019.

Seed replacement rate: Seed Replacement Rate (SRR) or Seed Replacement Ratio is the percentage of area sown out of the total area of the crop planted in the season by using certified or quality seeds other than the farm-saved seed (Pandey et al., 2017). Below mentioned formula was used to determine the Seed Replacement Rate (SRR) of rice. However, in the formula, we did not consider the crop produce from F2, F3, and F4 generations as improved seeds.

$$SRR = \frac{I \cdot 100}{A \cdot K}$$

Where,

SRR= Seed Replacement rate of crops

I=Improved seeds used by farmers

A=Area under the crop (ha)

K= Seed rate per unit of area (kg/ha)

This above formula was also applied by Verma and Sindhu (2009) to assess the seed replacement rate of Paddy in Punjab of India.

Correlation analysis: Correlation is the commonly used analytical tool to show the relationship between two continuous variables. Javadi et al. (2011) adopted this method to study groundwater pollution in the agricultural area. Here, we used Pearson correlation to show the relationship of independent variables like level of education of respondents, total land under rice cultivation, age of decision-maker in a household, seed rate used, and level of income with

dependent variable—Seed Replacement Rate. Pearson correlation 'r' value ranges from -1 to +1. Based on this value, we measured the relationship between the dependent and independent variables.

Simple linear regression: Simple linear regression was used to determine the relationship between seed replacement rate and yield of paddy.

$$y = mx + c$$

Where, y is the yield of paddy and x is the seed replacement rate.

Ranking of problems

Five-point scaling technique was used to measure the relative severity of production problems. Farmers' perception on the importance given to the different SRR constraints were analyzed by using 5 point scale of constraint indicating major factor or problem (1) to minor factor or problem (0.2). The index was calculated using following formula:

$$I = \sum (S_i f_j)/N$$

Where,

$I_=$ Index of importance

S_i= value in scaling

F_i= frequency of importance of problems, given by the respondent

N =Total number of respondents participated in ranking

Bhattarai et al. (2020) used the scaling technique to identify the constraints associated with the coffee production in Gulmi and Arghakhanchi districts of Nepal. This above formula was also applied by Maharatha et al. (2019) and Subedi et al. (2019) to identify the problems related to marketing of tomato and potato production in Terai region of Nepal.

RESULTS AND DISCUSSION

A recap of socio-economic characteristics is presented in table no.1. Among the 70 interview respondents, 50% were male. The sample household averagely featured 7.91 members in the family. Consistent with the government data, the majority of the household was able to read and write, however, very few (15.7%) of the sample respondents were illiterate. Being the majority of respondents (68.57%) under 27-50 years, the average age of the sampled respondents was 38.51 years. According to the farm size classification technique of Budhathoki and Bhatta (2015), the farm size of the respondents was categorized into 3 groups; small (<0.5ha), medium (0.5-2ha), and large (>2ha). The majority of the farmers (50.5%) had medium farms whereas very few of them (8.6%) of farmers had large farm sizes. Similarly, most of the household (67.1%) income ranged from NRs 223,000 to 444,000 (1856.47-3636.30 US$). The average income of the sampled household was 333,000; the figure is higher than the per capita income of Nepal (Joshi and Shrestha, 2018). 50% of the

sampled respondents had access to extension service; the rice zone provides the extension services to the farmers.

Tractor and draft power were used to carry out tillage operations. 46.3% of the farmers were using both tractors while the rest of them used either draft power (32%) or tractor only (21.7%). The average seed rate in the study area was 62kg/ha. Some of the farmers did seed treatment 12.9% while most of them were not doing (87.1%). The larger area of the study site was covered by improved variety (87.89%) followed by local variety (6.93%) and hybrid variety (5.165). The common variety used by the farmers in the study area were Sarju 52, Silki, Sukkha-3, Sukkha 6, Sawa Mansuli, Ramdhan, Sehran, Radha-4, PR 13, DY 69, USB 312, 6444, etc.

Table 1. Socio-economic characteristics of the sampled respondents

Variables	Frequency	Percent
Sex		
Male	35	50
Age (years)		
Less than 27	9	12.85
27-50	48	68.58
Above 50	13	18.57
Family size (number)		
Small (below 5)	8	11.45
Medium (5-12)	52	74.3
Large family (Above 12)	10	14.3
Land holding size (ha)		
Small (<0.5)	29	41.4
Medium(0.5-2)	35	50.5
Large (>2)	6	8.6
Level of Education		
Illiterate	11	15.7
Literate	5	7.1
Primary	12	17.1
Secondary grade (6-10)	22	31.4
High School (+2)	11	15.7
University Level	9	12.9
Family income (Rs '000')		
Low (<223)	10	14.3
Medium (223-444)	47	67.1
High (>444)	13	18.6
Extension service (yes)	35	50

Trend of seed replacement rate in Nepal

The trend analysis of seed replacement (SRR) of rice in Nepal presented in figure.no1. The trend analysis revealed that the seed replacement rate of rice is increasing at a rate of 1.81% per year. The Seed Vision (2013-2025) has targets to achieve 25% Seed Replacement Rate (SRR) for rice by 2025; with the current rate seed (SQCC, 2013), it seems impossible to achieve the goal (KUBK, 2017). The use of traditional varieties coupled with farm-saved seed was the major

setback for attaining the goal. Besides, Manjunatha et al (2018) reported that farm-saved seed lacks genetic purity and has poor germination, thus, it cannot be substituted with the certified quality seed.

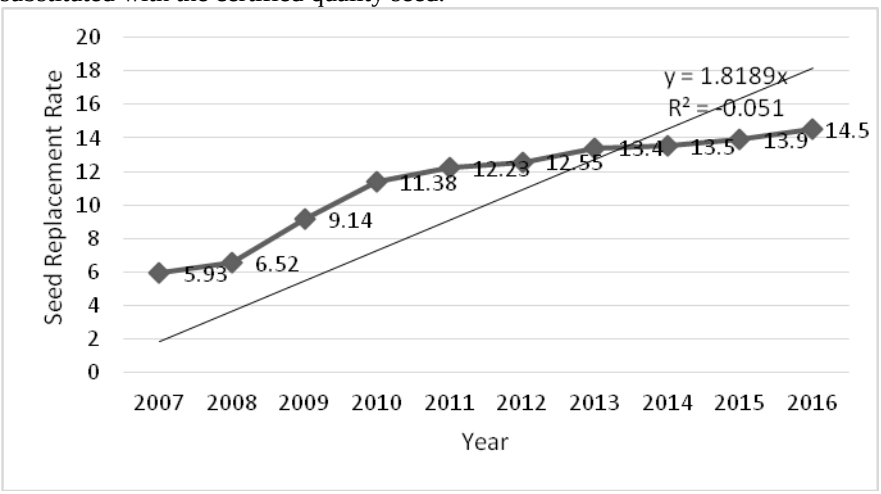

Figure 1. Trend analysis of seed replacement rate in Nepal

Seed replacement frequency

Farmers within the zone area were found to replace seed more frequently than outside zone area. Around 34% of farmers within the zone area replaced seed in 2 years followed by 25% of them in 3 years and 22.8% in 4 years. Very few farmers (11.42%) from the zone area replaced the seed every year. The majority (60%) of farmers, outside zone area, have replaced the seed in 4 years; however, very few of them (5.7%) replaced the seed annually. Ideally, seed should be replaced every year for hybrids and every three to four years for non-hybrids. More than 90% of the farmers were not replacing seed at the recommended interval.

Table 2. Seed replacement in the study area

Replacement frequency	Outside zone	Inside zone	Total
1 year	2	4	6(8)
2 years	3	12	14(18.7)
3 years	6	9	15(20)
4 years	21	8	29(38.66)
>4 years	4	2	6(8)

Figures in parenthesis denote percentage

Seed selection and storage

The process of seed selection in the study area was inefficient; among the sampled respondents, only 2.85% of farmers selected the seed through observation in all stages of crop development. The majority (51.42%) of farmers selected the seed by observing at harvest, 28.57% of them during threshing, and

17.16% of farmers selected seed without any field observation. Farmers observed filed performance and plant structure for seed selection during harvesting, and seed color during threshing. Farmers used plastic bags (59.8%), plastic/oil drums (5.2%), wooden bins (3.65%), and traditional houses (*bhakari*) for seed storage. Most of the farmers (87.8%) have faced problems during seed storage. Among the sampled farmers, almost all (90%) had a strong willingness to purchase new varieties. Similarly, 85.71% of farmers of outside zone area and 94.28% of farmers within the zone area were willing to pay for new rice varieties.

Sources of seed

Most of the farmers (59.28%) were using the farm-saved seed, 44.35% of them were from the rice zone area, and 55.65% outside the zone area. Around 6.47% were using seeds from friends and neighbors, (15%) zone area (85%) outside the zone area. Around 11.59% of total seeds were provided by PMAMP in zone area. About (9.00%) of seed was purchased from the local market, 31.39% by zone area farmers, 68.61% by farmers outside zone area; similarly, around 9.28% of seed was purchased from seed dealer/ agro vet, 95% by zone area farmers and 5% by farmers from outside zone area. Around 3.5% of seeds were obtained from Community based seed groups; however, 1.06% of seeds were purchased from the foreign market (India) by respondent farmers outside the zone area.

Table 3.Determinants of seed replacement rate

Variables	Pearson Correlation 'r'	Sig.(2 tailed)'p'	Sample Size
Education status of respondents	0.234*	0.05	70
Land under rice cultivation	0.067	0.582	70
Age of decision makers	-1.95	0.106	70
Seed Rate	-0.1	0.408	70
Level of Income	0.482**	0.001	70

Source: Field Survey, 2019; (Note: ** indicates 1% level of significance, * indicates 5% level of significance)

Out of five variables included in correlation analysis, the education status of the respondents and level of income had a significant positive relation with the seed replacement rate (SRR). The positive relationship between education status and SRR revealed that farmers with higher education status were more likely to have a higher seed replacement rate. This could be attributed to the fact that farmers with higher education status have higher planning horizons—increase the chance of technology adoption. A similar positive relationship between education status and adoption of improved agricultural technology is observed by (Ghimire et al., 2015; Budhathoki and Bhatta, 2015; Adhikari et al., 2019). Positive relation of household income with SRR depicted that farmers with higher income were more likely to replace seed at the recommended interval. A

plausible explanation to this statement can be partly ascribed by the fact that farmers with higher income have higher purchasing power which increases the chance of purchasing quality seed (Pandey, et. al. 2017). Although the area under rice cultivation had a positive relationship with SRR, the result was statistically non-significant. Similar positive relation of farm size and adoption of improved varieties of rice was obtained by (Ghimire et al., 2015), but, the result is in contrast with (Budhathoki and Bhatta, 2015). Consistent with the theory, the age of the decision-makers in farm harmed SRR. Although aged farmers have more experience in farming, younger farmers are more cognizant about advancement in agricultural technologies—increase the chance of adoption. A similar result on the age of farmers with the adoption of improved seed was obtained by (Budhathoki and Bhatta, 2015). The seed rate was negatively correlated with SRR; however, the result was statistically non-significant.

Simple linear regression analysis between yield and seed replacement rate

Consistent with the theory, the seed replacement rate had a positive relationship with the yield of rice. This could be attributed to the fact that replacing quality seed at a certain year interval increases the yield of rice (Krishnan and Rao, 2005; Guei et al., 2011; Budhathoki and Bhatta, 2015). The coefficient of regression was 22.042 revealed, with an increase in seed replacement rate by 1% the yield of rice would increase by 22.042 kg/ha. Similarly, the coefficient of determination was 0.402 depicted that 40.2% of the yield of rice was determined by the seed replacement rate. Seed Replacement Rate of the study area was found to be 29% which is much greater than the national average of 14.5%, however, the difference in net productivity of rice between the nation and study area is very low.

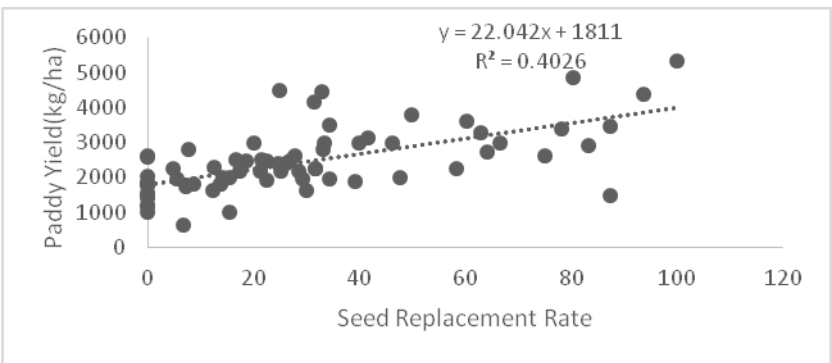

Figure 2: Linear relationship between seed replacement rate and yield of paddy

A plausible explanation to this statement is partly ascribed by the fact that farmers of the study area are still following the traditional way of farming. Besides, the trend of importing unregistered seed from India (Joshi, 2017; Kafle

and Joshi, 2018), timely unavailability of fertilizers (Panta, 2018) has resulted in poor productivity.

Reasons for low Seed Replacement by farmers

Farmers perceived that lack of awareness on importance of quality seed was the major reason for low seed replacement. Similarly, farmers unwilling to change and high cost of seed were other factors hindering the adoption of improved seed.

Table 4. Reason of low seed replacement rate

Problems	Weight	Index	Rank
Lack of awareness on quality seed	63	0.9	I
Unwilling to change seed	58.8	0.84	II
High cost of seed	51.8	0.74	III
Non-availability	35	0.5	IV
Long distance to market	21	0.3	V

CONCLUSION

The primary objective of the study was to determine the socio-economic factors affecting seed replacement rate in Kanchanpur district of Nepal. The seed replacement rate of rice in the study area was 29.54%; the rate is higher in the PMAMP rice zone (40.33%) area than outside the zone (18.75%). The difference in SRR has revealed the efficacy of PMAMP rice zone Kanchanpur in the dissemination of agricultural technologies. Further, the result has suggested expanding the working area of the PMAMP rice zone. The major factors responsible for the higher Seed Replacement Rate (SRR) were the education status and income of farmers. Besides, farmers perceived that lack of awareness on the importance and high costs of quality seed were the major hindrances to increase Seed Replacement Rate. The study has indicated the need of a study on the impact of subsidy on the adoption of quality seed.

RECOMMENDATION

The government of Nepal should launch an awareness campaign on the importance of quality seed for attaining seed replacement rate as per the seed vision (2013-25). Further, providing subsidy on the quality seed offsets the cost and increases the chance of adoption. Subsidy in the quality seed is indispensable for a better Seed Replacement Rate.

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Effect of water stress and salinity stress on growth in Amaranth (*Amaranthus retroflexus* L.)

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ABSTRACT

Redroot pigweed (Amaranthus retroflexus L.), a summer annual weed, is the third most common dicotyledonous aggressive weed in semiarid environments such as Mediterranean areas. Drought stress and salinity stress are the major challenges that are accelerated by climate change. The high-water use efficiency and seed production potential allows it to grow successfully in a wide range of climatic conditions that hinder its control. An experiment was conducted in greenhouse of Universitat Politechnica de Valencia from 3rd October to 19th November to see the response of Amaranthus retroflexus L. to water stress and salinity (150mM and 300mM NaCl). The experimental design was Random Complete Block Design with four treatments. The seed was planted in germination trays containing finely ground loam texture soil with a potting mix (3:1) peat and vermiculite on 3rd of October. Three readings of Electrical conductivity (EC) and Moisture content were measured three times a week interval. At the fourth week fresh and dry weight of aerial part and root was measured. The data collected was analyzed by R stat software package (version 3.6.1). High Electrical conductivity was observed in high salt concentration 300mM and 150mM in all three observations. In second and third observation moisture content was highest19.66 % & 21.50% respectively) in 150mM salinity and lowest in water stress condition. The plant height and leaf number were significantly lower in 150mM and 300mM whereas highest (21.5 cm and 19 respectively) in control. However, root length was found highest (20.2 cm) in water stress condition. The similar effect was found in fresh weight and dry weight of aerial parts and root.

Key words: *Amaranths*, salinity stress, water stress, salt tolerance, growth

INTRODUCTION

Redroot pigweed (*Amaranthus retroflexus* L.), a summer annual weed, is the third most common dicotyledonous weed and is widely distributed in the tropics and subtropics regions of the world (Horak & Loughin, 2000). It is one of the most common weeds of corn, common bean, and sunflower (Holm, 1991). It is an increasingly aggressive weed in semiarid environments such as Mediterranean areas. The increased aggressiveness as a result of its ability to keep high-water use efficiency under drought conditions makes this crop difficult to control (Lovelli, Perniola, Ferrara, Amato & Tomasso, 2010).
Drought stress and salinity stress are the major challenges that are accelerated by climate change.Salt stress generally involve osmotic stress and ion injury. Soil salinity caused by NaCl is harmful particularly at early stages of germination that is species specific and concentration dependent (Bhattacharjee, 2008). The C4 plants, including common pigweed, usually have higher water use efficiency and seed production potential that allows them to grow successfully in a wide range of climatic conditions (Long, 1999).

But the availability of limited scientific literature about the water use efficiency of *Amaranthus* species was the basis of this study (Liu & Stützel, 2002). Long (1999) discussed that higher water use efficiency and seed production potential could be a reason for a wide range of climatic conditions in *Amaranthus*. It provides the future research prospects in salt tolerance and high yield in *Amaranthus.* Therefore, the objective of the research was to study the response of marginal crop *Amaranthus retroflexus* L. Under different stress conditions-Water stress and Salinity stress.

MATERIALS AND METHODS

Plant materials: Seeds of *Amaranthus retroflexus* L. produced in Valencia, Spain were used as planting material.

Experimental conditions: The experiment was conducted in greenhouse in Universitat Politecnica de Valencia, Spain from 3rd October to 18th November 2019. Room temperature was maintained in experimental site.

*Amaranthus retroflexu*s L. seeds were planted in germination trays containing finely ground loam texture soil with a potting mix (3:1) peat and vermiculite on 3rd of October. Planted seeds were watered at 4 days interval. After three weeks, seedlings of 4 to 8 cm in height were transplanted into square, free-draining black plastic pots (7 cm diameter and 10 cm height) containing the same soil mixture with 3 plants per pot. Each pot was filled with dry soil, and the soil was lightly tapped from the top to ensure homogeneous soil bulk density within and between the pots.

For the experiment, one control group, one group with water stress and other two with sodium chloride (NaCl) solution (150 milliMolar (mM) and 300 milliMolar (mM)) were studied with six replications in Randomized complete block design. Pots were watered lightly every other week to avoid transplant shock until the initiation of water stress treatments at 7 d after transplanting. The plants (except water stress group) were irrigated every 7 days throughout the study period.

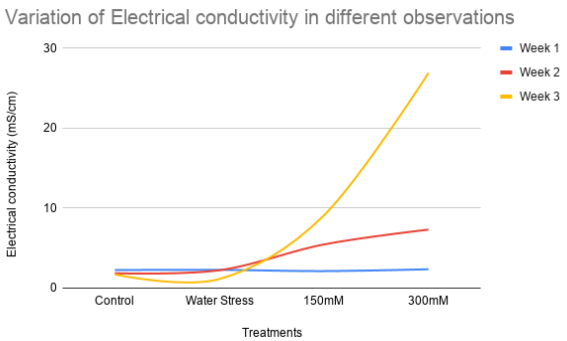

Fig 1(a)

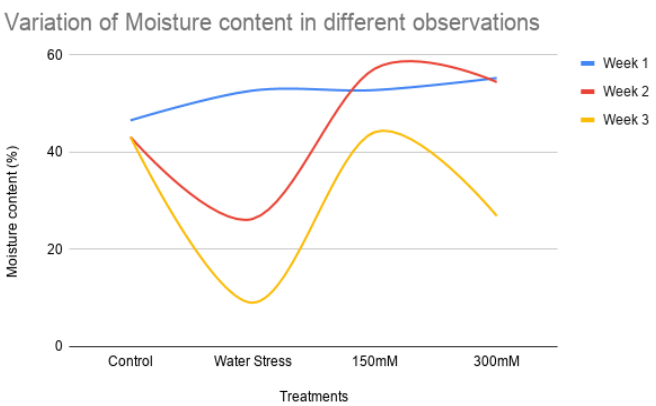

Fig 1(b)

Figure 1. Graph showing variation of Electrical conductivity (a) and Moisture content (b) in three observations

Parameters: Electrical conductivity (EC) and Moisture content were measured three times using Electrical conductivity and Moisture meter. Three readings were done at 5th November,11th November and 19th November.

At the fourth week, all plants were carefully removed from the pots along with roots to measure their aerial (shoot) and root weights. Then the plant was oven dried to determine the dry weight.

Evaluation: The pictures of all the sample plants were taken and the plant height was measured using Digimizer software whereas analysis was done using R stat software package (version 3.6.1). The analysis includes parametric test ANOVA for normal data and non-parametric test *Kruskal* Wallis test for non-normal data.

RESULTS

From the study we found high electrical conductivity in high concentration of salt. The moisture content was lower in water stress condition (Fig 1 (a, b). The electrical conductivity was highest (17 mS/cm, 21 mS/cm, and 21 mS/cm, respectively) in 300 mM in first, second and third week, respectively. In the first week it was statistically similar to other treatments. In the second week electrical conductivity was lower in control (3.66 mS/cm). In the third week it was lower in water stress (5.75 mS/cm).

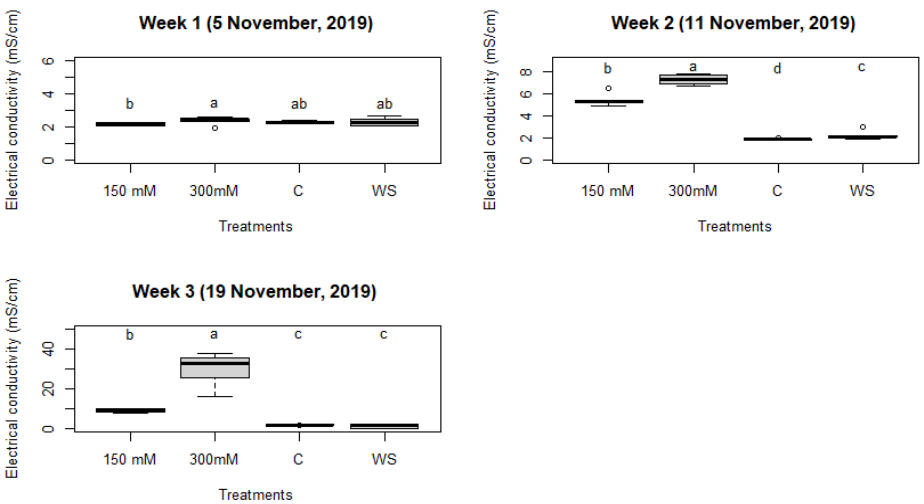

Figure 2. Electrical conductivity observed in three observations in different salinity stress

Figure 3 revealed that moisture content in soil was at parity in all treatments in the first week (week 1). The moisture contents in the second and third week (week 2 & 3) were found the highest (19.66% & 21.50%, respectively) in 150 mM salinity. The moisture content of soil was the lowest (3.5%) in water stress condition because of lack of external water supply.

During the harvest time plant height was highest in control (21.5 cm) and lowest in 300 mM NaCl salinity (8.33 cm) that was statistically similar in 150 mM NaCl Salinity and water stress. The leaves number was also highest in control (19) that was in parity with water stress condition and lowest in 300 mM NaCl salinity (5) whereas root length was highest in water stress condition (20.2 cm). The less effect of salinity in vegetative character might be because of stress tolerant nature of *Amaranthus*.

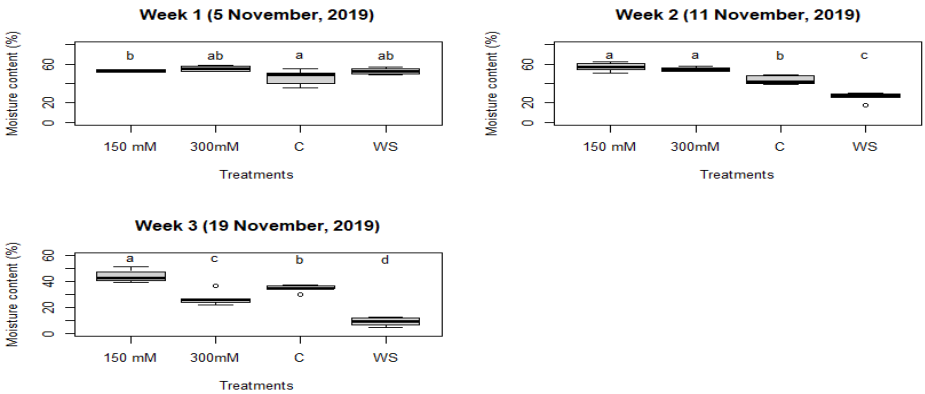

Figure 3. Moisture content observed in three observations in different salinity stress

The variation in root length was not significantly different in 150 mM salinity, control, and water stress condition (Fig 4).

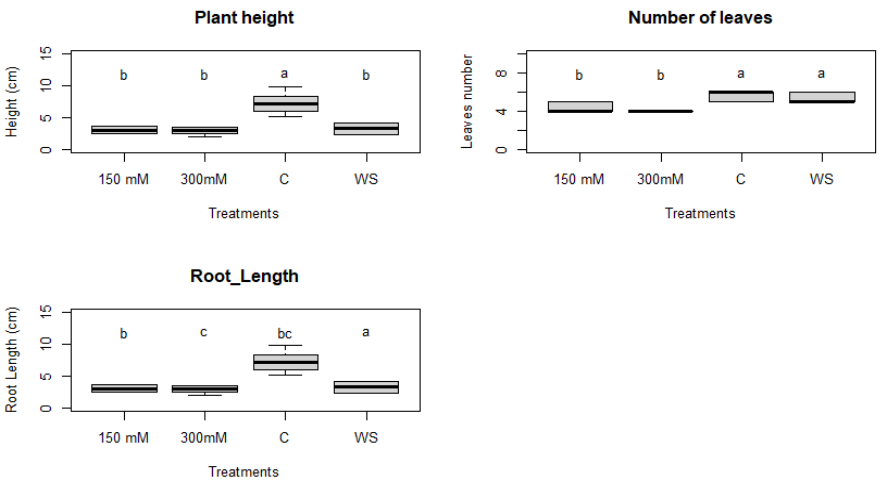

Figure 4. Vegetative characters at the harvest time observed in three observations in different salinity stress conditions

The fresh weight of shoot and root was the least in the 300 mM NaCl salinity (0.23 g & 0.086 g) whereas fresh weight of shoot was highest in control (0.73 g) but fresh weight of root was highest in water stress condition (0.24 g).

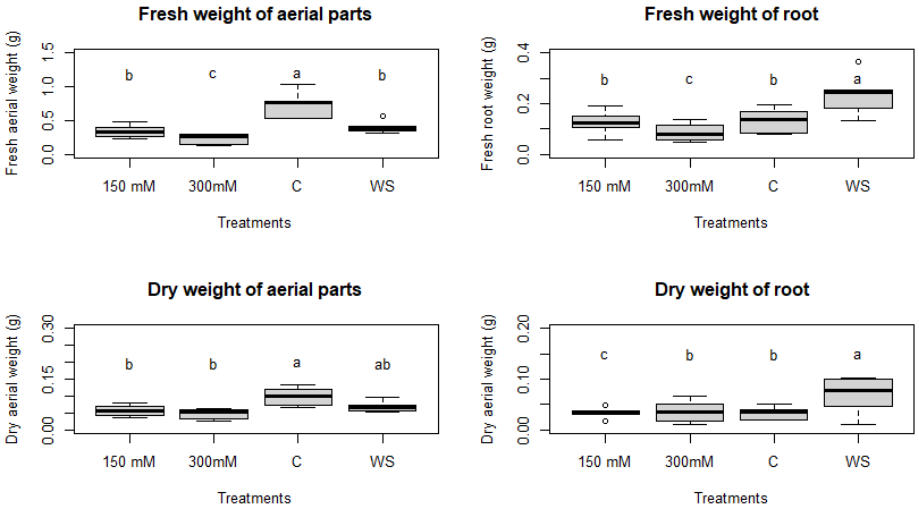

Figure 5. Fresh and dry weight of aerial parts and underground parts after harvest

The dry weight of shoot was highest in control (0.099 g) and was not significantly different in other treatments. The dry weight of root was highest in water stress (0.069 g) and lowest in 150mM salinity (0.032 g).

DISCUSSION

The highest electrical conductivity in high saline condition was because of the presence of high ion mobility. The study showed that there was high moisture content in the soil in high salinity condition. The presence of salt excess in rhizosphere might have led to reductions in osmotic potential. It is related to the decrease in plant water potential (Sánchez-Blanco et al., 2004; Munns, 2005; Franco et al., 2011). It means plant absorbed less water.

This study showed less plant height, less number of leaves, less root length and less fresh and dry root of aerial and root in saline condition as compared to control. The reduction of photosynthetic capacity under salt stress has been reported in numerous species and is considered to be, at least partly, responsible for salt-induced growth reduction (Liu et al., 2011; da Silva, 2011; Saleem et al., 2011; Shahid et al., 2011; Shaheen et al., 2013; R'him et al., 2013). Omami and Hammes (2006) showed that all NaCl concentrations up to 100 mM NaCl decreased photosynthesis in different amaranth species and our treatment is above 100 mM. But the growth of amaranth was similar in different levels of salinity (150mM and 300mM NaCl) which might be because of their resistance

to a higher level of salinity. Similar result was seen by Omami (2005) who found greater tolerance *A. cruentus* to salinity since they survived in 200 mM NaCl.

We found the highest fresh and dry weight of root in water stress condition, but the fresh weight and dry weight of aerial part was lower than control. This might be because of high stress of plants to water deficit condition. This was justified by Souza and Amorim (2009) due to the fact that plants stressed due to lack of water tend to perform a lower rate of cell division, thus reducing leaf production, providing a lower accumulation of dry matter at the end of the cycle (Souza & Amorim, 2009). The higher growth of root helps the plant to obtain water at deeper levels in the soil profile that helps to avoid water deficit in upper surface of soil (Ludlow & Muchow, 1990).

CONCLUSION

According to the study the Electrical conductivity was higher in higher salinity condition because of presence of free ions. The moisture content in soil was higher in high salinity condition which may be because of presence of free ions. The study also suggests higher fresh and dry weight of *Amaranthus* in water stress and 150 mM NaCl salinity stress than in 300mM NaCl salinity. However, the root growth was higher in water stress condition. The plant height was statistically similar in both concentration of salinity (150 mM and 300 mM) and water stress condition but was lower than control condition, the leaves number was not different significantly in control & water stress condition. But it was higher than two salinity concentration. The root length was significantly higher in water stress condition. Therefore, we can conclude that *Amaranthus* can tolerate stress condition (water stress and salinity stress) by producing root and shoot biomass similar to that of control condition.

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Value chain analysis of vegetable seeds in Rukum (West) district

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ABSTRACT

The study entitled 'Value Chain Analysis of Vegetable Seeds in Rukum (West) District' was conducted during September to December, 2019 to analyze value chain of vegetable seeds. Altogether, 109 respondents including actors and enablers were purposively selected. Both primary and secondary data were used for the study. The study found five value stages. Six different types of value chain actors and 5 categories of enablers were clearly observed along value chain function. Average cost of cultivation and gross margin was highest in onion seeds (NRs. 4,34,800/ha and NRs. 17,88,200/ha) and lowest in turnip seeds (NRs. 1,77,600/ha and NRs. 73,400/ha). The study found all vegetable seeds production businesses were profitable, however out of the seven vegetable seeds produced in the study areas, the B/C ratio was found highest for onion seeds (5.1). The seeds produced in the study areas were found to be marketed through different traders and seed companies in more than 15 districts including the capital of the country. The average marketing margin was found highest in onion seeds (NRs. 675/Kg) and lowest in cress seeds (NRs. 25/Kg). Also, the highest farmer's share was recorded for cress seeds (90.00 percent) and the lowest for cauliflower seeds (55.56 percent). The SWOT analysis of the vegetable seeds production business revealed profitability and agro-climatic suitability as major strengths, increasing demand and support from N/GOs are major opportunities. It seems a huge opportunity to scale up the vegetable seeds production business in the district with increased collaboration and cooperation among the value chain actors.

Key words: *Value chain, Cost of cultivation, Gross margin, B/C ratio, Marketing margin, farmer's share*

INTRODUCTION

The concept of 'value chain' was developed and popularized in 1985 by Michael Porter. He defined 'value chain' as a representation of a firm's value-adding activities, based on its pricing strategy and cost structure. One of the dimensions of a value chain is its flow, which is also called its input-output structure. In this sense, a chain is a set of products and services linked together in a sequence of value-adding economic activities.

Nepalese agriculture is dominated subsistence farming with small and fragmented land holding is the pertinent characteristics, however different studies has revealed the higher importance of horticulture for poverty reduction and food security compared to cereal crops (KUBK, 2016). Seeds are the most crucial input in agriculture. Seeds-based technologies offer the easiest and cheapest options for increasing crop productivity (Joshi and Gurung, 2009). In Nepal, vegetable seeds production as a low volume and high value commodities are recognized as lucrative enterprise for improving the livelihood of farmers and addressing the issues of self-sufficiency, food security as well as growth and development of rural economy (CEAPRED, 2013 and UMN, 2015). Vegetable seeds give 3-5 times higher income as compared to alternative cereal crops, enabling farmers to buy at least three times more food as compared to growing traditional food crops on the same land. Most of the studies reported that vegetable seeds production is more profitable than food grain crops (Munakarmi and Dhakal, 1990).

The former Rapti zone (Rukum, Rolpa, Salyan, Pyuthan and Dang) is one of the major areas of vegetable seeds production in the country. It contributes 25-30 percent of the total country vegetable seeds production. Out of the total vegetable seeds produced in Rapti, almost 60 percent is from Rukum (West) district. Currently, it only shares about 8-10 percent in the total national vegetable seeds production (VSPC, 2018). Since last 40 years, farmers have been involved in vegetable seeds production as the major source of income where majority of the people (about 89.50 percent) involved in agriculture as their major occupation (DADO, 2016 and PMAMP, 2018).

The scenario of national requirement and domestic production indicates a huge gap between demand and supply of vegetable seeds (Pun and Poudyal, 2018). The practice of value chain management is common in all parts of the country (ACI, 2017). However, there is mismatch across different functions and actors of the vegetable seeds value chain (KUBK, 2016). Similarly, lack of collective marketing, linkages and coordination between (or among) different actors, highest price from market actors, inadequate market information system (MIS), market destination for produce, divergent interest areas of actors, high cost of production, price fixation and presence of middlemen in the chain are other issues. There is a need for development of the seeds sub-sector in a profitable way, increasing the area under cultivation, and market linkages (AEC, 2012). In

response to these issues, this study proposes to analyze the vegetable seeds value chain for identifying the gaps in order to make the better, competitive, profitable as well as effective and efficient vegetable seeds production in the district.

Probably, this is the first study and it would impart some lights to analyze the different aspects of value chain of the vegetable seeds produced in Rukum (West) district. Therefore, the findings of the study may be helpful to policy makers at national, province as well as at local level and to researchers as well as to entrepreneurs for making this as a business more prosperous and in profitable as well.

MATERIALS AND METHODS

The Rukum (West) district was selected and it was the universe for the study. But, due to various constraints, the whole universe could not be studied. Therefore, the study covered only the vegetable seeds production pockets areas viz. Khalanga, Machhmi, Sankha, Chapa, Solabang, Chhibang, Kholagaun, Chaurajarahi, Purtimkanda and Nuwakot (DADO, 2016). Altogether 109 respondents (94 seed producers, 10 agro-vets and 5 enablers of vegetable seeds value chain were purposively selected for the study. Because, the available sampling frame (as of 2016) was outdated and it did not represent the current (or updated) status of the vegetable seeds producers in the field. Also, there might be tremendous changes over the last four years of period as well.

Various sources and techniques were used for collection of necessary information. The primary data were collected at field level. Both open and close ended semi-structured questionnaire were administered during face-to-face interview. Similarly, key informant interview (KII), focus group discussion (FGD) and field observations were carried out for the collection of primary data. For the secondary data collection, the desk review method was adopted. Relevant data of vegetable seeds value chain were gathered through various literature reviews. The data thus collected were summarized in the table and then categorized into separate variables. They were compared, analyzed and interpreted systematically along with simple tables, figures and charts wherever necessary. Also, all the calculation regarding the sample size as well as the economics of vegetable seeds production was performed with the help of Microsoft Excel. The simple statistical tools like percentage and mean were used for the analysis and interpretation of data.

RESULTS AND DUSCUSSION

Value chain analysis of vegetable seeds

The vegetable seeds value chain in the study areas (Figure 1 and Figure 2) started from input supply, followed by production, collection and processing value stages respectively. And, it ended at logistics value stage. This result was consistent with the study carried out by PMAMP (2018) in Rukum (West)

district. While, this finding was contrary to previous study carried out by HVAP (2018) which reported that the value chain of vegetable seeds in Nepal started from research and development to market logistics value stages. Additionally, 6 different types of value chain actors viz. farmers and their organizations (farmer's groups/cooperatives), VSPC, GOs (KUBK and PMAMP), agro-vets, local seed suppliers and various seed companies as well as 5 categories of enablers as ADO, VSPC, GOs (KUBK and PMAMP), SQCC and RCCI were clearly observed along the value chain function.

Value Stages	**Input Supply**	**Production**	**Collection**	**Processing**	**Logistics**
Actors	VSPC, KUBK, PMAMP, Agro-Vets, Local Seed Suppliers, Seed Companies	Farmers, Farmer's Groups, Cooperatives	Farmer's Groups, Cooperatives, Local Seed Traders	Seed Company	VSPC, Seed Company, Agro-vets, Local Seed Suppliers
Actor's Activities	Provided Source Seeds, Technical Inputs and Agro Inputs	Production of Improved Seeds	Collection, Grading, Pricing, Packaging and Transportation	Importing, Grading, Packaging, Labelling and Pricing	Transportation and Distribution
Enablers	ADO, KUBK, PMAMP	ADO, KUBK, PMAMP	RCCI, KUBK, PMAMP	SQCC, VSPC, KUBK, PMAMP	SQCC, KUBK, PMAMP
Enabler's Activities	Facilitated the Distribution of Agro Inputs	Trainings and Knowledge Exchange and Supervision	Market Linkages and Price Negotiation	Seeds Testing, Certification and Registration	Market Research and Market Monitoring

Figure 1. Value chain of vegetable seeds in the study areas
Source: Field survey (2019)

One unanticipated finding was that same actors and enablers were playing different roles in different value stages as well as there was mismatch across their different functions in the vegetable seeds value chain. Vertical and horizontal relationships among the actors were found to be still inadequate. And, inputs relationship was found very weak in the study areas. This might be due to the lack (or absence) of sufficient dialogue among the actors and enablers. Similarly, the overlapping roles (or functions) among actors and enablers as well as public and private sectors, resulting weak the value chain. This result was further supported by the findings of KUBK (2016) that formal contracts between

buyers and production actors were not in practice and all relationships were based on mutual trust.

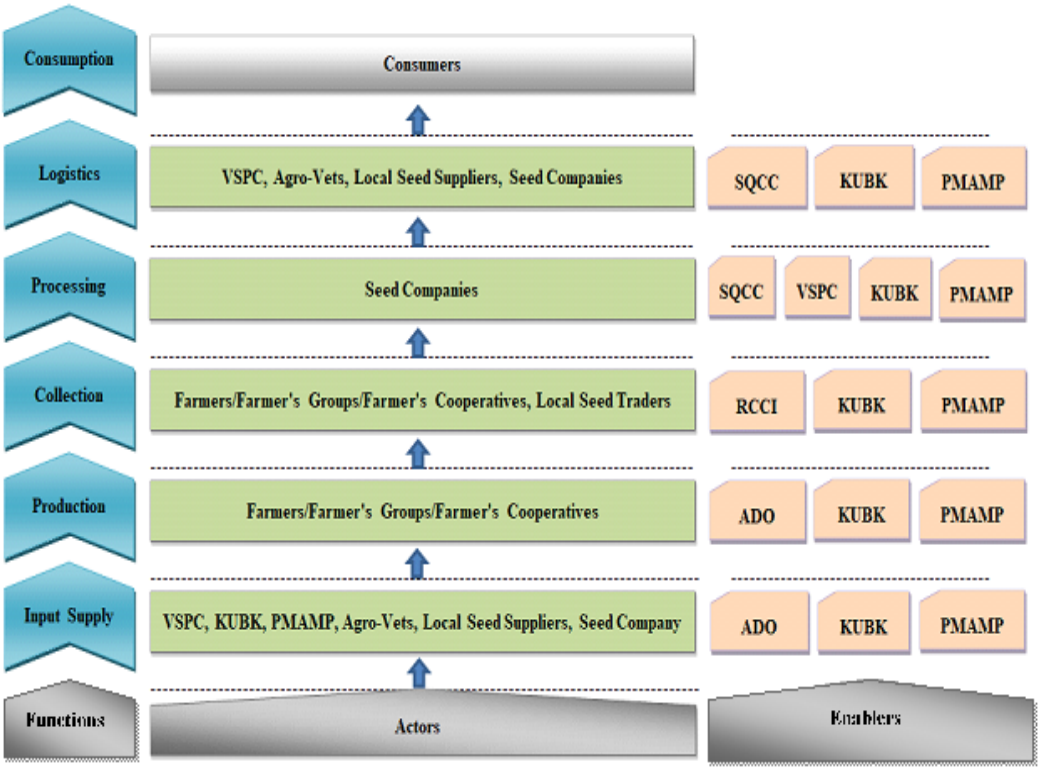

Figure 2. Value chain map of vegetable seeds in the study areas
Source: Field survey (2019)

It is therefore, to make strong vegetable seeds value chain, there is needed some intervention. First, the actors should be motivated through value capture (or distribution), provision of vegetable seeds in subsidized prices, inspection support and transport subsidy etc. towards the vegetable seeds value chain. Secondly, enough dialouges/meetings/conversations should be done in order to strengthen mutual trust as well. Similarly, there should be durable vertical and horizontal cooperation and collaboration among the vegetables seeds value chain stakeholders (or actors and enablers).

Cost and return analysis of vegetable seeds production

The cost and profitability analysis is carried out on the economics (economic viability) of vegetable seeds. The analysis of the economic viability of vegetable seeds is done by calculating costs of cultivation and assessing their profitability by gross margin and B/C ratio analysis.

Cost of cultivation of vegetable seeds

Table 1 shows that the average cost of cultivation was highest in onion seeds (NRs. 4,34,800/ha) and lowest in turnip seeds (NRs. 1,77,600/ha). The highest cost of cultivation in onion seeds was simply because of more inputs used and time required for its seeds production. Since, it took up two years for seeds production. Whereas, in the first year, onion bulbs were produced and in the second year, its seeds were produced from that bulbs. Hence, it needed regular labors for seeds production. In addition, onion seeds price was too much expensive than other vegetable seeds. But, in case of turnip seeds production, it took up short time period and inputs used were available at cheap prices as well. Therefore, it had the least cost of cultivation compared to other vegetable seeds.

Table 1. Cost of cultivation of vegetable seeds

S.N.	Vegetable Seeds	Av. Total Cost/ha. (NRs.)	Av. Total Production/ha. (Kg)	Av. Cultivation Cost per Kg (NRs.)
1.	Radish	3,52,400	2,000	176.20
2.	Onion	4,34,800	2,000	217.40
3.	Cauliflower	2,82,600	960	294.38
4.	Broad Leaf Mustard	2,50,900	1,300	193.00
5.	Turnip	1,77,600	760	233.68
6.	Cress	2,17,200	2,400	90.50
7.	Swiss Chard	1,93,800	2,000	96.90

Source: Field survey (2019).

Also, the average cost of cultivation per Kg was maximal in cauliflower seeds (NRs. 294.38/Kg) and minimum in cress seeds (NRs. 90.50/Kg) than other vegetable seeds. The maximum cost of cultivation per Kg in cauliflower seeds might be due to its lower productivity and minimum cost of cultivation per Kg in cress seeds might be due to its higher productivity respectively. However, their cultivation costs per hectare seemed to have no huge differences.

Gross margin and benefit-cost ratio analysis of vegetable seeds production

The gross margin provides simple and quick method of analyzing a farm business. For any enterprises gross margin is the difference between the gross return and the variables cost incurred. For the analysis of gross margin, only the variables costs are considered. The variable costs must be specific to single enterprise and vary approximately in proportion to the size of the enterprise. The gross margin is calculated as follows.

$$\text{Gross Margin} = \text{Gross Return} - \text{Total Variable Cost}$$

Likewise, the benefit-cost (B/C) ratio analysis is done after calculation of the total cost and gross return from production. Simply, it gives an idea about recovery of cost incurred during the production by return from the production. The cost of production is calculated by summing the variable as well as fixed

cost items in the production process, while for calculation of gross return, income from vegetable seeds and its integration. The given project is accepted for implementation among alternatives based on higher (more than 1) B/C ratio. It is the ratio of gross return to total cost. The benefit-cost ratio is estimated with the help of following formula.

B/C Ratio = Gross Return / Total Cost

Table 2 shows that on an average, the gross margin was highest in onion seeds production (NRs. 17,88,200/ha) and lowest in turnip seeds production (NRs. 73,400/ha). High gross margin in onion seeds might be due to higher production compared to other vegetables seeds. The analysis of gross margin revealed that onion seeds production was more profitable business compared to other vegetables seeds.

Table 2. Gross margin and benefit-cost ratio of vegetable seeds production

S.N.	Vegetable Seeds	Av. Gross Return/ha. (NRs.)	Av. Total Variable Cost/ha. (NRs.)	Av. Total Cost/ha. (NRs.)	Av. Gross Margin/ha. (NRs.)	Av. B/C Ratio
1.	Radish	4,20,000	3,29,400	3,52,400	90,600	1.2
2.	Onion	22,00,000	4,11,800	4,34,800	17,88,200	5.1
3.	Cauliflower	4,80,000	2,59,600	2,82,600	2,20,400	1.7
4.	Broad Leaf Mustard	3,80,900	2,27,900	2,50,900	1,53,000	1.5
5.	Turnip	2,28,000	1,54,600	1,77,600	73,400	1.3
6.	Cress	5,40,000	1,94,200	2,17,200	3,45,800	2.5
7.	Swiss Chard	6,00,000	1,70,800	1,93,800	4,29,200	3.1

Source: Field survey (2019).

The average B/C ratios of vegetable seeds production were found to be greater than 1 as shown in Table 2. Thus, it revealed that all the vegetable seeds production businesses were running in profit. Among seven different vegetables cultivated for its seed production, the maximum average B/C ratio was recorded by onion seeds (5.1) compared to other vegetable seeds. The result further revealed that onion seeds production business significantly outweighed its cost of production. Moreover, the business was able to return NRs. 5.1 in benefits for each NRs. 1 of its costs. Hence, onion seeds production was economically most profitable as well as viable business than other vegetable seeds in the district.

Market and marketing analysis of vegetable seeds production

After harvesting of the vegetable seeds, now these were made ready for marketing as they got threshed, cleaned and stored in dry place. Then, they were directly filled in sacks in order to packaging. And these were weighing on the balance to sell in required quantity. Finally, the vegetable seeds were ready for marketing.

Form of market and price fixation

The study areas were the perfect market for the vegetable seeds. There were large number of sellers and large number of buyers. In addition, the produced vegetable seeds were not differentiated. The price was fixed according to the market's demand and supply of vegetable seeds by the individual producer. But, the farm under the government i.e. Vegetable Seed Production Center (VSPC), Chapa, fixed the price as per the norms set by Vegetable Development Directorate (VDD), Khumaltar, Lalitpur. Likewise, the seed producer's groups and cooperatives fixed the price of vegetable seeds on mutual negotiation among their members. However, the price was found almost same by virtue of the marketing activities which were carried out by VSPC at cheap and reasonable price in the study areas.

Marketing areas for vegetable seeds

The study found the vegetable seeds produced in the district were sold in more than 15 districts including the capital of the country. The major marketing cities for those vegetable seeds included Kathmandu, Nepalgunj (Banke), Dhangadi (Kailali), Biratnagar (Morang), Pokhara (Kaski) and Chitwan. Similarly, Butwal and Bhairahawa (Rupandehi), Dang, Salyan, Makawanpur, Tanahun, Nuwakot, Dhading, Gorkha and Baglung were the other marketing areas. This proves the national recognition of vegetable seeds produced in Rukum (West) district.

In addition, the seeds produced in the study areas were found to be marketed through different traders and seed companies viz. Rukumeli Agro Seed Center (Dang), Panchashakti Seed Company (Dhangadi), Shree Ram Seed Company (Chitwan), Lumbini Seed Company (Chitwan), SEAN Seed Service Center Limited (Kathmandu), Live Seed Company (Kavre), Anmol Seed Production Company, Api Himal Seed Company and Local Agro-Vets. Similar result was reported by RCCI (2019) in Rukum (West) district. These companies and agro-vets purchased fresh vegetable seeds and then processed and finally re-distributed to the local suppliers for marketing of vegetable seeds over the country.

Marketing channels of vegetable seeds

At the national level, the vegetable seeds enter into Nepalese market from three major sources: government/ formal sectors, farmers/private sectors and import (KUBK, 2016). The vegetable seeds produced in the study areas reached to various markets of Nepal through different channels. In general, local traders or seed companies through their local agent collected the seeds from the production areas. In case of seed companies, they distributed to various market centers and ultimately re-distributed to local suppliers (or agro-vets). While, in case of local traders, they sold to traders at district or regional markets. Then, the seeds again

re-distributed to various market centers and ultimately to the local suppliers (or local traders).

The study also revealed that vegetable seeds were being produced solely by farmers and farmers organized into seed producer's groups and cooperatives. The cooperatives at village level were coordinating with district level traders and seed companies for contract agreement to produce the vegetable seeds. The private sectors such as Rukum (West) Chamber of Commerce and Industries (RCCI), seed companies and traders were helping farmer's linkages with markets. They facilitated backward and forward linkages in seeds value chain. Cooperatives and agro-vets bought the seeds from the local producers as agreed in the contract. This result was in line with those of PMAMP (2018) studies on its project sites in Rukum (West) district.

In addition, it was found that 8.51 percent farmers sold their vegetable seeds directly to seed companies, while majority of farmers (52.13%) sold through local traders (Figure 3). And, remaining 39.36 percent farmers sold their vegetable seeds through farmer's cooperatives. This showed that there was well established farmer's groups and cooperatives network for production and marketing of vegetable seeds in the study areas.

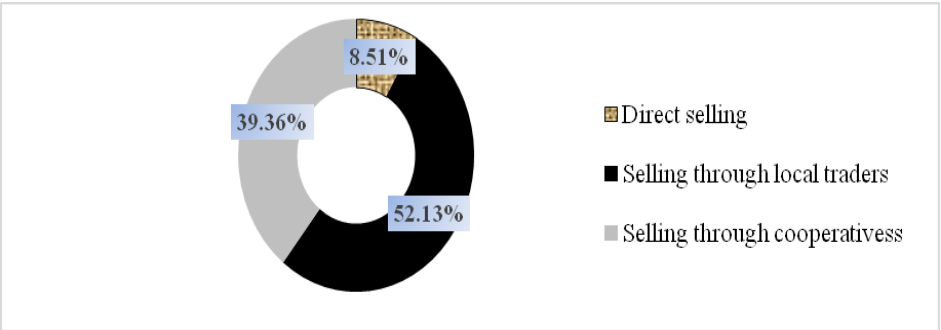

Figure 3. Marketing of vegetable seeds with different actors
Source: Field survey (2019)

However, the findings of current study did not support the previous study of PMAMP (2018), on its project sites in Rukum (West) district that there were no farmers who directly sold vegetable seeds to seed companies whereas, majority of farmers (73 percent) sold through local traders. Meanwhile, Timsina and Sivakoti (2018) found that only 0.6 percent of the farmers sold directly to the seed companies.

Export potentiality of vegetable seeds

The vegetable seeds produced in Rukum (west) district have increased domestic demand and export potentiality. HVAP (2011), further revealed that radish

seeds, particularly the Mino Early variety produced in the Vegetable Seed Production Center (VSPC), Chapa, Rukum (West) were once of export quality and sought by farmers all the way from India besides being exported to Bangaladesh and Qatar.

In addition, KUBK (2016), reported that Nepal exported nearly 14 MT of vegetable seeds (including radish seeds) in 2003 and continued to export till 2008/9 (slightly above 10 MT). The vegetable seeds used to be exported to India, Bangladesh, Germany, Belgium and other countries. But, such a regular trends had not been observed since 2008. Rather, the import of vegetable seeds was observed in recent years.

Marketing cost of vegetable seeds

Marketing cost is the total cost associated with delivering of goods or services to customers (or) expenditure entirely met by the supply chain players to move the product from different levels and ultimately to respective consumers. The marketing cost of the vegetable seeds in the study areas mainly involved the cost of post-harvest activities that was incurred before disposing it to the terminal market (to the consumers), cost of harvesting, packaging (material and labor cost), handling (sorting, cleaning, grading, loading and unloading), transportation and tariff, tax and unseen cost etc. Generally, these components constituted a large share in the total margin between the final retailer price and the cost of production (or farm gate price) especially when the production pockets were at a considerable distance from the market linking roads.

Marketing margin and farmer's share of vegetable seeds

Marketing margin provides an indication of the efficiency of existing marketing systems consideration of it in economic analysis of marketing systems of vegetable seed businesses. The marketing margin also known as retail-farm-gate margin, is the difference between the retail price of a product and the price received by farmers for its vegetable seeds product, which is calculated as follows:

$$\text{Marketing Margin} = \text{Retailer's Price} - \text{Farm Gate Price}$$

Likewise, the farmer's/producer's share gives an important message on the gap between producer's price and price paid by the consumers. It is the ratio of farm gate price to retail price of any product (or commodity). It can be expressed as follows:

$$\text{Farmer's/Producer's Share} = (\text{Farm Gate Price} / \text{Retailer's Price}) \times 100\ \%.$$

It was shown that on an average, the marketing margin (Table 3) was highest in onion seeds (NRs. 675/Kg) and lowest in cress seeds (NRs. 25/Kg). The main reason behind high marketing margin in onion seeds was due to the absence of

seed processing center in the district. Consequently, farmers had to sell vegetable seeds to various seed companies in distant markets. The other factors which were responsible for higher marketing cost and marketing margin of these vegetable seeds might be due to underdeveloped marketing and transportation system, poor infrastructure and highly price instability.

Likewise, the highest farmer's/producer's share in vegetable seeds was recorded for cress seeds (90.00 percent) and the lowest for cauliflower seeds (55.56 percent). This might be caused by either direct selling or low transaction cost incurred during the marketing of the vegetable seeds. High farmer's/producer's share in cress seeds was a reflection of slight gap between the price received by farmers/producers and price paid by the consumers (or seed users).

Table 3. Marketing margin and farmer's share of the vegetable seeds production

S.N.	Vegetable Seeds	Av. Farm Gate Price (NRs./Kg)	Av. Retailer's Price (NRs./Kg)	Av. Marketing Margin (NRs./Kg)	Farmer's Share (%)
1.	Radish	210	262	52	80.15
2.	Onion	1,100	1,775	675	61.97
3.	Cauliflower	500	900	400	55.56
4.	Broad Leaf Mustard	293	475	182	61.68
5.	Turnip	300	500	200	60.00
6.	Cress	225	250	25	90.00
7.	Swiss Chard	300	360	60	83.33

Source: Field survey (2019).

Likewise, the highest farmer's/producer's share in vegetable seeds was recorded for cress seeds (90.00 percent) and the lowest for cauliflower seeds (55.56 percent). This might be caused by either direct selling or low transaction cost incurred during the marketing of the vegetable seeds. High farmer's/producer's share in cress seeds was a reflection of slight gap between the price received by farmers/producers and price paid by the consumers (or seed users).

Value addition in vegetable seeds value chain

Value addition sector has been identified as a thrust area for development needs, huge investments in logistics for supporting the value chain from farm to plate are needed. It was found that the vegetable seeds thus produced got value added through four means viz. form value, location value, time value and information value as well. However, the farmers in the study areas yet practiced traditional method like plastic sacks for packaging the vegetable seeds in order to add more values on the products.

SWOT analysis of vegetable seeds value chain

The vegetable seeds production is affected by various external and internal factors/situation. Some of them are internal to the vegetable seeds sector, which are either helpful in achieving the objectives whereas others are harmful in doing so. At the same time, several other external factors also constrain (or facilitate) the production and marketing of the vegetable seeds (KUBK, 2016). The following SWOT analysis of the vegetable seeds value chain showed (Table 4) a number of strengths and opportunities for boosting value adding interventions. During the designing of the interventions, adequate provisions needs to be created for addressing the weaknesses and threats for the growth of the vegetable seeds.

Table 4. SWOT analysis of vegetable seeds value chin

Strengths	**Weaknesses**
1. Agro-climatic suitability 2. Economic viability/profitability 3. Established producer's group and cooperative 4. Established brand as Rukum Vegetable Seeds 5. Involvement of agro-vets and seed companies 6. National recognition as major vegetable seeds production pocket areas	1. High cost of production 2. Diversity of vegetable seeds 3. Unavailability of skillful manpower and laborers 4. Fragmented land and small sizes of land holdings 5. Lack of irrigation, storage and processing facilities 6. Scattered production limiting the scope for maintaining isolation distance
Opportunities	**Threats**
1. More interests of N/GOs 2. Provision of crop insurance 3. Road accessibility (like as Rapti Highway) 4. Presence of VSPC at Chapa in Rukum (West) 5. Increasing domestic demand of vegetable seeds	1. Unavailability of quality source seeds 2. Price fluctuation and lack of uniformity 3. Problem of hailstorms, diseases and pests 4. Competition with imported seeds from India 5. Increased globalization

Source: Field survey (2019).

CONCLUSION

Rukum (West) district has been recognized as the major pocket areas for the vegetable seeds production in Nepal. Harnessing the climatic suitability, farmers are producing different vegetable seeds profitably. Similarly, considerably large number of value chain actors are also actively engaged in this seed value chain with coordinated efforts and cooperation. Still it shows further potentiality to scale-up vegetable seeds production in terms of production, productivity, quality and profitability among the chain actors with increased collaboration and cooperation among the value chain actors and business enablers.

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Effect of climate change variables on cocoyam farming in Southwest Nigeria

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ABSTRACT

The study examined the effect of climate change variables on cocoyam farming in Southwest, Nigeria. The specific objectives of the study were to describe the farmers perceived effects of climate change on cocoyam farming; identify the activities of the farmers that aggravate the effect of climate change on cocoyam farming and determine the climate change variables influencing cocoyam output in the study area. Multistage sampling technique was used to select 240 cocoyam farmers from two states in the region. Both primary and secondary data were used for the study. Primary data were obtained with the aid of pretested questionnaire while secondary data was collected from Nigerian Meteorological Agency, Ondo State chapter. The analytical tools employed were descriptive and inferential statistics. Results revealed that the major perceived effects of climate change on cocoyam farming in the study area were high intensity of sunlight (2.99), prolonged dry season (2.54), reduction in soil fertility (2.64), rapid erosion of farmland (2.76), poor yield (3.12), increased Pest and rodent attack (2.69), damage of plants due to windstorm (2.86), scarcity of cocoyam (2.95) and post-harvest losses. Continuous cropping (92%), bush burning (91.1%), use of agrochemicals (70.5%) and deforestation (62.5%) were the major farming activities that worsen the effect of climate change on cocoyam farming in the study area. The significant variables determining climate change variables that influence cocoyam output in the study area were relative humidity ($p<0.05$), wind ($p<0.01$), pressure ($p<0.05$), sunshine ($p<0.05$) and rainfall ($p<0.01$). The study concluded that climate change had both positive and negative influence on cocoyam farming in the study area and recommended that awareness programs and policies to regulate the anthropogenic practices that worsens the effects of climate change variables on cocoyam farming in the study area should be put in place by government at all levels.

Key words: Climate change, cocoyam, output, Southwest, Nigeria

INTRODUCTION

Climate is the average weather condition recorded over a period of time usually 35 years (Adebayo, 2012). Temperature, rainfall, sunshine, water, air and relative humidity are the climatic variables which serves as main drivers of crop

growth and yield. According to intergovernmental panel on climate change (IPCC, 2007) climate change is variation in the frequency and significance of recurrent weather events as well as the gradual perpetual rise in global average temperature. Conversely, the United Nations Framework Convention on Climate Change (UNFCCC, 1992) considers climate change as a change of climate ascribed directly or otherwise to human exertion that modifies the composition of the global atmosphere, in addition to natural climate variability observed over relative period of time. Climate change is one of the most deleterious factors that severely inhibit maximum production from agricultural activities (Eze *et al.*, 2016). Climate variables play an important role in ascertaining the productivity of agricultural crops. Agricultural production in Nigeria like in other developing countries is rain-fed and inclined to climate change (Ozor, 2009). Farmers depend on weather signal for their farming activities for instance the onset of rain ushered in the planting activities for a season (Ifeanyi-Obi & Togun, 2017). The effect of the climate variabilities on crops includes increased incidence of disease and pest infestations, inconsistency in rainfall pattern, increased temperature, increased sunlight intensity, increased flooding and erosion, prolonged drought, loss in biodiversity, loss of soil moisture and nutrition content, reduced income and so on (Abaje & Giwa, 2007; Onyeneke & Madukwe, 2010).

Cocoyam (*Colocasia esculenta* "taro" and *Xanthosoma sagittifolium* "tannia") belong to the Araceae family, an important staple food in the plant family, grown in South Eastern and South Western part of Nigeria (Chukwu *et al.*, 2009). Cocoyam ranks third in importance after cassava and yam among the root and tuber crops cultivated and consumed in Nigeria (FAO, 2005b; Okoye *et al*., 2008). Cocoyam is a useful cover crop and the corms are ready to harvest in 8 to 12 months (Uguru, 1996). It is one of the major five tuber crops produced in Nigeria for local consumption alongside yam (*Discorea spp*), Cassava (*Manihot esculenta*), Irish potato (*Solanum tuberosus*) and Sweet potato (*Ipomea batata*) and specifically referred to as Nigeria's giant crop because it is nutritionally superior to other roots and tuber crops in Nigeria (Agbelemoge, 2013). Nigeria is the largest producer of cocoyam in the world with an annual production of 5.49 million metric tonnes equivalent to 45.9% of the world's production and 72.2% of West Africa's total output. Relative to cassava and yam, cocoyam contains higher contents of protein, phosphorous, vitamins and easily digestible starch while the root is rich in carbohydrates and minerals (Ezedinma *et al.*, 2006). It can be consumed in various forms when boiled, fried, pounded, roasted and can be processed into cocoyam flour and chips (Ume *et al.*, 2016). The leaves are used as vegetables in form of spinach for soup preparation in various parts of the world (Ukonze, 2012). It is highly medicinal for diabetic patients, persons with intestinal disorders, the aged, and recommended for children with allergy (Ume *et al.*, 2018). Despite the nutritional importance of cocoyam, their advantage over other tuber crops, its potentials for poverty alleviation and food security abilities, its growth is often threatened with drought, excessive rainfall, and pest and diseases infestation, increased temperature occasioned by climate

change resulting to poor yield of cocoyam. Hence, there is a need to examine the effect of climate change variables on cocoyam production in Southwest region of Nigeria. The specific objectives of the study were to describe the farmers perceived effects of climate change on cocoyam farming in the study area; identify the activities of the farmers that aggravate the effect of climate change on cocoyam farming; and determine the climate change variables influencing cocoyam output in the study area.

MATERIALS AND METHOD

The study was carried out in Southwest Nigeria. The region is made up of six states, namely, Lagos, Ogun, Oyo, Osun, Ondo and Ekiti. It lies between longitude $2^0\ 3^1$ and $6^0\ 00^1$ East and latitude $6^0\ 2^1$ and $8^0\ 37^1$ N with a total land area of 77,818 km^2 and a population of 38,257,260 (NPC, 2016). The study area is bounded in the East by Edo and Delta states, in the North by Kwara and Kogi states, in the West by the Republic of Benin and in the south by the Gulf of Guinea. It has two distinct seasons which are: rainy season (April-October) and dry season (November-March). The temperature in the zone ranges between 21°C and 34°C while the annual rainfall ranges between 150 and 3000 mm with high humidity of 77 percent. Agriculture was the main stay of the zone's economy.

Multistage sampling technique was used to select respondents for the study. The first stage involved the random selection of two states (Ondo & Ekiti) from the six states in the zone. In the second stage, two agricultural zones were selected from each State through random sampling technique. The third stage involved the use of simple random sampling technique to select one Local Government Area (LGA) from each agricultural zone using the list of LGAs available in the agricultural zone as sampling frame. In the fourth stage, five villages were purposively selected from each of the LGAs giving a total of 20 villages. The basis of selection was the dominance of cocoyam production in these villages. Finally, in the fifth stage, a simple random sampling procedure was used in choosing 12 cocoyam farmers from each of the 20 villages giving a total of 240 farmers for interview using the list of cocoyam farmers from the village extension agents as the sample frame. However, a total of 224 respondents were used for analysis as others were discarded due to incomplete information and non-responsiveness of some respondents.

Both primary and secondary data were used in the study. The secondary data were collected from Nigerian Meteorological Agency, Ondo State chapter, to elicit latest information on climate changes. The primary data were obtained from a field survey through the use of a pretested questionnaire and focus group discussion. The questionnaire was designed to elicit information on the socio economic characteristics of the farmers, cocoyam farmers' activities, and

climate variables affecting cocoyam farming and perceived effects of climate change on cocoyam farming in the study area.

The following analytical tools were employed for data analysis:
Descriptive statistics such as frequency and percentages was used to analyze cocoyam farmers' activities that worsen effect of climate change variables in the study area

Likert-Scale: A 4-point Likert scale was used to measure the farmers' perceived effects of climate change on cocoyam farming. The farmers were asked questions graded on a four point likert scale, the responses were highly severe, moderately severe, less severe and not severe. The responses were given scores of 4,3,2 and 1, respectively. The mean score was 4+3+2+1 = 10/4 = 2.5 (cut-off point). Therefore, using the cut-off point value of 2.5, effects with mean score less than 2.5 were not severe while those with mean score of 2.5 and above were severe.

Multiple Regression Model: This was used to determine the climate change variables influencing cocoyam output in the study area.
The model is specified as:
$Q = f(X_1, X_2, X_3, X_4, X_5, X_6, e)$ (1)

Where Q = Cocoyam Output (kg)
X_1 = Relative humidity (%), X_2 = Wind (M/S); X_3 = Pressure (N/M^2); X_4 = Sunshine (Kg); X_5 = Temperature (^0c); X_6 =Rainfall (mm); e = error term

Four functional form of the models: Linear, Exponential, Double Log, Semi-log were fitted and the best of the 4 functional forms was selected based on: Economic criteria in terms of a-priori expectation of signs of coefficient; Statistical criterion in terms of values of coefficient of multiple determination (R^2) and F-test statistics.

RESULTS AND DISCUSSION

Perceived effect of climate change variables on cocoyam production

The result in Table 1 reveals that the major effects of climate change variables on cocoyam farming perceived by cocoyam farmers in the study area based on the cut-off point of 2.5 were high intensity of sunlight (2.99), prolonged dry season (2.54), reduction in soil fertility (2.64), rapid erosion of farmland (2.76), poor yield (3.12), increased Pest and rodent attack (2.69), damage of plants due to windstorm (2.86), scarcity of cocoyam (2.95) and post-harvest losses. The implication of this result is that, high intensity of sunlight, excessive rainfall and high windstorm witnessed in the Southwestern region as a result of climate change resulted to prolonged dry season leading to drought; erosion of top soil leading to reduction in soil fertility; damage/breakage of plants due to windstorm and post-harvest losses particularly during storage due to high heat

intensity. The end results are poor yield leading to scarcity and high price which negatively impacts the availability, accessibility, affordability and utilization of cocoyam in the region. This result agrees FAO, (2008) report that climate change affected all components of food security, namely, availability of food, access to food, utilization of food, food systems stability and malnutrition. Similar results were also reported by Eze *et al.*, (2016), Okringbo *et al.*, (2017), Ifeanyi-Obi & Togun (2017)

Table 1. Perceived effects of climate change on cocoyam production in the study area

Effects	Mean	Std. Deviation
High intensity of sunlight	2.99	0.493
Prolonged dry season	2.54	0.568
Reduction in soil fertility	2.64	0.626
Rapid erosion of farmland	2.76	0.913
Uncertainty in harvest time	2.02	0.502
Increased pest and rodent attack	2.69	0.764
Increased weed growth	2.17	0.709
Damage of plants due to windstorm	2.86	0.529
Poor yield	3.12	0.668
fire outbreak	2.42	0.639
Post-harvest losses	2.75	0.691
Shift to substitute crop	2.24	0.713
Scarcity of cocoyam	2.95	0.613
Reduced home consumption	2.28	0.808
Likelihood of extinction of cocoyam	1.99	0.474

Farmers' activities that aggravate the effect of climate change on cocoyam farming

Table 2 presents results on farming activities that worsen the effect of climate change on cocoyam farming in the study area. The result shows that continuous cropping (92%) was the highest activity of the cocoyam farmers that worsen the effect of climate change on cocoyam production in the study area. This implies that, not practicing fallow system of farming due to inadequate farmland can worsen the effect of climate change of cocoyam farming in the study area. This was followed by bush burning (91.1%); bush burning can cause the soil to lose its ability to absorb and retain water, washes away the top soil, exposes the soil wind and water erosion, increases the soil temperature, causes loss of soil nutrients and increases soil's pH. Use of agrochemicals (70.5%) is another farmers' activity aggravating the effects of climate change on cocoyam farming. Agrochemical contaminates soil, water, aquatic organisms and beneficial organisms. Deforestation (62.5%) which exposes the farmland to erosion and loss of biodiversity is also part of cocoyam farmers' activities that worsen the effect of climate change in the study area. other activities were use of firewood (32.1%) and burning of waste (22.3%). This is line with the findings of Elijah *et al.*, (2018). This result is an indication that human activities are major factors

leading to upsurge in the adverse effects of climate change in agriculture and its attendant on the society as a whole.

Table 2. Farmers' activities that aggravate the effect of climate change on cocoyam production

Activities	Frequency	Percentage
Bush burning	102	91.1
Continuous cropping	103	92.0
Burning waste	25	22.3
Use of agrochemicals	79	70.5
Deforestation	70	62.5
Use of firewood	36	32.1

Determinants of climate change variables influencing cocoyam output

Table 3 presents the result of the multiple regression analysis used to determine the climate change variables influencing cocoyam output in the study area. In estimating the production function, four functional forms; linear, semi-log, double-log and exponential were fitted. However, the double-log model was chosen as the lead equation because it had more number of significant variables which conform to the a-priori expectations, highest coefficient of determination R^2 and significant F value. The F-statistics of 39.476 was significant at 1% level of significance indicating that the model fits the data well. The coefficient of determination R^2 of the lead equation was 0.732. This implies that, about 73% of the variation in cocoyam output was explained by the climatic variables included in the model. The significant variables determining climate change variables that influence cocoyam output in the study area were relative humidity ($p<0.05$), wind ($p<0.01$), pressure ($p<0.05$), sunshine ($p<0.05$) and rainfall ($p<0.01$).

The coefficient of relative humidity was found to be positive and significant at 1percent alpha level. This implies that relative humidity increases the output of cocoyam in the study area. The result agrees with the findings of Ogunniyi and Omoteso (2011) that relative humidity is capable of controlling transpiration and photosynthesis ability of plants. Ume *et al*., (2018) also reported that relative humidity is capable of impacting crop performance, excessive dryness and rain formation. The coefficient of pressure and sunshine also had direct significant relationship with cocoyam output at 5% alpha levels respectively. This implies that cocoyam output increase with the increase occurrence of these climate variables in the study area. This result concurred with the findings of Iwena (2015); Eze *et al.,* (2016) that long duration of sunshine is essential for cocoyam growth as it influences the photosynthesis and evapo-transpiration abilities of the crop thereby increasing output.

On the other hand, the coefficient of wind had an indirect significant relationship with cocoyam output at 1% level of significance in the study area. This implies that cocoyam output decrease with high windstorm and vice versa. High windstorm blows away top soil and causes physical damage/breakage to

plants. In the like manner, coefficient of rainfall had an inverse relationship with cocoyam output in the study area. This implies that increasing volume of rainfall decrease cocoyam output and vice versa in the study area. Excess, inadequate and irregular rainfall as a result of climate change could cause water logging, erosion, flood, drought and stunted growth of cocoyam, thereby reducing the output and productivity of cocoyam in the study area. Erratic rainfall especially during the growing stages could cause crop failure Molua and Lambi (2006). This result corroborates the findings of Akanda and Howlader (2015) that high rainfall encourages the growth of disease causing organisms (Pathogens), increases leaching of plant nutrients, water logging in clay soil and increase in the incidence of erosion

Table 3. Determinants of climate change variables influencing cocoyam output in the study area `

Variable	Linear	Semi log	Double log	Exponential
Constant	36046.157 (0.406)	-748843.195 (-1.652)	7.343 (2.181)	11.659 (18.879)
Relative humidity (%)	-78.297 (-0.237)	11429.337 (0.576)	0.293** (2.105)	0.003 (1.130)
Wind (m/s)	-19734.483*** (-8.368)	-1704.606*** (-8.004)	-1.350*** (-9.030)	-0.156*** (-9.543)
Pressure (mmHg)	296.349*** (2.968)	182543.053** (2.245)	1.286** (2.251)	0.002*** (2.926)
Sunshine (%)	-143.247 (-0.434)	-14201.901 (-0.952)	0.224** (2.140)	-0.003 (-1.261)
Temp (°C)	1825.184 (0.506)	12650.879 (0.166)	-0.463 (-0.864)	-0.005 (-0.204)
Rainfall (mm)	-18.934 (-0.354)	-690.105 (-0.192)	-0.015*** (-2.576)	.000 (-0.462)
R^2	0.652	0.651	0.732	0.686
Adj. R^2	0.632	0.631	0.693	0.669
F	32.728	32.683	39.476	38.318

**** Significant at 1%, **5%*

CONCLUSION AND RECOMMENDATIONS

The study revealed that cocoyam farmers contributed to the adverse effects of climate change on their crop as their activities such as continuous cropping, bush burning, use of agrochemicals and deforestation worsen the effects of climate variables on cocoyam production in the study area. The study however concludes that climate change had both positive and negative influence on cocoyam farming in the study area as its variables such as relative humidity, pressure and sunshine increase cocoyam output while climate change variables such as wind and rainfall decrease cocoyam output in the study area.

The study therefore recommends that:

1. Awareness programs and policies to regulate the anthropogenic practices that worsens the effects of climate change variables on cocoyam farming in the study area should be put in place by government at all levels.

2. Federal government should invest more on modern meteorological equipment and organize adequate training programs for the meteorological personnel for accurate and timely weather forecast as well as information that would help the farmers plan and prepare ahead for the farming season, for instance, time to plant in the study area.
3. Agricultural extension officers should be encouraged to include climate change information in their focus for timely dissemination of same to farmers.

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Comparative economics of tomato production under polyhouse and open field condition in Dhading district of Nepal

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ABSTRACT

Tomato (Lycopersicon esculentum) is one of the common high value vegetables being cultivated under different production system in mid hills of Nepal including Dhading. A study was conducted during October 2019 to compare economics of tomato production under polyhouse and open field condition in three different municipalities of Dhading district. Total of 80 tomato growers, 40 from each category of production system were selected randomly for the study. Data were collected through face to face interview method using semi-structured questionnaire. The estimated cost of production of tomato per ropani in open field farming was Rs 19955.75 and Rs 58791.01 in polyhouse farming. The gross return per ropani of tomatoes in open field farming was Rs 42623.21 which is less than that of tunnel farming i.e. Rs 134279.90.The BCR was higher in polyhouse farming (2.28) compared to open field (2.06). Among the factor cost, labor was found to contribute highest in both the production system whereas seed cost and machinery and bullock cost was found to be significant contributors in open field condition (P value < 0.05). Similarly, labor cost and machinery cost were found to be significant factors in polyhouse (P value < 0.05) to contribute in total revenue. The study revealed that polyhouse tomato production is more profitable and coupled with many other advantages in the study area.

Keywords: Tomato, polyhouse, questionnaire, revenue, BCR

INTRODUCTION

Vegetables are cultivated in almost all agricultural regions. Available data from (MOAD, 2016) revealed that the area of vegetables in Nepal is continuously increasing since 1991/92 in Nepal but the production is increasing at faster rate than the cultivated area. Among such cultivated vegetables tomato production is increasingly grown in most of the places in Nepal, including Dhading district. Tomato is a labor intensive crop, wage alone constituting half of the total cost of production. Production peaks in summer in the Hills (from May to September)

when it is off-season in Terai. On the other hand, it can be produced in the Terai in winter (from November to March) when it is too cold in the Hills. The crop is majorly grown in open field and under polyhouse. The practice of growing tomato in open field is more common than growing in polyhouse. Polyhouse tomato cultivation is emerging farming practice among Nepalese farmer in the District. The tomato grown and produced in plastic tunnels are sold as off-season product fetching higher prices in general. It is one of the viable alternatives for quality tomato production in Mid and High hills of Nepal (Chapagain et al., 2011) because of relatively higher market potential due to appropriate size, bright color pattern and, shining appearance than the tomatoes produced in open area in the country. According to (MOAD, 2018), the area of tomato cultivation, total tomato production and yield of tomato per hectare were 771 ha, 13,762 mt/ha and 18mt/ha respectively which was highest among all other vegetables grown in Dhading district. Because of the increase in demand of fresh fruit for daily consumption and as a raw material for different agro-based industries, increased awareness on nutritive value of the tomato, food diversity behavior of the consumer and the increased purchasing power of the consumer might be the major cause for increased demand.

METHODOLOGY

The area of this study included Jeewanpur (Dhunibesi municipality), Panditpauwa, Musurekot, Koiralathok, Jafatey (Thakrey rural municipality), Chakmake, Pipley, Asarey (Galchi rural municipality) of Dhading district. A list of tomato producers was prepared from farmer group's membership list which served as study population from which 40 growers adopting plastic tunnel and 40 growers growing tomato in open field were randomly selected. Primary information was collected with pre-tested questionnaire and face to face interview method with the respondents. The collected information was tabulated, coded and entered into the computer and the final following analysis was done using computer software Statistical Package of Social Science (SPSS) and Microsoft Excel.

Cost of production

The total cost of production was calculated by using following equation 1.

TC=TVC+TFC ……. Equation 1

Where,

TC= Total Cost

TVC = Total Variable Cost which included all the running costs such as costs of input materials, fertilizers and manures, pesticides, human labor, bullocks and machineries and transportation cost.

TFC = Total Fixed Cost which included the land rent, depreciation on farm equipments and interest on initial investment.

Profitability analysis

The study uses gross margin and net profit to determine and compare the profitability levels for both tunnel and open-field tomato production systems. Following functional forms was adopted from Adhikari, 2013; Kumar, Chauhan and Grover, 2016, Ali et al., 2017 to calculate the gross margin and net profit.

GM=TR-TVC …… equation 2

Where, GM is gross margin; TR is Total Gross Revenue; TVC is Total Variable Costs

NP = GR – TC …… equation 3

NP = P*Q -TC

Where,

NP = Net profit

GR = Gross Revenue = selling price (P) * Quantity produced (Q)

TC = Total Cost

Benefit cost ratio

This is a ratio obtained when the present worth of the benefit stream is divided by the present worth of the cost of stream. It measures the worth of project.

B: C ratio=$Gross\ revenue/Total\ cost$ **…… equation 4**

Problems of production system

Open field tomato producers and tunnel tomato producers and distributors both face problems, these problems are to be listed and ranked by using index. The index was prepared mainly taking the qualitative data into account. The problems faced in farm and market were ranked by using scaling technique comparing intensity of severity using scales values 1.00, 0.75, 0.50, 0.25, 0.00 for most serious, serious, moderate, a little bit, and no problem at all respectively. And the intensity of problem was computed by using formula (Adhikari, 2012).

$I_{prob} = \sum \frac{S_i \times F_i}{N}$ **…… equation 5**

Where, I= index 0 to 1,

S_i= scale value at i^{th} severity,

F_i= frequency of the i^{th} severity

N= total number of respondents.

Analysis of factor share to total output

To determine the contribution of different inputs as well as for the estimation of the efficiency of variable production input in two different production system, Cobb-Douglas production function was used (Adhikari, 2013, 2012; Ali, Ashfaq and Khan, 2017; Dhakal et al., 2019; Gujarati, 2009). The general form of Cobb-Douglas production function (equation 5) was used to determine resource productivity, efficiency and return to scale.

$Y=aX_1^{b1}X_2^{b2}X_3^{b3}X_4^{b4}X_5^{b5}X_6^{b6}e^u$ …… equation 5

Where, Y= Gross return (Rs./ropani),X_1=Cost on seed (Rs. /ropani), X_2=Cost on Fertilizer (Rs. /ropani), X_3= Cost on manure (Rs. /ropani), X_4= Cost on machinery and bullock (Rs. /ropani), X_5=cost on labor (Rs. /ropani),X_6=cost on transportation, (Rs. /ropani),e= base of natural logarithm, u=random disturbance term, a=constant and b1, b2...b7 are coefficient of respective variable.

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

The percentages of female respondents were higher in both the production system i.e. 65%in open field farming and 55%in polyhouse farming. The average age of respondents in open field farming was 42.07 years and that of polyhouse farming was 40.92 years. Illiteracy rate was higher among the farmers from open field farming than polyhouse farming. The average year of experience of open field farming was 15.9 years and polyhouse farming being the recently introduced production system had the average year of experience of 3.8 years. The average area of tomato farming in open field farming and polyhouse farming was 1.9 ropani and 0.3 ropani respectively.

Cost and return analysis

Cost of production of tomato per ropani in open field farming was Rs19955.75 which was significantly lower than that of polyhouse farming (Rs 58791.01). The variable cost per ropani was Rs 17329.03 in open field farming which was significantly less than polyhouse farming (Rs 35788.81) Total fixed cost per ropani in polyhouse farming was Rs 23002.19 which was significantly higher than in open field farming (Rs 2626.71). The analysis of the total variable costs of production reveled that the main cost items in open field were input costs, transportation and harvesting. In polyhouse cultivation the main cost items were fixed cost, inputs costs, maintenance and cultural operations.

Per ropani yield of tomatoes in open field farming was 866.42 kg which is significantly less than that of polyhouse farming i.e. Rs 2173.75. The average per kg price of tomatoes produced from open field farming was Rs 47.62 and that of polyhouse farming was Rs 60.75 .The gross return, gross margin and net profit from the open field farming was Rs 42623.21, Rs 25294.18, and Rs 22667.46 respectively and that of polyhouse was Rs 134279.90, NRs 98491.09, and Rs 75488.89 respectively. The BCR was higher in polyhouse farming (2.28) compared to open field farming (2.06).

Problem ranking

Among the 9 problems listed in the survey the major problem that was ranked highest was disease and pest (0.93) and was considered most serious problem followed by lack of proper market (0.89) which was even considered as one of the serious problem in open field farming. Similarly in polyhouse farming as disease and pest was ranked highest (0.80) and considered as a most serious problem followed by quality seed materials (0.75). Other problems like

availability of fertilizers, irrigation, inappropriate marketing channels, and labor availability were also considered as major problems in both the system of production. When the problems from both the production system were pooled occurrence of disease and pest remained at first followed by inappropriate marketing channel and so on.

Table 1. Comparative analysis of cost of production of tomato (Rs/ropani) in two different production system

Parameters (Unit)	Polyhouse system	Open Field system	Mean difference	t-value	p-value
Total variable cost (Rs/ropani)	35788.81	17329.03	8459.77**	13.57	0.000
Total fixed cost (Rs/ropani)	23002.19	2626.71	20375.48**	22.33	0.000
Total cost of production (Rs/ropani)	58791.01	19955.75	38835.26**	20.25	0.000
Total average yield (kg) (Rs/ropani)	2173.75	866.42	1307.32**	9.38	0.000
Average SP (Rs/ropani)	60.75	47.62	13.12**	6.62	0.000
Gross return (Rs/ropani)	134279.90	42623.21	9032.03**	10.14	0.000
Gross margin (Rs/ropani)	98491.09	25294.18	73196.91**	8.63	0.000
Net profit (Rs/ropani)	75488.89	22667.46	52821.43**	6.37	0.000
Benefit Cost Ratio	2.28	2.06	0.22	1.32	0.189

***Note**: ** indicates significant at 95% confidence interval (p<0.05). Figures in parentheses indicate the standard deviation of the means.*

Factor share to total revenue

The Cobb Douglas production function model was found to be the best fit since the F-ratio was significant (at 5% level of significance).For open field the coefficient of multiple determination(R^2) was found to be 0.572 which indicates that the 57.2% variation in the dependent variables was described by the explanatory variables included in the model. It was found that seed and machinery and bullock have significant contribution in total revenue whereas fertilizer, manure, labor and transportation were not found to have the significant contribution to total revenue. Similarly, for polyhouse tomato farming the coefficient of multiple determinations (R^2) was found to be 0.604 which indicates that the 60.4% variation in the dependent variables was described by the explanatory variables included in the model. Among the six independent variables; seed, fertilizer, manure, machinery and bullocks, labor and transportation, labor and machinery and bullock has significant contribution in total output.

Table 2. Comparative problem ranking in between two production system of tomato

Problems	Open field		Polyhouse		Pooled	
	Index value	Rank	Index value	Rank	Index value	Rank
Availability of fertilizers and manures	0.31	6	0.51	5	0.41	6
Disease and pest	0.93	1	0.80	1	0.86	1

Inappropriate marketing channel	0.82	3	0.68	4	0.7	2
Irrigation	0.19	7	0.41	7	0.3	8
Labor availability	0.15	8	0.24	8	0.18	9
Lack of proper market	0.89	2	0.71	3	0.64	3
Problem of transportation	0.41	5	0.44	6	0.42	5
Quality seed materials	0.49	4	0.75	2	0.62	4
Soil fertility	0.14	9	0.23	9	0.4	7

Note: *Scale value range from 1.00 to 0.00, where 1.00= most serious, 0.75= serious, 0.50= moderate, 0.25= little bit and 0.00= no problem at all.*

Table 3. Factors share to total output in open field tomato farming

Variables	Estimated coefficient	Standard error	t-statistics	p-value
Constant	1.316	1.986	0.662	0.512
Seed	0.198**	0.102	1.945	0.040
Chemical fertilizer	-0.035	0.117	-0.299	0.766
Manure	0.189	0.116	1.633	0.111
Labor	0.228	0.208	1.099	0.279
Machinery and bullock	0.299**	0.129	2.318	0.026
Transportation	-0.158	0.163	-0.964	0.341

Multiple R= 0.756 R square= 0.572 Adjusted R= 0.534 F-ratio= 7.350 ** Significant at 5% level of significance ($p<0.05$)

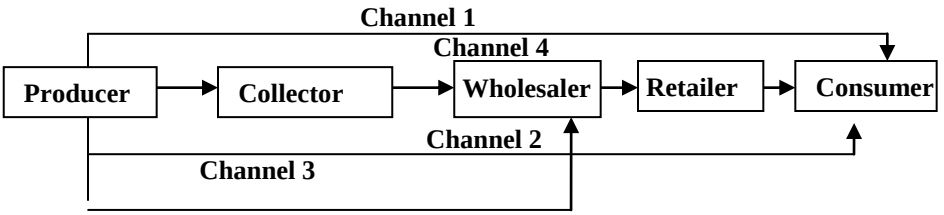
Table 4. Factors share to total output in polyhouse tomato farming

Variables	Estimated coefficient	Standard error	t-statistics	p-value
Constant	2.023	2.721	0.633	0.530
Seed	-0.060	0.133	-0.453	0.653
Chemical fertilizer	0.1452	0.141	1.023	0.313
Manure	0.115	0.122	0.946	0.350
Labor	0.496**	0.193	2.566	0.015
Machinery and bullock	0.364**	0.150	2.413	0.021
Transportation	-0.098	0.150	-0.654	0.517

Multiple R= 0. 778 R square= 0.604 Adjusted R= 0.578 F-ratio= 7.077(** sig at $p<0.05$)

Marketing channel and Market

Both open field farmers and polyhouse farmers sell their produces (tomato) through different marketing channel like self marketing, consumer in field, seller in local market, seller to outside market. Following are the marketing channels adopted by the farmers:



Majority of the open field farmers used channel 3 and channel 4 for marketing tomatoes whereas polyhouse farmers mostly used channel 1 and channel 2 for their product marketing as polyhouse produced tomatoes were off seasonal and gained market within village. Major markets were farm gate, village market, outside market and farmers group. Polyhouse produced tomatoes being off seasonal gained market within village whereas the open field tomatoes were sold to outside markets mostly.

CONCLUSION

The gross return, gross margin and net profit were more in polyhouse farming in comparison to open field farming. Regardless of the high cost of cultivation of polyhouse farming it turns out to be profitable in future. The cost of production of tomato in polyhouse was 66.05% higher than open field farming this might cause farmers to rethink about their future preference of choosing polyhouse tomato production system but increase in yield in polyhouse by 60.14% than open field farming convinces their choice of choosing polyhouse system of tomato production in future is appropriate. Not only this in this study we found that the yield, gross return, gross margin and net profit from polyhouse farming of tomato was 60.14%, 68.25%, 74.32% and 69.97% respectively higher than that of open field farming. Among the factor cost, labor cost was found to contribute highest in both the production system whereas seed cost and machinery and bullock cost was found to be significant contributors in open field condition (P value < 0.05). Similarly, labor cost and machinery cost were found to be significant factors in polyhouse at (P value < 0.05) to contribute in total revenue. The yield per ropani of tomato increases, increasing the average selling price in off season, hence compensates for the initial investment. The positive BCR in both the production system indicates profitability of tomato production. Higher the BCR in polyhouse tomato farming higher is its profitability than the open field farming.

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The impact of potato-based cropping system on livelihood and income generation at Tamankhola rural municipality, Baglung

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ABSTRACT

The impact of potato-based cropping system on livelihood and income generation in Tamankhola Rural Municipality, Baglung was conducted in Tamankhola of Baglung district from15th June to 18th July, 2018 using research tools such as questionnaire interview, focus group discussion, direct observation and review of literatures. Altogether 100 HHs were selected for this study through simple random sampling method for field survey. Study showed poor access of HHs to assets. Primary source of income in Tamankhola was agriculture and animal husbandry followed by remittance. The present agriculture business in Nepal is subsistence based. Due to poor economy of the farmer, lack of education and training about scientific crop production and management, outbreak of disease, poor marketing system; there is less development in the agriculture sector in Nepal. The potato based cropping system in Tamankhola rural municipality is very unique as they cultivated potato without making bunds and maize seed are sown in the same field after 2 months. Despite potato has great potential to serve in food security and nutritional value. Less attention has given to lunch the program to improve and increase the production of potato. Lack of improved variety is the common problem of the potato producer farmer. In the study area it was found that economic of the potato farmer is minimum 15000 and maximum is 300000 in a season. Most of the households have used the income in house expenditure and also spending their income in children's education, to pay debt, improving agricultural field and even buying new land and constructing new houses. All these factors are definitely positive trends of improvement in the livelihood of farmer, which potato cultivation have made possible. Potato cultivation has increased the income of the farming households and is able for utilization of income in various activities.

Key words*:* Potato, production, cropping system, livelihood, food insecurity

INTRODUCTION

Agriculture is dominant player of the Nepalese economy. It contributes about 27% shares to the gross domestic product (GDP), and employs 66% of the total population. It serves as the major source of raw materials to most of the agro-based industries. Among the agricultural commodities horticultural crops play a significant role in improving the livelihood of the farmers in general and economic growth of the country (MOAC, 2018/2019). Cash crop like tea, sugarcane, oilseed, potato, tobacco and jute are also most important crops in Nepal. Potato covers more than half area of cash crop. It is cultivated in two seasons per year. Potato crop plays the significance role in the economic activity of the rural area. Throughout the developing world too, the relative importance of high value agricultural commodities is increasing (Gulati, 2006).

Potato (*Solanum Tuberosum* L.) is considered as one of the fourth most important crops in the world after wheat, rice and maize. It is one of the important cash crops to address food insecurity and reduce poverty among smallholder farmers in the developing countries like Nepal. It is grown in 185,879 hectares (ha) with 13.95 Mt/ha productivity and 2,591,686 mt. productions in Nepal. In Baglung district, it is cultivated in 3,000 ha, productivity of 11.87 ton/ha with the total production of 35,610 mt (MOAD, 2016/2017). In the Nepalese context, it is believed that nearly 200 years ago potato was introduced in Nepal. While ranking the important crops of Nepal, Potato occupies the sixth position in the area coverage, fourth in total production and first in the productivity. Potato is grown in all the 77 districts from lower to high hills up to 4,400 meter from the sea level. It can be grown in various kind of soil, although sandy loam or silt loam is regarded best potato cultivation. A comparatively high yield can be achieved during a short period of time (3-4 months). In some areas, potatoes are grown 2-3 times in a year.

Potato is grown as a major staple crop in the high hills and mountains since other crops are not very successful. In hilly areas potato are cultivated mainly from tuber and farmers don't cultivate seed potato separately rather they sort out potatoes for seed from the same lot harvested. The cropping system and crop rotation of potato is very interesting. In the mountainous region, where potato is grown as a main summer crop, it fits well in a cropping system of two years rotations with wheat - barely in the first year and maize in the second year. In hills, the crop under irrigated and rain- fed conditions potato is grown as a winter crop and fitted in a cropping system of one-year rotation (EAD, Economic Analysis Division).

Potato is a cool-season crop. The rate of development of the sprouts from seed pieces depends on soil temperature. Very little sprout elongation occurs at 43oF (6oC), elongation is slow at 40oF (9oC) and is maximized at about 64oF (9oC) and is minimized at about 64oF (18oC). The optimum soil temperature for initiating tubers is 61-66oF (16-19oC). Tuber development declines as soil temperatures rise above 68oF (20oC) and tuber growth practically stops at soil temperatures above 86oF (30oC). The number of tubers set per plant is greater at lower temperatures

than at higher temperature, whereas higher temperatures favor development of large tubers. Yields are highest when average daytime temperatures are about 69oF (21oC). Cool night temperatures are important because they affect the 10 accumulation of carbohydrate and dry matter in the tubers. At lower night temperatures, respiration is slowed, which enhances storage of starch in the tubers. Potato plants are herbaceous perennials that grow about 60 cm (24 in) high, depending on variety, with the leaves dying back after flowering, fruiting and tuber formation. They bear white, pink, red, blue, or purple flowers with yellow stamens. In general, the tubers of varieties with white flowers have white skins, while those of varieties with colored flowers tend to have pinkish skins. Potatoes are mostly cross-pollinated by insects such as bumblebees, which carry pollen from other potato plants, though a substantial amount of self-fertilizing occurs as well (Tony Winch, 2006).

MATERIALS AND METHODS

Tamankhola rural municipality lies in the North West part of Baglung district. Before federal structure, there were three locations namely, Bungadobhan, Taman and Khungkhani and at the present time, this is structured as Tamankhola rural municipality which includes six wards. It borders Myagdi district in north and east, while Dhorpatan municipality is in south and west sides. The total area of Tamankhola rural municipality is 178 km2 with 10,659 total populations (CBS, 2011).

The study was conducted mainly by collecting primary data supported by secondary data. The primary data were collected from the field survey while secondary data were collected by reviewing of various published as well as unpublished documents, reports, testimonials and research papers related to the study. On the basis of the consultation with advisor a standard questionnaire was prepared. Pre-testing of questionnaire was carried out and modification was made before the actual field survey. Thus a set of prertested semi-structured questionnaire was used to gather relevant infotmation from the targeted areas. Survey was conducted with randomely selected 100 respondents.

RESULTS AND DISCUSSION

Reason and opportunities of potato cultivation

The potato is staple food of high hill of Nepal. Respondent showed several reasons for choosing potato cultivation in their field. Majority of the respondents i.e. 48 percent reported that it was due to high income where as 20 percent respondent said that it was because they had no other occupation. Similarly 24 percent respondent chose due to climatic suitability and 8 percent chose due to availability of supports from NGOs and INGOs etc.

Years involved in potato production

From the survey it was found that subsistence farming of potato in the district has been more than 80 years. While commercial farming of potato production has just started in the district. Only 8 percent respondents were found cultivating potato since more than 20 years ago. But 58 percent of respondents have just started potato cultivation from the year 2067/68.

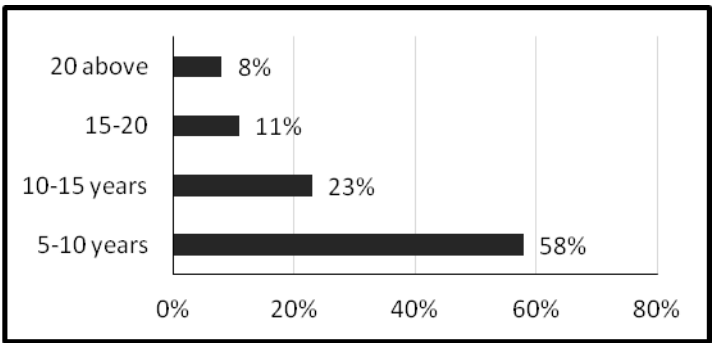

Figure 1. Years involved in potato production (N=100)

Cropping pattern

Mixed farming system is a tradition in Nepal. However, the system was disturbed after introduction of conventional farming system. As compared to pure or sole crop farming, mix farming system has a lot of advantages. Cropping pattern followed by the respondents is shown in (Table 1).

Table 1. Cropping patterns in study areas (N=100)

Ecosystem	Land types	Monsoon (July-Sept)	Winter (Oct-Feb)	Summer (March-May)
Terai (<400m)	Low lands	Rice	Potato	Maize + vegetables
		Maize + Potato	Pulses	Vegetables
Hills (>1800m)	Up lands	Maize+ soybean	Potato	Millets
		Cowpea	Potato	Vegetables

Major problems faced by farmers during potato cultivation

From the survey, it was found that potato is highly nutrient and important cash crop which can be cultivated easily to earn good income but it has some problems. Problems faced by potato growers are lack of transportation facility, frequent political interference, lack of supply of reliable high quality potato seed/tuber, unstable price of agriculture products including potato, lack of economy uplifting programs, lack of coordination with DADO and other entrepreneur ,irrigation, incidence of insect pests and diseases, earthing up, marketing, storage etc.

Respondents facing technical problem were 43% while those with market problem were found to be just 5%. Farmers reported that majority have been facing the technical problem regarding training in scientific cultivation practice of potato. Most of them had no idea about plant protection measure. The farmers could not

irrigate their potato field timely which had somewhat affected the overall production of the crop. Most of the farmers 37% expressed irrigation as the problem since they had no choice of irrigation for their potato field. During survey 13% of the respondents reported of serious plant protection problem. They were unaware of effective management of disease and pest of potato. On field observation, their potato growing field was found unmanaged and poor in sanitation. Similarly, 2% of the respondents reported financial problem which they were facing.

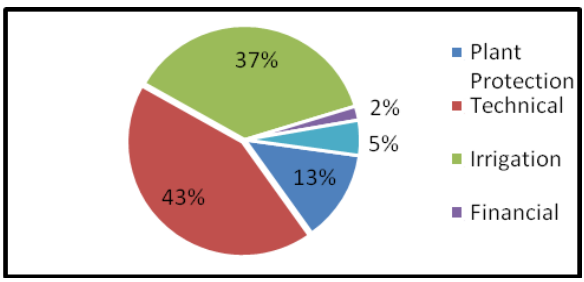

Figure 2. Lack of technical skill and knowledge on potato grower (N=100)

From the survey, it was found that the entire traders stated that the main problem in the potato marketing is storage. There is loss in weight and rotting of potato during storage. There is lack of proper storage facilities and farmers/ trader lack good knowledge and skills in potato storage. There is a higher loss during storage of potato.

Impact of potato cultivation on livelihood

In the study area, it was found that economic status of the farmer was affected by potato production per household. Survey data revealed that household income from potato production ranged from NRE 15,000-25,000 (14%) to 200,000 - 300,000 (16%) per year (Figure 3). Majority of the households (27+24%) had annual incoime ranging from NRE 25,000 to 200,000.

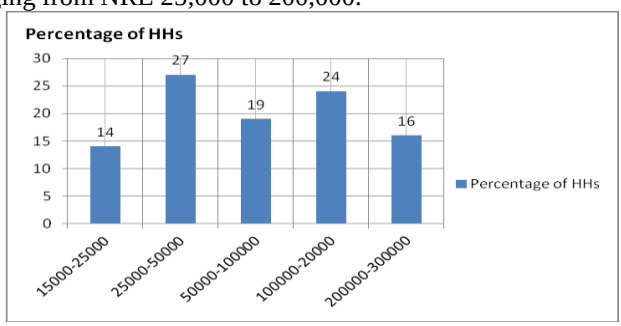

Figure 3. Annual household income from potato production in percentage (N=100)

Average annual production of potato

In the study area, it was found that most of the respondents (44%) had an average annual production of 1000-2000 kg below 500 kg (Table 3). It was followed by 31% of the respondents who had an average annual production of 500-1000 kg. Only 16% of the respondents had an average annual production of more than 2 ton.

Table 3. Average annual production per household (N=100)

Average annual production, Kg	Percentage
<500 kg	9
500-1000	31
1000-2000	44
> 2000	16
Total	100

Use of income made from potato cultivation

From the survey it was found that most of the households (56%) used the income in house expenditure *Figure 4). They also spent their income in children's education (20%), to pay debt (12%). Few households spent their income for improving agricultural field (7%) and even for buying new land or constructing new houses (5%). All these factors are definitely positive trends of improvement in the livelihood of farmer, which potato cultivation have made possible. Potato cultivation has increased the income of the farming households and enables them for utilization of income in various activities.

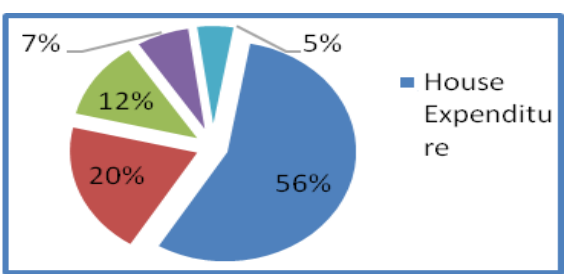

Figure 4. Use of income from potato production (N=100)

CONCLUSION

A survey was conducted gather the information on the documentation of local knowledge, to study the socio-demographic status of the potato growing farmer, to assess present situation of potato cultivation on livelihood of the farmers, impact of potato based cropping pattern in the livelihood and income of the farmer and cropping pattern, major problems faced by the farmers in potato cultivation and general cultivation practices. The surveyed area of Tamankhola Rural Municipality

is potential pocket of potato in Baglung district. Many farmers consider potato as a main cash crop and majority of farmers are engaged in commercial potato production. The average total land area of farmer is 13Ropani and average land area under potato cultivation is 6 Ropani. The productivity of potato is low (6MT/ha) because of traditional farming and lack of fertilizers. Major market center for selling potato is Myagdi district. Both male and female farmers are involved in commercial cultivation of potato. The climatic condition of Tamankhola is suitable for potato cultivation which ranges from 1700 to 2400 masl. Despite all these good indicators, majority of farmers are still illiterate and potato growers have faced a number of problems like plant protection management, inadequate facility of irrigation, insufficient amount of improved variety of seed potato. Lack of storage and organized market facility has compelled farmers to do late harvesting and forced farmers to have post-harvest losses. In spite of good demand of potato, farmers are not able to catch the market price of distant market due to not having an access to those distant markets.

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Economics of mandarin production in Kushe Rural Municipality of Jajarkot District

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ABSTRACT

The study had been carried out among the mandarin producer households in the Kushe Rural Municipality of Jajarkot District to analyze the financial viability of mandarin production, calculate cost of production, gross margin, internal rate of return (IRR), benefit cost ratio (BCR) and payback period (PBP). A total of 80 respondents had been selected through random sampling method. Primary data has been collected through household survey through questionnaire and other relevant information has been taken as secondary sources. Relevant statistical tools like SPSS and Ms Excel has been used to analyze the data. The study found BCR as 1:55, the net present worth at 12 percent discount wasNRs.111702, and IRR has been found 26%. The cost of production of 1 kg mandarin orange was NRs15.326 for 5-12 years and the capital return was estimated at 7.9 years as PBP within the economic life of 20 years. This study showed that the mandarin production is a financially viable agri-business in the study area.

Key words: Mandarin, production, benefit cost ratio, agribusiness

INTRODUCTION

Nepal has been a predominantly agrarian economy since time immemorial. The development efforts with transportation infrastructures and modernization efforts in agriculture over the last few decades have doubtlessly strengthened the country's industrial base. Still agriculture continues to be the mainstay of Nepalese economy and even today 65.6 per cent of population depends on its (CBS, 2014).Citrus, particularly the mandarin is the most important commercial fruit crop in the hills of Nepal. The area under mandarin cultivation is 65.16 per cent of the citrus fruits and 26.3 per cent of the total area covered by fruits in the country (MOALD, 2016).

Jajarkot District is one of the mid hill districts of Karnali province, where 91.89% of populations are being involved in agriculture. Based on land used statistics only 7.5% of land is available for agriculture Out of this only 30% land is facilitated with regular and seasonal irrigation. Agriculture land in Jajarkot

District is 349 ha, whereas only 150 ha is only productive, with production of 1520 Mt. and yield is 10.1 Mt. /ha DADO,(TEPC, 2073**)**.Citrus being one of the high value agriculture product, it is the major source of income generation in mid hills of Nepal. Among fruits, citrus plays important role in uplifting socio economic conditions of people. Citrus development activities are being carried out in 42 districts of Nepal. The present study is aimed at to understand the economics of economics of mandarin production in Kushe Rural Municipality (KRM) of Jajarkot District.

RESEARCH METHODOLOGY

Description of the study area

The survey area KRM is at 5 hour travel distance from the district Head Quarters Khalanga. KRM is located at elevation ranging from 600 m to 1700 m from mean sea level. Out of 1175.42ha of arable land only 797.3 ha of land is under cultivation.

Mandarin orange growers of KRM of Jajarkot District constitute the population for this study; and out of 750 mandarin growers 80 growers were taken as a sample population purposively. Simple random sampling method was used for selecting the study. The study was mainly based on primary information collected from the field survey while secondary information were collected from different sources were also wherever necessary. Primary data were collected through interview with selected farmers through semi-structured questionnaire, observation and focal group discussion. Focus group discussion wee done to check the reliability and validity of the collected data.MS-Excel and SPSS software were used for processing and analyzing the data, Mean, frequency, percentage were studied using descriptive statistical tools. Frequency and percentage were presented in tabular form and bar graphs, pie-chart and narrative analysis were used as per necessity.

RESULTS AND DISCUSSION

Economics of mandarin orange production

To calculate economics of mandarin orange various economic tools were used such as cost return, cash flow budget were prepared to analyze payback period (PBP), BCR, Net present Worth (NPW) and IRR were calculated to find out whether the mandarin orange enterprise is financially viable or not.

Costs, return for mandarin orange production

The cost and return were computed for nonbearing and bearing stage of mandarin orange. Bearing stage of mandarin orange orchard was demarcated in to three stages i.e. 5-12 years, 13-16 years and 17-20 years. This classification was made on the basis of nature of yield received. The detailed costs and return

incurred in the establishment of 4 Ropani were computed and given in the annexure table.

Cost of production (Per Kg)

Cost of production of year 5-12 was NRs 15.326, the cost of production of year 12-16 was Rs 7.27 while the cost of production of year 17-20 was NRs 8.89. The above analysis of cost and net return showed that mandarin orange agribusiness is financially feasible in the KRM .The highest value of input output ratio 3.15 indicates a return of Rs 3.15 per unit of cost.

Table 1. Annual Average cost and return from mandarin production (Rs/Ropani)*

Attributes		Range			
		Non-Bearing	Bearin		
		(1-4)	(5-12)	(13- 16)	(17-20)
A	Average cost of production of mandarin orange	3444.22	7296.18	9440	7627
B	Average cost of production of intercrops	2250	1560		
C	Gross cost (a+b)	5694	8858	9440	7627
E	Return from intercrops	3200	2508		
F	Gross return (d+e)	3200	13758	29736	13728.5
G	Net return (f-c)	-2494	4900	20296	6102.5
H	Input - Output ratio (f/c)	0.5	1.5	3.15	1.7

*Source: Field survey from this study of 2018

The annual average net return per ropani from the orchard of mandarin has been found higher Rs 20296 of year 13-16 year which is due to higher productivity as 13-16 years are called productive stage of mandarin and farmers receive good price in this stage (Table 1).

Payback period of mandarin

The Table 1shows the summary of stream of net value of cash inflow from investment on orchard. The payback period was found to be 7.99 years

indicating that in order to cover cost of capital investment in mandarin orange only 7.99 years would be required.

Benefit- cost ratio of mandarin

The study showed that present worth of benefit and costs at 12 percent discount rate was found to be 1.55 which revealed that NRs 1.55 benefit can be obtained by investing NRs 1.00 during the whole project period. As the value of BCR is greater than 1, it principally indicates that production of mandarin orange is financially viable among the producers in KRM.

Net present worth of mandarin

The NPW at 12% discount rate was found to be Rs. 11170.8. Positive NPW shows that there is profitability in the investment of mandarin orange and is financially viable.

Internal rate of return in the Mandarin cultivation

The IRR was found to be 26%. It indicates that mandarin orange enterprise was financially viable as it was greater than normal Bank interest rate.

Table 2. Cash flow budget (NRs / Ropani)

Plant age	Average cost of management	Average cost for intercrops	Return from mandarin orange	Return from intercrops	Total return	Net incremental return	Cumulative net incremental return	Cost at 12% discount	Return at 12% discount
1		3462		4300	4300	-19382	-19382	21144.6	3839.3
2	15499	3200		4500	4500	-14199	-33581	14906.7	3587.4
3	15499	3100		4200	4200	-14399	-47980	13238.4	2989.5
4	15499	3000		4250	4250	-14249	-62229	11756.4	2701
5	30652	2800	50000	4000	54000	20548	-41681	18981.6	30641
6	30652		50000	4000	54000	23348	-18333	15529.3	27358
7	30652		50000		50000	19348	1015	13865.4	22617
8	30652		50000		50000	19348	20363	12379.8	20194
9	30652		50000		50000	19348	39711	11053.4	18031
10	30652		50000		50000	19348	59059	9869.12	16099
11	30652		50000		50000	19348	78407	8811.72	14374

12	30652		50000		50000	19348	97755	7867.6	12834
13	38707		140000		140000	101293	199048	8870.65	32084
14	38707		140000		140000	101293	300341	7920.22	28647
15	38707		140000		140000	101293	401634	7071.62	25577
16	38707		140000		140000	101293	502927	6313.95	22837
17	26695		60000		60000	33305	536232	3887.98	8738.7
18	26695		60000		60000	33305	569537	3099.47	7802.4
19	26695		60000		60000	33305	602842	3099.47	6966.4
20	26695		60000		60000	33305	636147	2767.38	6220
	553321	**15562**	**1200000**	**25250**	**1225250**	**636147**	**3821832**	**202435**	**314138**

Constraints and problems faced by farmers during mandarin production

The indexing /scaling method has been used to analyze the constraints faced by the sample farmers.

Table 3. Production problems

Problems in Mandarin cultivation	Index	Category
Management of orchard	0.9	I
Disease insect and pest	0.8	II
Knowledge on training and pruning , post-harvest	0.7	III
Natural calamities	0.4	IV
Economic Problems		
Inadequate institutional finance	0.8	I
High rate of interest	0.7	II
Unable to repay loan regularly	0.5	III
No crop insurance	0.3	IV
Marketing Problems		
High cost of Transportation	0.9	I

Lack of storage facility	0.8	II
No grading of product	0.6	III
Packaging materials	0.4	IV
Price information	0.3	V

From the Table 3 it has been found that management of orchard is the utmost production problem of the sample farmers of KRM. No proper training was given to the farmers about orchard management. The second major problem faced by the farmers was disease insect and pest and the Citrus Greening Disease has been found as a major cause for decrease in per unit production of mandarin. Insects such as scales mites, sting bug and fruit fly have been found to cause other pertinent problems in citrus production. Farmers also reported lack of knowledge on training and pruning and post-harvest technology.

Concerning the economic problems farmers proclaimed that lack of financial support institutions is the major economic problems. Since majority of the farmers are marginal and financial institutions requires collateral for sanction of the loan, thus they have to take loan from informal sources with a high rate of interest, because of which the BCR ratio may have also minimized.

In respect of marketing problems high transportation cost was the major problem as KRM is a remotely situated municipality in the Jajarkot district where transportation facility is poor and vehicles are not available in a sufficient number. Similarly there were constraints on post harvest management like lack of storage facility, grading and packaging as well as there was marketing problems faced by the sample farmers.

CONCLUSION

As majority of the farmers belong to untrained, with small land holdings and marginalized group, while the mandarin cultivation requires excellent technical skills on mandarin biology, orchard management and post harvest technology, for adopting production of such kind of crops, which generate higher level of income and employment, proper attention from concerned line agencies is highly sought. The hilly area was felt better option for enhancing profitability with supplement of nutritional requirement. Thus for planning of commercial farming, developing cooperatives among small farmers at large scale and being a perishable crop, it is necessary to examine present status of production cost and return per unit area. The valuable information generated through the study will serve as a basis for planning of mandarin orange in more profitable manner. Although KRM area is one of the potential for mandarin production, the average area for mandarin production has been found 4.1 Ropani. As majority of the farmers are marginalized as it can be a good source of high income generation as

its payback period has been found to be.7.9 years whereas benefit cost ratio 1.55 with IRR 26%.

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Good agriculture practices: an emerging trend of agriculture in Kavre district

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ABSTRACT

The study was carried out in three wards of the Bethanchowk Rural municipality of Kavre district from January to March 2020 to assess the Good Agriculture practice (GAP) which has become more popular among the farmers. Primary information was collected through surveying 100 respondents using semi structured questionnaire. Out of 100 respondents 23 were performing cultivation under polyhouse, 19 were utilizing their livestock byproducts by improving animal shed, 4 plastic ponds were installed to resolve the water scarcity in the area, 54 respondents used bio-pesticides for plant protections.

Keywords Good agriculture practice, sustainable agriculture, compost, bio pesticides

INTRODUCTION

Agriculture is the main driver of national economy on Nepal with 28.89 percent of GDP share (MOALMC, 2018). Agriculture provides livelihood for 68 percent of Nepalese population. Nepal faces food insecurity; and has been struggling hard for the attaining sustainable livelihood since few past decades (NJAS, 2020). The reason behind food insecurity could be the limited access of farmers to improved seeds, appropriate technologies, and market opportunities. Changes in agriculture practices with time led to a decline in soil fertility along with its structure and with it increase in soil borne plant disease. Integrated pest management (IPM) could be a decision support system for the selection and use of the pest control tactics, singly or harmoniously coordinated management strategy so that benefit analysis that take into an account the interest of and impacts on producers' socioeconomic conditions, and the healthy environment.

The Food and Agricultural Organization of the United Nations (FAO) recommends good agricultural practice (GAP) as a collection of principles to apply for on-farm production and post-production processes, resulting in safe and healthy food and non-food agricultural products, while taking into account economic, social and environmental sustainability. The United States Department of Agriculture (USDA) marketing service operates a certification program to verify that farms use good agricultural practice or good handling practice. It is a voluntary program typically utilized by growers and packers to

satisfy contractual requirements with retail and food service buyers. The program was implemented in 2002 after the New Jersey Department of Agriculture petitioned USDA-AMS to implement an audit-based program to verify conformance to the 1998 Food & Drug Administration publication (Fajalah Kinara, Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables.). The program has been updated several times since 2002, and includes additional certification programs such as commodity specific audit programs for mushrooms, tomatoes, leafy greens, and cantaloupes. In 2009, USDA-AMS participated in the GAPs harmonization initiative which harmonized 14 of the major North American GAP audit standards, which in 2011 resulted in the release and implementation of the produce with GAPs Harmonized Food Safety Standard.

Poverty and unemployment are wide spread in Nepal. It is very likely that several million Nepalese people are food insecure. Food insecurity prevails when all people at all times have access to sufficient, safe and nutritious food to maintain a healthy and active life (FAO, 2003). In Nepal, Farmers Field School (FFS) was the tool to spread location specific IPM technology. After FFS initiatives the IPM practicing farmers reduced pesticides application by 36 percent over the non-practitioner. The FFS farmers are also getting more yields of crops, more annual income and they had developed better leadership to agriculture than the non-practitioners. It has been widely accepted technology transfer platform for the policy maker, academics, technicians and farmers in Nepal (Kafle et al., 2014).

GAP has been implemented in different parts of the word. It is a system that is focused on closing the fertilizer loop by using waste, and reducing the dependence on inputs by creating healthy soil and diversity of produce. It is also responsible for its waste; it aims not to pollute the surrounding environment, i.e. neither with excess nitrogen released into the water systems, nor weed seeds into any natural systems. Permaculture is process to engage all people of different ability, not just young strong people who can shovel compost. It aims to integrate agricultural practices along with nature. Visually this is the most noticeable difference between organic gardening and permaculture. In permaculture gardens (home systems is the more holistic term) there is rarely bare soil, the conservation of soil and water is a high priority. There is a more complex use of space. Plants are allowed to set seed and are interplant for pest control.

The permaculture system aims to harvest and maximize water, sun and other natural energies, e.g. wind, dust, leaves, bird droppings. The permaculture system aims to provide nutritious food and habitat for people and native animals and birds. Basically, Permaculture uses organic gardening and farming practices but it goes beyond these practices and integrates the garden and home to create a lifestyle that impacts less on the environment whereas organic farming promotes the use of natural fertilizers, making use of the natural carbon cycle so that

waste from plants becomes the food (fertilizer) of another. In organic farming however, as like conventional farming, minerals are being lost from the farm every time a truck load of produce is carted to market. Permaculture goes one step further. Permaculture brings production of food closer to consumers and the consumer's wastes back into the geochemical cycle. It also reduces the energy wasted in transporting the foods by producing the foods where the resident people are. In permaculture the people contribute in their daily life toward the production of their food and other needs. There will be times when a permaculture system is not strictly organic because it is using local resources rather than importing certified organic resources or perhaps the designer wants to increase diversity by bringing in unusual plants/seeds from another source that is not indigenous in origin.

It is observed that intuitional capacity is lacking in the study area to address the appropriate problems and challenges of the marginal groups. Similarly, the capacity, accountability and responsibility of the local bodies must be further strengthened, as they are the focal point for the socially inclusive service provision, and can greatly contribute to generating public goods for socio-economic development. Present study aims to address the issues of knowledge gap along with their strengths in GAP.

MATERIALS AND METHOD

The field experiment was conducted in the farmer's field at Bethanchowk VDC of Kavre district. It lies in the 85 24-85-49 latitude and 27 20-27 45 longitudes in between the range of Mahabharata Hills. It is situated at the altitude of 280masl to 3018masl. Majority of land here are of sloppy nature. In addition to this, some plain lands are also there in the river basins. From the point of it structure, out of 1, 40,486 ha of its total area, 52.5 % of land is sloppy i.e. 73,736 ha and 41.3 percent of the land is less sloppy. Remaining 5.1 percentage of land i.e. 7292 ha of land is plain and valley where as 1.1 percentage of land i.e. 1565 ha are covered by gravel, stones and rivers. 97.1 percent of the total land is hill and remaining 2.8 percent of the land falls under Shivalik Hill area. Along with the diversity in topography there is diversity in climate too. It has altogether 3 types of climates including Cool Temperate Zone, Warm Temperate Zone, and Sub-tropical Zone.

We surveyed 100 farmers from 3 wards using purposive and simple random sampling techniques. The sample was taken 50, 30, and 20 in those 3 wards. Scheduled household interview was done during January to March, 2020. The information collected from the survey was edited, coded, classified in appropriate format and entered into the computer for analysis. Data entry and quantitative and qualitative analysis was done by using computer software using SPSS. Different descriptive and inferential statistics were used for the analysis.
Secondary information was obtained from the in-depth study of the literature include various departmental and organizational report (Ministry of Agriculture

and livestock Development, Central Beauro of Statistics, Food and Agriculture Organization, United nation , journal articles, books and websites.

RESULTS AND DISCUSSION

Key areas of concern when implementing a GAP program are soil, water, crop and fodder production, crop protection, livestock production, energy and human welfare, health and safety, wildlife and landscape.

Good agriculture practices

Suatainable agriculture practices were the most important method followed by the farmers to cope with the situation of climate change (Figure 1). Those practices included river water for irrigation, poly house, rain water harvesting.

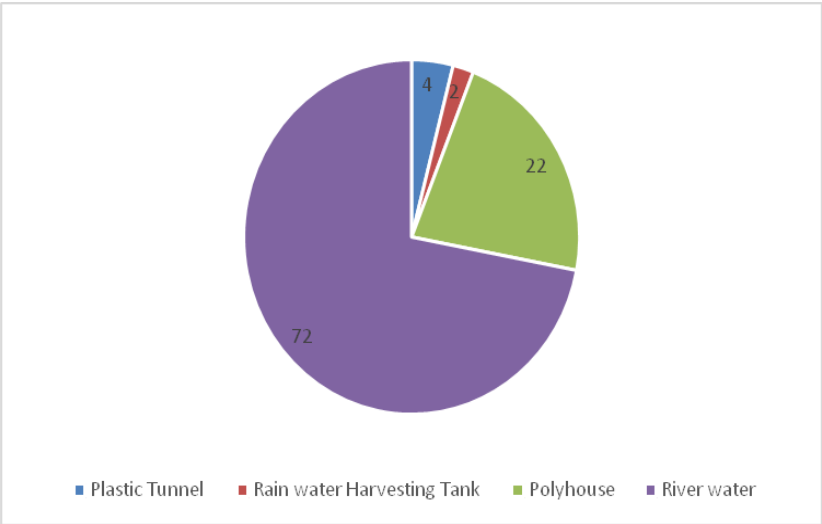

Figure 1. Good Agriculture Practice used in Bbethanchowk

1. Soil

The main aspect of the soil nutrient management is the management of the farm yard manure because collection and utilization of the farm yard manure is done in the traditional methods thus nutrients managements is not found sufficient for the plants. In most of the household of villages the urine of the cattle's are wasted, open aerobic conditions of manure storage and sloppy land structure makes a huge loss of nutrients due to leakage from the farm manure site. Random grazing and rearing of animals outside of the farm also causes the loss of nutrients in the manure.

It is found that 90 percent of the nutrients got seepage from the traditional animal shed in Nepal. The wasted nutrients can be utilized by managing the urine and cattle dung. Farmers prepare compost manures by different methods

during different season. They followed pit method during winter where there is no rainfall. At the time of monsoon or rainy season, they prefer heap method and the site where there is abundant land of marshy area they prefer pit and heap method of compost preparation.

As awareness level is increased in farmers due to different training and orientation programs conducted by Association for Rural Development (ARD), an NGO established in the year 1992 AD in Kavre district, farmers are interested in compost manure and green manure. The cultivation of leguminous plant has benefited farmers with the soil fertility of their cultivable land. The leguminous plant cultivated in 1 ha collects almost 200 Kgs of Nitrogen in the field where as 100- 140 Kgs of Nitrogen is sufficient for the production of any crop.

2. Crop and fodder production

The major vegetable crop produced in study site are mustard, radish, broad leaf mustard, spinach, long bean, carrot, coriander, cauliflower, cabbage, broccoli, tomato, potato, garlic, onion whereas fruit crops are apple, peach, pear, hog plum, citrus, grapes kiwi and walnut. There are mainly two cropping season. For the first two season farmers in the study site cultivate rice followed by maize. During September -November the farms are occupied by mustard-oat and wheat whereas potato farmers grow potato during August and January. Twenty percent of the farmer sold their products; and the rest of them are cultivating it for subsistence. Since the advance technology has not been introduced in the study site the farmers are passing through a transition phase of improved sustainable agriculture practice. Majority of respondents are dependent on Community Forest User Groups (CFUGs) for timber/wood and other forage as well as fodder crops. Forty percent of them reported they have grown their own fodder crops in their pasture land and feed their livestock. The agroforestry practices found helpful to protect land from soil erosion. As they have been cultivating diversified crops, but the data shows the higher income is coming from Livestock products as shown in figure.

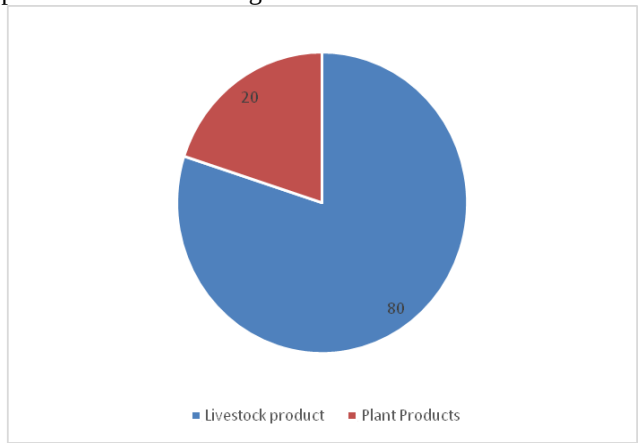

Figure 2. Percentage of Used plant made and animal made products

3. Water

Water sources are abundantly available in the study site but it is not in reach of farmers residing in the upper hills so they collect rain water and harvest it either by making a rain water harvesting tank or whatever available to their residence. Few farmers were found installing plastic pond in the study site.

Almost 75 percent of the respondents were facilitated with abundance of water available in the river, natural water reservoir and tap water. Four percent of them have installed plastic pond and 2 has installed rooftop rainwater harvesting tank where there is scarcity. Water stored in the pond is utilized for the irrigation purpose either by passing it through a canal or HD pipe from pond to the cultivating land. In the high hills the rain water is stored in the rainy season and utilized till spring. Similarly water stored in the rain water harvesting tank are utilized for other domestic purposes like dish washing, cleaning livestock and construction rather than drinking purpose in the study site. It is the most efficient and practical water delivery system practiced in this season.

4. Crop protection

Along with the cultivation of different fruits and vegetables, the farmers in the study site also rear honey bee for their substantial farming. The rearing of honey bee has been found very beneficial for the production of crops with the transfer of pollen grains for breeding. Pollination induced by honeybee is more efficient than air pollination, hand pollination or other manual means. Due to the increased production in the study site the perception about honeybee and its related myths are being crystal clear to the farmers. Honeybee detoriates the quality of mustard seeds was the prevailing misunderstanding of the people which has been now tested by farmers and proved wrong. Besides that honey bee also helps to raise their income by producing honey which helps farmers for securing and fulfilling their basic needs. Due to this farmers have felt that the quality of mustard and other fruit crops like kiwi has been increased rather than decreasing. 23 Percent of the farmers reported that they cultivate their crops under poly house. It has helped them to protect their plants from different disease like Blight, Bacterial wilt, *Alterneria* leaf spot, Club root of crucifers. The Intercultural operation method has helped them to get rid of the Nematode disease. The adjustment of temperature under poly house has reduced the infestation of powdery and downy mildew. Several disorders like cat facing, sunscald has also overcome through this technology. Farmers used to prepare liquid manure and bio pesticides. 67 percent of the farmers are found following IPM techniques for the management of insect pest in the study area.

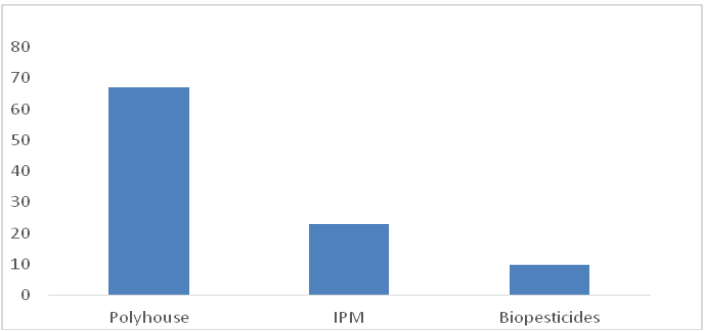

Figure 3. Control agents used for insects and pest management

5. Livestock production

Quality grass and grains increases the weight and overall health of the livestock. As farmers in the study sites are more depended on livestock for their livelihood, farmers are utilizing their available resources by preparing compost manure, making biological pesticides using their cattle's urine and dung which also helps to maintain balanced ecological environment. Meat product is also one of the main sources of income and it is cultural requirement of farmers because of the interrelated relationship of these factors GAP implementation is being more popular in this field.

Nineteen percent of the respondents constructed animal shed house as per the guidelines of the Government of Nepal (GoN). It has played a vital role in supplying the required dose of nutrient to the livestock by not wasting the feed, forage and fodder. From the point of animal sanitation the health of livestock is also ensured. Most of the respondents in the study area are found livestock keeping as the major source of income. 69 percent of the total respondent keep livestock for the purpose of milk and manure where as 31 percent keeps livestock for the purpose of meat. They sell milk in the nearby dairy. Several factories of milk derivatives are in operation in the study site locally called as khuwa Udhyog. The by- product are also utilized by collecting in a pit or plastics drum so that it is utilized as liquid manure or in making the bio-pesticides.

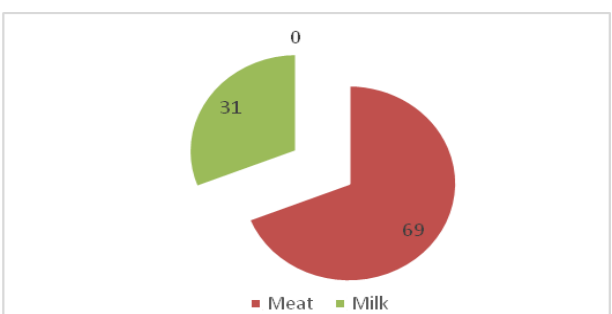

Figure 4. Percentage of rearing livestock for different purpose

CONCLUSION

The finding of the study on GAP reflects a similar performance with Permaculture and organic farming that can be performed with substantial variation among the crops and input level. It indicates that GAP equally contributes to the food security issues among the small farmers, protecting and promoting the best traditional practices of the field. Because of continuous tillage and absence of incorporation of organic matter without compensating nutrient supply from natural and artificial sources might have led to low level of soil nutrient content. Analysis of the soil characteristic is recommended the area to address the soil fertility issues.

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Biodiversity conservation and livelihood improvement through community-based forest management in Nepal

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ABSTRACT

This study aimed at assessing the impacts of community forestry program on biodiversity conservation and livelihood improvement was conducted in Kavre, Makwanpur and Nawalpur districts. Sample size 31, 49, and 25 were taken in Makwanpur, Nawalpur and Kavre respectively. Therefore, the total surveyed households were 105 in numbers.. This study revealed that community forests in study areas had both opportunities and limitation to contribute in sustainable livelihoods of local users. Restoration of degraded land, improving forest conditions, involving local people in the management and utilization of local resources were the major benefits of community forests. The community forests were rich in biodiversity; however quite a limited plant species were in use for livelihoods. Bamboo craft and vegetable cultivation in Banepa, and Triphala production in Gaindakot were registered and they prepared their business plan. But there was a need of business plan update for wooden craft and bamboo enterprise in Hetauda; essential oil production (from wild plant species) and furniture enterprises in Banganga, and vegetable production enterprise in Panauti. CFUGs are effective and inclusive institutions, bringing together both the rich and the poor people to address poverty and livelihoods by utilizing available resources. However the local people and communities needed support to improve their skills.

Keywords: Community forest, biodiversity conservation, livelihood improvement

INTRODUCTION

Forest and tree resources provide the basic commodities such as fuel wood, timber and fodder and serve important ecological functions such as biodiversity conservation, erosion control, and carbon dioxide consumption. Agriculture is the mainstay of the economy in the country as agriculture and forestry contribute

39% to the total gross domestic product of the country. Nearly two-thirds of the country's total population depends on agriculture for sustaining their livelihoods. Out of 9.9 million economically active populations over 10 years of age, about 6.5 million are engaged in agriculture and forestry (CBS, 2002). NTFPs have become the source of income for the rural poor, medicine for primary health care and revenue for the government. Out of the total tourists visiting Nepal about 45% visits protected areas. Although the forestry sector has a significant role in the economic development of the country, no comprehensive study has been done yet on the contribution of the forestry sector to the Gross Domestic Product (GDP). The contribution of the forestry sector has been underestimated and it has a low policy profile in Nepal. FAO has estimated that Nepal's forestry sector contributed 3.5% to the GDP of the country in 2000 and 4.4% for the period 1990 to 2000. But it is estimated that the forestry sector alone contributes 15% to the GDP of the country. Livelihood revolves around resources such as land/property, crops, food, knowledge, finances, social relationships, and their interrelated connection with the political, economic, and sociocultural characteristics of an individual community. A livelihood consists of capabilities, assets, and activities that are required for living. It is estimated that 90% of the world's poor depend on forests for at least a portion of their income (World Bank, 2000; Scherl et al., 2004; USAID, 2006). In Africa, 600 million people have been estimated to rely on forests and woodlands for their livelihoods (Anderson et al., 2006), and in India, 50 million people are estimated to directly depend on forests for subsistence alone. Timber, non-timber forest products (NTFPs) and animal protein are all used by the rural poor for subsistence, and also as a source of income and employment (Angelsen & Wunder, 2003). Depending on circumstances, forest products may offer both a "daily net" and a "safety net". The "daily net" describes everyday use, with products meeting current household needs, offering a reliable source of income to purchase agricultural inputs (Shackleton&Shackleton, 2004), or fodder for livestock herds. A "safety net" comes into play when other sources of household income (e.g. plantations) fail to meet dietary shortfalls, or whenever a quick cash option is required (McSweeney, 2003).Community forestry is a successful participatory approach for forest protection and management in Nepal. Until now, about 850,000 hectares forests of Nepal have been handed over to eleven thousand forest user groups. The community forest operation cost of poorer households exceeds the benefits received by them because free access to collect forest products has been restricted in order to improve the forest condition. This directly affects poorer people in keeping livestock. In addition, some poorer households living near town and roadside were selling fuel wood in hotel and teashops. This has now been stopped and has created problem to these poorer households for generating day to day income for survival. As a user, every household whether rich or poor should pay an equal amount as monthly membership fee and buy once freely collected forest products based on forest operational plan rules and regulations.

Nepal is rich in biodiversity, from the perspective of species diversity in wild habitats; Nepal occupies 26th position and 11th position on the global and continental scales respectively. Nepal possesses over 2.7 percent of the world's flowering plants, 5 percent of bryophytes, 3 percent of pteridophytes, 9.3 percent of the world's bird species and 4.5 percent of the world's mammal species. About 19.7 percent (28,999 km2) of the total area of the country is under the protected area system to conserve the representative biodiversity and outstanding landscape of the country.

MATERIALS AND METHODS

The study area was carried out in Makawanpur, Kavre (Banepa and Panauti) and Nawalpur districts of Nepal. The data were collected through both means primary and secondary methods. Major tools such as Household survey, Key Informant Interview, In-depth Interview, Focus Group Discussion and community consultation were used. The total sample size was 105 and was drawn by using the following formula.

Sampling Strategy, n=NZ2p (1-p) \ Nd2+Z2p (1-p)

where, n= Total sample size
N= Total no. of sample units (households) d= Maximum acceptable error (0.10)
Z = z- value (value used in 1.64 to correspond90%reliability) p= Probability (0.5).

The primary data were verified with secondary data included from CBS journals, working paper (published/unpublished) and e-materials. Focus group discussions were carried out in mixed pattern to obtain general information on impact of community forests which includes the history before 5-10 years, resources of livelihood and maintenance of Biodiversity. Therefore, community forest user groups were targeted.

RESULTS AND DISCUSSION

Socio-demographic features

Community forestry program was implemented in the district since its initiation in the country back in 1978. Since then community forestry has been source of income and employment opportunities for rural communities. Total of 362 community forestry have been formed covering 62304.46 ha. CFUG practices technical forest management activities guided by forest department viz controlled firing, thinning, pruning, cleaning where technical input is being provided by forest officials from district forest office. CFUG in the district has been successfully implementing different income generation activities for supporting and uplifting rural poor livelihood and conserving forest resources simultaneously. The forest resources in study sites are managed through major

four approaches i.e. community forestry, leasehold forestry, government managed forestry and protected areas

In the HH survey, total respondents were 105 and among them, 60% respondents were female out of which 29% were literate. The climate varies from temperate to subtropical with temperature varying is sub-tropical with temperature varying from 1°C to 32°C. In winter season, it comes down at 1°C and rises up to 32°C during the summer season. Precipitation here averages 2300 mm per year. About 30% of land area is occupied by forest, herbs and shrubs land. Bio-diversity includes diversity in cereal crops, trees, wild foods and fodder trees. Brahmin, Tharu along with mixed communities were present. Their main occupation was agriculture followed by business and remittance because they do not have registered land and therefore their major dependency on the community forestry.

Table 1. Description of study sites

Feature	Makawanpur	Kavre	Nawalpur
Ethnic communities	Mixed	Brahmin and Chhetri	Tharu
Traditional Occupation	Agriculture	Agriculture	Agriculture
Land ownership	Registered land 5% are land less	Registered land 15% are landless due to the migration	Registered land but the 25% of the community have no sufficient land so they work on other land *(Adhiya)*
Topography	Hilly area	More steep	Plain area

Major cropping patterns

Rice-wheat-vegetables followed by leguminous crops were cultivated in the upland and low land. Community forests are managed by the community through the coordination with district forest office. They plant Oogenia oogenesis (sallo), Trminiliatomentosa (Saj), Schimawallichu (chilaune), katus, uttis, and gurans along with Shorarobusta, Cardamom, and other medicinal plants.

Status of forest products in the community

No individual was found involved in the sales of forests products available from the community forest. However FUG community sold their products such as fuel wood during the time of forest was open to collect. After distribution of one bhari of fuel wood per day to participating household remaining fuel wood is

sold to the users themselves at the rate of 10 NRs per bhari during this period. Today the FUG claims that they have surplus fuel wood and litter produced from the forests.

Table 2. Cropping patterns distribution by land type in study areas

Type of land	CP (Kavre)	CP (Makawanpur)	CP (Nawalpur)
Khet	Rice - vegetables	Rice – Vegetables	Rice – Wheat
Bari	Rice –Vegetables – Fallow	Maize/pea/rice bean-vegetables-fallow	Maize - Vegetables-Kidney bean
Community Forests	Sallo, Chilaune, Katus,Setikaath,Utis, Gurans,Fern	Sal, Chilauney, Sanjh,Uttish,Sisso	Shorea robusta, Oogenia Oogenesis,Micheli a,champaca,Saj(Tr miniliatomentosa), Chilaune(Schima wallichu)

Impacts of community forestry

Community forestry appears to have a net positive effect on livelihoods and a range of other development concerns in Nepal resulting in direct and indirect positive impacts on rural livelihoods and social welfare. They covered different types of enterprise in these 3 districts which helps them to sustain their livelihood along with future betterment.

The names of the enterprises in 3 districts are listed below along with their current status. All the enterprises are run by community Entrepreneurship and they earn a good income from these enterprises. At first they got some projects to run all these enterprise but due to the phase out of different projects and lack their collaborations 30% enterprises were closed and 70% of enterprises are still in a function. They utilize this earning in the social welfare of the community.

There were a number of areas where the enterprises can work to improve the value and trustworthiness of their product. Drying of cardamom and packaging in the production area, labeling with trademark, purchase of jar and cylinder to store the essential oil, production of bamboo furniture together with wooden handicrafts were some of the activities of the concerned enterprises that can add the value to their products. None of the enterprises were found receiving present support except some regular advice from government and networking, coordination, marketing and advertisement support from CFUGs. Enterprise run using the Forest products are generating income from the sale of forest products and from membership fees, fines and donations and the income were used for the Community development and social welfare activities such as irrigation canal improvement, schools, community building and temple construction,

drinking water schemes, Also this community Forests surrounding villages are sometimes used for extensive grazing.

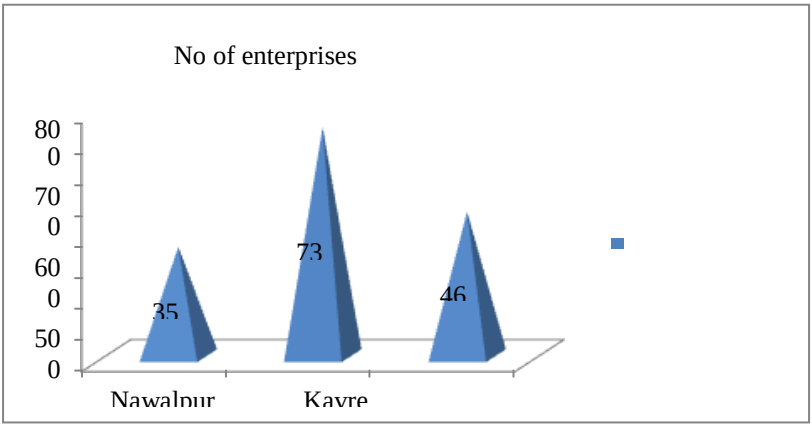

Figure 1. Number of enterprises and their positive impacts

Shifting cultivation (cycle (House, 1997; Coomes et al., 2000) or "slash and burn" agriculture is also often practiced by village communities which is considered as an ecological approach for the sustainable resource management therefore some ethnic group clear-felled the forest land and used to grow crops, and then left fallow, allowing secondary forest regeneration and soil renewal before the forest is cut again on a multi-year rotational. This practice is still following by 20% of the population in my survey who belongs to the ethnic communities to sustain their livelihood and food security.

Table 3. Current status of community forestry supported enterprises

SN	Name of Enterprises	Districts			Current Status	Established year
		Makawanpur	Nawalpur	Kavre		
1	Organic manure		Binaya Community Forest, Nawalpur		Running	2071
2	Babiyo Rope		Binaya Community Forest, Nawalpur		Closed	2065/66
3	Trifala		Sundari community Forest, Nawalpur		Running	2063/64
4	Leaf Plates		Sundari Community Forest,Nawalpur		Closed	2063/66

5	Bamboo products (handicrafts)			AdharEkata, Kavre	Running	2072/73
6	Honey			Adhar Ekata, Kavre	Running	2072/73
7	Cardamom			Adhar Ekata	Running	2072/73
8	Amriso (Broom Grass)			AdharEkata, Kavre	Running	2072/73
9	Vegetable products			Adhar Ekata, Kavre	Running	2072/73
10	Furniture and handicrafts	Kastha tatha gairkastha hasta kala ra betbas furniture Udyog ,Piple Pokhara C.F			Medium	2072 B.S
11	Medicinal plants	LaligurasMahilaJadibuti SAMUHA ,Pashupati C.F			Running	2073

CONCLUSION

The study showed that there were various direct and indirect benefits such as fuel wood, fodder, leaf litter and other forest products. The study showed that in five year period of active forest management a community forest was converted to a very productive dense forest, which assured that under proper management a forest could be promoted in a productive forest that will fulfill the need of the rural community. There was surplus production of leaf litter and fuel wood, which were stored in forest itself therefore calorific value of the fuel wood was destroyed after a certain time. Such storage may be common but there will be the chances of forest fires. The selected enterprises have performed 'none' or 'very little' value addition activities. The community forests were rich in biodiversity; however quite a limited plant species were in use for livelihoods. Bamboo craft and vegetable cultivation in Banepa and Triphala production in Gaindakot were registered and they prepared their business plan. But there was a need of business plan update for wooden craft and bamboo enterprise in Hetauda; essential oil production (from wild plant species) and furniture enterprises in Banganga, and vegetable production enterprise in Panauti. The required skills for them included: a) market production, b) linkage and

coordination, c) record keeping, d) production and processing, e) value edition, f) grading and packaging, g) business initiation, h) raw material production, i) equipment handling j)storage and k)trademark.

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Screening of phytochemicals and allelopathic potential of selected botanicals on germination and growth of maize (*Zea mays* l.) *a*t Paklihawa, Nepal

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ABSTRACT

Phytochemical screening of six different botanicals (Azadirachta indica Juss, Artemisia dubia Wall, Lantana camara L, Parthenium hysterophorus L, Justicia adhatoda Linn. and Moringa oleifera L.) and their allelopathic potential on germination and growth of maize was done at Agriecology lab of Institute of Agriculture and Animal Science, Paklihawa Campus, Rupandehi. Among the qualitative tests done for the presence of secondary metabolites, saponin was found to present in all the botanicals extract except in M.oleifera L. Most of the tested metabolites were extracted by the aqueous solution rather than other 3 menstrums (acetone, methanol and petroleum ether). Similarly, Azadirachta indica Juss and Artemisia dubia Wall were found to contain most of the tested metabolites as compared to other botanicals tested. Result of quantitative test revealed that percentage of alkaloid was found 11.58%, 6.78%, 18.01%, 17.75%, 8.20% & 17.78% and flavonoid12.89%, 2.85%, 7.5%, 15.32%, 11.36%, 13.63% respectively in M. oleifera L., A. dubia Wall., L. camara L., J. adhatoda Linn., A. indica Juss and P. hysterophorus L. Allelopathic effect of those botanicals extract on radical and plumule growth of maize was examined invitro condition for 15 days. Seven treatments (leaf extract of A. indica, A. dubia, L. camara, P. hysterophorus. J. adhatoda and M. oleifera and distilled water as control) maintained as 3 different concentrations (stock solution, 10% of stock solution & 25% of stock solution) were arranged in CRD design with 3 replications. Application of highest concentration (stock solution) of P. hysterophorus extract found to cause the maximum reduction in radical length of maize seedlings. Similarly, mild concentration of L. camara (25% stock solution) caused maximum reduction in plumule length. Thus, Lantana camara and P. hysterophorus found to possess allelopathic effect on growth of maize seedlings and probably

on other C_4 crops as well as other crops of poaceae family. So, it was concluded that the locally available botanicals having allelopathic potential can be utilized for the weed management in cost effective and eco-friendly manner thus, to promote the sustainable agriculture.

Key words: metabolites, botanicals, allelopathy, sustainable agriculture

INRODUCTION

Nepal is very rich in diversity of medicinal plants. It is ranked at 31th position in the world in terms of biodiversity richness (MFSC, 2014). Among the 7,000 species of medicinal plants recognized all over the world, more than 900 types of precious medicinal plants are said to be found in Nepal (Manandhar, 2000). Phytochemical is the chemical extract of plant (*phyto* means 'plant' in Greek) which are thought to be responsible for protective health benefits (Webb, 2013). Naturally phytochemical occur in medicinal plants, leaves, grains, vegetables, roots etc. Primary phytochemicals includes chlorophyll, proteins and sugars whereas in secondary compounds flavonoid, alkaloids, sterols, terpenoids, flavonoid, saponins, tannins, volatile oils, etc (Motalab, 2011). In the context of huge challenges of food security weed, insect pest, disease, abiotic stress & imbalance crop nutrition created the major threat to crop production and reduced crop yield. The term 'allelopathy' consists of two Greek words, *allelon* meaning 'mutual' and *pathos* meaning 'to suffer' harmful effects on each other (Rizvi *et al.,* 1992, Chon and Nelson, 2013). Allelopathy is a natural phenomenon in which presence of one organism affect the other organism present near vicinity either positively or negatively by producing the secondary metabolites, produced during physiological process of plant (Rice, 1984). Allelochemicals promote growth at low concentration; however, suppress the growth if applied at high concentration (Kamran *et al.,* 2016). Lots of research has been done to explore the inhibitory potential of different allelopathic crops and tree for weed management (Cheema *et al.,* 2004; Farooq *et al.,* 2011). Thus the concept of allelopathy is a good substitute for synthetic herbicide and hazardous agrochemicals (Bhadoria, 2011). Uses of the synthetic herbicides & pesticides have been creating the serious health issues & environmental problem. Thus the study of best alternative from locally available botanicals is realized to reduce the various environmental as well as health problems. In this regards, study aims to explore the various phytochemicals present in selected botanicals both qualitatively as well as quantitatively and their allelopathic effect to provide accessible, safe, reliable and inexpensive sources of control of various weeds.

MATERIAL AND METHODS

Collection of botanicals: Leaves & young twigs of 6 different botanicals (*Azadirachta indica* Juss., *Artemisia dubia* Wall., *Lantana camera* L.,

Parthenium hysterophorus L. *Justicia adhatoda* Linn. *& Moringa oleifera L.) w*ere collected as sample botanicals from Rupandehi district. Collected samples were cleaned thoroughly & shade dried for 12 days at room temperature (30 ± 5^0C). Well dried samples were made fine powder by using electrical mixture. Experiment was conducted in Agroecology lab of Institute of Agriculture and Animal Science (IAAS) Paklihawa; Rupandehi district located at 27°30′N 83°27′E on Aug. 11, 2019.

Extraction of phytochemicals & preparation of stock solution: For the preparation of stock solution 50 gram of crude power of each collected sample (*A. indica, A. dubia, P. hysterophorus, J adhatoda, M. oleifera & L. camera)* were soaked in 250 ml of 4 extraction solvent (acetone, methanol, petroleum ether, distilled water) separately and left for overnight in air tight plastic bottle for maceration. Mixture was filtered in Whatman filter paper No. 42, boiled for 5 and allowed for cooling. Stock solution was made by diluting the 10 ml prepared solution with 100 ml water.

P**hytochemical screening:**
Qualitative phytochemical screening was done for the alkaloid, flavonoid, phenol, terpenoids, and saponin by the various tests as described by Visweswari *et al.,* (2013). Similarly quantitative determination of Alkaloid & Flavonoid was done by gravimetric method using following formula as described by Harbone (1973).
Alkaloid % = W2-W1/W1 × 100
Flavonoid %= W2-W1/weight of sample × 100

Test of allelopathy: 10 maize seeds (local variety) were placed in each Petri dish with moistened filter paper inside. Seven treatments including leaf extract of (*A. indica-T1, P. hysterophorus- T2, M. oleifera-T3, A. dubia-T4, L. camara-T5, J. adhatoda-T6 &* distilled water as control. Each treatment was maintained as (stock solution, 10% & 25% of prepared stock solution .The setup was replicated thrice in CRD design.The No of germinated seeds were recorded in a day interval and Length of radical and plumule was measured in a day interval after 4 days of experimental set up to 15 days. Data of germination %, radical & plumule length of maize seedlings were recorded. All the data were entered in Microsoft office excel 2007 & analysis by R Studio version 1.1.456. Data were subjected to analysis of variance (ANOVA) and means were separated by LSD at $P < 0.05$.Data were subjected to square root transformation.

RESULTS AND DISCUSSIONS

Results of qualitative phytochemical screening

Qualitative phytochemical screening of *M. oleifera* revealed that, there was presence of alkaloid and terpenoids in the extract. Presence of alkaloid was indicated by the positive result in Wagners test in distilled water medium

whereas presence of terpenoids was confirmed by the copper acetate test in acetone and methanol menstrum. Research done by the Ojiako (2014) also reported the various secondary metabolites like tannin, saponin, phenol, alkaloid etc were extracted by the aqueous solution of *M. oleifera*. The result was also found in accordance with the finding of Santi & Sengottuvel (2016).

Table 1. Result of qualitative phytochemical screening of *M. oleifera* L

SN	Test name	DW	PE	Acetone	Methanol	Change
1	Alkaloid test Mayers test Wagners reagent	 _ +	 _ _	 _ _	 _ _	Green ppt Brick color ppt
2	Flavonoid test Shindo's test Alkaline reagent test	 _ _	 _ _	 _ _	 _ _	Pink ppt Colorless solution
3	Phenol test Pheric chloride test	_	_	_	_	Blue black solution
4	Terpenoids test Copper acetate test	_	_	+	+	Green color
5	Saponins test Foam test	+	_	_	_	Foam appearance

Note: DW- distilled water, PE- petroleum ether, (+) = presence, (-) = absence, ppt—precipitate.

Table 2. Result of qualitative phytochemical screening of *A. dubia* Wall

S. N	Test name	DW	PE	Acetone	Methanol	Change
1	Alkaloid test Mayer's test Wagners reagent a	_ +	_ _	_ _	_ _	Green ppt Brick color ppt
2	Flavonoid test Shindo's test Alkaline reagent test	_ _	_ _	_ _	_ _	Pink ppt Colorless solution
3	Phenol test Pheric chloride test	+	_	_	_	Blue black solution
4	Terpenoids test Copper acetate test	_	_	_	+	Green color
5	Saponins test Foam test	+	_	_	_	Foam appearance

Note: DW- distilled water, PE- petroleum ether, (+) = presence, (-) = absence, ppt—precipitate

Table 2 showed the result of qualitative phytochemical screening of *A. dubia* Wall. This indicated the presence of alkaloid, phenol and saponin. All those metabolites were extracted by the distilled water. Rest of the menstrums used in experiment couldn't extract any metabolites. Ashok & Kumud (2010) also reported that hexane and methanolic extract of *A. dubia* showed the presence of phenol, flavonoid, saponin, protein and amino acid.

From the qualitative analysis of secondary metabolites flavonoid, terpenoids, and saponins were found to be present in *A. indica* extract. All those secondary metabolites were extracted in distilled water. Biu *et al.*, (2009) reported that aqueous leaf extract of *A. indica* possesses higher amount of saponin moderate quantity of tannin and glycoside & low quantity of alkaloid, terpenoids, reducing sugar & carbohydrate. Uwague (2019) also reported the presence of alkaloid and glycoside in aqueous extract of *A. indica* leaf.

Table 3. Qualitative phytochemical screening of *A. indica* Juss

S. N	Test name	DW	PE	Acetone	Methanol	Change
1	Alkaloid test Mayer's test Wagners reagent	_ _	_ _	_ _	_ _	Green ppt Brick color ppt
2	Flavonoid test Shindo's test Alkaline reagent test	_ +	_ _	_ _	_ _	Pink ppt Colorless solution
3	Phenol test Pherric chloride test	_	_	_	_	Blue black solution
4	Terpenoids test Copper acetate test	+	_	_	_	Green color
5	Saponins test Foam test	 +	_	_	_	Foam appearance

Note: DW- distilled water, PE- petroleum ether, (+) = presence, (-) = absence, ppt—precipitate.

Result of quantitative screening of alkaloid and flavonoid

L. *camera* contains highest percentage of alkaloid among all tested botanicals (18.01%). Which was statistically at par with that of *P. hysterophorus* & *J. adhatoda* and significantly different with other tested plants. Flavonoid % was found maximum in *J. adhatoda* (15.32%) whereas *A. dubia* was found to content least amount of it (2.85 %). The finding of Uwague (2019) reported that neem content 11.2 % alkaloid & 2.10 % flavonoid. Similarly, the alkaloid & flavonoid content of Moringa leaf was found 5.92 (W/W) and flavonoid 15.74 (W/W) (Santhi & Sengottuvel, 2016). Variation in result may be due to the plants parts used, geographical factor, solvent used and other unseen factors. Not all phytochemicals present in all plant parts & that % occur in different degree based on type of extracting solvent used (Ayinde *et al.*, 2007; Tijjan *et al.*, 2009).

Allelopathic test on maize seedling

Among all the sample botanical extract, highest concentration (stock solution) of *P. hysterophorus* resulted in lowest radical length of maize seedlings. Thus, found to have strong negative allelopathic effect compared to other tested botanicals. Beside that concentration, inhibitory effect was found to be higher in increasing concentration than the lower concentration. Similar result was also

found by Singh (1991) in rice wheat & other pulses. Devi and Dutta (2012) also reported that among the five different concentrations, 10% concentration of *P. hysterophorus* leaf extract causes highest degree of inhibition in radical growth of maize. This can be explained as *P. hysterophorus* alkaloid might be operating as growth inhibition as reported by earlier worker (Singh *et al.* 1991). Application of *M. oleifera* leaf extract promoted the radical growth of maize as in accordance with result found by Phiri (2010) and Foidl *et al.*, (2001).

Table 4. Result of quantitative screening of alkaloid and flavonoid

Plants	Alkaloid %	Flavonoid %
L. camera	18.01[a]	15.32[a]
P. hysterophorus	17.78[a]	13.63[b]
J. adhatoda	17.75[a]	12.86[b]
M. oleifera	11.58[b]	11.36[c]
A. indica	8.20[c]	7.51[d]
A. dubia	6.78[d]	2.85[e]
Grand mean	13.35	10.59
LSD value	1.12	0.84
MSE (±)	0.40	0.22
CV%	4.74	4.50
F-value	***	***

Note: DAT= CV- Coefficient of Variation, LSD- Least Significant Difference, MSE= Mean Squared Error *= Significant at 5 % level of significance, ** =Significant at 1 % level of significance, ***= Significant at 0.1 % level of significance. Different letter signifies the significant difference among the treatments

Similarly *L. camera* had strong inhibitory effect on plumule length of maize than other tested plant extracts. The result is also supported by the findings of Enyew & Raja (2015**)** in maize & wheat. Mersie & Singh (1987) recorded about 30 % reduction in shoot length of corn by the application of 4 % lantana extract powder. Hence higher concentration of *L. camera* found to have strong allelopathic effect on plumule growth of maize.

Table 4. Effect of botanicals extract on radical and plumule length of maize seedling

Treatments	Radical length		Plumule length	
	5 DAT	16 DAT	5 DAT	16 DAT
Stock solution of *A. indica* (T1)	1.92[abcd]	1.61[abcde]	1.33[ab]	2.02[a]
Stock solution of *P. hysterophorus* (T2)	1.09[g]	1.110[e]	0.63[bc]	1.29[ab]
Stock solution of *M. oleifera* (T3)	1.72[bcdef]	1.64[abcde]	1.10[abc]	1.64[ab]
Stock solution of *A. dubia* (T4)	1.17[fg]	1.18[de]	0.81[bc]	1.45[ab]
Stock solution of *L. camera* (T5)	1.46[defg]	1.49[bcde]	0.538[c]	1.31[ab]
Stock solution of *J. adhatoda* (T6)	1.31[efg]	1.33[cde]	0.92[bc]	1.71[ab]

10%stock solution of *A. indica* (T7)	1.83^{abcde}	1.67^{abcde}	0.85^{bc}	1.25^{b}
10%stock solution of *P. hysterophorus* (T8)	1.74^{bcde}	1.54^{bcde}	0.72^{bc}	1.27^{b}
10% stock solution of *M. oleifera* (T9)	2.35^{a}	2.12^{ab}	0.77^{bc}	1.52^{ab}
10% stck solution of *A. dubia* (T10)	2.31^{a}	2.10^{ab}	1.73^{a}	1.56^{ab}
10% stock solution of *L. camera* (T11)	1.82^{abcde}	1.73^{abcde}	0.70^{bc}	1.26^{b}
10% stock solution of *J. adhatoda* (T12)	1.713^{bcdef}	2.19^{a}	0.93^{bc}	1.21^{b}
25% Stock solution of *A. indica* (T13)	1.50^{cdefg}	1.17^{de}	0.63^{bc}	1.41^{ab}
25% Stock solution of *P. hysterophorus* (T14)	2.06^{abc}	1.93^{abc}	1.09^{abc}	1.85^{ab}
25% Stock solution of *M. oleifera* (T15)	1.92^{abcd}	1.80^{abcd}	0.68^{bc}	1.18^{b}
25% Stock solution of *A. dubia* (T16)	1.94^{abcd}	1.86^{abc}	1.28^{ab}	1.44^{ab}
25% Stock solution of *L. camera* (T17)	1.61^{bcdefg}	1.52^{bcde}	0.41^{c}	1.10^{b}
25% stock solution of *J. adhatoda* (T18)	2.13^{ab}	1.55^{abcde}	0.42^{c}	1.35^{ab}
Control (T19)	1.82^{abcde}	1.75^{abcd}	0.719^{bc}	1.55^{ab}
Grand mean	1.76	1.65	0.85	1.44
LSD value	0.48	0.54	0.61	0.62
CV %	16.64	19.81	43.11	25.94
F -value	***	**	*	ns

Note: DAT= Days after Treatment, CV- coefficient of variation, LSD- least significant difference, *= Significant at 5 % level of significance, ** =Significant at 1 % level of significance, ***= Significant at 0.1 % level of significance, ns= Non Significant. Different letter signify the significant difference among the treatments.

CONCLUSION

Qualitative phytochemical screening was done by the various tests as described by Visweswari and coworker at agroecology lab of IAAS, Paklihawa campus. Among the various metabolites tested, saponin and amino acid was found in most botanicals. Most of these metabolites were extracted by the aqueous solution rather than other 3 menstrum (acetone, methanol, and petroleum ether). *A. indica* extract contain most of the tested metabolites compared to other botanicals tested in the experiment. Quantitative test revealed that percentage of alkaloid was found 11.58%, 6.78%, 18.01%, 17.75%, 8.20% & 17.78% and flavonoid 12.89%, 2.85%, 7.5%, 15.32%, 11.36%, 13.63% respectively in *M. oleifera* L., *A. dubia* Wall., *L. camara* L., *J. adhatoda* Linn., *A. indica* Juss and *P. hysterophorus* L. *Lantana camera* extract was recorded to have strong

inhibitory effect on radical growth in maize seedling compared to the other botanicals extract. *M. oleifera* (10% stock solution) enhanced the growth of radical in maize seedling at early stage (11 DAT).So the diluted concentration of *M. oleifera* leaf extract can be used as a growth promoter for maize as well as may be in other crops of same family. Application of *P. hysterophorus* extract shows the highest inhibitory effect against the radical growth in maize seedling. Inhibitory effect was found to be increased with increasing concentration of plant extract solution i.e. stock solution of *P. hysterophorus* greatly reduced the radical length as compared to other diluted solution. Mild concentration of *L. camara* (25% stock solution) causes the maximum reduction in length of plumule. Thus *lantana camera & Parthenium hysterophorus* are considered to have strong allelopathic effect on maize seedling and possibly in other C4 crops & of poaceae family also.

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Adaptation and mitigation of climate change through the use of improved sustainable agriculture practices

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ABSTRACTS

The entitled study was conducted from June to September 2019. The study covered Bethanchok rural municipality of Kavre district and Suryabinayak municipality of Bhaktapur district. A total of 200 respondents were selected through random sampling techniques for questionnaire survey. Group discussions, interviews, observations and various relevant publications were used as a method of information collection. Out of 200 respondents, 52.5 percent were female; which might be due to outmigration of male members of the households. The study areas were dominated by ethnic minorities (Tamang, Newar) followed by Brahman/Chhetri. The outcome of the study shows that a transition towards improved, sustainable agricultural practices is needed by discouraging the use of chemical fertilizers and encouraging organic crop production. Awareness campaigns on climate change are recommended among the farmers by creating a climate change group for climate information sharing thereby allowing them to adopt and mitigate the adverse impact of climate change.

Key words: Farming, livelihoods, biogas, rainwater harvest, empowerment

INTRODUCTION

Climate change is a significant and lasting change in the statically distribution of weather patterns over periods ranging from decades to millions of years. It may be a change in average weather condition or the distribution of extreme events around that average. Climate change may be limited to a specific region or may occur across the whole earth (ICIMOD, 2013). According to the IPCC Fourth Assessment Report of the Working Group II on the impacts, adaptation and vulnerability, climate change will have an extreme impact in the sectors of water, food, industry, settlement and society and health.

Climate change has become a serious challenge and threat to living organisms as well as farmers at the global scale and local level. Agriculture being the biological enterprise and engineering meant for food and fiber production and processing essential for fulfilling basic human needs and income, the impact of climate change variability / change on agricultural needs a special emphasis. Some of the most important impacts of global climate variability and changes are felt among the populations, predominantly in developing countries, referred to as "subsistence "or "smallholder" farmers. These impacts are often difficult to model or predict because of the lack of standardized definitions of ecosystem and ethnicity, specific farming systems and therefore missing standard data collection protocolsat the local or national level. Nepal has observed the trend of annual increase in temperature per decade by 0.41 degree Celsius which is much higher than the global average. Climate change is a relatively new challenge on a global scale but has strong local effects (Dahal, 2008). The effects of global warming and climate change have a greater impact on the ecosystem in the Himalayan region of the globe where the melting of glacial ice and glacial lakes outburst floods occur.

Climate change creates a new ecological niche that permits the entry, establishment and spread of pest and diseases into new geographical areas. Biodiversity loss is also occurring and is expected to continue if the effect of climate change intensifies. The experts of the Asia-Pacific assessment point to the value of ecosystem based approaches and identify, among others, lack of solid waste management, as well as air, water and land pollution as factors undermining gains in a number of the Aichi Targets and SDGs for many countries e.g. extinction of plant and animal species due to deforestation, rising temperature and water pollution (IPBS, 2019). Since different plant and animal species are suitable to specific ecosystems, changes in soil, temperature, humidity, sunshine and water availability will change a particular species' ability to survive in the given environment. The hill region is located between the mountainous and terai region and represents about 42% of Nepal's total land area. This region is home to 44% of the population and the food demand supersedes the production by 16%. Farmers in the hills have observed changes in the intensity and timing of rainfall as well as a rise in both summer and winter temperatures. Snowfall has both changed in timing and decreased in volume while frosts have been occurring later. Farmers have also noticed greater incidence of pest and crop diseases that were not present in the past.

MATERIALS AND METHOD

Kavre and Bhaktapur districts were selected for the study where ARD has implemented a project on adaptation and mitigation of climate change. This study was conducted mainly by analyzing the primary data collected through household survey and field observation. There were altogether 37 questions in the household survey questionnaire. Secondary data were also collected from various sources. The study covered Bethanchok rural municipality of Kavre

district and Suryabinayak municipality of Bhaktapur district to assess the effectiveness of the program in the targeted areas. A total of 200 respondents were selected through random sampling techniques. Questionnaire survey, group discussion, interviews, and observations were used as a method of information collection. MS Excel was used to analyze the data.

RESULTS AND DISCUSSION

Distribution of respondents by gender

Both, male and female respondents were involved in improved sustainable agriculture practices promoted through the climate change project. In the study area, overall female respondents were found to be more active as compared to the male members. It was found that among 200 respondents, 47.5 percent were male and 52.5 percent were female (Figure 1). A higher number of female respondents were due to the migration of a substantial number of male members from the selected households. Migration has become a general trend in rural areas of Nepal as means of addressing rampant hunger and poverty.

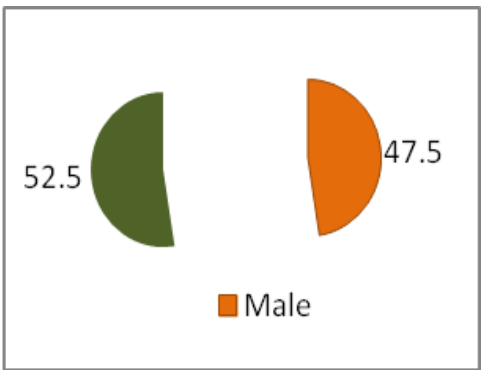

Figure 1. Distribution of respondents by sex (N=200)

Distribution of respondents by age and ethnicity

The age group of the respondents was divided into three groups. Respondents younger than 16 years and older than 60 years were taken as economically inactive groups. The respondents of the age group 17-59 years were defined as economically active group. From this survey, it was found that the majority of the respondents were in the age group of 17-59 years old (Table 1).

Table 1. Distribution of respondents by age group and ethnicity (N=200)

Age group	Percentages	Ethnicity	Percentage
<16 years	10.0	Brahmin/ Chhetri	44.5
17-59 Years	75.0	Ethnic minorities*	54.5
>60 years	15.0	Dalit (Kami)	1.0

*Ethnic minorities: Tamang (52.0%); Newar (2.5%)

In the study areas, the population is ethnically diverse, being predominated by ethnic minorities (*Tamang*/ Lama and *Newar)* and *Dalit (Kami*). Respondents from ethnic minorities were 54.5 percent, which was higher than that of other ethnicities. The average number of respondents was Tamang 25 percent, Newar 2.5 percent, and *Dalit* (*Kami*) only 1 percent (Table 1).

Perception of respondents towards climate hazard and disaster

It was found that less than 50 percent of the sampled respondents had knowledge on climate change as they had heard about the change on climatic parameters (atmospheric temperature, humidity, rainfall) directly or indirectly. Farmers from Bhaktapur were relatively more aware of climatic issues than Kavre. This might be due to easy access to various sources of information, being closer to the city and awareness level of the people. This information indicated the need of conducting project activities relatively more intensively in Kavre than in Bhaktapur.

The results further suggested that extreme rainfalls, landslides, flood and extreme cold and hailstorm were the major hazards with increased frequency of occurrence in the last five years which were identified in the group discussions and based on literature. The value obtained from the occurrence ranking scale (I- the highest to V- the lowest) showed that flood and landslides were the major extreme events (II & I) in Kavre district. Similarly, heavy rainfalls and land slides were the major hazards (I & II) identified in the Bhaktapur district (Table 2).

Table 2. Perception of the respondents towards climate change hazard (N=200)

SN	Climatic hazard	District	
		Kavre	Bhaktapur
1	Flood	II	III
2	Landslides	I	II
3	Extreme hot and drought	V	V
4	Extreme cold and hailstorm	IV	IV
5	Heavy rainfalls	III	I

Use of improved sustainable agriculture practices

To promote climate change adaptation and mitigation practices, 41% of the respondents had managed garbage waste, 27% had installed plastic tunnels, 14% had improved their animal sheds, 9.5% conducted organic kitchen gardening, 5% had installed biogas plants, 2.5% had installed plastic ponds and 1% had installed roof top rain water harvesting tanks in study area (Figure 2). Respondents have reported that these activities were quite useful to achieving their objectives, thus contributing to be more resilient to climate change.

Agriculture smart activities

Out of 200 respondents, 54 households (27%) had started cultivating vegetables under plastic tunnels and 28 households (14%) had constructed improved animal sheds (Figure 2). The improved animal shed offered space for housing at least 3 to 4 buffaloes. Cattle urine collected in plastic drums were used for organic vegetable farming. It has improved livestock health, enhanced the sanitary quality of animal products (i.e. milk) while lowering the environmental impact.

Five plastic ponds were constructed in different locations to collect rainwater (Figure 2). The water stored in ponds was utilized for domestic purpose like washing dishes, cleaning and irrigating kitchen gardens or off-season vegetable production under plastic tunnels. Local farmers are getting benefit from these ponds by having healthy organic vegetables throughout the year; and even have generated additional income.

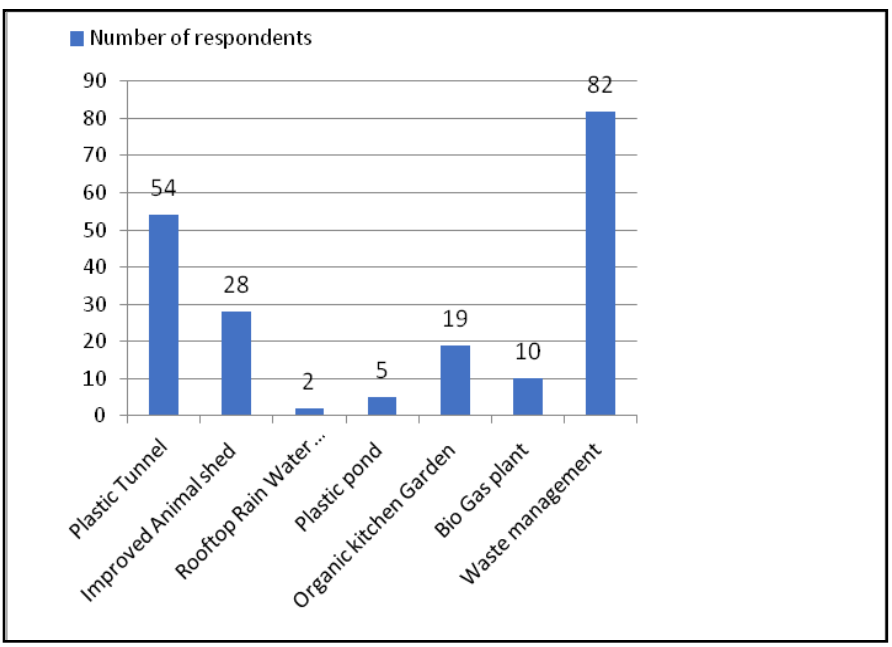

Figure 2. Adaptation and mitigation measures practiced in the study area (N=200)

Mitigation measures practiced in the study area

Tree plantation activities were conducted in the study area to conserve the forest resources and support the interlinked aspect of biodiversity including the flora and fauna of different indigenous species. Also; this is an important activity of

the project to address climate change in the study area as trees will absorb $C0_2$ from and release O_2 to the atmosphere.

Under this project altogether 34 biogas plants were installed in suitable heights in the study sites and were serving as source of fuel energy for cooking. Each biogas plant has a minimum capacity of 6 m^3 and serves a 6-member family household. In general, 6 kg of firewood are required daily for cooking food in one family. Thus 34 households have been burning 74.5 tons of firewood per year resulting in substantial volume of gas emission thereby contributing to climate change. In order to address this serious issue, 34 biogas plants have been constructed and operated by the local people, representing 34 households.

Furthermore, respondents in the study area revealed that 41 percent of the respondents segregated the waste products into degradable and non-degradable waste. Degradable waste materials were used in making compost. While 59 percent of the households do not segregate waste produced in their houses, indicating that they require more awareness activities within the project.

CONCLUSION

Climate change is one of the major challenges for the environment, human health and security. It is a threat to the livelihood of people relying to a great extent to agriculture and livestock production as a source of consumption. The study areas in Kavre and Bhaktapur were shown to be no exception to this reality.

Survey results confirmed that perception of farmers in the study sites was in line with findings of other researchers around the world. Respondents were able to identify the change in temperature and precipitation. Flood, landslide and climatic extremities were identified as the major hazards.

Water management is vital for food production, nutrition security and household income. The installation of rooftop rainwater harvesting tanks and water collection plastic ponds were found useful to address the issues of food production, nutrition security and household income in parallel to climate change.

Biogas plant installation, forestry nursery development, waste management and tree plantation were found effective in adaptation to and mitigation of climate change.

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Effects of feeding hydroponic maize fodder on performance of lactating cattle

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ABSTRACT

An experiment was conducted to know the effects of feeding hydroponics maize fodder on the performance of lactating cattle. A total of 6 lactating cattles of (avg. body weight 387 kg, and avg. daily milk yield 8 l) mixed breed (Jersey cross and Holstein Friesian cross) were allocated in a completely randomized block design to 2 treatments. Treatment 1(T1) was fed 100% Conventional feed (Green fodder + Concentrate feed) and Treatment 2(T2) Hydroponic Maize fodder supplemented feed (88% Green fodder + Concentrate feed and 12% Hydroponics maize fodder). Each treatment had three dairy cattle as replication. The experiment lasted for three weeks. Dietary treatments had non-significant effects (P > 0.05) on milk yield, and nutrient composition of milk of the lactating cattle. Lactating cattle fed with Treatment 2 had the higher milk yield (9.05±2.06 lit/day) in 1st week of experiment while the lower yield (7.41±2.92 lit/day)) was recorded in 3rd week of experiment of lactating cattle fed with Treatment 1. Fat content in milk was found highest (5.60%±0.60) in 3rd week of experiment fed with 12 percent substitution of commercial feed with hydroponic maize fodder and lowest (4.38%±0.49) with 1st week of experiment fed with Treatment 2. Protein content in milk was found highest (2.96±0.03) in 3rd week of experiment fed with Treatment 1 and lowest (2.86±0.06) with 2nd week of experiment fed with Treatment 1. The nutrient content in hydroponic maize fodder recorded DM 12.39 percent, CP 12.55 percent, NDF 47.04 percent, ADL 16.51 percent. The cost to produce per kg hydroponic maize fodder recorded Rs. 20.62 which was found higher than the cost in India. The profit from the milk was only 6.79 percent but the impact of hydroponic fodder supplementation on the health is positive.

Key words: Concentrate compounded feed, hydroponic maize fodder, nutrient content, production cost, cattle

INTRODUCTION

Green fodder plays a vital role to improve the production and of dairy cattle. Dairy farming is economic, and good source of income in the farm family in Nepal. Feeding dairy animal is major activity in the farming activities, and cost 60 to 65 percent of all cost evolved. Nepal is feed deficit by 20.6 percent mostly during the winter so supplementary feeding is needed (MoALD, 2019). This situation is demanding to produce more green fodder during the winter season in the country. The major constraints in dairy farming is shortage of feed, labor, inputs such as fertilizer, land to cultivate the fodder and impact of climate change i,e. drought, cold wave and flood. Further, the non-availability of quality fodders round the year aggravates the constraints of the sustainable dairy farming (Naik *et al.* 2013a). In this situation, hydroponic fodder production can be one of the activity to support winter feeding to the dairy animal in the country. Several works have claimed that hydroponic fodders are more nutritious, safer and cheaper to feed to the animal especially during the winter (Naik *et al.* 2013a). The hydroponic fodder products are sprouted grains with sufficient green mass and are very beneficial to the dairy animal compared to the conventional green forage (Mc Candlish, 1939). In the recent days, several countries are using the hydroponic fodder to the dairy animal and are benefited specially during the winter season when there is shortage of green fodder. Several works on the production and utilization of hydroponic fodder have been done by ICAR in India, and farmers are using fodder as supplementary feed in dry winter season. There are several cereal crops selected as suitable for hydroponic fodder production by several workers. Some of them are barley (Reddy *et al.*, 1988); oat, wheat (Snow *et al.*, 2008); sorghum, alfaalfa, cowpea (AI-Karki *et al*., 2012) and maize (Naik *et al*., 2011; Naik *et al*; 2014). Studies have proved that the nutrient contents and digestibility of hydroponic fodder are superior to certain common cereal and leguminous fodder such as berseem and clover in terms of nutrients availability such as CP, EE and NFE content (Reddy *et al.*, 1988, Pandey and Pathak, 1991; Naik *et al.*, 2012a).

Some farmers in Nepal have established the hydroponic fodder production system which is a soil less culture and alternative to conventional method of green fodder production. In current farmer's practices, as they reported, the cereal or forage seeds are soaked in water or nutrient solution for overnights and put in a plastic tray; the seed sprouts within 12 hours and grow about 20-25 cm high fodder mat within 7 days, very similar to Jamara, and the whole mass is offered to animals. Nepal Agriculture Research Council (NARC)/ Swine and Avian Research Programme has initiated hydroponic maize fodder feeding to the piglets but not in dairy animal. Therefore, this study was designed to find the production potential of hydroponic fodder crop, and its utilization by the dairy animal during the winter. The need of research on hydroponic feeding was suggested by NARC, Regional Technical Working Group (RTWG) meeting of the Government of Nepal in 2014. The objective of the study was to study on the

nutrient content of hydroponic green fodder, and to study on the effect of hydroponic green fodder feeding on the milk production of dairy cattle.

MATERIALS AND METHODS

Production of hydroponic maize fodder

Hydroponic maize fodder (HMF) was produced in a poly house established at Pasture Fodder Division, Khumaltar. The measurements of poly house were of 12 ft long, 8 ft width and 9 ft height. The poly house was equipped with automatic fogger to control the relative humidity, and sprinkler for irrigation. Clean and unbroken seeds of maize (*Zea mays*) were soaked in tap water for overnight and then it was kept in jute sack for two days. Germinated seeds were placed in antifungal tray of size of 2'6" long and 1'3"width inside the poly house. The plants were allowed to grow for 10 days until it reaches to the height of 20-30cm. Fodder was harvested on 11^{th} days of sowing, and fed to the dairy animals. Hydroponic maize fodder, a mat of germinated seeds embedded in their white roots and green shoots, was fed to dairy animals maintained at the farm of NARC/Animal Breeding Division, Khumaltar, Lalitpur.

Economics of hydroponic maize fodder

The cost of HMF was calculated by considering as of fixed cost. The cost of seed (Rs.30/kg), electricity (Rs.12/Unit) and labour cost (Rs.46.96/ tray) were included as the variable costs. The costs of each expense was recorded to calculate the cost of hydroponic fodder production and cost calculation was done.

Study site and experimental design

This experiment was carried out in the Animal Breeding Division, Khumaltar during October 2017 for three weeks. Six crossbreed lactating Jersey/ Holstein cattle of 2^{nd}parity were selected considering their body weight (average 387 kg) and daily milk yield (average 8ltr/d), that were divided into two groups to conduct the experiment. The feeding practices used were Treatment 1(T1) fed with 100% Conventional feed (Green fodder + Concentrate feed) and Treatment 2 (T2) were fed with Hydroponic Maize fodder supplemented feed (88% Green fodder + Concentrate feed and 12% Hydroponics maize fodder).

Feeding and management

A seven days adaptation period was adapted before starting the experiments. Animals were drenched and dipped before tart of experiment. The drenching materials used were Albendazole (5 mg/kg body weight) against internal parasites, and Malathion of 0.5% solution to control the external parasites.

The experimental animals were offered feed twice daily on the basis of dry matter requirement as adapted in the farm. The clean drinking water was made available *ad lib*. Dry matter requirements of experimental cattle were calculated by considering the nutrient requirements recommended by NRC, 2012. The feeding practices were, Treatment 1 (T1) fed with 100% Conventional feed (Green fodder + Concentrate feed) and Treatment 2 (T2) were fed with Hydroponic Maize fodder supplemented feed (88% Green fodder + Concentrate feed and 12% Hydroponics maize fodder).

Milk production and composition measurement

Milking was done twice daily at 6 and 16 hours to record milk yield. Milk samples of 10 ml from individual animal at 7 days interval were analyzed using Lacto Scanner ®. The analyzed milk constituent was fat, protein, total solids (TS) and Solids not Fat (SNF) to compare the changes in milk constituent due to the treatment effect.

Data analysis

Data were analysed by using GenStat 5.3.2 statistical software to test the significance of the treatment.

RESULTS AND DISCUSSION

Yield and yield attributing characters of hydroponic maize fodder

The mean height of HMF recorded as 27.65 ±0.34 cm in 11 days (Table 1) was similar to range given by Naik *et al.,* 2015 (11-30cm).Leaf colour was yellow green. Other studies stated that depending upon the type of grain, the hydroponics fodder looks like a mat at the end of germination period of about 8 days consisting of germinated seeds embedded in their white roots and green shoots (Snow et al., 2008; Naik et al., 2014).In the experiment, one kg maize grain produced 5kg HMF which was lower than the report of Naik *et al*., 2013b (8-10kg).Several authors reported that the fresh yield and DM content of the hydroponic fodder are mainly influenced by the type of crops , days of harvesting, degree of drainage of free water prior to weighing, type and quality of seed, seed rate, seed treatment, water quality, pH, irrigation frequencies, nutrient solution used, light, growing period, temperature, humidity, clean and hygienic condition of the green house etc.(Trubey and Otros 1969;Sneath and McIntosh,2003; Dung *et al*.,2010a;Fazeli et al., 2011;Naik 2013a; Naik; 2013b).

Nutrient composition of hydroponic maize fodder

The fresh dry matter (FDM) content of HMF was recorded as (12.39±0.55%) which was similar with the result of Naik *et al.,* 2015 (11-14%) but was less as reported by Adebiyl *et al.,* (25%). Decreased starch content during sprouting

sometimes declines the FDM (Naik *et al*., 2015). Hydroponic Maize Fodder had shown good crude protein (CP) content (12.55 ± 1.79%) which was higher than that of CP content of the used maize grain (7.38%) in this study. But the CP content of the HMF was lower than the reported by other authors (13.57% and 13.75%) Naik *et al*., 2015; and Adebiyi *et al*., 2018, respectively. Several authors reported that the nutrient content of hydroponics fodder are superior to certain common non-leguminous fodders, but comparable to leguminous fodder in terms of available OM, CP, EE and NFE content (Reddy *et al*., 2014, Pandey and Pathak, 1991; Naik *et al*., 2012a).

Table 1. Yield and yield attributing characters of hydroponic maize fodder

SN	Attributes	Values	Standard Error of Mean (SEM)
1	Plant height (cm)	27.65	0.34
2	Leaf color	Yellow green	-
3	Yield (kg tray^{-1})	3.09	0.06

The recorded fibre fractions were (47.04± 9.99%) and (23.16±3.40 %) for NDF and ADF, respectively (Table 2). Naik *et al*., (2015) reported that the increase in the content of CF, NDF and ADF; and decrease in the NFE and NFC may be attributed to the increase in the number and size of cell walls for the synthesis of structural carbohydrates (cellulose and hemicellulose).

Table 2. Nutrient composition of hydroponic maize fodder

SN	Parameters (Nutrient related)	Nutrient Content (%)	SEM
1	Fresh dry matter (FDM)	12.39	0.55
2	Crude protein (CP)	12.55	1.79
3	Neutral detergent fiber (NDF)	47.04	9.99
4	Acid detergent fiber (ADF)	23.16	3.40
5	Acid detergent lignin (ADL)	16.51	2.63
6	Hemi-cellulose (HC)	23.87	11.16
7	Cellulose (C)	6.64	3.22

Milk production of dairy cattle

The milk yield was increased with the inclusion of hydroponic fodder (Table 3) but the result was not significantly different (P>0.05). Lactating cattle fed with T2 had the higher milk yield (9.05±2.06 l/d) in 1st week of experiment while the lower yield (7.41±2.92 l/d) was recorded in 3rd week of experiment of lactating cattle fed with T1. Similar result was found in the study of Naik *et al*, 2014 that concentrate feed supplement with HMF had higher milk yield (4.64 ±1.21 kg/d)

than the dairy cattle offered only with the green fodder (4.08±0.11 kg/d). The higher milk yield could be due to the higher concentration of minerals in hydroponic fodder.

Table 3. Milk yield of dairy cattle in different weeks

SN	Treatments	Initial	1st Week	2nd Week	3rd Week
1	T1 100%Conventional feed (Green fodder + Concentrate feed)	7.45	7.82	8.28	7.41
2	T2 Hydroponic Maize fodder supplemented feed (88% Green fodder + Concentrate feed and 12% Hydroponics maize fodder)	8.33	9.05	8.93	8.61
SEM		1.63	2.06	3.23	2.92
P value		NS	NS	NS	NS
LSD (0.05 level)		7.03	8.88	13.92	12.59
CV%		25.4	30	46	44.7

Milk composition of dairy cattle

Dietary treatments had non-significant effects (P> 0.05) on milk constituents. Fat content in milk was found higher (5.60%±0.60%) in 3rd week of experiment fed with T2 and lowest (4.38±0.49%) with 1st week of experiment fed with T2. Protein content in milk was found higher (2.96±0.03%) in 3rd week of experiment fed with T1 and lower (2.86±0.06%) with 2nd week of experiment fed with T1. However, feeding hydroponic maize fodder produced almost similar quality of type of milk in terms of its constituent indicating no negative impact of feeding hydroponic fodder maize to the lactating dairy cattle (Table 4 and 5).

Table 4. Major Milk composition of dairy cattle in different weeks

SN	Treatments	Fat				SNF				Total Solids			
		Initial	1st Week	2nd Week	3rd Week	Initial	1st Week	2nd Week	3rd Week	Initial	1st Week	2nd Week	3rd Week
1	T1	4.84	4.77	4.82	5.47	7.75	7.72	7.67	7.99	0.72	0.72	0.72	0.75
2	T2	4.49	4.38	5.11	5.60	7.62	8.17	7.75	7.94	0.71	0.76	0.73	0.75
SEM		0.37	0.49	0.40	0.60	0.11	0.13	0.11	0.10	0.01	0.01	0.01	0
P value		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
LSD (0.05 level)		2.20	3.02	2.46	3.67	0.70	0.81	0.68	0.64	0.07	0.09	0.08	0.05
CV%		13.9	18.8	14.1	18.9	2.6	2.9	2.5	2.3	2.8	3.6	3.5	2.0

Health status of dairy cattle fed hydroponic maize fodder

The faecal samples were tested for parasitic load in the beginning and the end of experiment at Animal Health Research Division (AHRD) of NARC, Khumaltar.

The Paramphistomes spp. was observed in 4 out of 6 samples at the end of experiment but the infestation level was of sub clinical. The body condition score in both treatments were find optimum indicating the good health of experimental animal.

Table 5. Milk composition of dairy cattle in different weeks

SN	Treatment	Protein				Conductivity				Lactose			
		Initial	1st Week	2nd Week	3rd Week	Initial	1st Week	2nd Week	3rd Week	Initial	1st Week	2nd Week	3rd Week
1	T1	2.89	2.88	2.86	2.98	5.19	4.82	5.03	4.79	4.07	4.06	4.03	4.19
2	T2	2.84	3.04	2.89	2.96	4.95	4.87	4.91	4.90	4.01	4.30	4.08	4.17
SEM		0.04	0.05	0.04	0.03	0.23	0.14	0.16	0.08	0.05	0.06	0.05	0.06
P value		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
LSD (0.05)		0.27	0.31	0.27	0.23	1.40	0.90	1.01	0.51	0.35	0.40	0.33	0.36
CV%		2.7	3.0	2.7	2.3	7.9	5.3	5.8	3.0	2.5	2.7	2.4	2.5

Cost of per kg hydroponic maize fodder

The cost of production per kg of HMF was recorded NRs.20.62 (Table 6) which was higher compared to Naik *et al.*, 2013 (NRs. 5.60), Jemimah *et al.*, 2015 (NRs 3.00) and Gunasekaran *et al*., 2017 (NRs.4.50) cost to produced per kg HMF production. Price of maize seed, electricity and labour cost was NRs. 14.50/kg, NRs. 4.00 /unit and NRs.4.50/tray respectively in case of Jemimah*et al.*, 2015 study. The cost depends upon the locations, market price and accessibility. Gunasekaran *et al*., 2017 reported that even though hydroponic fodder is costlier, it can be effectively utilized for feeding animals during adverse situation such as drought, flooding, cold wave in a reasonable cost.

Table 6. Production cost of hydroponic maize fodder kg^{-1}

SN	Input	Cost (NRs)
1	Fixed Cost	
1.1	Tray	0.84
2	Operational Cost	
2.1	Seed	6
2.2	Electricity	0.25
2.3	Labor	13.53
	Total cost kg-1	20.62

Cost benefit of feeding hydroponic maize fodder to dairy cattle

The cost benefit was analysed of the feeding trial to observe the feeding potential of hydroponic maize fodder to the dairy cattle. The result indicated the net profit of NRs. 9880.13 (Table 7) in hydroponic supplementary diet. From this study it can be concluded that hydroponic supplement to the dairy cattle is beneficial to get higher return from the milk. The profit from the milk was only 6.78 percent but the impact of hydroponic fodder supplementation on the health

is positive. Despite of the small marginal profit, the dairy animal fed with hydroponics are better than the the concentrate feed.

Table 7. Cost benefit of feeding hydroponic maize fodder to dairy cattle

SN	Parameters	T1 100%Conventional feed (Green fodder + Concentrate feed)	T2 (88% Green fodder + Concentrate feed and 12% Hydroponics maize fodder)
1	Cost of feed (NRs)	22848	26420.40
2	Cost of milk (NRs)	32099.60	36300.60
3	Net Profit (Experimental Period of 21 days) (NRs)	9251.60	9880.13

CONCLUSION

Hydroponic fodder yield was comparable to the production in Indian context indicating the country is suitable for hydroponic fodder production. The nutrient content in hydroponic maize fodder is nutritional good enough as CP and ADF was recorded 12.55 and 47.04 percent respectively. Nutrient composition of milk fed with HFM was almost similar indicating no negative impact of feeding hydroponic fodder maize to the lactating dairy cattle. The cost to produce per kg hydroponic maize fodder recorded Rs. 20.62 which was found higher than the cost in India. The profit from the milk was only 6.79 percent but the impact of hydroponic fodder supplementation on the health is positive. In conclusion, hydroponic fodder based feed can be used during winter to the lactating animal.

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Evaluation of growth and yield attributes of okra variety

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ABSTRACT

An experiment was conducted to evaluate the growth and yield of okra (Abelmoschus esculentus L. Moench) in the field of Nepal Agricultural Research Council at Jute Research Program, Ithari, Sunsari during May to August, 2020. Eight varieties (Shubham-11, TY COON, R-35, Kashi Pragati, Lady Luck, Arka Animika, Kashi Kranti and Suraksha) were selected with three replications. The experiment was laid out in a randomized complete block design (RCBD). The overall performance of varieties exhibited significant variation of growth and yield. Among the varieties, TY COON recorded the highest number of leaves (22) and number of branches plant $^{-1}$ (4.47). The highest plant height (196.00 cm) was recorded in Suraksha variety, while the least number of days to first flowering (42.33 days) was recorded in Kashi Kranti variety. TY COON variety was recorded highest yield such as fruit length (13.27 cm), fruit diameter (17.24 mm), number of fruit plant $^{-1}$(18.22), weight of fruits (15.90 g) and fruit yield hectare^{-1}(11.71 t).

Key words: Okra, variety, fruit, production

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is an economically important popular vegetablecrop grown in tropical, subtropical and warm temperate regions around the world for its tender, delicious green fruits (Singh et al., 2018). Fruits are cooked, canned and consumed in various forms (Rajesh et al., 2018). It is a member of the Malvaceae family. It is an annual high yielding plant which varies in fruit shape and size, branching habit, period of maturity and plant height (Purquerio et al., 2010). Fruits of okra are rich in vitamins A, B, C, carbohydrates, fats, calcium and protein which provide a valuable supplementary nutrition in the human diet (Dash et al., 2013). Ghimireet et al. (2018) reported that declining the productivity of okra while increased area and

production. The reduction in the roductivity and yield in okra is mainly due to a lack of location specific varieties (Rajesh et al., 2018). Meher et al. (2016) reported that used of old traditional cultivars and poor seed quality result poor yield and ultimately lower productivity. The farmers of eastern Nepal mostly save their own seed for cultivation. Okra production can play a significant role in the economy of nations as other annual crops. So this study was conducted to evaluate the varietal performance to support the farmers in okra cultivation.

MATERIALS AND METHODS

An experiment evaluation of Okra (*Abelmoschus esculentus* L. Moench) high yielding varieties was conducted in Nepal Agricultural Research Council, Nepal at Jute Research Program, Ithari, Sunsari, Nepal during the May to August, 2020. This experiment was laid out in a Randomized Complete Block Design (RCBD). There were eight treatments (Shubham-11, TY COON, R-35, Kashi Pragati, Lady Luck, Arka Animika, Kashi Kranti and Suraksha) with three replications. All the varieties were randomized separately in each replication. The well decomposed farm yard manure (FYM) at the rate of (20 t ha^{-1}), DAP (80 kg ha^{-1}), MoP (40 kg ha^{-1}) and half Urea (60 kg ha^{-1}) were applied as basal dose. The remaining half dose of urea (85 kg ha^{-1}) was applied as topdressing in two equal split doses as 30 and 60 days after sowing. Irrigation was provided at an interval of 7-10 days except during the period of intermittent rains and the field was kept free from weeds manually. The seeds were sown on line in 2-3 cm. depth and spacing between rows and plants was maintained at 45 cm and 25 cm, respectively. Thinning was done at 15 DAS by retaining one seedling per hill. The observations were recorded from ten plants from each plot. Plant height (cm), number of leaves per plant, number of branches per plant, date of flowering initiation, fruit length (cm), fruit diameter (mm), number of fruits per plant, average fruit weight (g), fruit yield per plot, marketable yield ton per hector were recorded.

Data collection and analysis

Plant height was measured from the ground level to the growing tip. Numbers of fully expanded leaves and total number of branches at the last pod harvest was counted. After seed emergence ten plants in each plot were randomly selected for days to first flowering. The days from seed sowing to the flowering of 50% of selected plants were counted for days of first flowering. Harvesting started 48 days after sowing. Green immature pods were harvested every 3 days. The fruit length was measured from the neck of the fruit to the bottom of 20 randomly selected fruits from each plot with the help of measuring scale and average was recorded in centimeter. The number of fruit per plant was recorded from selected plant by the following formula:

$$\text{Number of fruit per plant} = \frac{\text{Total number of fruit from 10 sample plants}}{10}$$

The fruit diameter was measured at the middle portion of 20 selected fruits from each plot with the help of Vernier calipers and their average was recorded in millimeter (mm). Mean weight of 20 randomly selected fruits at from each plot were measured in gram (g) with the help of electronic balance. The data obtained from selected plants were subjected to analysis of variance (ANOVA) at the 5% level of significance by using Statistical Tools for Agricultural Research (STAR), version: 2.0.1, 2014 edition.

RESULTS AND DISCUSSION

Growth parameters

The highest number of leaves per plant (22) was produced by TY COON followed by R-35 (21.47). The lowest number of leaves per plant was produced by Kashi Pragati (11.40) (Table 1). This might be due to that influenced by variety, growing season and fertility of the soil. The mean number of leaves per plant of different varieties was found significantly different. Similar report was found in different varieties of okra by Dimkpa et al. (2019).

Table 5. Growth parameters of different okra varieties at harvesting stages at JPR, Ithari, Sunsari, Nepal (2020)

Varieties	Growth parameters		
	Number of leaf plant $^{-1}$	Plant height (cm)	Number of Branch plant^{-1}
Shubham-11	12.93 ^{bc}	168.13^{abc}	2.67 ^{bc}
TY COON	22.00 ^{a}	154.87^{abc}	4.47 ^{a}
R-35	21.47 ^{a}	103.27^{c}	2.40 ^{bc}
Kashi Pragati	11.40 ^{c}	140.40^{abc}	1.71 ^{c}
Lady Luck	15.67 ^{abc}	126.80 ^{bc}	4.33 ^{a}
Arka Animika	17.75 ^{abc}	176.13^{ab}	2.56 ^{bc}
Kashi Kranti	11.67 ^{c}	139.60^{abc}	2.30^{bc}
Suraksha	19.87 ^{ab}	196.00 ^{a}	2.90^{b}
HSD (0.05)	7.91	66.88	1.18
F-Test	**	**	**
CV (%)	16.59	15.41	14.13

Means with same letter(s) within column do not differ significantly at p=0.05, HSD = Honest Significant Difference, CV = Coefficient of variance, ** significant at 1% and * significant at 5% level of significance

The average plant height varied significantly among the varieties (Table 1). The highest plant height (196.00 cm) was recorded in Suraksha. The lowest plant height was recorded in R-35 (103.27 cm). Similar variation in plant height was also reported by Muhammad et al. (2001) and Mohamed et al. (2018).

The highest number of branches (4.77) was recorded by TY COON and followed by Lady Luck (4.33). The lowest number of branches was recorded in Kashi Pragati (1.71) (table 1). This might be due to that variation in growth parameters was influenced by the variation in genetic makeup (Biswas et al., 2016). Similar result was reported by Alam and Hossain (2008) and Rajesh et al. (2018).

All treatments were found statistically at par. The number of days taken to first flowering ranged from 42.33 days (Kashi Kranti) to 45.67 days (Kashi Pragati). (Fig. 1). Rahman et al. (2012) also found similar results in his finding.The differential performance of the variety to flowering may influenced by their unique genetic characteristics. The difference in the number of days to flowering might be due to genetic variation among the variety (Salau & Makinde, 2015).

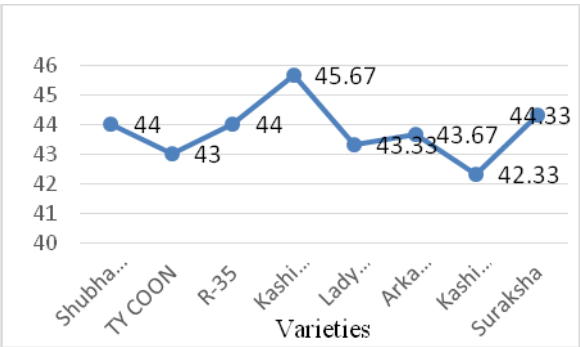

Figure 1. Number of days taken to first flowering by tested varieties

Yield parameters

The mean data obtained on yield attributes fruit length, fruit diameter, number of fruits per plant, and fruit weight were found significantly different among the variety. All treatments were showed significant difference in fruit length. The highest fruit length (13.27 cm) was recorded in variety TY COON followed by variety Lady Luck having (13.07 cm) while the lowest fruit length (11.09 cm) was recorded in variety Kashi Pragati (Table 2).This result might be due to environmental influence and varietal characteristics (Pandey et al., 2017). Rahman et al. (2012) also found similar results in varietal evaluation of okra.

Highest fruit diameter (17.24 mm) was recorded in TY COON followed by Arka Animika (17.21 mm) and Suraksha (16.94 mm). The lowest fruit diameter (13.23 mm) was found in Shubham-11 (Table 2). Similar result was reported in okra by Dash et al. (2013) and Saha et al. (2016).

The highest number of fruits per plant (18.22) was recorded in variety TY COON. The lowest number of fruits per plant (11.23) was recorded in variety R-35 (Table 2). Number of fruit per plant is one of the most important yield

governing characters of okra. Rahman et al. (2012) also reported significant differences among the okra variety for number of pods per plant and reported that this variation might be due to their genetic makeup of the variety and environmental effect.

The highest weight of fruit (15.90 g) was recorded in variety TY COON which was followed by Lady Luck (15.36 g). The lowest weight of fruit recorded (10.84 g) was recorded in variety Suraksha. Mohapatra et al. (2007) reported that higher pod weight of plant was affected by different genotypes. The highest fruit yield per hectare (11.71 t) was recorded in TYCOON followed by Lady Luck (10.74 t) whereas lowest fruit yield (5.73 t) was found in R-35 variety (Table 2). The variations in yield among the radish varieties were also reported by several workers (Jamala et al., 2011; Rahman et al., 2012 & Saha et al., 2016). The variations in yield among these varieties may be considered as varietal difference due to genetic factors and their interaction to the environmental conditions, as all these varieties are tested under same soil, management and similar agro-climatic conditions.

Table 2. Yield of different okra varieties at harvesting stages at JPR, Ithari, Sunsari, Nepal (2020)

Varieties	Yield parameters				
	Fruit length (cm)	Fruit diameter (mm)	Number of fruit plant $^{-1}$	Fruit weight (g	Yield hectare (t)
Shubham-11	11.29 ^{bc}	13.23 ^{b}	13.60 ^{abc}	12.08 ^{b}	8,09 ^{abc}
TY COON	13.27 ^{a}	17.24 ^{a}	18.22 ^{a}	15.90 ^{a}	11.71 ^{a}
R-35	12.02 ^{abc}	14.85 ^{ab}	11.23 ^{c}	13.47 ^{ab}	5.73 ^{c}
Kashi Pragati	11.09 ^{c}	15.65 ^{ab}	11.33 ^{bc}	13.13 ^{ab}	6.99 ^{bc}
Lady Luck	13.07 ^{a}	14.81 ^{ab}	17.99 ^{ab}	15.36 ^{a}	10.74 ^{ab}
Arka Animika	11.57 ^{bc}	17.21 ^{a}	14.25 ^{abc}	13.10 ^{ab}	7.90 ^{bc}
Kashi Kranti	11.46 ^{bc}	15.81 ^{a}	16.94 ^{abc}	14.96 ^{a}	6.11 ^{c}
Suraksha	12.42 ^{ab}	16.94 ^{a}	11.35 ^{bc}	10.84 ^{b}	8.76 ^{abc}
HSD (0.05)	0.32	2.56	6.68	2.83	3.79
F-Test	**	**	**	**	**
CV (%)	3.82	5.66	16.14	7.24	15.97

Means with same letter(s) within column do not differ significantly at p=0.05, HSD = Honest Significant Difference, CV = Coefficient of variance, ** significant at 1% and * significant at 5% level of significance

CONCLUSION

It is concluded that the investigation on evaluation of growth and yield of okra (*Abelmoschus esculentus* L. Moench) showed that the variety TY COON was found superior among the tested varieties under existing agro-climatic condition.

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Study on nutritional variation of different feed ingredients and compound feed found in Nepal

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ABSTRACT

This study was designed to analyze the nutrient content of compound feed and feed ingredients used for livestock feeding in Nepal. Compound feeds and feed ingredients like soybean cake, rice polish and maize were collected from farmer's fields and were brought for proximate analysis in Animal Nutrition Division (AND), Khumaltar, Lalitpur. The study showed that average crude protein (CP) content of different broiler feed B_0 (Pre starter), B_1 (Starter), B_2 (Grower) and B_3 (Finisher) were 19.61%, 17.75%, 17.14% and 18.68%, respectively. Similarly, crude protein content in layers feed L_1 (Starter), L_2 (Grower) and L_3 (Finisher) were 17.49%, 16.64% and 15.78%, respectively. CP content in cattle feed (mass and pellet) were found to be 15.72% and 16.87, respectively. Similarly, CP content of soybean, rice bran and maize were found to be 32.75%, 12.33% and 8.88%, respectively. The knowledge of the nutrient content of the feed ingredients and compound feed available in Nepal would be useful to farmers for formulating ration for domestic animals and feed manufacturing companies and will help manufacturers for improving the feed quality by utilization the locally available feed ingredients.

Key words*:* Compound feed, feed ingredients, nutrient content, Nepal

INTRODUCTION

Livestock is an integral part of mixed farming system in Nepal. The total population of cattle, buffalo, sheep, goats and poultry are estimated to be 7.4, 5.3, 0.8, 16.6 and 72.2 million, respectively (Krishi Diary, 2076). Livestock

plays significant role in the Nepalese economy contributing around 11% to the national Gross Domestic Product (MoLD, 2017). Livestock sector has a high potential for growth in Nepal. Meeting consumer demand for more meat, milk, eggs and other livestock products is dependent to a major extent on the availability of regular supplies of appropriate, cost-effective and safe animal feeds. Animal feed have been one of the major production inputs drawing attention of the producers as it alone shares nearly 65-70 percent of the production cost of milk and meat from ruminants (Sharma, 2015). Birthal and Jha (2005) has found feed scarcity as the main limiting factor to improving livestock productivity. Therefore, to increase the productivity potential of milch animals the use of commercial compound feed is inevitable as supply of feed and fodder is shortening due to shrinking pasture land in the country.

In the recent years, numbers of commercial farmers in the country have increased. They have been producing and marketing different types of concentrate feeds. The source of feed ingredients also varies greatly which will ultimately lead to the variation in the quality of finished products. Quality of these feed produced by various feed manufacturers should meet standard before and after reaching to the farmers. Due to lack of knowledge on nutritive value of locally available feed ingredients manufacturers / farmers are unable to formulate the balance diet for animals. As a result quality status of these feed ingredients and their effect on production performance of animals will not achieve as expected (Khanal and Subba, 2001). Except rice bran and calcium, all the ingredients like maize, soybean cake, sesame cake, sunflower cake, fish meal and feed supplement (80 %) are imported by the feed industry from India. As a result there is increase in the cost of production of concentrate of feeds.

Scientific study on the evaluation of the quality of feeds and feed ingredients thus becomes necessary to satisfy the farmers, scientists and the feed manufacturers for various purposes. Determining the quality of feed ingredients will help select feed industries the appropriate ingredients in maintaining the quality of their product. Both these information will also be useful for the researchers and scientists for preparing suitable feed formulae according to the demand of the farmers.

MATERIALS AND METHODS

Sample collection

250 gram of 10 compound feed samples of different feed industry (Broiler starter-5, cattle mash feed -3 and layers finisher -2) and 12 feed ingredients [soybean (4), rice bran (4) and maize (4)] used for feeding livestock were

collected from the farmer's fields of Kathmandu valley. Other 64 different feed samples of livestock [Broiler starter 0 -11, Broiler B1-10, Broiler grower B2 -9, Broiler finisher B3 -3, Cattle mash feed -12, Cattle Pellet feed -4, Layer L1- 4, Layer 2 -4, Layer 3 - 4)] that were brought by different stakeholders for proximate analysis in Animal Nutrition Division, Khumaltar by farmers in the fiscal year 2018/2019.

Data collection procedure

The collected feed ingredients samples were labeled name of sample and its date of collection. Compound samples were taken randomly from several different points of the lot. Subsequently the samples were then mixed to a single blend to produce a collective sample. Similarly, for the compound feed, name of the feed company and feed of particular livestock was included in the bag. Chemical analysis was carried out at Animal Nutrition Laboratory, Khumaltar. Samples were subjected to analyze for proximate components (AOAC, 1990). The parameters for chemical analysis were Dry matter (DM), Total Ash (TA), Organic Matter (OM), Crude Protein (CP), Crude Fibre (CF) Ether extract (EE). Kjeldhal method was used for finding nitrogen content of sample. The crude protein was calculated by multiplying the evaluated nitrogen by 6.25.

Nutrient content calculation

The data were first entered in Excel; and descriptive statistics were calculated.
Used formula for sample analysis
% Organic matter = 100 - Ash,

$$\% \text{ DM} = \frac{\text{Dry weight (g)}}{\text{Wet weight (g)}} \times 100$$

$$\text{CP (\%)} = \frac{0.014 \times \text{Normality} \times \text{Reading Point - Blank (ml)} \times \text{dilution} \times 6.25}{\text{DM} \times \text{Sample weight (g)}} \times 100$$

RESULTS AND DISCUSSION

Nutrient content in different level of Broiler feeds

The dry matter content in broiler feed B_1, B_2 and B_3 were found to be 87.63%, 86.02% and 88.91%, respectively. Similarly, Crude Fiber (CF) was satisfactory in case of B_0 (6.77%), B_1 (6.03%), and B_3 (6.9%) and it was higher in B_2 (8.41%) (Table 1).

Table 1. Nutrient content of different Compounded feed and feed ingredients

Feed type	FDM %	TA %	OM %	CP %	CF %	EE %	Sample No
Broiler 0	87.63±5.36	9.08±6.23	90.91±2.58	19.61±2.58	6.77±1.51	5.30±2.20	16
Broiler 1	86.02±5.90	7.07±1.86	92.92±1.86	17.75±3.28	6.03±1.51	4.06±2.31	10
Broiler 2	88.91±1.34	6.90±1.52	93.09±1.52	17.14±3.05	8.41±3.02	1.95±0.00	9
Broiler 3	89.16±0.0	6.59±1.01	93.40±1.01	18.68±2.86	6.91±2.86	-	3
Cattle feed (mash)	89.44±2.31	8.65±2.84	91.34±2.84	15.72±2.75	9.25±4.15	6.03±1.03	15
Cattle feed (Pellet)	86.65±6.13	10.06±3.26	89.93±3.26	16.87±3.83	7.50±3.82	2.84±1.91	4
Layer 1	88.88±0.69	7.90±1.33	92.09±1.33	17.49±2.37	9.19±4.05	1.76±0.88	6
Layer 2	88.43±0.47	8.05±2.14	91.95±2.14	16.64±1.28	6.96±1.44	2.08±0.00	4
Layer 3	90.23±1.42	9.01±1.50	90.99±1.50	15.78±3.44	8.81±3.42	2.12±0.89	7
Soybean cake	79.81±22.61	8.21±3.65	91.78±3.65	32.75±9.21	8.54±3.71	-	4
Rice bran	67.48±24.08	6.37±5.39	93.62±5.39	12.33±14.62	4.50±3.09	-	4
Maize	90.51±0.95	5.50±3.80	94.49±3.08	8.88±4.01	4.76±3.02	-	4

Crude protein content in broiler feed

Average crude protein content in broiler starter (B_0 and B_1) was found to be 19.5 and 17.5 %, respectively. Similarly, CP content in grower and finisher diet of broiler was 17.0 and 18.5 %, respectively (Fig1). Average crude protein content of starter and grower feed of broiler was less than the recommended by feed and feeding standard reference of Nepal for broiler. Similarly, finisher feed (B_3) was satisfactory in terms of crude protein content (18.68±2.86).

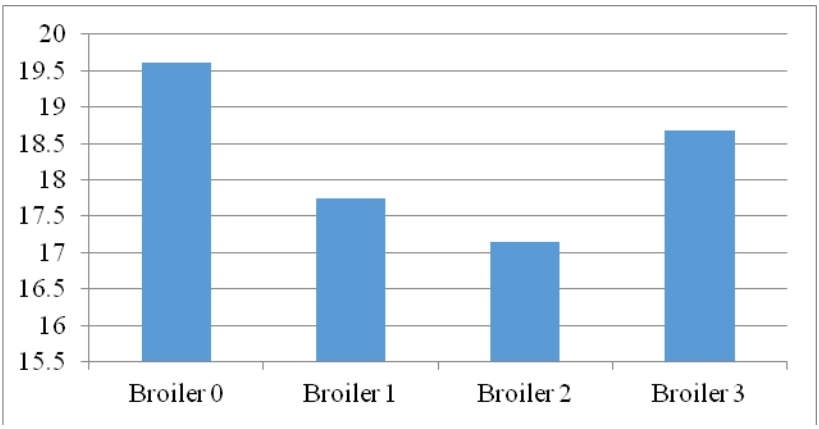

Figure 1. Crude Protein content in different level of broiler feed

The dry matter content in broiler feed B_1, B_2 and B_3 were found to be 87.63%, 86.02% and 88.91%, respectively. The dry matter percentage in B_0 and B_1 feed of were slightly less than the recommended level and satisfactory in case of B_2 and B_3 feed of broiler. Similarly, crude Fiber content was satisfactory in case of B_0 (6.77%), B_1 (6.03%), and B_3 (6.9%) and it was higher in B_2 (8.41%) (Table1).

Nutrient content in layers feed

Highest dry matter and total ash content was found in L_3 (90.23%) feed followed by L_1 (88.88%). Crude protein content in L_1, L_2 and L_3 feed of poultry was found to be 17.49 %, 16.64%, 15.78%, respectively. The protein content in L_1 feed was less satisfactory where as L_2 and L_3 feed fulfilled the CP recommended for layers (Figure 2).

Nutrient composition of cattle feed

The crude protein content of cattle feed (mash) was found to be 15.72 % and crude fiber was 9.25%. The crude fiber was found satisfactory in mass cattle feed where as crude protein content was less than the recommended level for cattle feed. Crude Protein and crude fiber content in pellet feed of cattle was 16.87% and 7.50%, respectively.

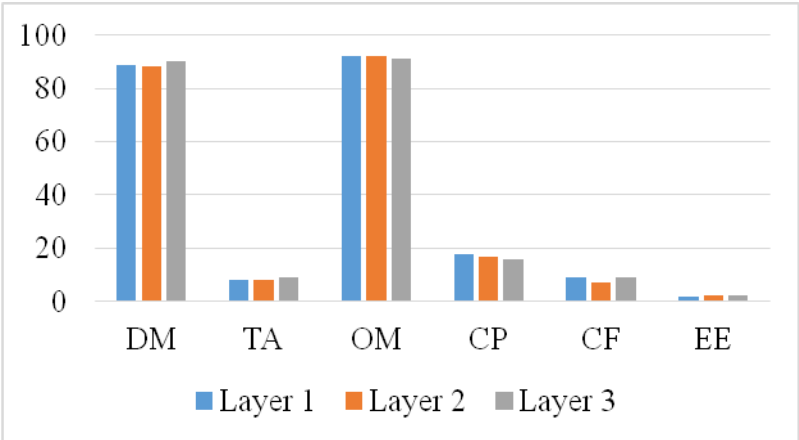

Figure 2. Nutrient content in layers feed

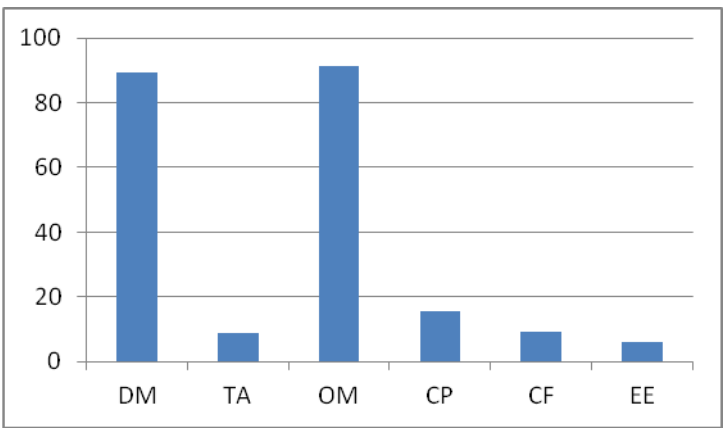

Figure 3. Nutrient content in cattle feed (Mash)

Nutrient content of different feed ingredients

Average DM content of soybean cake, rice polish and maize was found to be (79.81%), (67.48%) and (90.51%), respectively. Highest DM content was found in maize. Similarly, total ash and crude protein and crude fiber content was also higher in soybean followed by rice polish and maize (figure 3).

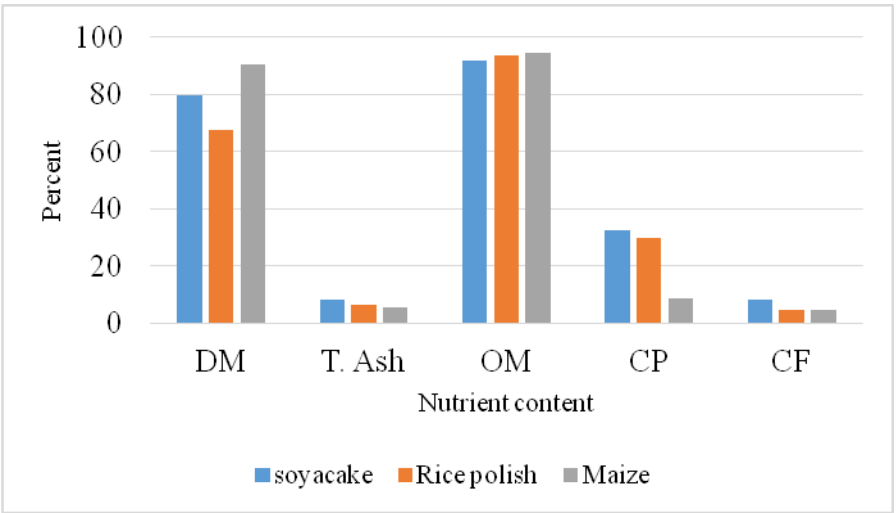

Figure 4. Nutrient contents in the different feed ingredients

Ingredients containing more than 20 % crude protein are considered as good quality sources of protein that can be used for feed formulation of livestock. Generally DM content of more than 86% in feed ingredients is considered to be suitable. Only maize meet the requirement containing 90.51% DM.

DISCUSSION

For broiler chickens, diets are often formulated as to contain 22% protein for the starter feed and 19% for the finisher feed, with a metabolisable energy value in the order of 3.3 ME/Kg. The first two weeks of life of broilers correspond to about 17% of their rearing period in days and 8 to 10% as a percentage to final weight gain (Lilburn, 1998).

Upreti and Shrestha (2006) reported the 92.52% DM, 87.09% OM, 12.91% TA, 20.24% CP, 8.63 CF in broiler starter (B_1) feed. Similarly, 92.03% DM, 87.09% OM, 10.93% TA, 19.23% CP, 7.38 CF was reported in broiler grower (B_2) where as 92.90% DM, 92.0% OM, 8.00% TA, 20.70% CP and 7.40 CF% were reported in finisher diet (B_3). The crude protein content in all broiler starter, grower and finisher were higher than our finding. Lower level of CP in all stage of broiler diet may have negative effect on growth, immunity, adaptation to the environment, and in many other biological functions. In our findings, CF content in all three type of broiler feed was higher than recommended level. The excessive use of fiber sources in the diet may also increase viscosity of the intestinal content, with a resulting decrease in bioavailability of vitamin A and utilization of dietary fats,

which adversely affects body weight gain and carcass quality. Similarly, Upreti and Shrestha (2006) reported 20.95%, 19.22% and 17.43% CP in layer starter L_1, grower (L_2) and Finisher (L_3) feed which was higher than our finding in all three stages of layers feed.

Similarly, Upreti and Shrestha (2006) reported 85.52% DM, 90.46% OM, 9.54% TA, 16.41% CP, 6.95% CF in cattle feed and we found 15.72 % and 16.87% CP in mash and pellet of cattle which was lowered than the recommended level by ICAR (i.e. 18%). Similarly, average CP content in soybean cake (39.43%), rice polish (10.37%), and maize (10.29) were also higher in all feed ingredients compared to our results. Ingredients containing more than 20% protein are considered as good quality sources of protein and can be used for feed formulation of livestock. Generally, DM content of more than 86% in feed ingredients is considered suitable.

Bista and Shrestha (2000) evaluated different feed ingredients from five development regions and reported that soybean found in eastern development region was significantly ($p<0.05$) rich in protein content (40.3%) than that of central development region (39.9%). Further, they noted that protein content (12.65%) of maize of central development region was significantly higher ($p<0.05$) than that of other regions (average 6.5%).

CONCLUSION

From this study it is concluded that, the knowledge of the nutrient content of the locally available feed ingredients and compound feed available in Nepal would be useful to formulate ration for livestock and feed manufacturing company. Similarly, feed manufacturers are suggested to evaluate the nutritive value of feed ingredients if they are imported from elsewhere before feed production or while using local feed ingredients. It will help them to produce quality feed and enhance the productivity of animals.

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Changes in livelihoods options of Magar community, Khanyakharka, Sindhuli: a case linked to the construction of BP Highway

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ABSTRACT

This study was done with the objective to understand and analyze the changes in livelihood assets of indigenous Magar community of Khanyakharka, Sindhuli district Nepal in relation to the construction of BP highway. The study was entirely done by using qualitative approach of information collection. Accordingly, by considering the defined population of fifty-four indigenous Magar households living in the study area, twenty-seven households were randomly selected. The elder men and women with different age groups participated in the interview and discussion process held to perform Focus Group Discussion (FGD). Besides, Key informants' interview was also done with the representatives and key persons living in the community for which a standard check-list was employed. The findings revealed that respondents were engaged with agricultural activities as a major income source before the construction of BP Highway which was substantial in nature, but scenario has now visibly changed upon construction of the high way. Majority of the households' members involved in the discussion agreed that their household income is increased now-a-day. Likewise, highway imparted positive effects in increasing values of residential, commercial, as well as agricultural lands in the community and peripheral sites, which has in some instances increased up to 100%. Increased household incomes were mainly because of new job opportunity in hotel and grocery business as well as selling of their farm products. Nearly half of the households in the community now-a-day own certain kind of vehicles for the transportation of goods and agricultural products resulting in better price and access to the market. Respondents had realized the fact that BP highway became a catalyst to increase business and trading opportunities, tourism, vegetables and fruit trading leading to more employment opportunities; and to generate more income at the household level. The highway has made Khanyakharka bazaar and Magar communities flourish to a nationwide tourism destination quite similar to the touristic destinations such as that of Vedatar in the East, and Ghale gaun in the west.

Key words: BP Highway, livelihood, Magar community

INTRODUCTION

Nepal's territory is mostly mountainous and hilly and its transport infrastructure is poor, leaving many communities with limited access to local and international markets. Thus, road is a line of communication using a stabilized base other than rails or air strips open to public traffic, (OECD, 2016). Road includes bridges, tunnels, supporting structures, junctions, crossings, interchanges and toll roads, but not cycle paths. In ancient time roads refers to a tract or route without any human intervention (Lay & Vance, 1992). But in modern time roads are especially built or prepared to permit different mode of transport

The construction of roads provides socio economic impact for the beneficiaries; as they connect with places, people, social and economic activities. The development and expansion of the road network leads to increase easy access and quick mobility while reducing travel and transportation costs and time. In fact, building of new roads, rehabilitating of existing roads and upgrading of road infrastructure all involve the use of economic resources (ADB, 2012). Technology has the potential to change the impact of transport on the environment and other aspects of the relationship between transport and the broader economy. Road infrastructure can play a significant role in changing the socio- economic conditions of the people of a region through dynamic externalities that such development often generates (Atsushi et al., 2015). For instance, road and transport directly benefits the individual and also provides benefits to society as a whole through the provision of employment generation and livelihood development.

In Nepal, road transport is overwhelmingly responsible for the transportation of cargo and passengers in the absence of rail, sea or inland waterways. The length of its road network has tripled in the past 10 years, with most of the increase taking place in the rural road network. With the strategic network at nearly 11,000km (and another 3,000km under construction or planned) and the rural network considered to be approximately 60,000 km in size, the road density is around 48km per 100 square kilometers (NRSAS, 2013). These road networks have played a vital role in building up the framework of the current economic, social, physical and cultural developments of the country. The inadequate transport connectivity, supply chain, and regulatory bottlenecks are considered as major hindrances for social and economic changes in Nepal (NTIS, 2016). To alleviate these constraints, the Government of Nepal is pursuing several solutions domestically and also by seeking support from foreign countries and also working with development partners such as the World Bank, Asian Development Bank, Japan International Cooperation Agency. for the development of various highways and corridor road.

The BP Highway, also known as the Banepa-Bardibas Highway, is a highway in the Eastern Nepal. This highway is the shortest link between Kathmandu valley

and the Terai region in Nepal that materialized with the expectation of benefiting the people and communities living in the neighboring areas, and the People of Nepal as a whole. This highway was constructed through the Grant assistance of Government of Japan. The construction of the highway began on 1996 and after encountering different issues with materials, manpower and budget, the road was finally completed and handed over to the Nepalese government on 3 July 2015. Under this scenario, a study was done with the objective to analyze and understand the changes in the livelihood of the Indigenous Magar Community, the major inhabitant of the Khanyakharka, Sindhuli district Nepal covering different important livelihood assets including social, physical, natural, financial and human resource before and after the construction of BP highway so that collected empirical information would have inferential support for development planning that are related to the livelihood improvement of the community people.

METHODOLOGY

Nepal is rich in cultural diversity. There are more than 100 ethnic groups, four creeds, thirty-six castes and over 100 languages and dialects are spoken. Magar community is the largest indigenous community in Nepal in terms of number of population (CBS 2005). This study was entirely based on qualitative method of information collection whereas twenty-seven households out of 54 households of an Indigenous Magar community of Khanyakharka, Sindhuli district Nepal was chosen as the study site. Khanyakharka is located on the stop of the hill just opposite from the historical SindhuliGadhi which is situated about 23 km North from the SindhuliMadhi: headquarter of Sindhuli District. It is also an important historical pass for the pedestrian before the construction of the highway. This area is also known for the Anglo-Nepalese War where the English troops were defeated by the Gurkhas led by King Prithi Narayan Shah. The Indigenous Magar communities are recognized for their dedication and valor during the Anglo-Gurkha war (Anglo-Nepalese). Likewise, this area is also famous throughout the country for the production of *Junar* (orange). Furthermore, Khanyakharka is one of the recently developing market centers of this region. In addition, the study area is dominated by ethnic community of Magar who have cultural diversity within and among communities. So, they are the ones mostly influenced by the construction of the highway and later generated opportunities.

Out of the total participants, 16 were male and 11 were female members of the households and all participants were actively involved in the Focus Group Discussion that was conducted based on prepared check-list to match with the objectives of this study. FGD was done only in one site of the community considering enough representation of the community people. Likewise, participant farmers were encouraged to express their views regarding changes made due to construction of BP highway and were asked to expressed their views in terms of social, physical, natural, financial and human resource that

highway has imparted contribution in their life. Besides, Key Informant's Interview (KII) was done in two locations representing two different areas of the communities and the information were largely used to triangulate the information obtained from the FGD. In each location, one Key Informant actively participated in the information sharing process. Collected information were translated, synthesized and final version of the content was prepared considering all important source of information collected. They were later triangulated with the information received from KII and finally major chunk of the findings were again presented in the same group of participants involved in the FGD and validation of the information was done based on consensus.

RESULTS AND DISCUSSION

Demography of the study area

Out of 324 total population, 157 were male and 167 were the female (District Profile Sindhuli, 2019). Likewise, it was also learned from the district information that 42 out of the total population in the community were illiterate; 37 were those having primary level of education; 139 with secondary level of education and 106 with higher level of education (District Profile Sindhuli, 2019). This fairly showed that most of the people are educated up to secondary level in the study site.

Occupation

Findings revealed that fruit selling was the major occupation of the participant respondents (n=17) followed by involving in other forms of business (n=14) whereas 12 participants were involving in traditional agriculture; 11 with service, 7 with livestock keeping, and 3 each with driving profession and as a seasonal labor. Thus, it was quite interesting to learn that business related changes were quite visible in the community as an occupation.

Livelihood Assets

Livelihood refers to their "means of securing the basic necessities of life". Livelihood is defined as a set of activities essential to everyday life that are conducted over one's life span. The livelihood framework identifies five core asset categories or types of capital upon which livelihoods are built: (a) human capital, (b) social capital, (c) natural capital, (d) physical capital, and (e) financial capital (DFID 1999). Findings about this livelihood frame in the study site revealed that there has been substantially change occurred with respect to the various parameters related to the human asset (Table 1).

Information from the table (Table 1) well revealed that health and hygiene of the household has improved now-a day. The availability and accessibility of the health care facility has been improved which ultimately improved the overall health condition of the household. Likewise, situation about awareness of eating balanced diet has also significantly improved.

Similarly, people are engaging to varieties of skill-based activities compared to the past. In the past, when there was no road access to the community, people were not exposed to the modern ways of living; the major skill practiced was farming. However at present, people have acquired business and service-based skills (Table 1).

Table 1. Details about the changes in various parameters related to the human assets in the study area, Khanyakharka, Sindhuli district, 2020

Indicators	Parameters	Status before the construction of High way	Status after the construction of High way
Health	Access of health Centre	A minimum of three hours walk from the community	There is a health center within 30 minutes-walk from the community
	Treatment practices to the common diseases and ailments	Used to be more dependent to the faith healers	Taking doctor's/health worker's advice is a common practice
	Awareness about consumption of balance diet	Limited to about one-tenths of the population in the community	About half of the community people are now aware about balanced diet consumption
	General health checks up	Rarely	Almost in a regular
Skills	Unskilled population	About one-third of in the community	Less than one tenth are unskilled now
	Opportunity to acquire skill	Skills mainly focus on farming	Skills mainly focus on business and service
	Opportunity to apply acquired skills	More	Less and competitive
	State of public knowledge	Very low	Very high Rapidly growing
Level of Confidence	Taking self-decision	About two-third	All most all
	Social involvement	About one-fifth in the community	About four-fifth of the community
	New creativity in society	About one-tenth	About half
	Seasonal migration	Less than one-tenth of the population	About one-third of the population

Source: Field study (2020)

In the similar ways, the percentage of community people taking self-decision and social involvement has increased. These information were obtained through FGD, observation at the community as well as various interaction and meeting including KII thus validity of these information are strong. Thus, based on these facts and information it can be generalized that the human capital of the

households in the community has been increased after the construction of BP highway.

Social asset

Social asset mainly includes the social resources that people draw on to make a living, such as relationships with either more powerful people (vertical connections), or with others- like themselves (horizontal connections), or membership of groups or organizations. Generally, relationships of trust, reciprocity and exchange that the poor can draw in times of need, and that lower the costs of working productively together. Like human capital, social capital has an intrinsic value; good social relationships are not simply a means, they are an end in themselves. Table (2) provides the details of change in status of major social asset in the community reflecting households under study (Table 2) that occurred mainly after the construction of BP highway.

Table 2. Status of changes in various parameters related of social capital of the households due to the construction of Highway, Khanyakharka, Sindhuli district, 2020

Indicators	Parameter	Before	After
Involvement in CBOs	Membership	About one-fifth of the population	About four-fifth of the population
	Attending Regular meeting	Less than one-tenth of the population	More than ninety percent of the population
	Women participations	Two-fifth of the population	Three-fourth of the population
Family links	CBOs \NGOs	About one-sixth of the population	About three-fourth of the population
	Cooperatives	-	About half of the population
	Political party	About one-tenth of the population	About half of the population
	Government offices	Less than one tenth of the population	About one-third of the population
Leadership	Major key post	Less than five percent of the population	About half of the population
	District level	Almost none	About ten percent of the population
	Local level	Less than five percent of the population3	About one-fourth of the population
	CFUG level	About half of the population	About three-fourth of the population
Involvement and influence to the politics	Access to the central leaders	-	Less than five percent of the population

	Access to the province level	Less than five percent of the population	About ten percent of the population
	Access to the Rural Municipality level	Less than five percent of the population	About half of the population
	Access to the ward level	About one-tenth of the population	About three-fourth of the population
	No access	About three-fourth of the population	Only about one-third of the population

Source: Field Study (2020)

Information from the above table (2) clearly revealed that only about one-fifth of the people were involved in the CBO'S before the construction of BP High way whereas this has been dramatically changed (Table 2). Similarly, the women participation has also increased from about two-fifth to about three-fourth before and after the construction of the highway, respectively (Table 2). Likewise, none of the family had access to the cooperatives whereas the percentage has increased to about half of the population in the community (Table 2). Participation in the political party and leadership position has also increased compared to the past. Therefore, it can be generalized that the overall social asset of the household has increased due to the construction of the highway (Table 2).

Natural asset

Natural asset commonly includes the natural resource stocks that people can draw on for their livelihoods, including land, forests, water, air and so on. The following table (Table 3) provides the details of the Natural asset of studied household in the community before and after the construction of BP highway.

The information/fact presented in the above table (3) revels that the value of the land has been doubled hence increasing the level of the confidence of the households. Likewise, the dependency of the households to the natural resources has been reduced that could be well due to their increased access to other alternative resources. On the other hand, the local climate of the study area varies with the topography which generally represents to that of subtropical type. People have realized that their forest resource in terms of biodiversity coverage has been slowly affected by the change in weather/climate reflecting its visible impact to the agricultural activities in terms of increased in crop diseases/insect-pest attach. Biodiversity has been affected as the movement of the traffic increased after the construction of BP highway. Fauna and Flora species has been diminishing over time, but boar and monkey population have dramatically increased. Often air quality has been deteriorated during winter due to accumulation of dust from the highway to the downstream locality.

Table 3. Status of changes in natural assets of the households before and after the construction of BP highway, Khanyakharka, Sindhuli district,2020

Indicators	Parameter	Before	After
Land	Food security round the year	33.33 %	25.93 %
	Land value (per ropani in NRs, approximately)	Up to 50000	Up to 1000000
	Occurrence of crop diseases (%)	-	25.93 %
	Commercial Vegetable farming (%)	18.51 %	55.56 %
	Productions of cereals such as soyabean, black eyed bean, French bean, lentil etc	100 %	37.03 %
Water	*Kuwa* (well)	81.48 %	7.41 %
	Piped water	18.52 %	92.59 %
	Rain water	44.44 %	88.88 %
Forest as the source of common products	Firewood	100 %	44.44 %
	Timber	100 %	18.51 %
	Fodder	100 %	44.44 %
	Medicinal plant	100 %	10 %

Source: Field Study (2020)

Likewise, the percentage of the household having access to the drinking water at home has been increased as along with the highway many modern tools, techniques and equipment are imposed to the study area. People often felt about deteriorating water quality, perhaps due to encroachment of modern equipment and facilitates, but overall access to water has been increased a lot (Table 3).

Physical asset

Physical asset mainly includes the basic infrastructure that people need to make a living, as well as the tools and equipment that they use; for example, transport and communication systems, shelter, water and sanitation systems, and energy. This highway system has a great significant role to changes in the physical capital related to the community. Table 4 provides the details of the physical capital of studied households in the community before and after the construction of BP highway.

Information provided in the table 4 well covers about the detail of the changes related to the physical asset. For example, most of the buildings built in the past were based on straw, mud and stone that are well replaced now-a-day by the modern concrete building with the use of corrugated sheet roof. About four-fifth of the households had Stone-Mud-Straw type buildings, also called temporary house-type, but now-a-day none of the household have such type of building.

Table 4. Status of the changes in physical asset of the households before and after the construction of BP highway, Khanyakharka, Sindhuli district, 2020

Indicators	Parameters	Before (%)	After (%)
Houses	Stone-Mud-Straw type	Four-fifth	None
	Stone-Mud-Corrugated Sheet used	About one-tenth	Two-fifth
	Stone-Cement- Corrugated Sheet used	Less than five	Two-fifth
	RCC Building	None	One-fifth
Vehicles	Motorcycle	None	One-third
	4 wheelers	0	About one-tenth
Furniture	**Before**	**After**	
	Tyanka, Sandush, Vitte daraz, Taand, Aatiya, Falaicha, Pirka, etc	Box palang, sofa, shair, metal wardrobe, kitchen rack, dining table,	
Utensils and appliances	Firewood stove; Traditional utensils kitchen (*Hadi, Madka, Theki, Chulesi, Ghaito*); specially utensils made of copper, wood and clay.	LPG stove; Modern utensils kitchen (pressure cooker, rice cooker, grinder, mixture, steamer, etc.); electric appliances (fridge, oven, electric jug, heater, fan, tv, mobile etc.)	
Hotel and Restaurant	Small cottage, tea shop	a star level resort, small and medium sized hotel (40 in number) along with restaurant has been opened.	
Industries	None	Junar (orange) juice production	
Road and transport	Pedestrian path	highway, sub-road and road networks; long and short route vehicles, privately owned vehicles can ply	

Source: Field Study (2020)

The percentage of the Stone-Mud-Corrugated Sheet house (also called the semi-permanent house type) was increased to 42 % which was only 15% before the construction of the highway. The percentage of the Stone-Cement-Corrugated Sheet (also known as permanent house) has increased from 4% to 40% before and after the construction of the highway, respectively. Likewise, there were no RCC building in the past, but at present, about one-fifth of the households do have RCC buildings (Table 4). Similar changes can also be seen in the case of

use of vehicle. Investors are now attracted to invest in hospitality sector in the study area and till now more than 40 different small and medium restaurants, hotels and resort are already opened (Table 4).

Financial asset

Financial asset mainly includes the savings, in whichever form, access to financial services, and regular inflow of money. Table (5) provides detail information about the financial aspect of studied household before and after the construction of BP highway that also include sources of household income through which the households earn their living.

Information provided in Table (5) showed the pattern of change in respondents' financial dependence before and after the construction of BP highway. It can be clearly seen that before the highway construction, majority of people in the Magar community were engaged with agriculture and livestock farming focusing for basic living and source of their household income. Nowadays, the trend has shifted more towards trade, business and service areas. Respondents farmers have identified commercial opportunities of earning from new areas and sources, mainly due to the changes in infrastructures, especially the PB highway, so they are shifting to new dimension of earning that also includes cash-crops oriented agriculture as a commercial way of farming.

Table 5. Status of changes in terms of household income source, before and after the construction of BP highway, Khanyakharka, 2020

Sources	Before (%)	After (%)
Agriculture	All most all	About two-
Livestock	One-third	One-fourth
Fruit	One-tenth	One-fifth
Business	None	Fifty
Labor/Technician	About one-	About one-
Driver	None	One-tenth
Service	None	Two-fifth

Source: Field Study (2020)

Table 6. Changes in financial asset including monthly income per household (NRs) before and after the construction of BP highway, Khanyakharka, Sindhuli district, 2020

Income in range (NRs)	Monthly income (approximately; based on consensus)		Monthly expenditure (approximately; based on consensus)		Monthly saving (approximately; based on consensus)	
	Before the Highway (%)	After the highway (%)	Before the highway (%)	After the highway (%)	Before the highway (%)	After the highway (%)
0-5000	90	10	95	10	100	55
5000-15000	10	30	5	40	0	25
15000-30000	0	35	0	30	0	10
30000-50000	0	15	0	10	0	10
50000+	0	10	0	10	0	0

Source: Field Study (2020)

Information provided in Table (6) revealed the fact that the monthly income level, expenditure pattern and saving level of the households have changed significantly. Before the construction of the BP highway, an average monthly income of almost all the households had about NRs.5,000, but after the construction of the BP highway, only 10% of the households falls in this range whereas about 35% of the households had a monthly income of NRs. 15,000 to 30, 000 (Table 6). Likewise, the table also covers the detail status about household expenditure levels that has been changed as per the changes in the income. The increase in the percentage of households with higher level of income, expenditure, as well as increased in the amount of saving reveals that the overall financial capital of the household has increased and improved, mainly due to the construction of BP highway (Table 6).

Impact of the BP highway as reflected in the general perception

The summary of the impact of the construction of the BP Highway has been presented in the Table (7). Accordingly, it has been well revealed that there are several aspects and dimensions including increased business and trading opportunities, increased in land price, opportunities for commercial agriculture, as well as increased in value of all sorts of important assets, including financial, physical, and natural (Table 7). Meanwhile there are some negative effect as well that could well impart positive aspects to compromise with the new paradigm. For example, people have been well experiencing about increased pollution, problem with garbage management, occurrence of new diseases and insect pests to the commercially grown crops and vegetables; noise, biodiversity maintenance and related problems (Table 7). However, people are more cautious about handling of all these negative aspects cautiously, and by garnering the

positive impact of the highway construction related opportunities to their livelihood.

Table 7. Summary and key points of respondents' perception about the impact of construction of the Highway, Khanyakharka, Sindhuli district

Positive	Negative
• Increased business and trading opportunities such as vegetables and fruit trading • More employment opportunities generated in and outside of the study area • Increased lands prices per unit area • Beginning of commercial agriculture farming • Good market access to the local agriculture and livestock product • Improved in educational infrastructures • Increased access to better health facilities • Increased education to girls and women • New job opportunities in local level • Local people shifted towards entrepreneurship	• Pollution (noise, air) increased • Garbage, dust, waste materials, chemicals generated from new market disturbed to local population and environment • New as well as frequent occurrence of diseases and illness, also seen in human and animals • Vibrations disturb people closed to road they caused damaged to building equipment and wild animal habitat • Deforestation might be increased • Magar language, culture and customs might be encroached.

CONCLUSIONS

The findings of this study revealed that the construction of BP highway has been advantageous for the indigenous Magar communities of Khanyakharka, Sindhuli district, Nepal. The Magar people living in the community have uplifted their life style and identified the opportunities generated by the highway. The overall livelihood assets of the households have been increased after the construction of BP highway. Thus, the findings of this study could serve as the basic information to help the local people in planning and policy making regarding the betterment of the livelihood assets. In deed majority of the people who were living in the community/study area are satisfied about road construction, road quality, and drainage system and road maintenance, and the positive consequences of these development that are related to the livelihood paradigm of the local inhabitants.

BP highway became a catalyst to increase business and trading opportunities such as vegetables and fruit trading, to generate more employment opportunities in and outside the area, and also to hike their land prices well as to support for commercial agriculture farming. The Magar community recognized and made a decent share of living out of them. Most of the respondents have overcome their basic obstacle: lack of money. Once having no source of income and no job

opportunities at local level, the highways has become tangible blessing to the community people.

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