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Himalayan College of Agricultural Sciences & Technology (HICAST)
Kalanki, Kirtipur Municipality 1
Post Box 25535
Kathmandu, Nepal
Emails: binayakprajbhandari@gmail.com; bpchaula@gmail.com
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RESEARCH ARTICLES

Bypass protein supplementation on milk production performance of dairy cattle

M.R. Tiwari[1], S.R. Pant[2], M.P. Acharya[2], L.N. Pandey[1] and B.K. Shrestha[1]

[1]Animal Nutrition Division, Khumaltar
[2]National Cattle Research Program, Rampur, Chitwan
drmeghraj238@gmail.com

ABSTRACT

An experiment was carried out at National Cattle Research Program (NCRP), Rampur, Chitwan from November to December, 2016 for 30 days to evaluate the effect of bypass protein supplementation on milk production performance of dairy cattle. A total of eight lactating cattle of similar parity, calving date and milk production were selected for experiment. These animals were divided into two groups (control and treatment) by using completely Randomized Design (CRD). Concentrate mixture was prepared by using feed ingredients of Kisan Feed Industries, Patan Industrial State of Lalitpur. Control group were provided 6 kg concentrate mixture whereas treatment group were provided 6 kg concentrate and 1.5 kg formalin treated soybean cake. Experimental animals were allowed to graze for three hours in the pasture lands of NCRP and adlib amount of green grass such as Teosenti, Bajra, Perennial sorghum and local grass was also provided as per availability once a day. Feed intake and milk yield of individual animal was recorded daily. Results revealed that treatment group produced significantly higher ($p<0.001$) average milk per animal /day than that of control (10.28 and 8.51 kg, respectively). Similarly, feed intake per animal /day was also noted significantly higher ($p<0.001$) in treatment group than that of control (7.36 and 5.92 kg, respectively). Green grass intake was found to be non-significant between groups (6.85 and 6.9 kg/day/animal for control and treatment group, respectively). Experiment revealed that bypass protein supplementation to lactating animals is one of the option for improving the milk production and suggested that further study should be conducted to precise the optimum level of bypass protein supplementation and to quantify the experimental period.

Key words: Dairy animal, bypass protein, milk production, feed, concentrate

INTRODUCTION

In Nepal, dairy farming alone contributes 78 percent in total AGDP and the population of lactating cattle and buffaloes is estimated to be 1.02 and 1.34 million, respectively, and they are producing 1724823 mt milk per annum (Krishi diary, 2073). Dietary proteins are mostly degraded in the rumen and transformed in microbial protein. The method to increase protein supply to the animals is termed ***Bypass Protein Technology*** (Preston and Leng 1987; Garg *et al* 2007). Bypass protein has been shown to be quite useful in increasing milk production, especially when animals are energy deficient. In developing countries, animals are fed pre dominantly on crop residues based diet with little supplementation of green fodder and or/concentrates, depending upon availability and economic consideration. Feeding bypass protein directly or through concentrate mixture at

various levels has shown improvement in milk production in medium and high yielding cattle (Garg, 1998). There are different methods of protecting proteins from ruminal degradability, however, some of the protein sources such as oilseed meal, fishmeal, cereal bran, tannin-containing legume, corn gluten meal and cottonseed meal are naturally less degradable in the rumen hence can be considered as natural bypass proteins or nutrients (Preston and Leng, 1980; Preston and Leng, 1987). In the case of soluble protein meals, their bypass protein qualities can be improved and they can be protected from degradation in the rumen by protection processes which include heat (depending on the protein source); reactions with aldehydes, such as formaldehyde and gluteraldehyde or mixing with tannins or selection of plants with tannins (Leng, 1991).

It is generally presumed that bypass protein is most beneficial to high yielding animals, however, in view of the positive results obtained in several studies in India on medium producing animals, the subject needs a rethinking on the part of ruminant nutritionists (Walli, 2005). Limited research works on bypass protein supplementation has been done in Nepal. Therefore, this experiment was done with objective to evaluate the effect of feeding a concentrate containing formaldehyde-treated protein meals on milk production in lactating cattle under station condition.

MATERIALS AND METHODS

Experimental animals

This experiment was carried out at National Cattle Research Program, Rampur, Chitwan for 30 days from November to December, 2016. A total of eight cattle having similar parity (2-3rd), date of calving (interval of 30 days) and milk production was selected and distributed into two groups (control and treatment) with four replication by using CRD.

Chemical analysis and feed formulation

All feed ingredients (maize, rice bran, soybean cake, mineral mixture and salt) were procured from Kisan Feed Industry, Patan Industrial State, Lalitpur and subjected for chemical analysis. Representative samples were analyzed for dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and total ash contents (TA). The DM was determined by oven drying at 100°C for 24 hrs. Crude protein of the samples was determined using the Kjeldahl method. Ether extract was determined using Soxhlet apparatus. Ash content was determined by ashing at 550°C in a muffle furnace for 16 hrs (AOAC, 1980). Crude fibre of the samples was determined using the Van Soest method (Goering, H.K. and Van Soest 1970). After chemical analysis compound feed was prepared. The composition of compound feed is presented in Table 1.

Table 1. Composition of compound feed on dry matter basis

S/n	Ingredients	Part	Protein content, %	Total Crude protein, %
1	Maize	50	9.96	4.01
2	Rice bran	19	12.77	2.03
3	Soybean cake	28	45.07	10.08
4	Mineral mixture	2	0	0
5	Salt	1	0	0
Total		**100**		**16.11**

Formaldehyde treatment of soybean cake

Soybean cake was treated with 1-1.2g formalin (40%)/100 g crude protein (CP) as suggested by (Thomas *et al*. 1979). At first, one part of formalin was diluted in nine part of water. Then after formalin diluted solution was sprayed over cake and mixed manually then the cake was stored in plastic bags for seven days.

Experimental diet of the animal

Two types of experimental diets were composed for experimental animals as presented in Table 2.

Table 2. Experimental diets of the animals

Treatment	Experimental diet
Control	Adlib green grass + 6 kg concentrate mixture + 3 hrs grazing
Treatment	Adlib green grass +6 kg concentrate mixture +1.5 kg formalin treated soybean cake + 3 hrs grazing

- green grass (Teosenti, Bajra, Perennial sorghum and local grass as per availability)

Feeding regime

Half dose of the concentrate mixture was provided in the morning and half dose in the evening before milking. After milking animals were allowed to graze for 3 hours in the NCRP grazing lands. In the evening, after milking animals of both groups were provided adlib amount of green grass. In the day time animals were kept in open yard and they had easily access of fresh drinking water.

Observation recording

The trial period consisted 30 days after an adaptation period of 7 days. Total feed and grass intake and milk production by the individual experimental animal was recorded daily during entire experimental period.

Data analysis

Data of feed, grass intake and milk production were analyzed for mean, standard deviation and p value was determined by "***T test***" by using computer statistical package Minitab 2003, versions 13.20.

RESULTS AND DISCUSSION

Chemical composition of feedstuffs

The result of chemical analysis of used feedstuffs in the experiment has been given in Table 3 and crude protein content of prepared concentrate mixture was verified in laboratory that is presented in Table 4.

Table 3. Chemical composition of different feed ingredients (% DM basis)

Ingredients	DM	OM	TA	CP	CF
Maize	89.34	98.95	1.05	9.96	4.24
Rice bran	83.69	91.48	8.52	12.77	12.61
Soybean cake	92.04	91.13	8.87	45.07	NA
Teosenti	19.4	83.74	16.26	13.73	NA
Bajra	14.2	93.7	6.3	NA	NA
Sorghum	13.1	87.5	12.5	8.9	NA

Table 4. Chemical composition of prepared concentrate mixture (% DM basis)

Particular	DM	OM	TA	CP	CF	EE
Formaldehyde treated soybean cake included concentrate mixture	89.2	91.59	8.41	42.15	7.82	8.23
Compound feed	89.66	93.22	6.78	20.86	3.94	4.69

Feed intake

Average daily intake of concentrate mixture and fodder by individual cattle during experimental period has been presented in Table 5.

Table 5. Daily feed intake of experimental animals

Feedstuffs	Mead ±SD	
	Control	Treatment
Feed intake	5.93±0.2	7.36±0.37
Forage intake (g)	6.90±1.01	6.85±1.04
Dry matter intake, kg /animal /day	6.26	7.46
Total dry matter intake (DMI) (kg)/animal	187.2	223.8

Table 5 showed that average forage intake of both group was almost similar for control and treatment group (6.9 and 6.85kg, respectively) which was non-significant between groups. Average feed intake per day of individual animal was highest in treatment group (7.36 kg) than that of control group (5.93 kg) which was highly significant ($p<0.001$) between groups. Similarly, highest DMI of individual animals was observed for treatment group (223.8 kg) than control group (187.2 kg) during entire experimental period which also was highly significant ($p<0.001$) between groups.

Milk production

The average milk production of per animals per day is given in Table 6 and figure 1. At the beginning of the experiment, average milk production of both groups was almost similar (8.21 and 8.13 kg, respectively) which reached the 10.45 and 8.2 kg, respectively by the end of the experiment for experimental and control animals; and was highly significant ($p<0.001$) between groups.

Table 6. Milk production performance of experimental animals, kg

Parameter	Mean± SD	
	Initial	Final
Control	8.21±1.13	8.2±1.19
Treatment	8.13±1.89	10.45±1.59
Mean	8.17±1.44	9.17±1.73

Since the beginning of the experiment, milk production of experimental animals was found to be in increasing trend (Figure 1).

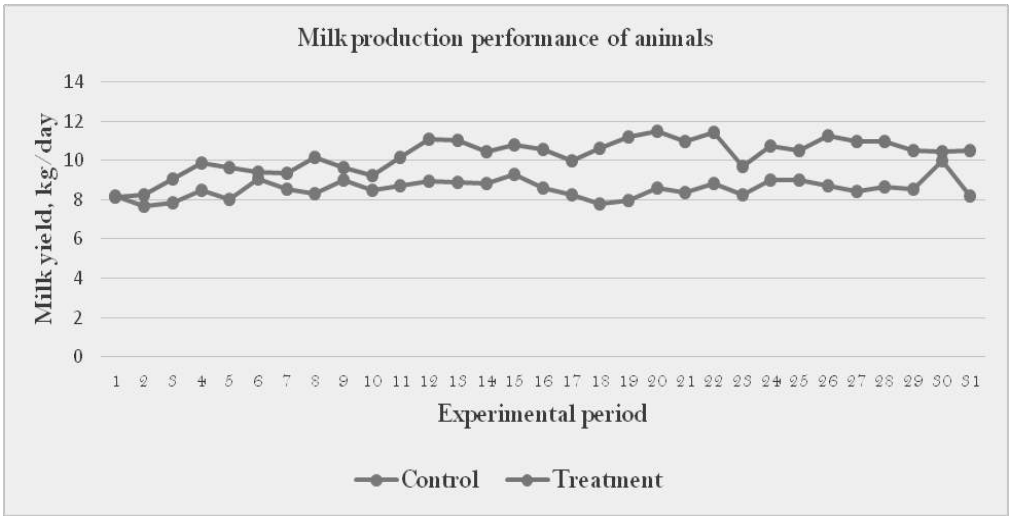

Figure 1. Milk production trend of experimental animals

This study was initiated to evaluate the bypass protein feeding to lactating animals and its effect on milk production. Study revealed that supplementation bypass protein level in the diet significantly ($p<0.001$) contributed in higher milk production in experimental group (10.45 kg) than that of control group (8.13 kg). The increase in milk production might be attributed to more availability of protein for digestion in the intestine, thereby increasing supply of precursors of milk production. Similarly, feed intake of experimental animals also significantly ($p<0.001$) was higher (7.36 kg) than that of control group (5.93 kg). It might be also due to that as bypass protein is known stimulate the voluntary feed intake. Osti *et al* (2013) also observed significantly different ($p<0.01$) in milk production before and after bypass protein feeding to the animals. Milk yield was low (8 kg/day/animal) before bypass protein feeding, significantly increased during bypass protein feeding (10 kg/animal/day).

Vahora *et al* (2012) conducted an experiment on 24 lactating buffaloes in their 2nd to 3rd lactation for the 90-days. They were randomly divided in two equal groups based on their body weight and milk production. A control group was fed the untreated concentrate; the other was fed the concentrate treated with formaldehyde. In that experiment, the authors reported that feeding buffaloes with protein meals treated with formaldehyde led to a 15% increase in milk yield of 6% FCM compared with feeding untreated protein meals. The increase in milk production may be attributed to more availability of protein for digestion in the intestine, thereby increasing supply of precursors of milk production (Mishra *et al*, 2006).

Kunju *et al* (1992) conducted an experiment on 25 lactating cows about 400 kg body weight of 2nd and 3rd lactation which were distributed into 5 groups. The experimental animals were supplemented bypass feed at the level of 0, 1, 2, 3 and 4 kg for six weeks. The findings revealed that milk production response on feeding of bypass protein was almost linear. The maximum response of bypass protein feed was observed in cows fed 3 kg bypass protein level. Aasiwal *et al* (2015) also conducted an experiment on 27 lactating Jersey cows in their different parity groups viz. 1st - 3rd parity, 4th - 6th parity and $\geq$ 7th parity at different stages of lactation i.e. early (1-3

months), mid (4-6 months) and late (7-9 months) in each parity groups lactating cows for 40 days. They noted that milk yield was increased in early lactating which was in line of Sherasia *et al.* (2010), who observed significantly ($p<0.05$) higher milk yield from 9.85 to 10.72 kg/day when one kg of formaldehyde treated rapeseed meal was fed to crossbred cows. Shelke *et al.* (2012) also reported significantly ($p<0.01$) higher milk yield up to 19% in early lactating Murrah buffaloes fed with mixture of formaldehyde treated mustard and groundnut cakes.

CONCLUSION

The findings of this study proved that bypass protein supplementation had a special role to improve the milk production of experimental animals. Therefore, it is suggested that under those situations, where animals' basal diet is poor, comprising straw/stovers, grasses etc., bypass protein supplementation can lead to increase in milk yield. Furthermore, such type of experiment should be carried out to optimize the supplementation level of bypass protein and to quantify the experimental period.

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Variability studies in yield attributing traits of early maize genotypes in western hill of Nepal

B. P. Kandel[1], A. Poudel[1], S. Sharma[1]and M. Subedi[2]
[1]Institute of Agriculture and Animal Science (IAAS), Tribhuvan University, Lamjung Campus, Sundarbazaar
[2]Nepal Agricultural Research Council (NARC), Regional Agricultural Research Station (RARS), Lumle, Kaski, Nepal
bkandel33@gmail.com

ABSTRACT

This study was conducted at Regional Agriculture Research Station (RARS), Lumle, Kaski during June 2016-Oct 2016 to determine the various parameters of genetic variability, broad sense heritability and genetic advance estimates in eleven early maize genotypes. The experiment was laid out in randomized complete block design having eleven maize genotypes with three replications. Grain yield kg ha^{-1} Plant height , ear height and ear weight, were showed high heritability accompanied with high to moderate genotypic and phenotypic coefficient of variation and genetic advance, which indicates that most likely the heritability is due to additive gene effects and selection may be effective in early generations for these traits. High to moderate heritability with low genetic advance were observed for days to 50%silking, days to 50% tasseling, days to maturity, ear aspect ,tassel length, ear per plant, leaf width, ear length, ear diameter, no. of kernel per row ,number of kernel row per ear and grain yield kg ha^{-1}.

Key words: Genetic advance, genotypic and phenotypic coefficient of variation, heritability, maize

INTRODUCTION

Maize-an important cereal crop, is cultivated throughout the world. It is an important staple food crop and provides bulk of raw materials for the livestock and many agro-industries in the world. Maize has a high yield potential than any other cereals; and is popularly known as the 'queen of cereals' (Singh, 1998). Maize is the second most important staple food in terms of area and production in Nepal (Adhikari, 2007). In Nepal, maize is one of the most important staple food crops of mountainous people; and can be used for feed and fodder purpose also. At present, the maize area in Nepal is 882,395 ha with a total annual production of 2,145,291 metric tons and productivity of 2.43 ton ha^{-1} (MOAD, 2014/15).

Being an out crossing crop the genetic diversity of maize is very broad for conservation and utilization in breeding programs. Genetic variability among individuals in population offers effective selection. The magnitude of genetic variability present in population is of paramount importance for the success of any plant breeding program. In breeding programs, having information regarding the heritability and genetic advance of traits is useful (Mohamed *et al.* 2012). Heritability estimates allow breeders to develop more efficient selection strategies: population structure and size, selection differential; and to predict heritability alone provides no indication of the amount of genetic improvement that would result from selection of individual genotype. Hence knowledge about genetic advance coupled with heritability is very useful. This

study was carried out to find the phenotypic as well as genotypic coefficient of variation, broad sense heritability and genetic advance of early maize genotypes in the hill ecosystem in Nepal.

MATERIALS AND METHODS

Experimental details

The experiment with eleven maize genotypes (viz. EARLY MID KATAMARI, RAJAHAR LOCAL, S97TEYGHAYB (3), POP-445/POP-446, COMPOZ-NIPB, R.C/POOL17, SO3TETEY/LN, ARUN-4 (standard check), FARMERS VARIETY (MANAKAMANA-5), ZM-621/POOL-15, EEYC1) was laid out in RCBD design with three replications at RARS Lumle during June 2016- Oct 2016. The station is situated at an altitude of 1740 meters above mean sea level in the south facing slope at 28.297607° north and 83.816754° east coordinates. The experiment was planted by using crop geometry of 75cm*25cm (RR*PP). Each genotype received the plots of 9 m^2 area with the net plot area of 99 m^2 per block/replication used for this experiment. Genotypes such as Arun-4 and Manakamana-5 were used as the standard and local check, respectively. Initially two seeds per hill were sown and later on one plant was thinned to maintain single plant per hill. Two border rows were also planted to avoid the border effect. Fertilizer was applied at the rate of 120:60:40 NPK kg/ha. Nitrogen was applied in two splits at knee-high and pre-tasseling/silking stages. Earthling up was done at knee high stage. All the data were obtained from central two rows i.e. sample row from fifteen randomly selected plant except for 50% tasseling, 50% silking and days to physiological maturity. Observation on yield and yield components were 1000 kernel weight (g) with moisture adjustment at 15%, number of kernels per row, number of kernel rows per year, ear length (cm), ear diameter (cm), ear weight (g). Similarly, observations for traits like plant height (cm), ear height (cm), ear per plant, leaf width, tassel length, days to 50% silking, days to 50% tasseling, days to maturity and grain yield (kg ha^{-1}) after moisture adjustment at 15% were taken.

Statistical analysis

Genotypic and phenotypic coefficient of variation

The phenotypic and genotypic variance components and coefficients of phenotypic and genotypic of variation to compare the variation among traits were calculated by the methods suggested by Lush (1940) and Chaudhary and Prasad (1968).

Genotypic variance $\sigma^2 g = TMSS - EMSS/R$

Error variance $= \sigma^2 e$

Phenotypic variance $\sigma^2 p = \sigma^2 e + \sigma^2 g$

Genotypic coefficient of variation (GCV) = $(\sigma g/X) \times 100$

Phenotypic coefficient of variation (PCV) = $(\sigma p/X) \times 100$

Where,

σg = Genotypic standard deviation

σp = Phenotypic standard deviation

X = General mean of the trait

Sivasubramanjan & Menon categoried the value of GCV and PCV as follows:

0 – 10 %= Low

10 – 20 %= Moderate

>20 %= High

Broad sense heritability (h^2bs)

The ratio of genotypic variance (Vg) to the phenotypic variance (Vp) is called broad sense heratibility; and is expressed in percentage (Hanson et al., 1956). Heritability in broad sense for all characters was computed using the formula given by Falconer (1996) as:

$H = Vg/ Vp*100$

Where:

H = heritability in broad sense

Vp = phenotypic variance

Vg = genotypic variance

The heritability percentage was categorized as low, moderate and high as followed by Robinson et al., (1949) as follows:

0 – 30%= Low

30 – 60%= Moderate

> 60%= High

Genetic advances (GA)

Under selection expected genetic advances where for each character at 5% selection intensity was computed by the formula described by Johnson et al., (1955).

Genetic Advances (GA) = $k.\sigma p.H$

Where: k = constant (selection differential where k = 2.056 at 5% selection intensity),

σp = phenotypic standard deviation

H = broad sense heritability

Genetic advances as percent of mean was calculated to compare the extent of predicted advances of different traits under selection, using the formula GAM =GA/X *100 (Falconer, 1996).Where:

GAM=genetic advances as percent of mean

GA=Genetic advances under selection

X = Mean of population in which selection will be employed.

Data were statistically analyzed by using computer softwares R-Studio & MS-Excel.

RESULTS AND DISCUSSION

Genotypic and phenotypic variance

High estimates of genotypic variance and phenotypic variance were recorded for grain yield kg ha^{-1}, plant height, ear height, 1000-kernel weight, days to physiological maturity, days to 50 % silking and days to 50% tasseling as presented in table 1 , indicating presence of sufficient inherent genetic variance over which selection can be effective. Similar results were reported by (Rather *et al.*, 2003, and Anshuman *et al.*, 2013).

Genotypic and phenotypic coefficient of variation

High to moderate PCV and GCV recorded for grain yield kg ha^{-1} , 1000-kernel weight ,ear height, plant height, , number of kernels per row , ear length and ear weight ear aspect and ear per plant as presented in table 1. In consistence with these results, high to moderate PCV and GCV were recorded plant height, ear height, ear length, ear per plant, thousand kernel weights and grain yield reported by Taye (2014) suggesting sufficient variability and offers scope for selection.

Heritability

Heritability was found to be highest for days to maturity(0.89) followed by plant height (0.86), Grain yield ton ha^{-1}(0.85), days to50%tasseling(0.84),ear diameter (0.84), ear weight(0.80), ear length(0.79), ear height(0.78), days to 50 % tasseling (0.72), number of kernel row per ear (0.68), number of kernel per row(0.64) where as moderate heritability was found in trait like tassel length(0.43), ear per plant(0.580 leaf width(0.47) and thousand kernel weight(0.33), as presented in table 1. In consistence with these result, high heritability estimate were recorded for ear height, plant height, days to 50% silking, days to 50 % anthesis, number of kernel row per ear (Taye, 2014). High values of heritability in broad sense (H) indicate that character is less influenced by environmental factors.

Table 1. Estimates of Phenotypic (σ^2P) and Genotypic (σ^2g) Variance, Phenotypic coefficient of variability (PCV) and Genotypic coefficient of variability (GCV), Broad sense heritability (H), Expected genetic advances (GA) and Genetic advance as percent of mean (GAM) of early maize genotype in RARS, Lumle, 2016

Character	σ^2 g	σ^2 p	Coefficient of variation		H	GA (%)	GAM
			GCV	PCV			
DTT	16.10	22.26	5.24	6.16	0.72	7.03	9.19
DTS	18.93	22.39	5.81	6.32	0.84	8.24	11.02
DPM	21.96	24.51	3.60	3.81	0.89	9.13	7.03
PH	1131.36	1310.26	18.17	19.55	0.86	64.38	34.78
EH	519.86	660.36	24.91	28.08	0.78	41.67	45.54
EA	0.55	0.68	22.92	25.52	0.80	1.37	42.41
TL	1.51	3.49	6.29	9.55	0.43	1.67	8.54
EPP	0.02	0.03	12.64	16.49	0.58	0.23	19.95
LW	0.13	0.28	4.03	5.85	0.47	0.51	5.72
EL	5.76	7.25	15.80	17.73	0.79	4.40	29.03
EW	343.46	409.56	30.94	33.79	0.83	34.96	58.37
ED	0.12	0.14	8.51	9.28	0.84	0.65	16.09
NKPR	9.13	14.22	11.71	14.62	0.64	4.98	19.33
NKRPE	1.12	1.63	7.96	9.61	0.68	1.80	13.58
TKW	1224.667	3700.667	41.22	71.66	0.33	41.47	48.85
GY	3024386	3552812	36230.75	39268.55	0.85	3305.35	68861.6

DTT=Days to 50% tasseling, DTS=Days to 50% silking, DPM=Days to physiological maturity, PH=Plant height, EH=Ear height, EA=Ear aspect, TL=Tassel length, EPP=Ear per plant, LW=Leaf width, EL=Ear length, ED=Ear diameter, EW=Ear weight, NKRPE=Number of kernel row per ear, NKPR=Number of kernel per row, TKW=Thousand kernel weight, GY=Grain yield kg per hectare.

Genetic Advance & Genetic Advance as percentage of mean

High heritability with high genetic advance were observed for grain yield kg ha^{-1}plant height, ear height and ear weight similar result of high heritability with high genetic advance were observed for grain yield, plant height ,ear height,100 kernel weight by(Dar et.al, 2014) .High to moderate heritability with low genetic advance were observed for days to 50%silking, days to 50% tasseling, days to maturity, ear aspect ,tassel length, ear per plant, leaf width, ear length, ear diameter, number of kernel per row, number of kernel row per ear and grain yield kg ha^{-1}presented in table 1. Dar et.al (2014) reported high to moderate heritability along with low estimates of genetic advance were observed for days to 50 percent tasseling, days to 50 percent

silking, ear length , days to maturity ear diameter, and number of kernel rows per year, which is similar to our findings.

High GAM were observed for grain yield kg ha^{-1}(68861.6) followed by ear weight (58.37), thousand kernel weight(48.85).ear height (42.41), plant height (34.78) and ear length (29.03) .Moderate GAM were observed from ear per plant(19.95) followed by number of kernel per row (19.33),ear diameter (16.90),number of kernel row/ear (13.58) and days to 50% silking. Low GAM was observed for days to 50% tasseling (9.19) followed by tassel length (8.54), days to physiological maturity (7.03) and leaf width (5.72). Taye (2014) showed grain yield ton ha^{-1}, thousand kernel weight, plant height, ear height and days to maturity had low GAM. Our findings agreed to his results.

CONCLUSION

In the present study, high to moderate PCV and GCV recorded for grain yield, ear height, plant height, 1000-kernel weight, number of kernels per row, ear length, ear weight, ear aspect and ear per plant suggested prevalence of sufficient variability that offered scope for selection. High heritability was found for days to maturity, plant height, grain yield kg ha^{-1}, days to 50 % tasseling, ear diameter, ear weight, ear length, ear height, thousand kernel weight, days to 50% tasseling, number of kernel rows per ear, number of kernels per row. These traits were less influenced by environmental factors. High heritability with high genetic gain was found in plant height, ear height, ear weight and thousand kernel weight. These traits can therefore be used for crop improvement program.

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Climate change and rice yield trends in Banke, Nepal

G. Shrestha[1], B. R. Baral[1], S. Shrestha[1], G. Malla[2], S. K. Rai[2]
[1]NARC, Regional Agricultural Research Station, Khajura, Banke
[2]NARC, Agriculture Environment Research Division, Khumaltar, Lalitpur
shresthagautam@live.com

ABSTRACT

Nepal is one of the most climate change vulnerable countries in the world. Besides increased global temperature, climate change has influenced the monsoon characteristics as well. Monsoon based rice farming in Banke district has been also affected with changing monsoon pattern. This study summarizes the meteorological data from 1995 to 2016 recorded at weather station in Regional Agricultural Research Station (RARS), Khajura, Banke, Nepal and analyzes its influences in rice yields. In addition, an open top chamber (OTC) study with three types of open top chambers and four rice cultivars was conducted during the rainy season in 2016. The data analysis and field research result revealed that the average rainfall during the monsoon months over 16 years was not consistent. Among the monsoon months, June rainfall significantly related to rice yield and years with higher rainfall in June had higher rice yield. September average maximum temperature increase was found significant whereas sudden increase in maximum temperature caused significant decline in rice yield. From open top chamber study (OTC), increased average daily temperature of 2.5^{0}C compared to the ambient conditions had increased rice yield of newly developed varieties and pipelines. In the context of changing climate, high accuracy prediction of weather and climate conditions will help to prepare the cropping calendar and select suitable cultivars and cultivation practices to maintain the rice productivity.

Key words: Climate change, Monsoon, Rainfall, Trend analysis, Yield

INTRODUCTION

Nepal is ranked on 24th position in Global Climate Risk Index (Kreft et al., 2016). In the context of climate change, agricultural practices and cropping calendars are also changing. Extreme weather conditions like drought, excess rainfall, heat stress and cold stress are more frequent in the recent years (Malla, 2009). Monsoon is a typical climatic condition determined by the differences in the atmospheric pressure in the ocean and the land surfaces. Southwest Asian monsoon is one of the active monsoons in South Asia (Trenberth et al., 2000). In Nepal, 80 percent of the total precipitation occurs in the monsoon season starting from June and ending in September (Malla, 2009). Monsoon rainfall is the important source of irrigation water; and has high impact in the agriculture sector of Nepal (Agrawala et al., 2003), where 48 percent cultivable land is under rained farming (Ministry of Agricultural Development, 2016). Rice (*Oryza sativa* var. indica and japonica), a major staple food crop of Asia, is planted in synchrony with the onset of the southwest monsoon.

Global temperature is increasing due to anthropogenic greenhouse gases (GHGs) emissions (IPCC, 2007). IPCC (2007) predicted the increase in grain yield by 20% in Southeast Asia with increase in 1° - 3°C temperature using heat tolerant cultivars and change in planting time. With future prediction of 1° - 2°C temperature rise (Kirtman, 2013), there is an urgent need to develop crop cultivars, which are more heat tolerant (Malla, 2009).

Banke district is one of the mid-western terai districts of Nepal. In 2004, in the month of May, Banke experienced 48°C, which was the highest temperature of the recorded history in Nepal so far. Total rainfall in Banke district ranged from 937 mm to 2149 mm in a year, with average rainfall of 1317 mm from the year of 1950 to 2016. Though, Ministry of Enivornment (2010) has placed Banke district under very less vulnerable district to climate change, extreme temperatures , less and shifting rainfall pattern and existence of rain fed agriculture (70% out of total arable land) (DADO Banke, 2017) may result into significant decline in agricultural productivity. Survey (Shrestha and Rajee, 2016) results revealed that local farmers used to put paddy rice seedbed on the second fortnight of May and start transplanting on the second fortnight of June in Banke. Whatsoever rice seedling is transplanted early or late, rice harvesting starts on 1st fortnight of September and should not go beyond 2nd fortnight. Delayed harvesting of paddy rice means wheat sowing will also be delayed. Early transplanted paddy rice plants will have enough time to give more tillers and yield. Late transplanted rice seedlings will have lesser tillers and lesser time to give more spikelet in a panicle. Though there are data on climate change effect in agriculture sector for global (IPCC, 2007) and national level (Malla, 2009), micro-climate specific data are lacking. Microclimates have direct and magnifying effect in the agricultural production at locale. Banke district being a hotspot area of the extreme climatic conditions with possibility of hottest days and nights, flood, drought, chilling cold winter without sun for weeks or more, changes in climatic conditions have high impact in the agriculture sector as well. However, there are not such studies conducted in the past to generate knowledge on influence of climate in crop yield in the region. As rice crop yield is monsoon dependent, this study was conducted to find out the effect of climate parameters in the paddy rice yield at Regional Agricultural Research Station (RARS), Khajura, Banke conditions.

MATERIALS AND METHODS

Banke (27°N to 28°20'N longitude and 81°E to 82°08'E latitude) is a district with tropical to subtropical climate. Total arable land is 57,252 ha and cultivated area of 52,838 ha. Lowland field area is 37,382 ha and upland field area is 15,000 ha. Released rice cultivars cultivated for seed production in the area are Radha 4, Janaki, Hardinath 1, Hardinath, Sabitri, Ram Dhan, Barkhe 2014, Makawanpur 1, Sukkha 3, and Loktantra. Paddy is produced in 36,500 ha area with total production of 119,720 ton. Among irrigated fields, all year round irrigated land is 14,613 ha whereas seasonal irrigated land is 38,221 ha. Irrigated rice yield is 3.7 t/ha whereas rain fed paddy rice yield is 2.9 t/ha (DADO Banke, 2017).

Weather data record at Regional Agricultural Research Station (RARS), Khajura, Banke from 1995 to 2016 was analysed. This is a weather station number 049 established by DHM, GoN. In 1995 and 1996, only maximum temperature and rainfall data were recorded once a day at 5:45 PM. Starting from 1997 minimum temperature records were found. Weather data recording twice a day; in the morning at 8:45 AM and in the evening at 5:45 PM was initiated since July 2013.

Main season rice (*Oryza sativa* var. indica) yield from the long-term soil fertility trial initiated from 1978 was used. The main season rice is irrigated and yield data form 10 ton FYM per hectare was used. The cultivars and other details are described in the article published by Shrestha and Chaudhary (2015). We preferred on farm data, which yields more realistic relation with the weather data at the station compared to the estimated district level data.

Three open top chambers were created by covering plastic sheets to three heights (3.25 m, 4.17 m and 5.11 m) to maintain relatively higher temperature than the field condition with increase in the plastic covered heights. Inside the open top chamber, four rice cultivars (Sabitri, Hardinath, Sukkha dhan -3 and IR87377-B-B93-3) were transplanted in 2 July, 2017. Chemical fertilizer was applied @ 100-30-30 kg N-P-K per hectare. Temperature inside the chamber were recorded in the morning at 8:45 AM and in the evening at 5:45 PM with the help of maximum and minimum thermometers placed at 80 cm height inside the chambers.

RESULTS AND DISCUSSION

Paddy transplanting

Timely start of the monsoon in the past had made possible the timely transplanting of rice crop. However, delay in start of monsoon this year (SASCOF, 2017) has caused farmers to transplant aged rice seedlings more than a month old. In June 2017, there was only 50 mm rainfall, which fell during 5 days distributed in four week period. The rainfall was not enough for manual rice seedling transplanting activity in the rain fed rice fields. Delayed transplanting causes lesser tillering and subsequent reduced grain yield (Mahajan et al., 2009, Pasuquin et al., 2008). In Ludhiana, India condition, June 15 transplanting has resulted highest water productivity compared to other transplanting dates (Mahajan et al., 2009). Whereas there was 1 ton per hectare yield decline with delay seedling transplanting at the age of 21 days after sowing (three leaf stage) to 7 days after sowing (seven leaf stage) (Pasuquin et al., 2008) in Philippines.

Monsoon rainfall

Average monsoon rainfall in Banke district was 1127 mm during 1995 to 2016. Year 2002 was the year with the least rainfall record of 820 mm and in 2007 there was a big flood in the Banke due to heavy monsoon downpour (Figure 1). Monsoon rainfall accounted for at least 80 percent annual rainfall in Banke district; sometimes it reached 90 percent as well. During last five years, monsoon rainfall record is adding up and farmers surveyed at Kamdi VDC has also perceived same (Devkota, 2014).

June is the usual starting point of monsoon when 100 mm or more rainfall happens to suffice the rice seedlings transplanting activities. However, lesser rainfall as happened in 2012 (58.7 mm) and in 2009 (70.7 mm) is not enough for the rice seedling transplanting causing delay in that activity. In the months of June and July, there was a pattern of rise and fall in rainfall amounts (Figure 1). July is the main monsoon month getting large portion of rainfall. High rainfall in August causes lodging problem with tall growing rice cultivars.

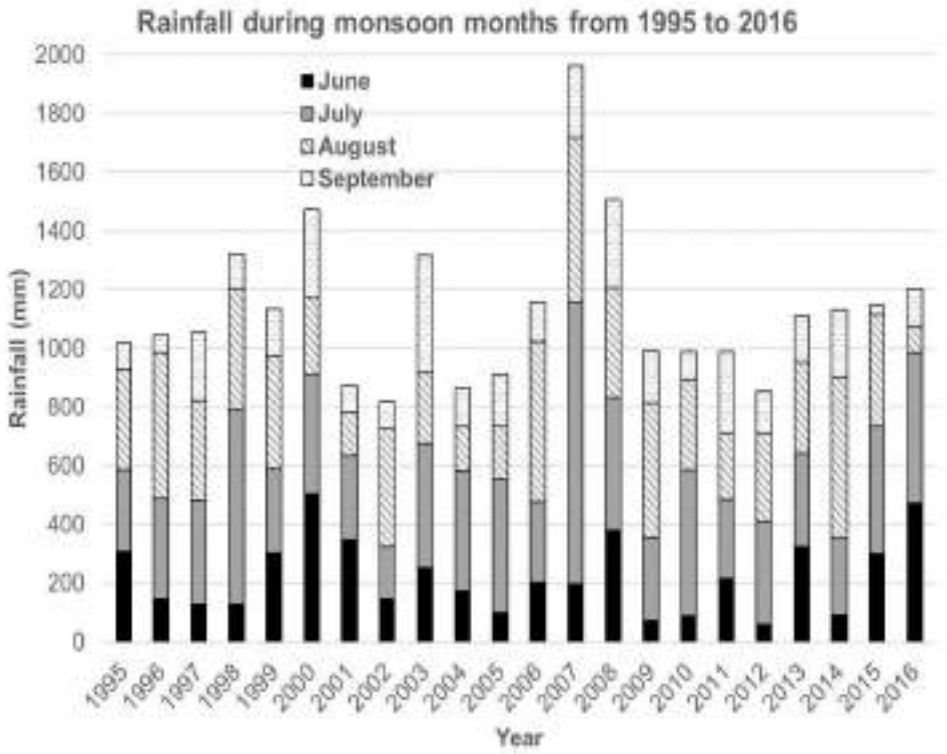


Figure 1. Monsoon rainfall (mm) during four months (June, July, August and September) from 1995 to 2016 at Khajura weather station, RARS, Banke

June rainfall and main season rice yield

There was a significant influence of June rainfall in the rice yield compared to other monsoon month rainfalls (Figure 2). There was 55 kg increase in the rice yield with each 10 mm additional rainfall in June. It was due to the uniform distribution of rainfall in the land surface retaining soil moisture for longer period in the root zone. In case of irrigation, only small area is irrigated which will be dry up soon if surrounding lands are not watered. In addition, timely transplanting of rice seedlings early enough to grow more tillers and develop more spikelets in the panicle ultimately contribute to gain the higher yield. Hence, rainfall during the transplanting time (June) which is stored in the soil can contribute in the rice yield.

Diurnal temperature range

The difference between daily maximum and minimum temperature (diurnal temperature range) was on an average 8.5°C during monsoon months. It ranged from 5.5 to 17.5°C. During the highest precipitation month of July, the diurnal temperature range (DTR) was 7.4°C. Very large DTR value means plants get heat and or cold stress (Figure 3).

In Banke district, average maximum temperature reached 40°C and minimum temperature remained at 25°C in June. In the context of rice cultivation, for rice seed germination, optimum temperature range is 18° – 33°C. For rice seedlings rooting, 25° - 28°C is the optimum temperature range. However, more than 35°C has inhibitory effect in rice seedling rooting (Nishiyama, 1976). Hence, frequent irrigation is the utmost requirement to maintain temperature for germination and seedling growth and development in Banke. After transplanting, for the growth of rice plants, 18° - 33°C is the favourable range. Tillering best happen in 20° - 25°C and inhibited below 16°C and above 33°C. Rice plant respiration and photosynthesis best happen in between 15° - 32°C (Nishiyama, 1976). In July and afterwards, maximum temperature remains below 35°C and minimum temperature around 25°C in Banke. Hence, rice seedling establishment and tillering happens in rapid speed. Panicle differentiation is favoured by 18° - 30°C. Number of panicles per rice plant is highest at 30°C (Nishiyama, 1976). In Banke, during panicle differentiation, average temperature is around 29°C. Hence, maximum grain yield can be obtained.

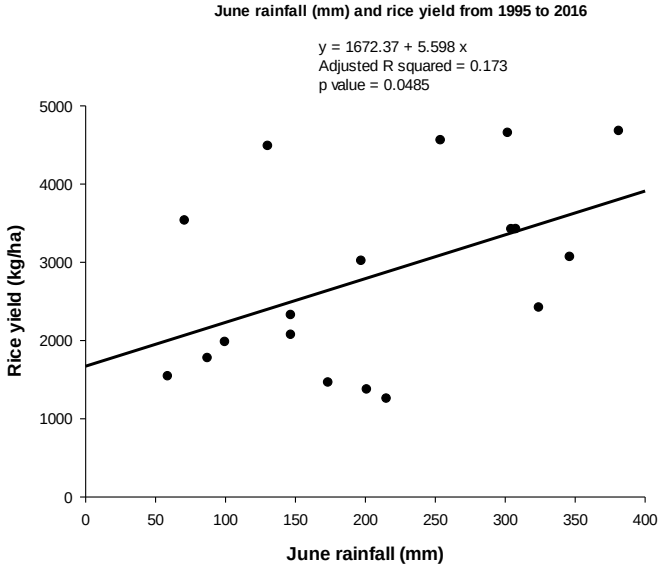


Figure 2. Role of June rainfall in the rice yield from 1995 to 2016 at RARS, Khajura, Banke

Maximum temperature

Average maximum temperature range during the monsoon months was 40.0° – 33.5°C in June, 34.8° – 32.1°C in July, 35.1° – 27.1°C in August and 34.3° – 31.8°C in September. Optimum maximum temperature for rice growth and development is 35°C (IRRI, 2015). With an average maximum temperature of 36.5°C in June, 33.6°C in July, 32.9°C in August and 33.0°C in September, Banke district had a very good weather condition for the rice growth and development. Shrestha et al. (1999) predicted 0.014°C annual increase in the maximum temperature during monsoon months in Terai region, this analysis of Banke district revealed 0.033°C annual increase for the month of June and 0.044°C in July and August and 0.058°C in September (Figure 4).

During monsoon months, maximum temperature reached 45°C in June 1995. July and August has not experienced heat more than 35° - 40°C. Except in June, maximum temperature in monsoon

months is rising up. In comparison to an average maximum temperature during the period, the maximum temperature anomaly is very high in Banke district during the monsoon period. In July, annual maximum temperature increase is 0.07°C highest among other monsoon months. Rate of temperature increase is 0.05°C in August and September (Figure 5). The favourable temperature range for ripening stage is 16° - 21°C (Munakata, 1976). High temperature during ripening stage can reduce grain filling and milling quality (broken grains) (Laborte et al., 2012). As September has maximum temperature of 35°C, grain yield in Banke district has more chances of having reduced grain filling and milling quality.

Rice yield and maximum temperature

Comparing rice yield and maximum temperature from 1978 to 2016 depicted that with increase in the maximum temperature (°C), rice yield declined at the rate of 500 kg per hectare for each degree rise from above 35°C. During the month of July, maximum temperature reached up to 40°C (Figure 8) which severely setback the rice plant tillering as it is inhibited above 33°C (Nishiyama, 1976). In September, maximum temperature was 38.5°C (Figure 6), which inhibits the seed fertilization activity, seed ripening, and number of panicles per hill. All above processes happen best below 30.0°C (Munakata, 1976, Nishiyama, 1976). Extremely high temperatures, even for a few hours, during the flowering stage can cause complete sterility (Laborte et al., 2012). The trend of inclining maximum temperature during monsoon months requires heat tolerant rice varieties for the future.

Minimum temperature

During the monsoon months, average minimum temperature ranged 31.1° – 24.1°C in June, 27.1° – 17.8°C in July, 26.7° – 18.0°C in August and 28.1° – 16.0°C in September. Above 25°C, increase of each 1°C minimum temperature can reduce 10% grain yield (Laborte et al., 2012). In the case of Banke, average minimum temperature was 26.1°C in June, 25.6°C in July, 25.7°C in August and 24.6°C in September. As average minimum temperature was around the optimum, grain yield was not influenced much. Trend of average minimum temperature was heading up in June and it was decreasing in the later months (Figure 7). Hence, farmers who are planting in June will need more frequent irrigation in coming years due to increase in temperature. The rate of temperature decline was 0.1°C for all three months per annum. In this way, there will be increase in the period of rice crop in the field in the future with minimum temperature decline.

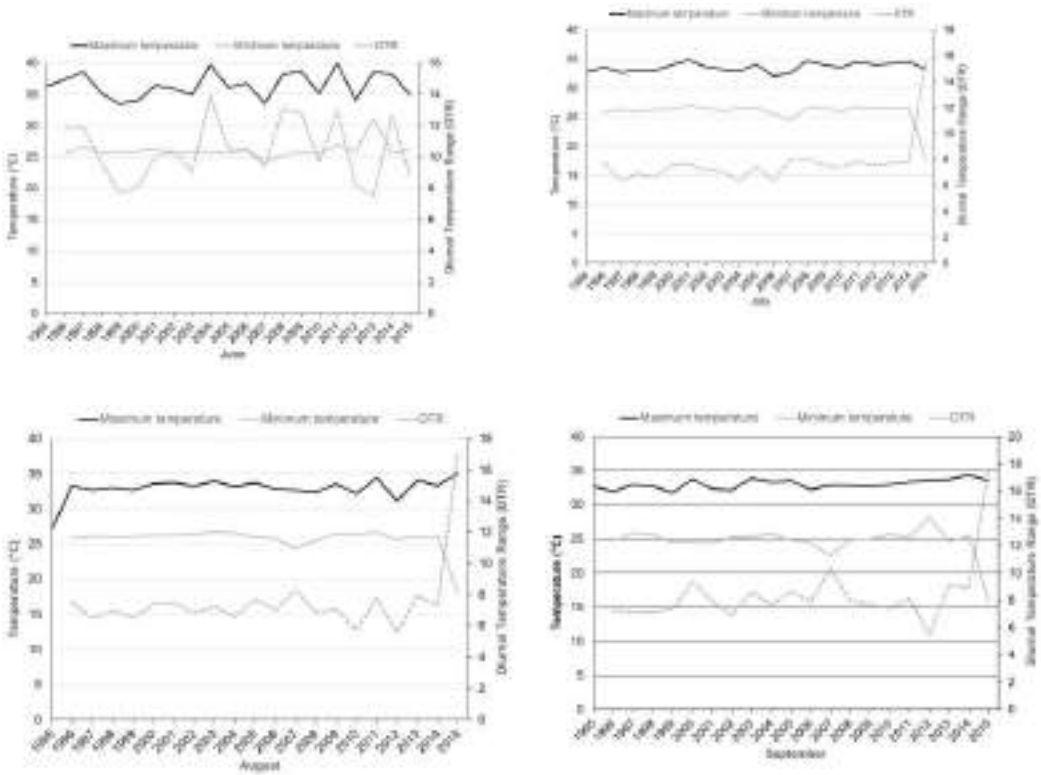
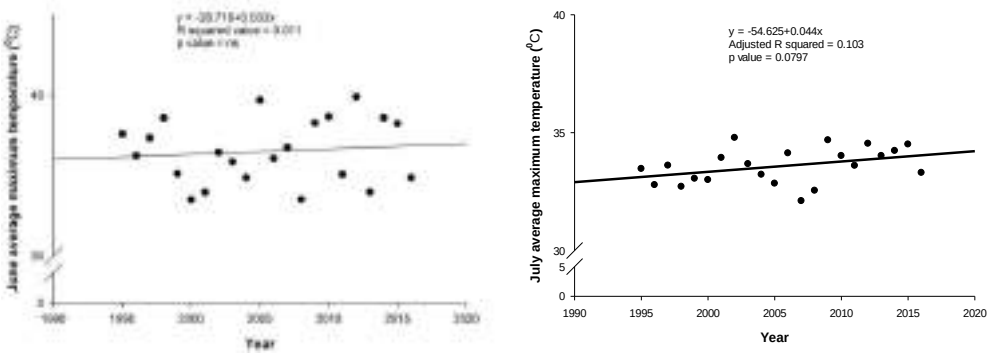


Figure 3 Diurnal temperature range (DTR) during monsoon months (June to September) from 1995 to 2016 at RARS Khajura weather station, Banke



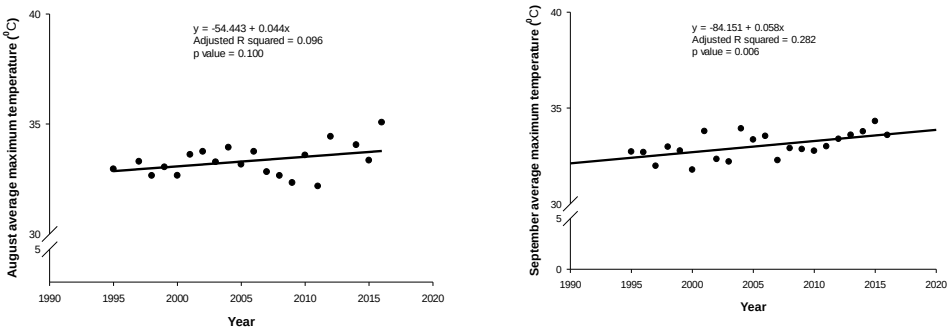


Figure 4. Regression analysis of average maximum temperature (°C) in monsoon months (June, July, August and September) from 1995 to 2016 at weather station, RARS, Khajura, Banke

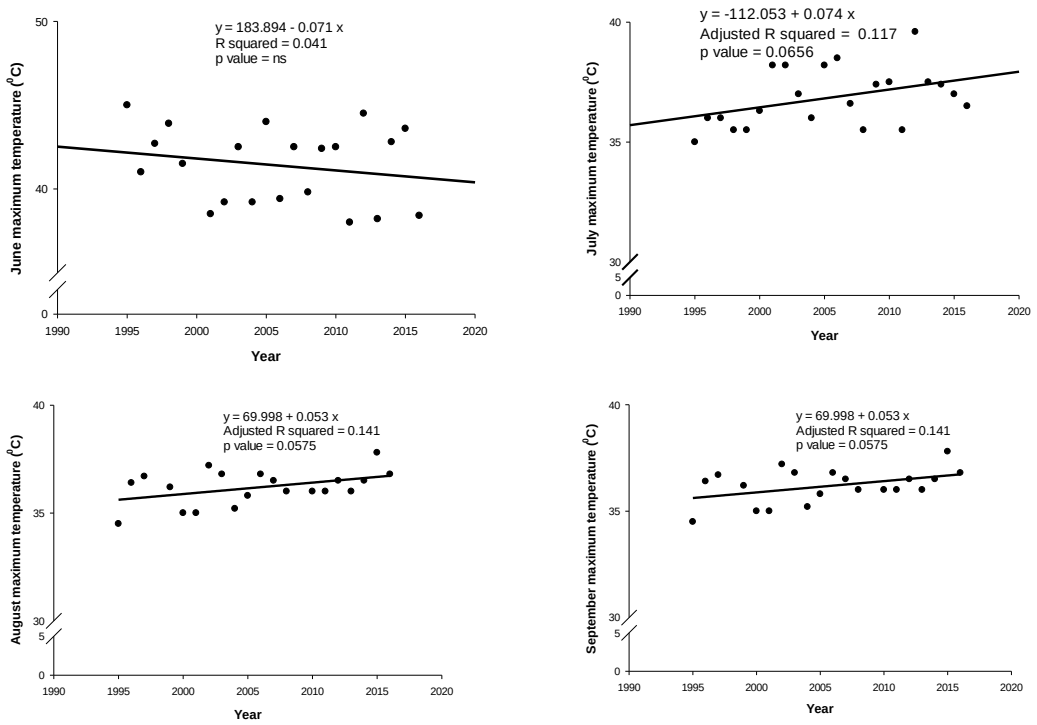


Figure 5. Regression analysis of maximum temperature (°C) recorded in monsoon months (June, July, August and September) from 1995 to 2016 at weather station, RARS, Khajura, Banke

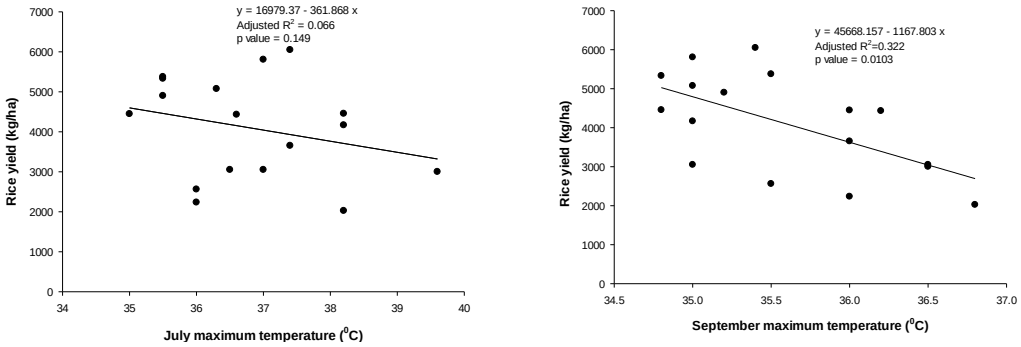


Figure 6. Correlation of maximum temperature (°C) in July and September with rice yield from 1995 to 2016 at RARS, Khajura, Banke

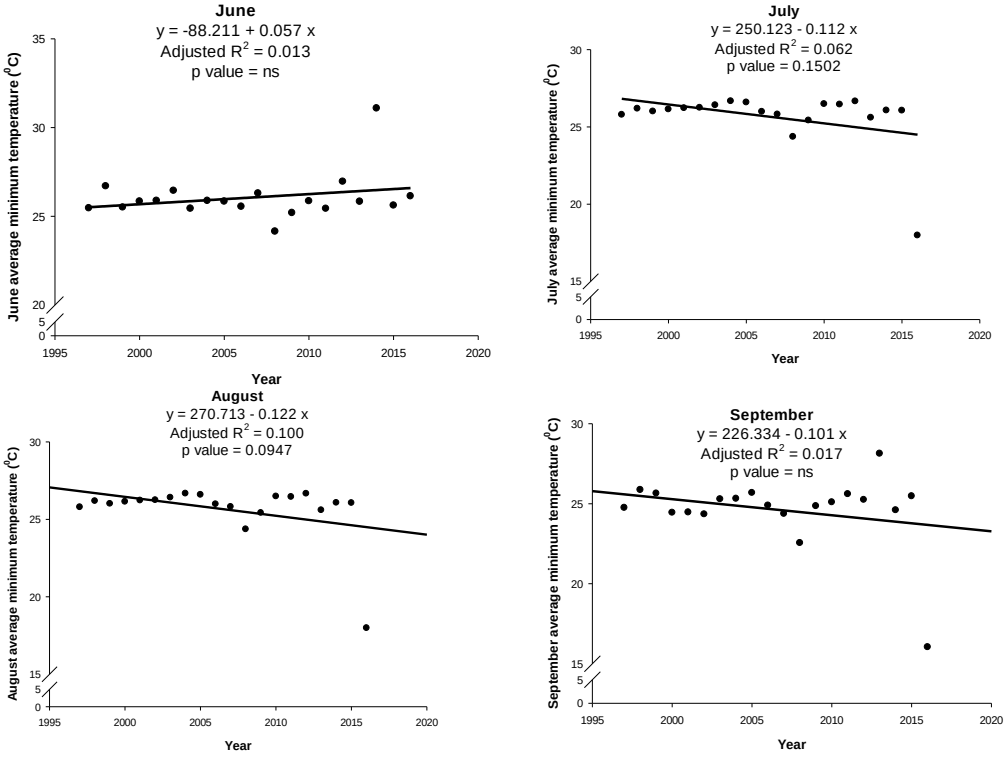


Figure 7. Regression analysis of average minimum temperature (°C) recorded in monsoon months (June, July, August and September) from 1997 to 2016 at weather station, RARS, Khajura, Banke

We analysed minimum temperature recorded in the monsoon months (June, July, August and September) since 1997 to 2016. Minimum temperature recorded in June ranged 20°- 23.5°C, 13°-24.6°C in July, 16.5°- 25.4°C in August and 13.4°- 24.4°C in September. Compared to the average minimum temperature, temperature anomaly is high and more frequent in recent years. The linear trend line thus created showed minimum temperature was going down each year (Figure 8). The minimum temperature required for the rice growth and development is 25°C (IRRI, 2015). Rice is sensitive to the cold stress. Rice yield declines up to 25% with decrease in temperature to 13°C at flowering stage for 15 days (Ghadirnezhad and Fallah, 2014). The current trend of decreasing minimum temperature in the monsoon months will show its effect in the declined yield in the coming decades.

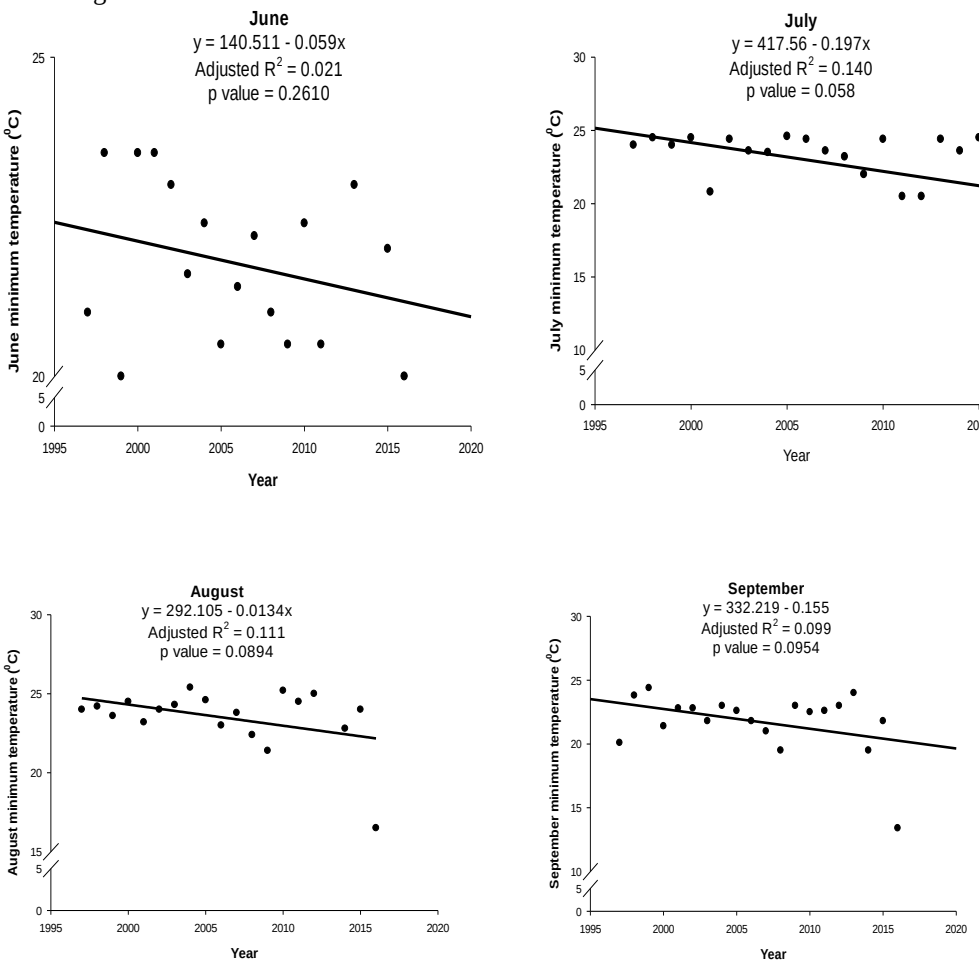


Figure 8. Regression analysis of minimum temperature (°C) in monsoon months (June, July, August and September) from 1997 to 2016 at weather station, RARS, Khajura, Banke

Rice yield and minimum temperature

Correlation results revealed 300 kg/ha rice yield decline with each degree decrease in minimum temperature during 1998 to 2016. Rooting of transplanted rice seedlings and tillering is inhibited

below 16°C (Nishiyama, 1976), which was the reason for very less yield in the year reaching 13°C minimum temperature in July (Figure 9). In addition, cool weather injury happens in the 15°C±5°C (Nishiyama, 1976).

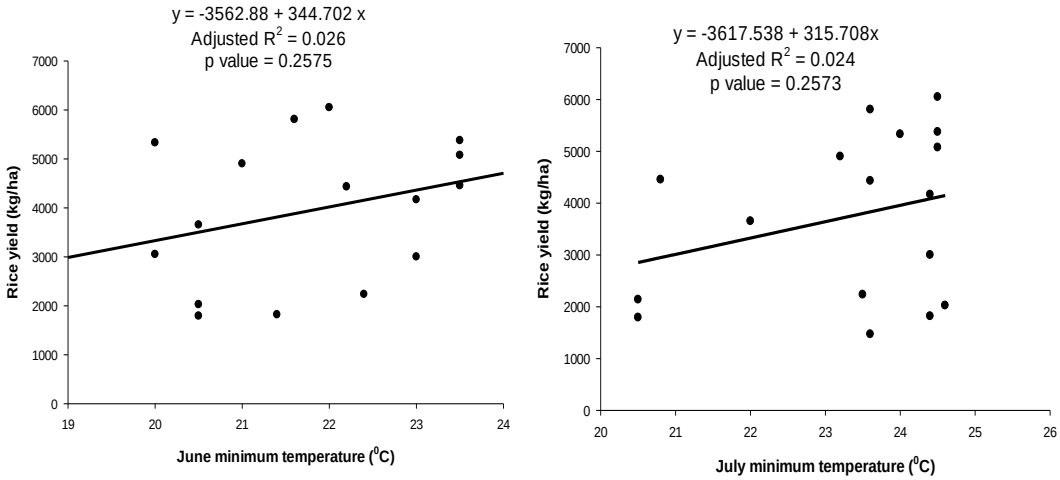


Figure 9. Correlation of minimum temperature during monsoon months (June in left and July in right) from 1998 to 2016 in rice yield at RARS, Khajura, Banke

Open top chamber study
Daily temperature record

During the rice season, on an average field temperature was 25.6°C whereas temperature inside chamber 1 (3.25 m plastic covered open top chamber) was 2.5°C higher than field. Similarly, in chamber 2 (4.17 m plastic covered open top chamber) there was 6.6°C higher temperature. In chamber 3 (5.11 m plastic covered open top chamber), it was 7.2°C higher temperature (Figure 10). Hence, chamber 1 resembles the near future prediction of 1 to 3°C average global temperature increase.

Rice yield

Rice yield increased with on an average 2.5°C higher temperature inside Chamber 1 (3.25 m covered open top chamber) than the ambient condition. Rice yield increased by 10 to 22% inside Chamber 1 than ambient condition when required irrigation water was supplied (Table 1). Rice yield of the Sukkha dhan -3 was highest as it has a drought tolerant gene (IRRI, 2017). It was at par with the IPCC (2007) prediction of crop productivity increase by 20% in the Southeast Asia with temperature increase of 1° - 3°C with altered cultivars. Rice yield declined inside chamber 2 and 3 by 10%. Our results was in line with the modeling studies conducted using DSSAT (Decision Support System for Agro-technology Transfer) revealed 3.4% yield decline in the terai area with 4°C temperature increase (Malla, 2009).

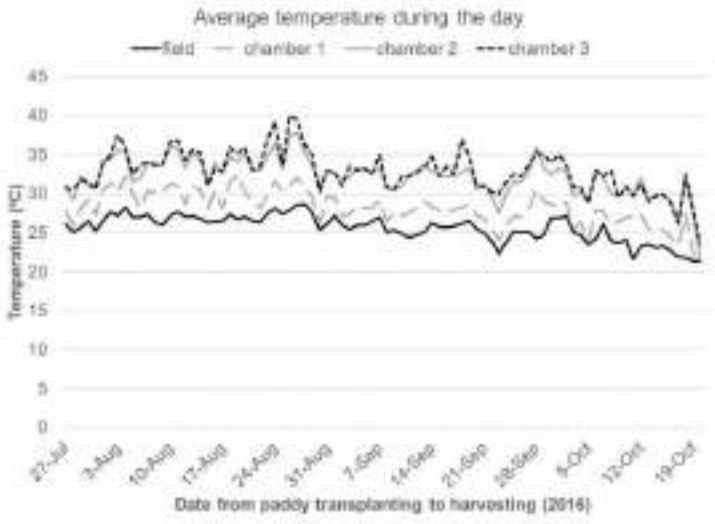


Figure 10. Average daily temperature in the field, chamber 1, chamber 2 and chamber 3 during rice growing season at RARS, Khajura in 2016

Table 1. Rice cultivars grain yield (t/ha) in open top chambers conditions at RARS, Khajura, Banke

Condition	Sabitri	Hardinath	Sukkha dhan-3	IR87377-B-B93-3	Grand mean
Chamber 1 (3.25 m)	4.25	2.52	4.66	4.25	3.92
Chamber 2 (4.17 m)	3.05	4.26	4.03	3.14	3.62
Chamber 3 (5.11 m)	3.24	2.91	3.85	3.48	3.37
Field	3.48	2.28	4.19	3.71	3.415
Grand mean	3.505	2.9925	4.1825	3.645	3.58125

CONCLUSION

Climate change has influenced the rainfall timing and amount, maximum and minimum temperature in the monsoon months. Delay in initiation of monsoon this year has caused this year's aged seedling transplantation problem. This problem could have been curbed with prior information dissemination on monsoon commencement time this year. Historical rainfall graphs showed inconsistent rainfall patterns in Banke district. Hence, it is a herculean task to predict monsoon pattern based on 17 years dataset. Rainfall during the transplanting period showed significant effect compared to rainfall during other monsoon months. Maximum temperature anomaly mainly sudden increase in maximum temperature has resulted into significant rice yield reductions in old cultivars. From open top chamber study, drought tolerant varieties were able to cope increase in average daily temperature within 1 to 3°C. Hence, for future agriculture, drought and heat tolerant varieties are required to adapt with climate change.

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Screening of rice genotypes against Leaf and Neck Blast disease

P. Ghimire, G. Khatri-Chhetri, S. Shrestha, and G. Parajuli
NARC, Khumaltar, Lalitpur

ABSTRACT

One hundred two rice genotypes were screened against leaf and neck blast under natural condition at NARC, Khumaltar, Lalitpur and Gokarna, Kathmandu, during June to November, 2014. Quantitative resistance in rice against blast was assessed based on area under disease progress curve (AUDPC). Out of 102 rice genotypes, 72 genotypes were found resistant, 23 moderately resistant, 2 moderately susceptible, 2 susceptible and 3 highly susceptible to leaf blast, where as one genotype was recorded resistant to neck blast , 28 were moderately resistant, 13 were susceptible and 60 were highly susceptible to neck blast in farmers field at Gokarn, Kathmandu. None of the genotypes was immune to leaf or neck blast. Genotype NR 11100-B-B-3-3-2 was resistant to both leaf and neck blast. Rice genotypes NR 11182-B-23, IR 87760-17-1-1-4, IR 83383-B-B-129-4 and NR 11182-B-5 were moderately resistant, whereas Taichung-176, NR 11165-B-B-22 and NR 11165-B-B-24 highly susceptible to both neck and leaf blast. Rice genotype NR 11011-B-B-B-B-33 was recorded resistance to leaf blast hence may be used as a source of resistance for breeding resistance to blast. Similarly genotype NR11100-B-B-3-3-2 was resistant to neck blast and genotype NR11100-B-B-3-3-2 to both leaf and neck blast. These three rice genotypes may be used as a donor parent for breeding blast resistance.

Key words: Rice genotypes, *Pyricularia grisea*, quantitative resistance, breeding, donor parents, susceptibility

INTRODUCTION

Blast disease caused by *Pyricularia grisea,* is one of the most devastating diseases of rice in most rice producing areas of the world (Ou, 1985). Rice blast is the most common and destructive disease in irrigated rice of both temperate and subtropical areas of East Asia (Bonman *et al.*, 1991). The pathogen is highly adaptable to various environmental conditions and can be found in irrigated lowland, rain-fed upland, or deep-water rice fields. In Nepal, the disease causes 10-20% yield reduction in susceptible varieties, but in severe case, it goes up to 80% (Manandhar *et al.*, 1992). Blast epidemic causes complete loss of seedlings (Chaudhary *et al.*, 1994) in nursery and epidemics in the field (Teng *et al.*, 1991) in Nepalese context. Panicle infection causes complete yield loss (Ou, 1985). Yield reduction by neck blast infection is twice as severe as the leaf blast (Hwang *et al.*, 1987). In Nepal, a grain yield loss of 38.5 and 76.0 kg ha-1 was reported in the rice cultivars: 'Masuli' and 'Radha-17', respectively, due to one percent increase in neck blast (Chaudhary, 1999). Host resistance is the highly cost effective, environmentally safe, convenient and preferable means of plant protection. Thus, disease management through use of host resistance is the best alternative. Resistant cultivars cost the farmer nothing, pose no pollution problem and are readily adopted. Hence, the successful breeding program for resistance to blast should be concentrated on effective and efficient screening techniques (Chaudhary, 1996); behavior of resistant genes and host parasite interaction in rice-blast patho-system are essential. Manandhar *et al*. (1998) also showed linear relationship between panicle infection and to its seed infection as well as further transmission to seedling. Therefore, identification of the durable new sources of

resistance and their development are necessary for blast management. In this study, 102 rice genotypes including checks were evaluated for quantitative resistance to blast in Khumaltar, Lalitpur and Gokarna, Kathmandu, during June to November, 2014.

MATERIALS AND METHODS

In field, 102 rice genotypes were tested against leaf and neck blasts including susceptible checks under natural condition at NARC, Khumaltar, Lalitpur and Gokarna, Kathmandu, during June to November, 2014. The experiment was laid out in augmented (rod row) design. To create blast congenial environment, windbreaks around the experiment and inoculum plots inside the windbreak were managed as per international specifications (Jennings *et al* 1979). The seedbeds were raised up to 15 cm high above the ground to avoid flooding. FYM and N: P: K were applied @ 10 ton/ha and 140:30:30 kg/ha, respectively, during land preparation. 100 seeds of each line were seeded in a row of 0.5 m long. Weed management was done as needed. Disease evaluation was started 25 days after seeding and continued for four observations at 5-day interval. Ten plants were selected randomly from each genotype from test plots for disease scoring. The leaf blast disease was scored in a 0-9 scale (IRRI, 1996) at 5 days intervals starting from 25 DAS, i.e. at 25, 30, 35, 40 and 45 DAS. Mean values of each genotype were computed.

The same augmented (rod row) design, except windbreak (maize) plot, and the same 102 rice genotypes used for screening against leaf blast, were used also for the study of neck blast. The same genotypes were evaluated for resistance to neck blast under direct seeded dry field conditions. Single seed per hill was planted at a spacing of 10 cm row to row and 10 cm plant to plant distance. FYM and N: P: K were applied @ 10 ton/ha and 140:30:30 kg/ha, respectively. Half amount of nitrogen and total amount of phosphorus, potash and FYM were mixed in soil at the time of land preparation (i.e. just before transplanting). Remaining half nitrogen was applied into two split doses; one at tillering stage, i.e. 20 days after transplanting and the other at head emergence stage, i.e. 35 days after transplanting. Fertilizers were used in between lines and mixed in soil with spades. Disease scoring of neck blast was done from five tillers each of five hills/genotype selected randomly and tagged. Scoring was done at panicle emergence stages (70 days after sowing). From the total 25 tillers, total number of infected tillers was counted and neck blast incidence calculated as below:

Incidence of neck blast (%) = (# of infected panicle / Total # of panicle)*100

Based on the percentage neck infected, the rice genotypes were classified as Resistance, moderately resistance, susceptible, moderately susceptible and highly susceptible (IRRI, 1996).

RESULTS AND DISCUSSION

Relationship between leaf and neck blasts

Out of 102 genotypes, NR 11100-B-B-3-3-2, was found resistant to both leaf and neck blast, IR 87760-17-1-1-4, NR 11182-B-23, IR 83383-B-B-129-4 and NR 11182-B-5 were found moderately resistant to both leaf and neck blast. Similarly, Taichung-176, NR 11165-B-B-22 and NR 11165-B-B-24 were highly susceptible to leaf and neck blast. Many genotypes were found resistant to leaf blast which were highly susceptible to neck blast. Rice genotypes NR 11105-B-B-50-3 and NR 11100-B-B-11-1-1 were observed resistant to leaf blast, while susceptible to neck blast and several other genotypes showed mixed reactions (Table 1). The study revealed that the genotypes were more prone to neck blast than leaf blast.

Table 1. Reaction of rice genotypes to leaf blast at NARC, Khumaltar, and neck blast at Gokarna, 2014

Genotypes	Leaf blast severity %	Reaction	Neck blast Score	Reaction
NR 11115-B-B-26-3	1.9	R	4	S
NR 11100-B-B-15-1	1.9	R	2	MR
NR 11120-B-B-27-3	1.9	R	4	S
NR 11105-B-B-50-3	1.9	**R**	5	**HS**
NR 110116-13-5-2-3-3-2	8.9	R	4	S
NR 11156-B-B-20	9.9	R	4	S
NR 11130-B-B-B-19	10.9	R	4	S
NR 11130-B-B-B-16	10.9	R	2	MR
NR 11100-B-B-11-1-1	10.9	**R**	5	**HS**
NR 11156-B-B-11	10.9	**R**	5	**HS**
NR 11156-B-B-10	10.9	**R**	2	**MR**
NR 11142-B-B-B-1-1	11.9	**R**	5	**HS**
NR 11140-B-B-B-4	11.9	**R**	5	**HS**
NR 11139-B-B-B-21	11.9	**R**	4	**S**
NR 11139-B-B-B-17	11.9	**R**	5	**HS**
NR 11115-B-B-31-3	11.9	**R**	4	**S**
NR 11111-B-B-23	11.9	**R**	5	**HS**
NR 11111-B-B-22-1	11.9	R	2	MR
NR 11138-B-B-B-7	11.9	R	4	S
NR 11137-B-B-B-10	12.9	R	2	MR
NR 11100-B-B-3-3-2	13.9	**R**	1	**R**
NR 11100-B-B-3-3-1	13.9	R	5	HS
NR 11139-B-B-B-10	13.9	R	2	MR
NR 11133-B-B-B-23	15.9	R	5	HS
NR 11130-B-B-B-12	15.9	R	2	MR
NR 11100-B-B-15-2-3	15.9	R	2	MR
NR 11182-B-17	15.9	R	2	MR
IR 87760-15-2-2-4	15.9	R	5	HS
NR 11100-B-B-15-2-1	15.9	R	2	MR
NR 11115-B-B-26-3-1	15.9	R	4	S
IR 87759-22-1-1-2	15.9	R	5	HS
NR 11142-B-B-B-6	15.9	R	5	HS
NR 11111-B-B-14-2-1	15.9	R	5	HS
Khumal-8	16.9	R	4	S
NR 11182-B-8	16.9	R	2	MR
NR 11130-B-B-B-8	17.9	R	5	HS
IR 70210-39-CPA-7-1	17.9	R	2	MR
IR 87759-21-2-2-1	17.9	R	5	HS
NR 11130-B-B-B-3	18.9	R	5	HS

NR 11130-B-B-B-2	19.9	R	4	S
NR 11130-B-B-B-24	19.9	R	2	MR
NR 11037-B-B-B-B-56-2	20.6	R	5	HS
NR 11182-B-12	20.9	R	2	MR
NR 11100-B-B-6-1	21.9	R	5	HS
IR 87759-18-1-1-1	21.9	R	5	HS
Manjushree-2	21.9	R	5	HS
NR 11139-B-B-B-18	22.9	R	5	HS
NR 11139-B-B-B-23	22.9	R	5	HS
NR 11182-B-21	23.9	R	2	MR
NR 11145-B-B-B-6	23.9	R	5	HS
NR 11016-13-5-2-3-1-3	23.9	R	4	S
NR 11100-B-B-16-3-3	24.9	R	5	HS
NR 11145-B-B-B-2	24.9	R	5	HS
NR 11153-B-B-18	25.9	R	4	S
NR 11011-B-B-B-B-22	25.9	R	5	HS
NR 11109-B-B-45-1	25.9	R	5	HS
NR 11139-B-B-B-6	25.9	R	5	HS
NR 11139-B-B-B-5	26.9	R	5	HS
Khumal-4	26.9	R	5	HS
NR 11100-B-B-13-2	26.9	R	2	MR
NR 11011-B-B-B-B-65	27.9	R	2	MR
NR 11100-B-B-23-1	27.9	R	5	HS
NR 11105-B-B-20-2-3	27.9	R	5	HS
NR 11120-B-B-22-3-1	27.9	R	5	HS
NR 11115-B-B-26-3-3	28.9	R	2	MR
NR 11100-B-B-15-3-3	28.9	R	2	MR
NR 11142-B-B-B-9	28.9	R	2	MR
Khumal-10	28.9	R	2	MR
NR 11042-B-B-B1-1	29.9	R	5	HS
NR 1105-B-B-16-2	29.9	R	5	HS
NR 11100-B-B-15-2	29.9	R	2	MR
IR 87761-52-1-2-2	29.9	**R**	5	**HS**
IR 87761-28-1-1-3	30.9	MR	5	HS
NR 11105-B-B-20-2-1	30.9	MR	5	HS
NR 11109-B-B-28-1-3	30.9	MR	5	HS
NR 11011-B-B-B-B-33	30.9	MR	5	HS
NR 11109-B-B-12-3-2	32.9	MR	5	HS
NR 11115-B-B-14-3-3	32.9	MR	5	HS
NR 11022-2-2-3-3-1	32.9	MR	5	HS
NR 11154-B-B-5	32.9	MR	5	HS
IR 83383-B-B-129-4	33.9	**MR**	2	**MR**
NR 11182-B-5	33.9	**MR**	2	**MR**
IR 87759-12-2-1-1	33.9	MR	5	HS
IR 87760-15-2-3-4	33.9	MR	5	HS
NR 11182-B-23	35.9	**MR**	2	**MR**

IR 83381-B-B-117-4	37.9	MR	5	HS
NR 11109-B-B-42-1	39.9	MR	5	HS
NR 11179-B-B-6	40.9	MR	5	HS
NR 11178-B-B-6-1	41.9	MR	5	HS
IR 87760-17-1-1-4	41.9	**MR**	2	**MR**
IR 87759-2-2-1-1	41.9	MR	5	HS
IR 87377-B-B-93-3	43.9	MR	5	HS
NR 11105-B-B-49-3	43.9	MR	5	HS
NR 11111-B-B-23-2	44.9	MR	5	HS
NR 11176-B-B-21	49.9	MR	5	HS
NR 11120-B-B-22-3-3	51.9	MS	5	HS
Khumal-11	56.9	MS	4	S
NR 11179-B-B-19	63.9	**S**	5	**HS**
NR 11179-B-B-14	69.9	**S**	5	**HS**
NR 11165-B-B-22	73.9	**HS**	5	**HS**
NR 11165-B-B-24	73.9	**HS**	5	**HS**
Taichung-176	79.2	**HS**	5	**HS**

The result revealed that

- Genotypes highly susceptible to leaf blast were also found highly susceptible to neck blast- for example: Taichung-176.
- Genotypes resistant to leaf blast were highly susceptible to neck blast- for example: IR 87761-52-1-2-2.
- Rice genotype NR 11100-B-B-3-3-2, was recorded resistant to leaf and neck blast

However, genotypes susceptible to leaf blast were not found resistant to neck blast. Result suggests that, neck blast was more severe and devastating than leaf blast. It might be due to the genetics of the genotypes. These types of variations in reactions might also be due to either climatic variations in two locations or at growth stages of crop plants, or due to occurrence of different races of the pathogen. Leaf and neck blasts appeared more or less independent. Similar finding was reported by Hwang et al (1987). Sreenivasa *et al*., (2001) and Bonman *et al*. (1989) had also reported similar results; and had concluded that leaf and panicle blasts were not linked.

CONCLUSION

Out of 102 rice genotypes, 72 were found resistant to leaf blast, and 29 as moderately resistant to neck blast, while 27 rice genotypes were moderately resistant to both leaf and neck blast. None of the genotype was found immune to both the blast. Thus, the study revealed rice genotype 11100-B-B-3-3-2 may be used as sources of resistance to both types of blast in field condition. Furthermore, it revealed that Genotypes e.g.Taichung-176, NR 11165-B-B-22 and NR 11165-B-B-24 were observed highly susceptible, which may be uses as susceptible check for leaf and neck blast research in Nepal.

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Assessment of microbial hazard based on HACCP module on chicken sausage production plant

P. Thapa
HICAST, Kathmandu
meparisha2@gmail.com

ABSTRACT

A study on the assessment of microbial hazard based on HACCP module on chicken sausage production plant was carried out from April 2016 to July 2016 in two small scale sausage industries. All together 80 samples were analyzed from two industries, namely Industry A and B (40 samples each) for microbiological examination. Comparison on various parameters in between the industry and within the industry was done. Samples such as raw meat, batter, ingredients, casing, water and finished product were used for the analysis of Total Viable Count (TVC), Staphylococcus aureus count, Coliform count and Clostridium count. Similarly, prevalence of Salmonella and E.Coli was also observed. Samples were analyzed in 5% and 1% level of significance. In comparison, among various steps of sausage production, between two industry there was a significant higher ($P<0.01$) in TVC, Staphylococcus and Coliform count of raw meat, batter, after stuffing, casing (TVC) and water samples (Staphylococcus and Coliform count) of industry B compared to A whereas there was no significant difference ($P>0.05$) between TVC of water, Coliform of finished product and Staphylococcus count of spices and finished product. Likewise, TVC, Coliform count of spices was significantly higher ($P<0.01$)of industry A compared to B where as Clostridium count was significant higher ($P<0.01$) of raw meat sample of industry B compared to A but was nil in samples of water, batter, spices, after stuffing, after cooking and finished product of both industries. Similarly, in comparison within the industry, microbial load of both industry showed that there was a significant difference ($P<0.05$) among the samples of raw meat, batter and after stuffing where as there was no significant difference ($P>0.05$) with each other among samples like after cooking, finished product, casing, spices and water. Highest microbial load in increasing order from raw meat, batter to after stuffing samples may be due to contamination during slaughtering, rough handling of meat and cross contamination from water and equipments. Proper temperature maintained at cooking showed the lowering of load in after cooking samples in both industries whereas further increased in load was due to post cooking contamination. The effective Critical Control Point (CCP) was quality of raw meat and cooking temperature however CCPs should be monitored in every steps of processing. Similarly, prevalence of Salmonella species were 6(15%) and 11(27.5%) and that of Escherichia coli were 13 (32.5%) and 19 (47.5%) of 40(each) samples from industry A and B respectively. Hygienic, sanitation and operating condition of both industry were also monitored which showed the insufficient knowledge among owners, employee, lack of training facility, irregular microbiological analysis of samples and need of treated water seems to be lacking in both industries.

Key words: HACCP, Microbial hazard, Critical Control Point (CCP)

INTRODUCTION

Livestock plays a vital role in food security for the poor, valued for its contribution to family nutrition, family income, as a buffer against financial risk, as a capital reserve and for social obligation/prestige. Livestock is the only source of high value protein in the diet in the form of milk, meat, meat products, and eggs. Food security is a complex issue, where animal proteins such as meats, meat products, fish and fishery products are generally regarded as a high risk commodity to infection and toxication (Yousef *et. al.,* 2008). These food borne infections and the consequent illnesses are some of the major challenges that lead to high mortality and economic loss (Adak *et. al.,* 2005). In the industrialized world, food borne infection cause considerable illnesses that heavily affect healthcare systems (Adak *et. al.,* 2005). Food borne diseases are diseases resulting from ingestion of bacteria, toxins and also cells produced by microorganisms present in food (Clarence *et. al.,* 2009). The muscle tissue of healthy living animals is usually free from micro-organisms. However, during the slaughtering process, this meat gets contamination on external surface, such as hair and skin, the gastrointestinal and respiratory tract (Unc and Goss, 2004; Biswas *et. al.,* 2011). Based on research, the equipment used in the slaughtering and dressing operations (knives, saws, cleavers and hooks) make significant contributions to the overall contamination through direct contact with hides and hair as well as by contact with steels, knife scabbards and the clothing of operatives (Marriot, 2004; Biswas *et. al.,* 2011). The quality of sausage or any food product can be defined against a wide range of criteria, including, for example, the chemical, physical, microbiological and nutritional characteristics (Nriagu and Simmons, 1990). The consumers expect the high quality of a product achieving a specified shelf-life without spoilage; and has the highest possible organoleptic standard that can be achieved (Tamime and Robinson, 1999). The increasing consumption of produce has resulted in increasing concern by the food industry with respect to safety of these products. Quality assurance norms covering all the processing steps, from farm to table, have become obligatory and assume a fundamental role in process innocuousness. This review contains information on the main factors responsible for the elaboration of a quality assurance system for produce plants: good agriculture practice (GAP) and good manufacturing practice (GMP), including sanitation standard operating procedure (SSOP) and hazard analysis and critical control points (HACCP) (Cruz *et. al.,* 2006).

MATERIALS AND METHODS

Raw Meat: Fresh poultry meat was received from local market for the sausage production. Poultry meat was then washed with water, cleaned and dressed. Trimming was done with the help of knife in order to produce lean meat. Then it was packed in polythene plastic and frozen at -18°C for 24hrs for tenderness and to minimize the microbial load.

By product: Certain byproducts such as skin, gizzard, and heart were cleaned from same poultry and wholesome. Meat, byproduct and separable fat were collected separately and stored at -18^{o}C like as raw meat.

Water: Water was used to clean up any foreign material adhered with it. Slush or lee water was used as it acts as solvent and also prevents protein denaturation.

Fillers/Binders: Wheat flour, soya flour were used in order to increase binding capacity.

Spices and Condiments: Cumin, Garlic, Ginger, Coriander were brought from the local spice industry. Mono Sodium Glutamate (MSG), manufactured by Ajinomoto Company of Japan, was included in spice mix.

Curing Mixture: Curing mixture was prepared by mixing common salt, sodium nitrite, ascorbic acid etc. Common salt was purchased from local market. Analytical grade of sodium nitrite and ascorbic acid obtained from chemical industry were used.

Casing: The casing used was the artificial casing available in local market.

Sausage: It was cooked after casing.

Sampling sites

Samples were collected from two private sausage industries namely Industry A (Star Meat Products, Kalimati) and Industry B (Quality Fresh Meat House, Soalteemode) of Kathmandu district. Both the industries did not have their own slaughter house. Industry A procured raw meat from the certain wholesaler in their own vehicles. Vehicle was well maintained with cold chain facility during transportation of raw meat. The industry was located on ground floor. Processing hall had a separate entrance. It was facilitated with ventilation and equipment. There was a fly repellent system. Hair mask, gloves, apron and boot were compulsory even for the visitors also. Processing equipment were washed by cold water first and then hot water (not usually). There was no specific treatment of water used in processing room. Visitors were not allowed to visit the industry without permission. Rest room was about 100ft far from the processing hall but with no automatic door lock system.

Industry B used local raw meat and locally available private paid vehicles to transport raw meat without maintaining cold chain system. The industry was also situated on ground floor. There was a direct entrance on processing hall from main entrance. Equipments were well maintained. There was no fly repellent system. Hair mask, apron, gloves and boot were not used regularly even by workers also. Processing equipment was washed by cold water only but daily. There was no specific treatment of water used in processing room. Visitors were not allowed to visit the industry without permission. Rest rooms were located about 50ft from processing hall with automatic door lock system.

Sample collection

Although 80 samples (40 samples from each industry) were collected and analyzed from the point of initial raw meat, its subsequent processing stages and finished product. Samples were repeated five times from each sampling points(sp) for microbiological analysis. The sampling points were as follows:

Sampling Points

i.	Sample I =	Raw meat (chicken)
ii.	Sample II =	Batter (mince meat with byproduct and other ingredients)
iii.	Sample III=	After Stuffing
iv.	Sample IV =	After cooking/Smoking/drying
v.	Sample V =	Finished product (sausage in packaging material)

vi. Sample VI = Spices
vii. Sample VII = Casing
viii Sample VIII = Water

RESULTS AND DISCUSSION

Prevalence of E. coli: The overall prevalence of E. coli from samples of industry A was 32.5% (13 of 40) and from industry B it was 47.5% (19 of 40). The organism was only found in raw meat, batter, after stuffing in pre-cooking areas. However, no E. coli was detected in their cooked counterparts (Figure 1).

Prevalence of Salmonella spp.: The percentage (frequencies) of isolated Salmonella spp from sample of industry A and B was 15% (6 of 40) and 27.5% (11 of 40), respectively (Figure 1). The pathogen was only detected in pre-cooked meat during the production of chicken sausage.

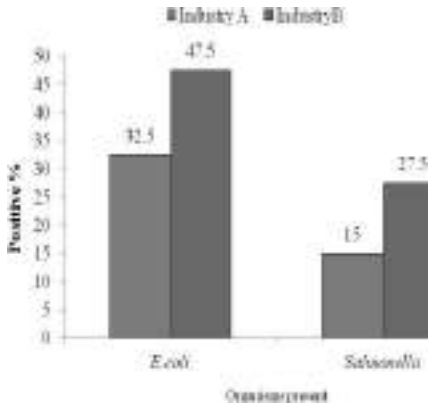

Figure 1. Graphical representation of prevalence of *E.coli* and *Salmonella* of industry A and B

The results of the study showed the existence of risks for the microbiological contamination from initial raw meat to finished products processed at the plant investigated. The potential for contamination from workers and handlers appears to be the most important risk factor that can affect the microbiological quality of the processed meats. Some organisms such as *E. coli*, *Salmonella* spp., *Staphylococcus*, Coliform etc were found in raw food samples but not in heat-treated products. This suggests that the heat treatment processes applied to the meats were effective in eliminating pathogenic bacteria. The effectiveness of cooking could also be concluded from the fact that raw meat samples along with ingredients harbored high counts of aerobic bacteria and other bacteria which were detected in substantially lower levels directly after cooking.

Thus, quality of raw meat and appropriate cooking temperature can be considered as CCP i.e. point where microbial load can be minimized to the acceptance level if precaution was taken.

Both the meat industry (A and B) had different hygienic levels as far as transportation, handling, and processing concerned. This might had accounted for the variations in total aerobic counts and

other organisms shown in different tables above. This also supports through the interview taken to owners and employees. The presence of the isolated bacteria shown in table may be due to improper/unhygienic handling and processing of the meat.

TVC on different samples, like raw meat, batter, after stuffing, after cooking and finished product show increased in microbial load. It may be due to initial low quality of raw meat where microbes tends to increase from raw meat to after stuffing samples due to further exposing of meat to environment. This also supports the James *et. al*., (2005) who stated that, the longer meat surface was exposed to the environment, the higher the microbial load. This may be enhanced by additional contamination during processing i.e during ingredients mixing and during stuffing. This finding was in line with the work of Adeyemo (2002) who stated that, animal product may be microbiologically contaminated by organisms living in them naturally or organisms entering them from the surrounding such as those resulting from processing operations.

While comparing between two industries microbial load of B was higher compared to A. This also supports through the result of interview which shows that knowledge about hygienic and sanitation was relatively higher to owners and workers of industry A compared to B and also the owners of A had taken the training while neither owner nor workers had been trained of industry B. It also supports the statement of Bhandare *et. al*., (2007) stated that, the unhygienic practices of meat processing in developing countries results in these meat been contaminated with microorganisms. Meat sellers were also observed busily conversing, coughing, and sneezing which might result in contamination through introduction of saliva on the meat.

Staphylococcus aureus was found in greater amount in industry B compared to A. Load seems to be increased from raw meat to batter and then to after stuffing samples in both industry (Table 1-9). Organism was found in spices and water sample also but was absent in casing. It may be due to artificial casing used in both industries. Similarly, in cooking sample it was found to be zero. It may be due to reason that cooking destroyed bacteria. But organisms present in finished product showed that post processing contamination occurred by the handler.

Coliform found in industry B was also high compared to industry A (Table 1-9). High counts of coliform were evidence that processing or unsatisfactory post-process contamination might had occurred. Likewise, *Clostridium* was found only in raw meat samples from both the industry (Table 1). But that was absent in other samples. It may be due to ability of organisms to grow well in warm meats usually in left-over meats kept unchilled or not reheated.

Table1. Industry wise comparison on various parameters for raw meat

Parameters	Industry A cfu/gm	Industry B cfu/gm	F-value	P-value
TVC	$1.2x10^6$	$3.12x10^7$	2639	**
Staphylococcus	$2.02x10^4$	$4.44x10^5$	1546	**
Coliform	$2.26x10^5$	$1.44x10^6$	4586	**
Clostridium	$2.0x10^3$	$6.06x10^4$	3984	**

* and ** = significance levels at P<0.05 and P<0.01 respectively; NS= Not Significant

Table 2. Industry wise comparisons on various parameters for water

Parameters	Industry A cfu/gm	Industry B cfu/gm	F-statistics	P-value
TVC	$4.12x10^3$	$4.12x10^3$	0	NS
Staphylococcus	146	278	290.4	**
Coliform	168	260	50.55	**
Clostridium	0	0	-	-

* and ** = significance levels at P<0.05 and P<0.01 respectively; NS= Not significant

Table 3. Industry wise comparison on various parameters for Batter

Parameters	Industry A cfu/gm	Industry B cfu/gm	F-statistics	P-value
TVC	$2.10x10^6$	$4.04x10^7$	$2.31x10^4$	**
Staphylococcus	$2.78x10^4$	$5.24x10^5$	$3.88x10^4$	**
Coliform	$6.06x10^5$	$3.92x10^6$	$7.39x10^3$	**
Clostridium	0	0	-	-

* and ** = significance levels at P<0.05 and P<0.01 respectively; NS= Not Significant

Table 4. Industry wise comparison on various parameters for Spices

Parameters	Industry A cfu/gm	Industry B cfu/gm	F-value	P-value
TVC	3280	2160	114	**
Staphylococcus	274	274	0	NS
Coliform	2020	120	2560	**
Clostridium	0	0	-	-

* and ** = significance levels at P<0.05 and P<0.01 respectively; NS= Not Significant

Table 5. Industry wise comparison on various parameters for casing sample

Parameters	Industry A cfu/gm	Industry B cfu/gm	F-value	P-value
TVC	$2.74x10^3$	$3.28x10^4$	669.9	**
Staphylococcus	0	0	-	-
Coliform	0	0	-	-
Clostridium	0	0	-	-

Table 6. Industry wise comparison on various parameters for after stuffing sample

Parameters	Industry A cfu/gm	Industry B cfu/gm	F-value	P-value
TVC	$3.28x10^6$	$4.62x10^7$	1190	**
Staphylococcus	$3.58x10^4$	$5.84x10^5$	8135	**
Coliform	$6.66x10^5$	$4.52x10^6$	488.5	**
Clostridium	0	0	-	-

Table 7. Industry wise comparison on various parameters for after cooking

Parameters	Industry A cfu/gm	Industry B cfu/gm	F-value	P-value
TVC	500	2120	410.1	**
Staphylococcus	0	0	-	-
Coliform	0	0	-	-
Clostridium	0	0	-	-

* and ** = significance levels at P<0.05 and P<0.01 respectively; NS= Not Significant

Table 8. Industry wise comparison on various parameters for finished product

Parameters	Industry A cfu/gm	Industry B cfu/gm	F-value	P-value
TVC	$5.12x10^3$	$6.06x10^3$	67.77	**
Staphylococcus	308	312	0.33	NS
Coliform	312	312	0	NS
Clostridium	0	0	-	-

* and ** = significance levels at P<0.05 and P<0.01 respectively, NS= not significant

Comparison on various parameters within industries A and B

Table 9. Mean microbiological parameters for various samples in Industry A.

Treatments	Microbiological Parameters			
	TVC cfu/g	*Staphylococcus* cfu/g	Coliform cfu/g	*Clostridium* cfu/g
Raw meat	1.20×10^6 c	2.02×10^4 c	5.36×10^5c	2×10^3 a
Batter	2.10×10^6 b	2.78×10^4 b	$6.06x10^5$b	0 b
After Stuffing	3.28×10^6 a	3.58×10^4 a	$6.66x10^5$ a	0 b
After cooking	5.00×10^2 d	0 d	0 d	0 b
Finished Product	5.10×10^3d	3.0×10^2 d	$3.12x10^2$d	0 b
Casing	2.74×10^3d	0 d	0 d	0 b
Spices	3.28×10^3d	2.70×10^2 d	$2.02x10^3$ d	0 b
Water	4.12×10^3d	1.46×10^2 d	$1.68x10^2$d	0 b
Probability	**	**	**	**
F-value	1002	1263	5243	$2x10^3$
LSD(P<0.05)	1.15×10^5	$1.2x10^3$	$1.19x10^4$	45.55
CV%	145.37	134.50	131.32	131.16
SEM	$1.90x\ 10^5$	2.25×10^3	4.69×10^4	1.31×10^2

a, b, c indicate significant differences (P<0.05) between the means of different sample types.* and ** = significance levels at P<0.05 and P<0.01 respectively; NS= Not Significant; CV= Coefficient of variation; SEM= Standard error of mean; LSD= Least Significant Difference

Table 10. Mean microbiological parameters for various samples in Industry B.

Treatments	Microbiological Parameters			
	TVC cfu/gm	*Staphylococcus* cfu/gm	Coliform cfu/gm	*Clostridium* cfu/gm
Raw meat	$3.12x10^7$c	$4.44x10^5$ c	$3.12x10^6$ c	$6.06x10^4$ a

Batter	$4.04x10^7$ b	$5.24x10^5$ b	$3.92x10^6$ b	0 b
After Stuffing	$4.62x10^7$ a	$5.84x10^5$ a	$4.52x10^6$ a	0 b
After cooking	$2.12x10^3$ d	0 d	0 d	0 b
Finished Product	$6.06x10^3$ d	$3.1x10^2$d	$3.12x10^2$ d	0 b
Casing	$3.28x10^4$ d	0 d	0 d	0 b
Spices	$2.16x10^3$ d	$2.74x10^2$ d	$1.20\ x10^2$ d	0 b
Water	$4.12x10^3$ d	$2.78x10^2$ d	$2.6\ x10^2$ d	0 b
Probability	**	**	**	**
F-value	1770	3699	992.3	4270
LSD(P<0.05)	$1.4\ x10^6$	$1.2\ x10^4$	$1.8\ x10^5$	$9.4\ x10^2$
CV%	133.39	131.98	133.3	141.44
SEM	$3.11\ x\ 10^6$	$4.05\ x\ 10^4$	$3.04x10^5$	$1.56\ x\ 10^6$

a, b, c Indicate significant differences (P<0.05) between the means of different sample types.* and ** = significance levels at P<0.05 and P<0.01 respectively; NS= Not Significant; CV= Coefficient of variation; SEM= Standard error of mean; LSD= Least Significant Difference

CONCLUSION

There is a relatively high level of risk of microbiological contamination of products manufactured at the food plant investigated. It seems that rough handling and re-contamination may be the most plausible explanation for products presenting with unacceptable levels of bacteria. This could be largely attributed to inadequate GHPs, GMPs, and the lack of separation between cooked and uncooked products, as well as equipment in pre- and post-cooking areas. Re-modeling of the plant with an appropriate design is necessary to allow for proper traffic flow, and with the implementation of the aforementioned recommendations, the quality and safety of sausage produced by the industry could be improved substantially.

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Evaluation of different varieties of oat at high hill of Rasuwa district, Nepal

B. Khanal[1], B. R. Baral[2], M.R. Tiwari[3] and N. Devkota[4]
[1]Nepal Agricultural Research Council (NARC), Singh durbar, Plaza, Kathmandu
[2]Sheep and Goat Research Program, Guthichaur, Jumla
[3] Animal Nutrition Division, Khumaltar, Lalitpur
[4]Agriculture and Forestry University (AFU), Chitwan, Rampur
birkhanal@gmail.com

ABSTRACT

Oat is one of the most important and well adapted cereal fodder crop grown in the entire country across the ecological regions. The study was conducted at highland of Nepal, Dhunche, Rasuwa (1950 masl) to evaluate the different varieties of oats in terms of productive performance. Ten different varieties of oat were cultivated using RCBD with 3 replications. Chemical fertilizer was applied @80:60:40 Kg NPK/ha and farm yard manure (FYM) @ 5 t/ha. Seeds were sown @ 100Kg/ha. Data of plant height, leaf length, leaf breadth and fodder yield per unit area were recorded. First cutting was done at forty five days after sowing and subsequent cuttings were done at each month interval. Statistically significant difference ($p<0.05$) was observed on plant height, leaf area, green matter (GM) and dry matter (DM) production of the treatments employed. Significantly the highest GM and DM were produced from 83INC19G3 followed by Awapuni and the least GM and DM was obtained from Croa118*. This study revealed that 83INC19G3 and Awapuni were suitable varieties for higher GM and DM production at highland of Nepal.*

Key words*: Avena sativa, green matter, dry matter, production*

INTRODUCTION

Oat (*Avena sativa* L.) is a winter fodder crop that has excellent growth habit, quick recovery after cutting and good quality herbage. It is a palatable, succulent and nutritious crop. Oat can be grown all part of Nepal from terai to high hill for supplying forage/fodder to reduce the feed deficient for ruminant animal. Its multi cut ability, acceptability to all categories of livestock, utilization in different feeding form (green, hay, straw, grain) and its availability during dry winter has helped in the development of a commercial industry. Oats as the most important cereal fodder crop can also be grown in the winter season in the areas where wheat and barley are grown (Pariyar, 2003). Rajbhandary and Shah (1981) reported that livestock get the greenest matter from June to September and the quality of forage available during this period could be regarded as more or less adequate. Crop residues such as rice straw, maize stover and other fibrous crop by-product are very poor in quality and are important food in winter season (Gatenby *et al*., 1989). Pariyar (2002) reported that with the introduction and cultivation of suitable oat cultivars combined with suitable legumes (Oat + Vetch and Oat + Pea) and appropriate husbandry, farmers in dairy pocket areas have been able to achieve a 30% reduction in milk production costs. Pariyar (2004) found 0.3 to 0.45 liters/day of milk increment due to feeding fodder oat. Gyaltsen *et al* (2000) also reported milk increments of 1.3 litres per day per animal due to feeding oat. The improved varieties of oats have potential to produce three-fold green fodder and could feed double the number of animals per unit area as against the traditional fodder crops (Haqqani *et al.,* 2003). Selection of oat varieties in

specific location is one of the most important steps for cultivating appropriate varieties. Therefore, the present study was undertaken to evaluate and identify the performance of oat varieties with superior green and dry fodder yield for livestock production in highlands of Nepal.

MATERIALS AND METHODS

The study was conducted at high hill at Dhunch, Rasuwa (1950 masl) during 2011-2012. Ten different oat cultivars were cultivated in Randomly Completely Block Design (RCBD) in plot size 4 m^2 with three replications. The Seed rate was applied @ 100 kg/ha. Farm yard manure (FYM) was applied @ 5t/ha. The chemical fertilizer NPK was used @ 80:60:40 kg/ha. Full dose of phosphorus and potash and half dose of nitrogen were applied as basal dose at the time of field preparation and the remaining dose of nitrogen was applied in split doses. Half of the nitrogen was applied after 1st cut and the remaining half after 2nd cut. Sowing was done in line with 25 cm spacing at the1st October. The different parameters on plant height, leaf length, leaf breadth and fodder yield were recorded. The green fodder yields obtained were converted into t/ha. Cutting was done in three times. First cut was taken forty five days after sowing and subsequent cutting was done on monthly interval. Ten plants were selected randomly from the four middle rows of each plot for data measurement. Leaf area was calculated by using formula length x breadth. The average data in each site was used for data analysis. All the data obtained in the experiment were subjected to statistical analysis using MSTAT for analysis of variance and Duncan's multiple range test (DMRT).

RESULTS AND DISCUSSION

Plant height

Plant height is a major factor contributing towards forage yield of different crops. Table 1 indicates plant height at different cut. The data obtained of plant height revealed that cultivars have significantly differences in all three cuts as well as average cutting height and cumulative plant height ($P<0.05$). At first cut it was found that the highest plant height (42.85 cm) was obtained from 83INC19G3 and the least plant height (31.02 cm) was obtained from NZ Saia. In second cut significantly the highest plant height (43.45 cm) was obtained by 83INC19G3 followed by Netra (41.65 cm), Awapuni (40.45 cm) and the least plant height (31.63 cm) was obtained from NZ92176,03. At third cut the highest plant height (39.53 cm) was obtained by 83INC19G3 followed by Awapuni (39.17 cm) and the lowest plant height (30.71cm) was obtained from variety NZ92176.04. Significantly the highest average cutting plant height was found in 83INC19G3 (41.94 cm) followed by Awapuni (39.45 cm) and Netra (38.72 cm). The least average cutting height (33.41 cm) was obtained by Croa118. Significantly the highest cumulative cutting height was found in 83INC19G3 (125.83 cm) followed by Awapuni (118.35 cm) and Netra (116.16 cm). The least cumulative cutting height (100.24 cm) was obtained by Croa118. The finding of differed cutting plant height with different varieties was supported by many authors. Chohan *et al (*2004), Hussain *et al* (2005), Kibite *et a*l (2002) and Shrestha *et al* (2009) reported that significant differences among the oats varieties regarding plant height. Zaman *et al* (2006) explained that plant height may differ in varieties due to environmental condition which in turn variation in hormonal balance and cell division rate. Kim and Seo (1988) reported that high yielding varieties of oats tended to gain more plant height than low yielding varieties. The highest plant height obtained from 83INC19G3 followed by Awapuni may be due to genetically superior that tended to gain more plant height.

Table1. Plant height, cm

Oat varieties	1st cut	2nd cut	3rd cut	Average height	Cumulative height
NZ Saia	31.02^{c}	37.26^{ab}	32.32^{bc}	33.53^{b}	100.60^{b}
Awapuni	38.73^{ab}	40.45^{a}	39.17^{a}	39.45^{a}	118.35^{ab}
NZ92173,02	35.12^{b}	32.52^{c}	34.12^{ab}	33.92^{b}	101.76^{b}
83INC19G3	42.85^{a}	43.45^{a}	39.53^{a}	41.94^{a}	125.83^{a}
Netra	39.11^{ab}	41.65^{a}	35.4^{ab}	38.72^{a}	116.16^{ab}
Stampede	35.21^{b}	38.42^{ab}	34.41^{ab}	36.01^{ab}	108.04^{b}
Swan (pak)	31.81^{c}	37.12^{ab}	34.13^{ab}	34.35^{b}	103.06^{b}
NZ 92176,04	33.42^{bc}	37.12^{ab}	30.71^{c}	33.75^{b}	101.25^{b}
Croa 118	33.12^{bc}	33.88^{bc}	33.24^{bc}	33.41^{b}	100.24^{b}
NZ 92176,03	34.05^{bc}	31.63^{c}	39.15	34.94^{b}	104.83^{b}
Overall mean	35.44	37.35	35.22	36.00	108.01^{b}
CV%	25.73	19.61	18.42	21.25	23.23
LSD (0.05)	3.40	4.03	3.99	3.80	10.36

Leaf area

Table 2 indicates the leaf area of oat varieties at different cut. The data obtained of leaf area revealed that cultivars have significantly difference ($P<0.05$) at all three cut, average leaf area and overall leaf area. At first cut the highest leaf area (33.86 cm^2) was found by 83INC19G3 followed by Netra (32.51 cm^2) and the least (28.32 cm^2) by Croa118. In second cut the highest leaf area (38.09 cm^2) was obtained by 83INC19G3 and the least (27.24 cm^2) was obtained by NZ Saia. At third cut the variety 83INC19G3 and Swan (Pak) yielded statistically the highest and lowest leaf area 33.54 cm^2 and 28.23 cm^2 respectively. Significantly the highest average leaf area (35.16 cm^2) was obtained by 83INC19G3 and the least (28.62cm^2) was obtained by NZ Saia. Significantly the highest overall leaf area (105.49 cm^2) was obtained by 83INC19G3 and the least (85.87 cm^2) was obtained by NZ Saia. The finding of difference leaf area among oat varieties was supported by many authors. Khanal *et al* (2013) indicated differed leaf areas among oat varieties at high hill of Rasuwa district. Shrestha *et al* (2002), Osti *et al* (2001) also indicated the differed leaf length and leaf width among the oat varieties that directly affected leaf area. Ahmad *et al* (2008) reported that the variation in leaf area in different varieties may be attributed to variation in genetic make up of the varieties, soil, heritability status and environmental adaptability. Kim and Seo (1988) also reported that high yielding varieties tended to be upright with broad leaves than low yielding varieties.

Table 2. Leaf area, cm^2

Oat	1st cut	2nd cut	3rd cut	Average leaf area	Overall leaf area
NZ Saia	29.47^{ab}	27.24^{c}	29.16^{ab}	28.62^{b}	85.87^{c}
Awapuni	31.92^{a}	34.23^{ab}	31.24^{ab}	32.46^{ab}	97.39^{b}
NZ92173,02	31.42^{a}	30.53^{b}	30.71^{ab}	30.89^{b}	92.66^{bc}
83INC19G3	33.86^{a}	38.09^{a}	33.54^{a}	35.16^{a}	105.49^{a}
Netra	32.51^{a}	33.76^{ab}	30.43^{ab}	32.23^{ab}	96.70^{b}
Stampede	30.82^{ab}	32.01^{b}	29.22^{ab}	30.68^{b}	92.05^{bc}
Swan (pak)	30.49^{ab}	29.79^{bc}	28.23^{b}	29.50^{b}	88.51^{c}

NZ 92176,04	28.68[b]	30.25[b]	28.31[b]	29.08[b]	87.24[c]
Croa 118	28.32[b]	30.42[b]	30.86[ab]	29.87[b]	89.60[bc]
NZ 92176,03	30.87[ab]	31.71[b]	31.54[ab]	31.37[ab]	94.12[b]
Overall mean	30.84	31.80	30.32	30.99	92.96
CV%	15.13	17.39	22.82	18.45	20.13
LSD (0.05)	4.19	2.52	4.61	3.77	8.52

Green matter and dry matter production

Table 3 indicates green matter (GM) and dry matter (DM) production. The data obtained that cultivars have significantly difference ($P<0.05$) on GM and DM production in all three cut as well as cumulative yield. At first cut the highest GM (12.64 t/ha) was obtained by 83INC19G3. At second cut the highest GM (12.86 t/ha) was obtained by 83INC19G3 followed by Awapuni (12.47 t/ha) and the least GM (9.46 t/ha) was obtained by Stampede. At third cut the highest (11.78 t/ha) GM was obtained by Stampede followed by 83INC19G3 (11.17tha), Awapuni (11.14 t/ha) and the least GM (9.21t/ha) was obtained by Croa118. Significantly the cumulative highest GM (36.67 t/ha) was obtained from the variety 83INC19G3 followed by Awapuni (34.47 t/ha) and the least (30.62 t/ha) was obtained from Croa118.It was found that the DM yield was directly affected by the GM yield. At first cut the highest DM (2.64t/ha) was obtained by 83INC19G3 and the lowest (1.93 t/ha) by NZ 92176,03. At second cut the highest DM (2.69 t/ha) was obtained by 83INC19G3 followed by Awapuni (2.59t/ha) and the lowest (1.97t/ha) was obtained by Stampede. At third cut the highest DM (2.46t/ha) was obtained by Stampede followed by 83INC19G3 (2.34t/ha), Awapuni (2.33t/ha) and the lowest DM (1.94t/ha) was obtained by Croa118. Significantly the highest cumulative DM (7.67 t/h) was recorded by 83INC19G3 followed by Awapuni (7.20 t/ha) and the lowest (6.40 t/ha) was obtained from Croa118. The finding GM yielded varied with verities was supported by many authors. Kshetri (1993), Shrestha (1995), Paudel and Suwal (1996), Shrestha *et al* (2002), Khanal *et al* (2013), Osti *et al* (2001) and Nawaz *et al* (2004) reported that differences among the oat cultivars regarding green forage yield. Paudel and Suwal (1996) reported that the cultivar Awapuni and Kent were most suitable for Lumle site as they produced significantly higher amount of biomass (11.7t/ha and 8.9 t/ha) in 141 and 135 days. This finding supported with our finding that Awapuni was higher yielding variety but low yielded than our study. Pariyar (1999) found that under fertilizer the highest green matter was produced by 83INC19G3 (45.5t/ha). This finding supported with our finding that 83INC19G3 was the highest yielding variety of oat. Pariyar (1989), Pradhan and Silwal (1989) and Pariyar *et al.* (1991) reported that that oat gives about 45-50 t/ha green matter when grown on sandy loam soils and with good agronomic practices. Our study could not achieve this target though followed good agronomic practices. The green fodder yielded was only 30.62-36.67 t/ha. The main high yielding varieties 83INC19G3 and Awapuni yielded green fodder 36.67 and 34.47 t/ha respectively. Hussain *et al* (1993) also reported that fresh forage yield differed due to differences in leaves per tiller and plant height. Bhatti *et al.* (1992) observed that the higher green fodder yielding cultivars were superior to others cultivars in plant height, tillering, leafiness and leaf area. Amanullah *et al* (2004) stated that higher yields of fodder in oat cultivars can be possibly attributed to their greater leaf area, responsible for more photosynthetic activities having high capacity to store assimilative products of photosynthesis. The highest GM and DM yielded

from 83INC19G3 followed by Awapuni may be due to highest leaf area responsible for more photosynthetic activities.

Table 3. Green matter and dry matter production, t/ha

Oat varieties	GM yield				DM yield			
	1st cut	2nd Cut	3rd Cut	Cumulative yield	1st cut	2nd Cut	3rd Cut	Cumulative yield
NZ Saia	9.48^{c}	11.12^{bc}	10.39^{ab}	30.98^{b}	2.00^{c}	2.29^{bc}	2.17^{ab}	6.46^{b}
Awapuni	10.86^{bc}	12.47^{a}	11.14^{a}	34.47^{a}	2.28^{bc}	2.59^{a}	2.33^{a}	7.20^{a}
NZ92173,02	10.39^{bc}	11.02^{bc}	10.01^{ab}	31.42^{ab}	2.19^{bc}	2.31^{bc}	2.11^{ab}	6.61^{ab}
83INC19G3	12.64^{a}	12.86^{a}	11.17^{a}	36.67^{a}	2.64^{a}	2.69^{a}	2.34^{a}	7.67^{a}
Netra	11.45^{ab}	11.59^{ab}	10.38^{ab}	33.42^{ab}	2.39^{ab}	2.45^{ab}	2.17^{ab}	7.01^{ab}
Stampede	10.87^{bc}	9.46^{c}	11.78^{a}	32.11^{ab}	2.29^{bc}	1.97^{c}	2.46^{a}	6.72^{ab}
Swan (pak)	11.26^{ab}	10.51^{bc}	9.47^{b}	31.24^{ab}	2.37^{ab}	2.21^{bc}	1.99^{b}	6.57^{ab}
NZ 92176,04	10.51^{bc}	11.16^{bc}	9.49^{b}	31.16^{ab}	2.21^{bc}	2.33^{bc}	1.98^{b}	6.52^{ab}
Croa 118	10.16^{bc}	11.25^{bc}	9.21^{b}	30.62^{b}	2.13^{bc}	2.36^{bc}	1.94^{b}	6.40^{b}
NZ 92176,03	9.16^{c}	11.31^{ab}	10.37^{ab}	30.85^{b}	1.93^{c}	2.37^{ab}	2.18^{ab}	6.48^{b}
Overall mean	10.68	11.27	10.34	32.29	2.24	2.36	2.17	6.77
CV%	19.52	14.62	20.28	18.14	18.43	15.25	21.03	18.23
LSD (0.05)	1.20	1.33	1.14	3.67	0.33	0.32	0.33	0.98

CONCLUSION

Among ten oat varieties cultivated at highland of Rasuwa district, significantly the highest plant height, leaf area, GM and DM was obtained from 83INC19G3 followed by Awapuni. From this study we can conclude that 83INC19G3 and Awapuni were suitable varieties for higher GM and DM production at highland of Nepal. The study revealed that plant height and leaf area affected on amount of GM and DM production.

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Gelatinization of Starch in Nile Tilapia Feed

S. Adhikari[1], T. Storebakken[2]
[1] HICAST, Kathmandu, Nepal
[2]Department of Animal Science and Aquaculture (IHA),
Norwegian University of Life Science (NMBU), Ås, Norway
adhikarishijan@gmail.com

ABSTRACT

The main objective of study was to observe the effect of different levels of starch gelatinization in feed for Nile tilapia. Wheat was extruded with different moisture addition (20%, 25%, 30% and 35%), to tentatively obtain different degrees of starch gelatinization. Five different diets were prepared one with raw wheat and remaining four with gelatinized wheat, using a pasta machine. Differential Scanning Calorimetry assessed the degrees of starch gelatinization of the diets. All diets with wheat that had been extruded had completely gelatinized starch. The diets (Diets 1-5) were fed to fishes in 10 tanks with 9 to 11 Nile tilapia with a mean initial weight of 120 g for 30 days. Each diet was fed to fish in two tanks. The tanks were supplied with freshwater from a recirculated aquaculture system with a mean water temperature of 27°C. The fish were weighed at the beginning and at the end of the experiment. Daily dietary dry matter intakes were assessed; chemical composition in initial and final fish samples and diets were analyzed. Growth rates, feed conversion ratio, and retention of dietary protein and energy were calculated. The feed intake of fishes in each tank was on average 91 g per fish, which results in average weight gain of 78 g per fish. Regression analysis showed that the retention of dietary protein (p-value: 0.00821) and energy (p-value: 0.00821) were significantly related to second order polynomial of dietary treatment, however feed conversion ratio and feed intake were not significantly related. It was interesting to observe that at little addition of moisture as 20% in extruding wheat gave complete gelatinization. This shows the advancement in engineering in the field of feed manufacturing technology, which can be beneficial to feed producer and farmers.

Keywords: Extrusion, gelatinization, Nile tilapia, moisture, feed

INTRODUCTION

Carbohydrate is an inexpensive source of energy and is extensively being used in animal feed. Carnivorous fishes, in general utilize dietary carbohydrate poorly, varying among species (Shiau and Lei., 1992). However, without starch, other nutrients such as protein are catabolized for energy(Li et al., 2013).Tilapia is an omnivorous fish which can withstand a high level of dietary carbohydrate. Gelatinization will increase susceptibility for starch degradation in digestive tract (Svihus et al., 2005), which consequently can increase the digestibility in Tilapia too. This research aims to seek the degree of gelatinization require to obtain the maximum positive impact on growth and overall body performance. Carnivorous fishes such as trout and European sea bass have poor utilization of carbohydrates whereas omnivorous fishes such as tilapia can withstand on diet with 41 to 56 percent of carbohydrate mere (Hemre et al., 2002a). However, the utilization of carbohydrates can be enhanced by wet-heat treatment, which includes pelleting and extrusion. The limited water content and temperature allow a small extent of gelatinization that makes pelleting less efficient than extrusion (Svihus et al., 2005). Although gelatinization increases digestibility,

some study shows that it has negative impact on growth and body performance in some animals such as broiler (Zimonja and Svihus, 2009).

MATERIALS AND METHODS

Processing of wheat

Prior to making experimental diets the main carbohydrate source wheat was extruded with five different percentages of moisture. Wheat was ground in a hammer mill (E-22115 TF, Muench - Wuppertal, Germany) with 1mm sieve and was passed in extruder machine. All the extruded wheat pellets were dried for one hour, packaged, labeled and kept in cooler (2-5°C).

Table 1. Wheat extrusion parameters

Parameters	Diet 2	Diet 3	Diet 4	Diet 5
Feeder, Main (Kg/h)	150.0	150.0	150.0	150.0
Extruder. Water (%)	0.0	7.5	15.0	25.5
Conditioner, stem (%)	11.9	12.3	11.9	10.8
Pressure at end plate (bar)	48.9	28.5	19.7	13.4
Drive Power (kW)	20.2	17.4	15.0	14.8
SME (Wh/kg)	134.4	110.5	91.2	84.1
Throughput	150.0	157.5	165.0	175.5
Extruder Section 1	94.2	78.4	56.8	67.9
Extruder Section 2	103.6	104.7	103.6	101.2
Extruder Section 3	131.5	128.6	119.2	123.7
Extruder Section 4	130.6	127.5	115.7	128.7
Extruder Section 5	130.3	120.8	95.4	109.1
Conditioner temperature (°C)	93.1	82.1	81.0	82.0
Screw speed (rpm)	502.0	502.0	501.0	348.0
Torque absolute (Nm)	384.1	331.0	286.7	404.8
Torque real (Nm)	88.3	76.1	66.0	93.1
Temperature at endplate (°C)	127.8	111.2	89.0	91.9
Knife speed (rpm)	547.0	547.0	547.0	547.0

Experimental diets

Five different complete plant based feeds were prepared for experiment. The ingredients present in feeds were soybean meal, wheat, corn gluten, rapeseed oil, methionine, taurine, phenylalanine, vitamin c 35%, yttrium oxide (Y_2O_3), mono-calcium phosphate (MCP), sodium alginate and premix (Table 2).

Feed preparation

Five different feeds were prepared in feed lab of NMBU with ten kilo of feed in each batch. Preparation of diets began with grinding of wheat pellet, soybean meal and corn gluten by using 1mm screen (sieve) (Retsch Gmbh Retsch-Allee 1-5, 42781, Haan, Germany). All the ingredients were correctly weighed and mixed uniformly. To make a mixing homogenous the spiral dough mixer (Moretti Forni Grain, Italy) was used for about 20 minutes. During the mixing 3ℓ of cold water (30% of total feed weight) and 1ℓ of rapeseed oil was added slowly and continuously in diet 1 and 2 (0 and 20% moisture added during extrusion). 3.5 ℓ (35% of total feed weight) of cold water and 1 ℓ of rapeseed oil was added in Diets 3, 4 and 5 (25%, 30%, and 35% moisture added during extrusion). The different water addition was due to differences in water absorption in the

differently extruded wheat preparations. All the feed dough was transferred to a pasta machine (P55DV, Italgy, Carasco, Italy) and was properly conditioned and mixed then cut in pellet at 3.5 mm die size by using the knife at the edge of the craft opening. The prepared feed was kept on drier at 50°C for seven hours, cooled to room temperature and stored at 2-5°C.

Table 2. Ingredients used in feed (g/kg)

Ingredients	Amount (g/kg)
Soybean meal[b]	440
Corn gluten[c]	65
Wheat[d]	410
Rapeseed oil[e]	37
Methionine[f]	5.0
Phenylalanine[g]	0.9
Taurine[h]	1.5
Monocalcium phosphate[i]	10
Premix[k]	10
Vitamin C -35%[l]	0.1
Yttrium oxide (Y2O3)[m]	0.8
Sodium alginate	20

[b] Soybean meal, Denosoy, Denofa, Fredrikstad, Norway.
[c] Maize gluten, Cargill 13864.
[d] Felleskjøpet, Norway
[e] Food grade, Eldorado, Oslo, Norway.
[f] Adisseo Brasil Nutricao Animal Ltda, Sao PauloBrazil.
[g] Adisseo Brasil Nutricao Animal Ltda, Sao Paulo, Brazil
[h] Taurine-JP8, Qianjiang Yongan Pharmaceutical Co., Ltd., Hubei, China.
[i] Taurine-JP8, Qianjiang Yongan Pharmaceutical Co., Ltd., Hubei, China.
[k] Contents per Kg: Vitamin A 2500.0 IU; Vitamin D3 2400.0 IU; Vitamin E 0.2 IU; Vitamin K3 40.0 mg; Thiamine 15.0 mg; Riboflavin 25.0 mg; d-Ca-Pantothenate 40.0 mg; Niacin 150.0 mg; Biotin 3.0 mg; Cyanocobalamine 20.0 g; Folic acid 5.0 mg; Pyridoxine 15.0 mg; Vitamin C: 0.098 g (Stay-C 35, ascorbic acid phosphate, DSM Nutritional Products, Basel, Switzerland); Cu: 12.0 mg; Zn: 90.0 mg; Mn: 35.0 mg; I: 2.0 mg; Se: 0.2 mg; Cd = 3.0 g; Pb = 28.0 g; total Ca:0.915 g; total K 1.38 g; total Na 0.001 g; total Cl 1.252 g;
[l] Stay-C 35, ascorbic acid phosphate, DSM Nutritional Products, Basel, Switzerland.
[l] Trouw Nutrition, LA Putten,Netherland
[m] Metal Rare Earth Limited, Jiaxing, China.

Fish and rearing unit

The experiment was conducted at Fish Nutrition Laboratory (NMBU) in Ås, Norway during 21st October to 17th November 2014. The experimental Nile tilapias (generation 12th of selection, donated by Genomar AS, Norway) were hatched at same laboratory and fed on a commercial diet

until the individual body weight was approximately 0.1 kg. For the experiment 10 indoor rearing tanks (70 cm× 50 cm × 50 cm) were chosen. The tanks were supplied with freshwater from a recirculation system, with the water level of 50 cm in each tank. Each tank was stocked with 10 fishes. Tanks were kept in 24 hour light system during whole experiment, and the water temperature was 28°C. First all the tanks and pipes were cleaned and fishes to be used in trial were selected from large population. Fishes were netted with minimum disturbance and anesthetized (Tricanine methanesulfonate-MS-222, 0.1 g/l water, buffered with $NaHCO_3$, 0.1 g/l water, Western Chemical Inc. Washington USA). Fishes were weighed individually. At the same time ten fishes were randomly taken from same population, weighted and kept in freezer at -20°C for initial whole body composition analysis. At day 28 of feeding trial fishes of each tanks were weighed, liver samples and feces from last 15 cm of intestine was taken (incision was given from dorsal part of operculum to base of pelvic fin, similarly from dorsal part of operculum to caudal part of anal fin via upper lateral line scale opening abdominal cavity) by firmly squeezing intestine and remaining part of intestinal content was cleaned. After that five fishes from each tank were kept for final whole body composition analysis.

Feeding experiment

The five different feeds were fed to the fishes. Different in sense of percentage of moisture added while extruding wheat. In 10 tanks ten fishes were kept with biomass 1170g (±10). Feeding one feed for two tanks was done and time of feeding was 8:15 to 9:15 in the morning and 20:15 to 21:15 in the evening every day for 28 days, with electrically driven band feeders. The uneaten feeds were collected from water outlet while feeding and 30 minutes after finishing feeding. Uneaten feed from morning and evening was collected and dried at 105°C overnight. Dietary dry matter was calculated from the difference of daily fed feed and uneaten feed after dried.

Chemical composition of diets and fishes

Diets and fish body composition was analyzed by proximate analysis. Sampled fishes were taken from -20 °C freezer and were cut in small piece and were homogenized in a grinder. The ground fish was freeze dried for a week and then samples were again ground with dry ice. The dry matter of fish was determined after the loss of moisture from the sample when heated at 105C for 20 hours in an oven. Crude protein was analyzed by Kjeltec auto 1035/1038 systems. Energy of both fish and feed was determined by Parr bomb calorimeter whereas HCL hydrolysis followed by diethyl ether extract method was used to determine crude fat. Ash content was analyzed by heating at 500°C in muffle furnace.

Degree of gelatinization

Degree of gelatinization was determined as per the procedure described by Zimonja and Svihus (2009). Feed samples were ground to 0.5 mm. They were assessed for gelatinization by differential scanning calorimetry. One part sample was mixed with two parts of water. The suspension was slowly stirred and for uniform mixing, suspension was run in vortex mixer for 2 min. The suspension was then allowed to stand for 1 h for equilibration purpose. After 1 h, approximately 130 mg sample was heated from 0 to 160°C with an increase of 5°C per min on a Metter DSC 30S (Metter Toledo AG, Schwerzenbach, Switzerland). Silicon oil was used as reference. Determination of enthalpy values was carried out by computer integration of inverse

peaks. Degree of starch gelatinization was calculated based on the difference in enthalpy between sample before and after feed processing. The measurements were conducted in duplicate. Since the four samples containing less than 30 percent of moistures were completely gelatinized so, the fifth sample is assumed to get gelatinized and is removed during analysis.

Table 3. Proximate compositions of diets (g/kg)

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Dry matter	57.9	69.4	80.8	59.1	55.3
Energy (MJ/Kg)	18.5	17.8	17.6	18.4	18.4
Protein	292	280.7	263.1	295.9	291.1
Carbohydrate	280.4	277.5	278	271.4	261.7
Fat	53.2	36.3	32.2	31.7	36.2
Ash	53	51	50	54	54

Fish growth performance, feed and protein utilization

Feed conversion ratio: (FCR) = Dietary dry matter intake (g)/weight gain (g)

$$\text{Protein Retention (\%)} = 100 \times \frac{\text{Final protein content in fish (g)} - \text{Initial protein content in fish (g)}}{\text{Protein intake by fish}}$$

$$\text{Energy Retention (\%)} = 100 \times \frac{\text{Final energy content in fish (kj)} - \text{Initial energy content in fish (kj)}}{\text{Energy intake by fish}}$$

Statistical analysis

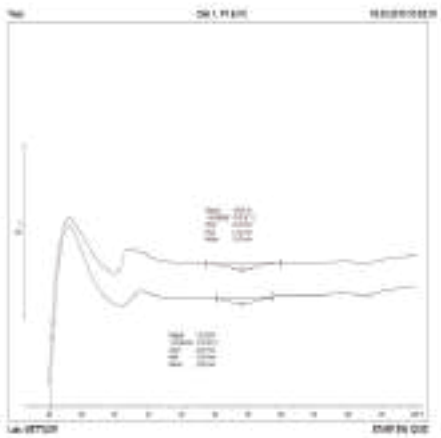
Results were analyzed statistically by 1st and 2nd regressions, and the model giving best fit was chosen. The plots were made in Microsoft Excel, and significance levels were calculated in SAS version 9.4, SAS Institute Inc., Cary, NC, USA. Statistical significance is indicated for $p < 0.05$.

RESULTS AND DISCUSSION

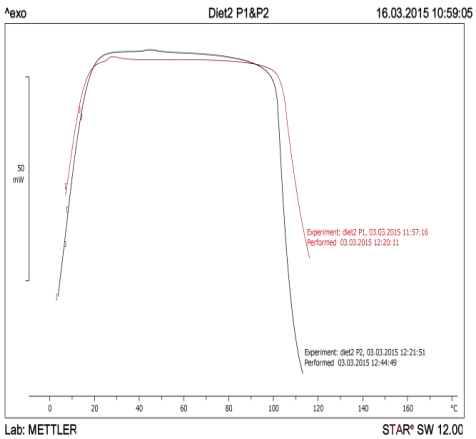
Degree of Gelatinization and Retrogradation

All starch present in extruded wheat was complete gelatinized as seen in DSC curve. Further, there were not any fluctuations in the curve at temperature below 25°C, which signifies that retrogradation phenomenon during storage, was not present in experimental diets fed to fish.

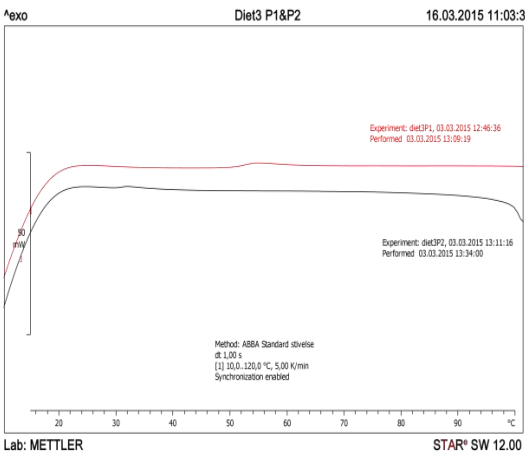
Diet 1



Diet 2



Diet 3



Diet 4

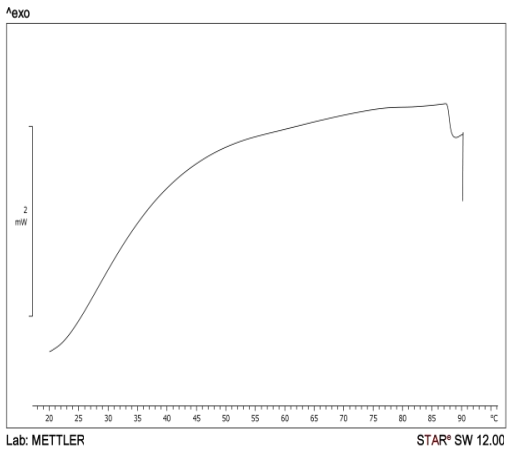


Figure 1. DSC diagrams for Diet 1 (with raw wheat) and Diets 2-4

Incomplete gelatinization of starch was seen for Diet 1 that was not extruded (Figure 1).This is indicated by the uptake of energy seen at approximately 69°C. Visible fluctuations in energy in the temperature range of 50°C - 90°C was not observed for Diets 2-4, signifying complete gelatinization of starch in these diets.

Survival, Growth and feed Performance

All the fishes survived during experiment. The growth and feed performance are presented in table 4.

Table 4. Average growth and feed performance in Tilapia

Parameters	Diet1	Diet2	Diet3	Diet4	Diet5
Initial weight (g)	117.3	124.0	124.9	112.7	118.5
Final weight (g)	193.3	222.3	188.0	190.3	193.4
Weight gain (g)	76.0	98.3	63.1	77.6	75.0
Feed intake	121.9	101.3	65.8	81.5	84.4
Feed Conversion Ratio	1.63	0.99	0.99	1.03	1.08
Protein retention (%)	32.0	53.7	56.4	53.3	49.6
Energy Retention (%)	19.3	36.9	35.7	39.6	32.6

Feed Intake

Fishes seem to prefer Diet 1, which was not gelatinized. It has higher average (121.9 g) level of feed intake than other diets (Table 4). The model fitted to see the effect of diet on feed intake has suggested that the diets have significant effect on Feed Intake (p-value: 0.021). The model has described around 67 percent of variation present in it.

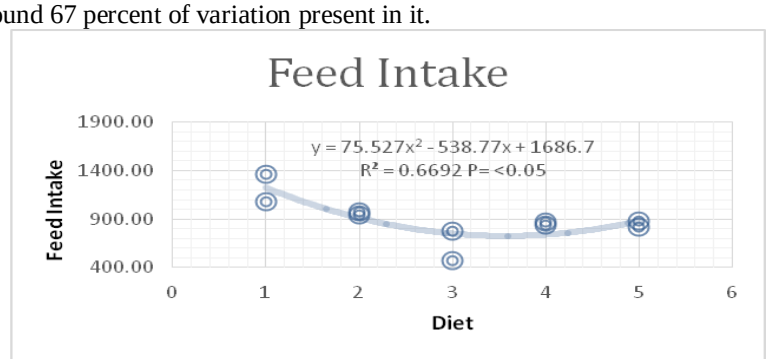


Figure 2. Feed Intake vs. diet with second order trend

Weight gain

Weight gain ranged from 63.1 to 98.3 g per fish with least weight being 63.1 g for Diet 3 and the highest 98.3 g for Diet 2 (Table 4). However, diets did not describe the variation present in weight gain during experiment significantly (p-value: 0.913). A model fitted with weight gain and diet is plotted in Figure 4.

Figure 3. Weight gain vs. diet plot

Whole body composition of Tilapia fed experimental diets

Average final composition of the whole body of tilapia was modeled with second order polynomial of diets. Although models are not significant, the average final protein is found significantly greater than the initial protein (Table 5).

Table 5. Whole body composition of Tilapia

Parameters	Initial	Diet1	Diet2	Diet3	Diet4	Diet5
Dry matter (g/kg)	293.7	287.8	332.7	297.3	306.6	296.0
Energy (Mj/kg)	23.5	22.7	23.5	23.3	23.8	23.3
Protein g/kg	504.5	520.2	518.2	513.6	514.1	525.8
Fat g/kg	285.8	241.0	287.1	297.3	321.2	285.8
Liver lipid g/kg		265.9	335.5	291.3	382.4	269.6
Liver glycogen g/kg		298.9	314.1	314.3	294.9	346.1
Blood sugar mg/dl		4.26	5.42	5.64	4.92	6.04

Feed Conversion Ratio (FCR)

FCR of tilapia fed experiment Diets 2 and 3 (Table 4) tended to be utilized most efficiently, since these diets have the lowest FCR (0.99). The effect of diet explained around 48 percent of variation in FCR. However, the model is not significant (p-value: 0.1).

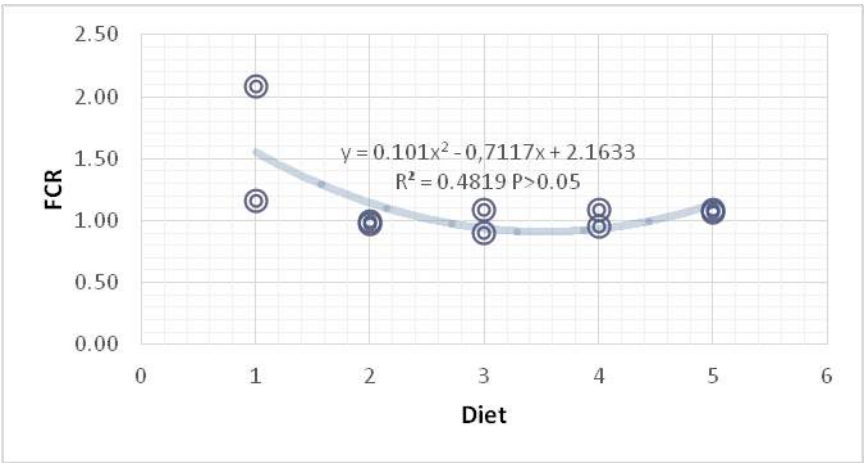


Figure 4. Feed Conversion Ratio vs. Diet with second order fitted trend

Protein Retention

The diets used during the experiments are responsible for more than 74 percent of variation present in protein retention. The fitted model as well as diet and its squared terms are significant (p-value: 0.008). Protein retention ranges from 39.9 to 56.4 with average value of 49.0.

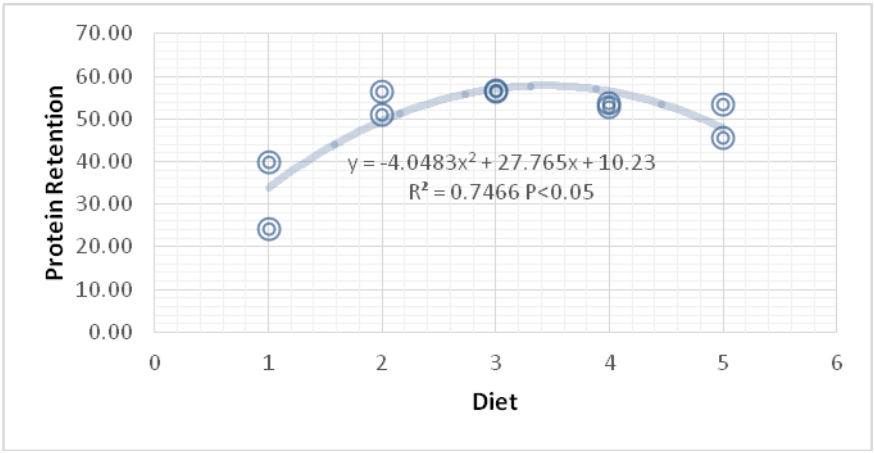


Figure 5. Protein Retention vs. Diet with second order fitted trend

Energy Retention

A similar effect of diet on energy retention is visible as in the case of protein retention (Figure 6). Almost 70 percent of its variation is explained by the second order polynomial of diets used. The model is significant (p-value: 0.016).

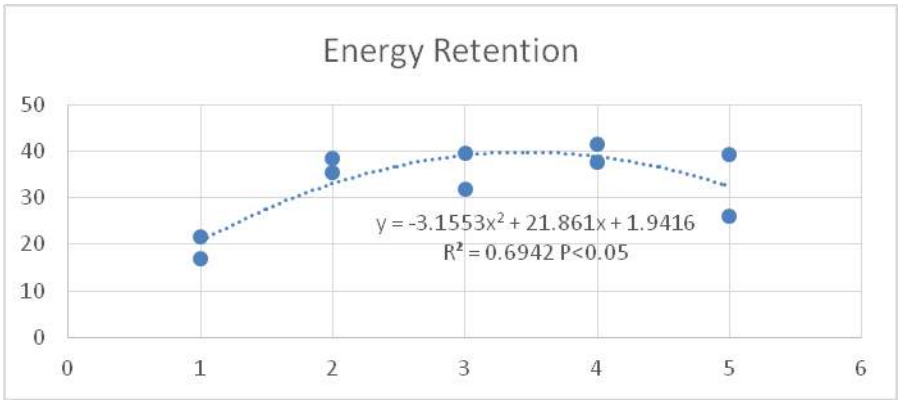


Figure 6. Energy Retention vs. diet

For optimal utilization of starch by Nile Tilapia present in feed, the main carbohydrate ingredient-wheat was extruded in different moisture level (20%, 25%, 30%, and 35%). The purpose was to get different percentage of gelatinization but all were complete gelatinized. We couldn't get the accurate estimate because extruded wheat was not available for DSC. Wheat samples kept in cooler room were thrown away while renovating the room without informing us. In extruding wheat from feed technology point of view, extruder machine didn't work efficiently while extruding wheat below 20% moisture addition, so the starting was 20%. As the moisture was increased temperature, pressure and shear was decreased and viscosity was increased. At last addition of moisture (7% steam addition) gave complete gelatinization, which is good achievement in regular practice. Extruded diets were examined in differential scanning calorimeter to determine percentage of gelatinization and found that all the starch were complete gelatinized. The result from Owusu-Ansah et al., (1983) supports the result, who found that at 90 rpm maximum gelatinization occurred at temperature 100°C and feed moisture 23%. Case et al., (1992) reported that wheat flour with 28% moisture was 86% gelatinized whereas corn meal, cornstarch and wheat starch with 35% moisture were 86%, 85% and 55% gelatinized respectively. The result is contradicted with Gomez and Aguilera (1984) who found that, maximum gelatinization was observed at about 28-29% moisture. Below 20% moisture, dextrinization becomes predominant during high- shear cooking-extrusion. The result of Da Silva et al., (1996) shows that, in 35% moisture, percentage of gelatinization is 10.6 ±0.3, which support Gomez and Aguilera (1984). From previous research we found that gelatinization is limited in feed with low moisture, for complete gelatinization moisture should be high. From the feed technologist point of view it is good achievement that we got complete gelatinization in 20% moisture and the feed is well utilized by fish. Five feeds were fed to Nile tilapia for 28 days in which weight gain was higher in diet two (20% moisture). The result is supported by Takeuchi et al., (1994) who found, increase in the level of gelatinization of diet increases the growth in tilapia and grass carp as well as improves the nutritive value of diet. There is also another finding that says carnivorous fish show growth promotion when gelatinized starch is included at low level (Hemre et al., 2002b). In contrast, research conducted by Peres and Oliva-Teles (2002) on European Sea bass (*Dicentrarchus Labrax*) found that weight gain, specific growth rate and feed intake was low in gelatinized starch feed than raw starch. In addition diet two fed fish have low FCR value, the improvement was not seen in other diets. There is no any explanation to this and this should be looked in further research. Diet one was not gelatinized and diet 3,4,5 were complete gelatinized,

which support the study of Amirkolaie et al., (2006), who explained that, growth was higher and FCR was lower for fish fed the gelatinized starch compared to those fed the native starch. Increasing the starch content of the diets resulted in an increased growth and improved FCR. Similarly, the study of Booth et al., (2000) says that, FCRs were poorest in fish fed both un-steamed diets and markedly improved for fish fed both the steamed and extruded diets. According to Pfeffer et al., (1991) replacing untreated maize or starch in the diets by the respective extruded maize or starch caused significant reductions of consumption and gain in trout. Feed conversion ratios were improved concurrently, as these reductions were more pronounced in consumption than in gain, The average weight gain/day of fish fed with diet one, four and five was about 2.7g while the gain is quite high which is at around 3.52 for the fish fed with diet two. Inverse to the diet two, weight gain of fish fed with diet three is much less (2.28). Protein and energy retention was higher in diet2 and lower in diet1 fed two times a day.

In the experiment water temperature was 28°C and PH7. According to Azaza et al., (2008) experiment conducted in four different temperature (22,26,30,34) and PH range from 6.98 to 7.41 found increase in feed consumption, mean body weight and decreased FCR in fishes kept in 26°C and 30°C than 22°C and 34°C. The experiment is also supported by Coyle et al., (2004) who found 100% survival and high diet acceptance in water temperature 27.4°C and PH8. This shows that temperature and PH were within suitable condition for the growth of Nile tilapia. The term retro-gradation is used to describe the changes that occur upon cooling and storage of gelatinized starch (Fredriksson et al., 1998). Retrograded starch is resistance to digestion (Haralampu, 2000). From the result we found that our starch was not retrograded. The practical importance of non-retrograded feed is it is fresh, pleasant, nutritive and digestible.

CONCLUSION

Complete gelatinization was achieved by the lowest water supplementation to wheat. No significant effects of water addition in extrusion of wheat were observed for growth or feed conversion. Thus, 20% water addition seems sufficient for extruding wheat for use in tilapia feed. The improved feed intake, retentions of protein and energy observed by comparing the use of non-gelatinized wheat (Diet 1) with that obtained by extruding with 20% water (Diet2), illustrates the advantage of using gelatinized starch in tilapia feed.

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Lemon grass oil feeding in relation to growth and carcass characteristics of broiler chicken

M.R. Tiwari[1], B. Shah[1], A.K. Jha[2] and M.P. Sah[2]
[1]Animal Nutrition Division, Khumaltar, Lalitpur
[2]Regional Agricultural Research Station, Parwanipur, Bara
tiwari65@yahoo.com

ABSTRACT

*An experiment was conducted at Regional Agricultural Research Station, Parwanipur, Bara for 42 days to test the effect of lemon grass oil inclusion in broiler feed and its effect on growth and carcass characteristics. A total of 180 day old Cobb-500 broiler birds were procured from Shivam Hatchery, Birgunj and divided into 4 treatments each with three replications (15 birds in each replication) by using Complete Randomized Design. Concentrate feed was purchased from Shakti feed industry, Birgunj. Control treatment (T1) was fed without oil inclusion and T2, T3 and T4 treatments were fed concentrate mixture mixed with lemon grass oil (LGO) @ 200, 400 and 600 ml per 100 kg feed, respectively. Experimental birds were provided adlib amount of grower feed (B1) for 21 days and that after finisher feed (B3) for 21 days in group basis and had easily access to drinking water. Feed intake was recorded daily and body weight gain was measured in 7 days interval in group basis. By the end of experiment (in 42 days) two birds was taken from each replication randomly for carcass study. The findings revealed that total weight gain was increased with the increment of oil. Highest weight gain was observed in T4 (2.96 kg) followed by T3 (2.*87 kg*), however, it was not significant among diet treatments. Similarly, highest cumulative feed intake was also observed for T4 (4.62 kg) followed by T3 (4.49 kg) but was also non-significant (p>0.05) among diet treatments. Carcass study revealed that there was also higher dressing percentage with the increment of LGO. Highest dressing percentage was noted for T4 (84.95%) followed by T3 and T2 (83%). Lowest abdominal fat was recorded in T3 (54 g) followed by T2 (58g). The findings thus suggested that inclusion of LGO improved the weight gain, reduce mortality and can reduce the period of broiler harvesting, however, further study should be carried out to precise the appropriate level of oil inclusion and higher cost benefit ratio.*

Key words: Lemon grass oil, broiler, feed, growth performance, carcass characteristics

INTRODUCTION

Demand for poultry meat is more compared to sheep/goat meat. In Nepal, the total population of poultry is estimated to be about 50.19 million (MoAC, 2015/16). More than 60% of the population belongs to indigenous and rest is exotic origin. Feeds are important for the growth of the broilers to produce quality meat from the reliable supply. Lemon grass extract will be using as a growth enhancer that will added in the drinking water instead of synthetic growth enhancer because commercial broilers today was bombarded with synthetic chemicals. Lemon grass is considered as a viable alternative to antibiotics for the broiler for minimizing expense in the production. Lemon grass, also called fever grass, is a perennial plant with thin, long leaves that is indigenous to many Asian countries, lemon grass smells like lemon, but it tastes milder and sweeter. This herb is used in various Asian cuisines as a flavoring agent due to its potent flavor. It also contains steroids, alkaloids, phenols, saponine tannins, anthraquinines and flavonoides. The lemon grass essential oil

has three main components, mircene, geranial and neral. The lemon grass oil is used for curing intestinal worms, anemia and manufacture of pesticides, perfumes and cosmetics (Russo, 1992).The lemon grass oil may be used as a growth promoter in broiler production. Many studies have shown positive effects of dietary LGO on body weight gain. Supplementing the dietary LGO would stimulate the growth performance of broilers (Cross *et al*., 2002; Bampidis *et al*., 2005). Mukhtar *et al.* (2012) reported that broilers fed diets supplemented with various levels of lemon grass oil consumed significantly more amount of feed compared to the broilers fed control diet. The results also showed significant improve in body weight gain of broiler fed diets supplemented with lemon grass oil compared with control group. This type of work has not been carried out in Nepal. Therefore, this study was carried out to evaluate the effect of addition of various levels of lemon grass oil as a natural growth promoter on the performance and carcass yields of broiler chicken.

MATERIALS AND METHODS

Experimental birds

The experiment was carried out using Cobb 500 broiler chickens at Regional Agricultural Research Station, Parwanipur, Bara from 6 December 2016 to 16 January 2107 (073/08/21 to 073/10/3 BS).One hundred eighty experimental day old birds were procured from Shivam hatchery, Birgunj, Parsa and were allotted into four treatments, each with three replication, having 15 birds in each replication by using Complete Randomized Design (CRD). All experimental birds were vaccinated with F1 vaccine @ one drop /bird against Ranikhet at the first week.

Diet composition

Compound feed was procured from Shakti Feed Industry of Birgunj, Bara (Table 2) and treated with lemon grass oil @ 200, 400 and 600 ml/100 kg feed for T2, T3 and T4, respectively. T1 group was as control. The sample of these feed was brought to the Animal Nutrition Division, NARC, Khumaltar, Lalitpur for chemical analysis.

Chemical analysis

Representative samples were analyzed for Dry Matter (DM), crude Protein (CP), crude Fibre (CF), organic matter (OM) and ash contents (TA). The DM was determined by oven drying at 100°C for 24 hrs. Crude protein of the samples was determined using the Kjeldahl method. Ash content was determined by ashing at 550°C in a muffle furnace for 16 hrs (AOAC, 1980). Crude Ether of the samples was determined using the Van Soest method (Goering, H.K. and Van Soest 1970).

Experimental diets

The following experimental diet was provided to the birds (Table 1).

Feeding regime

Concentrate mixture was given on group basis and was provided to the experimental birds once a day (morning) in *adlib* amount for both periods (starter–21 days and finisher – 21 days) of the experiment. Drinking water was provided in adequate amount.

Table 1. Experimental diets

Treatment	Diets
1	Adlib concentrate mixture (without inclusion of lemon grass oil)
2	Adlib concentrate mixture treated with lemon grass oil @ 200 ml/100 kg feed
3	Adlib concentrate mixture treated with lemon grass oil @ 400 ml/100 kg feed
4	Adlib concentrate mixture treated with lemon grass oil @ 600 ml/100 kg feed

Data measurement

The trial period consisted for 42 days (21 days starter and 21 days finisher). Quantity of concentrate mixture given daily to the birds in groups weighed daily and refusal was weighed in the next morning. The body weight gain was measured in group basis (replication-wise) in seven days interval in the morning before feeding.

Carcass study

At the end of the experiment, two chicks from each replication (6 chicks from each treatment) were randomly taken and fasted overnight, weighed individually, slaughtered, scaled after bleeding, feather hand plucked and eviscerated, hot carcasses, liver, gizzard and heart were weighed separately. Then carcasses were divided into two halves, with the left side divided into commercial cuts (breast, thigh and drumstick), then each cut was weighed and deboned.

Data analysis

Data of feed intake and body weight gain were analyzed by "*One way Annova*" test for every measurement using statistical package Minitab 2003, versions 13.20.

RESULTS AND DISCUSSION

Chemical Composition of Concentrate mixture

The chemical composition of treated and non-treated concentrate mixture is given in Table 2.

Cumulative feed intake (CFI)

The average feed intake of experimental bird is presented in Table 3. Mean feed intake of experimental birds was recorded 36.83 g in 7 days which reached 4563 g at the end of experiment (42 days) which was none significant ($p>0.05$) among diet groups.

At the 7 days of experiment, feed intake of T1 and T4 was noted similar (35 g) followed by T2 and T3 (38 g). At the 15 and 22 days of experiment, highest feed intake was observed for T2 (78.61g and 113 g, respectively) followed by T1 and T4 (77g and 111 kg, respectively). By the 29 days of experiment, highest feed intake was recorded for T4 (175.08 g) followed by T1 (162.02 g). Similarly, at the 36 days of experiment, feed intake was higher in T1 group (189.73 g) followed by T4 (178.49 g). Likewise, at the end of experiment (42 days), highest feed intake was monitored for T3 group (185 g) followed by T4 (184.44 g). The cumulative feed intake of experimental birds was found almost similar for T1 and T4 (4665 and 4626 g, respectively) followed by T3 and T2 (4493 and 4466 g, respectively). Experiment revealed that different level of Lemon grass oil inclusion in the diet did not affect significantly ($p>0.05$) in feed intake of experimental birds from beginning to end of the experiment.

Table 2. Chemical composition of the compound feed (DM basis)

Concentrate mixture	DM	TA	OM	CP	CF
Feed (Starter)	90.48	5.85	94.15	18.05	5.85
Feed treated with LGO @ 200ml/ 100 kg feed	90.88	5.63	94.37	18.33	4.62
Feed treated with LGO @ 400ml/ 100 kg feed	90.59	6.15	93.85	18.60	6.70
Feed treated with LGO @ 600ml/ 100 kg feed	91.32	8.93	91.07	18.23	6.28
Feed (Finisher)	88.59	7.70	92.30	16.11	6.85
Feed treated with LGO @ 200ml/ 100 kg feed	88.71	7.46	92.54	16.03	4.90
Feed treated with LGO @ 400ml/ 100 kg feed	88.77	6.33	93.67	16.32	6.52
Feed treated with LGO @ 600ml/ 100 kg feed	88.65	6.31	93.69	16.83	6.38

Table 3. Cumulative feed intake of the experimental birds, g (Mean ±SD)

TRT	Days						CFI (g)
	7	15	22	29	36	42	
1	35.37±4.6	77.15±3.3	111.06±22.8	162.02±22.7	189.73±3	181.66±1.7	4665.15±952.1
2	38.19±1.1	78.61±1	113.06±4.5	157.44±9.2	172.11±1.6	178.89±9.1	4466.68±860.5
3	38.08±0.4	76.37±3.7	104.55±6.8	158.48±0.2	172.57±3.3	185±0.3	4493.97±865.5
4	35.66±1	77.84±2.1	111.17±0.6	175.08±5.4	178.49±.09	184.44±0.7	4626.32±917.6
Mean	36.83±2.5	77.49±2.5	109.96±10.9	163.25±13	178.22±1.65	182.5±8.6	4563.03±898.9
P	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05	p>0.05

Body weight gain

The body weight gain trend of experimental birds is given in Table 4 and figure 1. Average mean body weight of experimental birds was 40.56 g at the beginning which reached 2782g by the end of experiment. At the 7 days of experiment, highest body weight gain was noted for T1 (168.93 g) followed by T3 (167.33g).

Table 4. Body weight gain trend of experimental birds, g (Mean± SD)

TRT	Days							Total weight gain	FCR, Kg
	0	7	15	22	29	36	42		
1	40.87±0.6	168.93±1.1	457.67±3.4	802.3	1436.0±1.8	2121.11±3.7	2707.93±1.2	2667±1.2	1.75
2	40.22±0.8	166.93±7	436.0±3.8	825.33	1458.67±6.1	2081.55±6.6	2668.33±2.8	2628±2.8	1.70
3	40.13±0.6	167.33±1.1	469.51±1.1	888.67	1398.67±1.2	2108.67±1	2913.78±1.1	2873±1.1	1.56
4	41.02±0.4	152.93±2.3	447.33±1.2	858.67	1518.67±3	2264.0±1	3003.33±4	2962±4	1.56
Mean	40.56±0.7	164.03±1.4	452.63±2.6	835.72	1453±1	2143±1.8	2823±2	2782±2	1.64
P	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

During 15-22 days of experiment, higher body weight gain was found in T3 (469.51g and 888.67 g, respectively) followed by T1 (457.67g in 15 days) and T4 (858.67 g for 22 days). After the 22 days onward in 29, 36 and 42 days of experiment, higher body weight gain was observed in T4 group (1518.67 g, 2264 g and 3003.33 g, respectively) followed by T2 (1458.67 for 29 days), T1 (2121.11g for 36 days) and T3 (2913.78 g for 42 days). Similarly, least FCR was recorded for T4 and T3 group (1.56 kg) followed by T2 (1.7 kg).

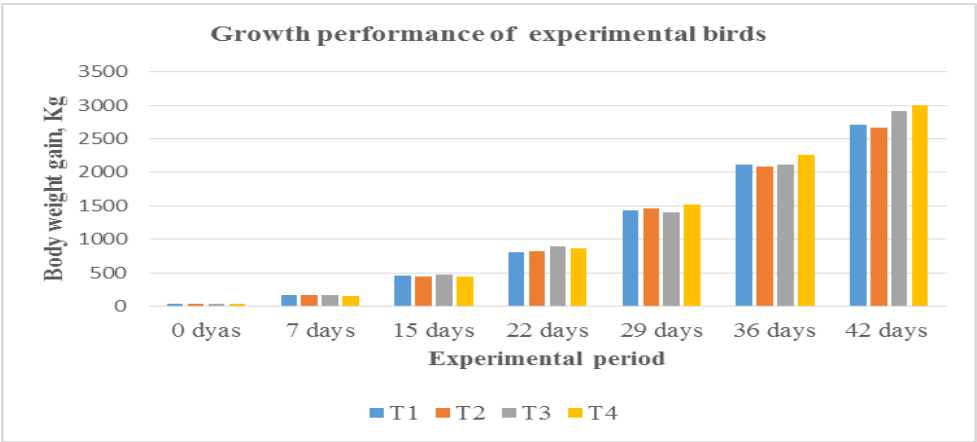

Figure 1. Body weight gain of experimental birds

Carcass characteristics

The carcass characteristics of experimental birds are presented in Table 5. The average mean live weight, blood weight, feather weight, liver weight, heart weight, gizzard weight and abdominal fat was recorded 3180.5 g, 81.25 g, 96.75 g, 77.5 g, 16 g, 70.5 g and 68.5 g, respectively. The live weight was highest in T4 (3310 g) followed by T3 (3246 g) whereas highest blood weight was noted in T3 (95 g) followed by T2 and T4 (80 g).

Table 5. Carcass characteristics of the experimental birds (g)

Treatment	Live weight	Blood weight	Feather weight	Dressing, %	Liver weight	Heart weight	Gizzard weight	Abdominal fat
1	2930	70	90	81.22	78	10	62	96
2	3236	80	108	83.18	80	20	76	58
3	3246	95	95	83.11	82	18	82	54
4	3310	80	94	84.95	70	16	62	66
Mean	3180.5	81.25	96.75	83.11	77.5	16	70.5	68.5

Similarly, the feather weight was higher for T2 (108 g) followed by T3 (95 g) while liver weight was higher in T3 (82 g) followed by T2 (80 g). Likewise, heart weight was observed highest in T2 (20 g) followed by T3 (18 g) whereas gizzard weight was highest in T3 (82 g) followed by T2 (76 g). The least abdominal fat was recorded for T3 (54 g) followed by T2 (58 g). The dressing percentage was higher for T4 (84.95%) followed by T2 (83.18%). Inclusion of lemon grass oil in different level did not affect significantly ($p>0.05$) in live weight, blood weight, feather weight, dressing percentage, liver weight, heart weight, gizzard weight and abdominal fat content.

Bird cut parts

The cut parts of experimental birds are presented in Table 6. The mean leg weight, neck weight, wings weight, breast weight and giblet weight was recorded 758.5 g, 176.5 g, 221.5 g, 852.5 g and 335g, respectively. The highest leg weight was recorded for T3 (794 g) followed by T2 (778 g) whereas neck weight was found to be highest in T2 (206 g) followed by T3 (180 g). Similarly, wings weight was found higher in T3 (242 g) followed by T4 (238 g) while breast weight was noted higher in T4 (948 g) followed by T2 (862 g). Likewise, least giblet weight was recorded for T1 (256 g) followed by T4 (328 g). Incorporation of lemon grass oil in different level significantly ($p<0.01$) affected on neck weight, wings weight, breast weight and giblet weight except leg weight.

Table 6. Cut parts of experimental birds, g

Treatment	Leg weight	Neck weight	Wings weight	Breast weight	Giblet weight
1	692	146	198	768	256
2	778	206	208	862	388
3	794	180	242	832	368
4	770	174	238	948	328
Mean	758.5	176.5	221.5	852.5	335

This study was initiated to evaluate the effect of different level of lemon grass oil inclusion in diet and its effect on production performance and carcass characteristics of broiler chicken. The findings revealed that feed consumption was almost similar (4400 g) in T2 and T3 groups where oil was included @ 200 and 400 ml /100 kg feed, respectively. Similarly, and also similar for T1 and T4 (4600 g) where diet was without lemon grass oil and included @ 600ml/100 kg feed, respectively. Increased level of inclusion did not reduce the consumption rate, however, total body weight gain was higher in T4 (2962 g) and FCR was similar (1.56) lower in T4 and T3 groups where oil was included @ 600 ml and 400 ml / 100 kg feed, respectively. There was no any mortality of birds up to 36 days of experiment but seven birds were died suddenly from T4 group due to the liver burst that was proved by postmortem report of birds during 36 to 42 days of experiment. Furthermore, dressing percentage was also higher in T4 (84.95%) than that of other treatments. Moreover, inclusion of LGO increases fibre, tenderness and taste of the meat.

Khattak *et al* (2014) reported that the inclusion of lemon grass in the broiler diets improved the body weight gain with positive effects on feed to gain ratio. Cabuk *et al* (2006) reported that the inclusion of lemon grass @ 24 mg\kg diet significantly improved the egg production, feed efficiency and also reduction in the percentage of cracked\broken eggs. Ozek (2011) reported that the use of lemon grass along with organic acid supplementation in commercial layers diets reduced the heat stress and also beneficial to increase the egg weight. Ando *et al* (2003) reported that the supplementation of essential oil could increase the nutrient digestibility significantly. Mukhtar *et al* (2012) reported that 50, 100 1nd 150 ml\kg supplementation of lemon grass oil in broiler diets caused an increased feed consumption. Furthermore, they reported that significantly improved in feed conversion ratio for broilers fed diets supplemented with various levels of LGO compared with control group.

Alcicek *et al* (2004) observed improvement in dressing percent by the dietary essential oil. Also there were no significant differences in commercial cuts percentages. Mmereole (2010) conducted

an experiment to evaluate the effects of dietary inclusion of lemon grass leaf meal on growth performances of broiler chickens and its ability to be utilized as a viable alternative to antibiotic growth promoters. The diet groups were: Diet 1 (D 1 = control = basal diet), Diet 2 (D 2 = basal diet +1% LGLM) and Diet 3 (D 3 = basal diet+1% Tetramycin antibiotic growth promoter). The results indicated that, although the final body weight of the birds on D2 (1895.56 g) was quantitatively higher than that of the birds in D3 (1875.92 g), the difference was not significant ($p>0.05$).

CONCLUSION

The findings of the experiment suggested that inclusion of LGO improved the weight gain, reduce mortality and can reduce the period of broiler harvesting, however, further study should be carried out to precise the appropriate level of oil inclusion to get more benefit from broiler production.

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The nutrient composition and nitrate content of ranked fodder tree species in the hills and mountain of Nepal

S. Upreti[1] and N. R. Devkota[2]
[1]Nepal Agricultural Research Council, Khumaltar, Lalitpur
[2]Agriculture and Forestry University, Rampur, Chitwan
sujayaupreti824@hotmail.com

ABSTRACT

Fodder chemical composition and nitrate level of major fodder tree species in the hills and mountain districts of Nepal was determined during June 15th, 2012 to December 20th, 2012 with the objective to access the major nutrient content and nitrate level of the top rank fodder tree species. The experiment consisted of nine treatments organized into a 3x3 factorial combination using RCBD. Two factors were: three categories of ages (3-6 years, 7-10 years and 11-14 years) and three fodder species Badahar (Artocarpus lakoocha), Kutmiro (Litsea polyanthus) and Kabro (Ficus lacor). A total of 180 samples were analysed. The energy level was significantly (p<0.01) higher in the Kutmiro (4286 kcal/kg fodder) with first age group (3984 kcal/kg).The crude protein content was significantly (p<0.01) higher in the Badahar with first age group (11.72%). The NDF content (71.9%), ADF content (68.49%) and ADL content (46.9%) was significantly (p<0.01) higher in the Kutmiro as well as the Ca content also was significantly (p<0.01) higher for Kutmiro (3.56%). Similarly the TA content was significantly (p<0.01) higher in the Kabro (11.92%).The Kabro had higher nitrate score (1.33) followed by Kutmiro (1.25) and Badahar (1.19). The study revealed that there was variation in nutrient and nitrate content of fodder tree available in hills and mountain districts of Nepal.

Key words: Chemical composition, fodder tree species, *Artocarpus lakoocha, Litsea polyanthus, Ficus lacor*

INTRODUCTION

Livestock is an important component of crop livestock mixed agricultural farming system in Nepal. Livestock diet is usually composed from green grasses, crop residues, crop by-products and tree foliage with little or no concentrate feed (Upreti and Shrestha, 2006). Over 50 percent of the total green fodder supply comes from forest resources, both from community forest and private farm land, out of which the share of tree foliage is 15 to 29 percent (Kshatri, 2007), yet inadequate feed supply and poor nutrition during the dry winter and early summer season are the major constraints to increase ruminants production in the hills of Nepal (Kiff *et al.*, 1999). Tree foliage is the main source of feed during winter and usually fed as a supplement to crop by-products or green grasses (Upreti and Shrestha, 2006). Out of total 1, 47, 18,000 hectare of land, 39.6 percent is covered by forest, 12 percent by pasture land and 7 percent covered by under non cultivated land in Nepal (MoAD, 2012). About 41 percent Dry Matter (DM) in animal feed comes from the fodder trees (either planted or naturally grown) and tree shrubs (Panday, 1982). Likewise, 47 percent Total Digestible Nutrients (TDN) comes from the cropland, 30 percent from the forests,

7 percent from the shrub land, 5 percent from the grassland and 11 percent TDN from the non conventional ingredient (Pariyar, 2004).

In the context of existing feed balance, more than 50 percent of the fodder for ruminant animals comes from forest resources (Kadariya, 1992). There are more than 500 fodder tree species out of which about 250 have been recognized as economical fodder tree available across the agro ecological zone in the country (Subba, 2000). Amatya (1990) reported that there are 44 different fodder species preferred by the farmers. Furthermore, a study of FAO (2012) revealed that 19 major economical and safe fodder tree species with their selection index have been identified considering the polyphenolics and the toxic substances such as nitrate using Diphenylamine Field Test (DFT) method. This scenario of fodder tree resources available in Nepal indicated that there is great potentials on the production and use of fodder tree species to the livestock feeding especially during winter season in Nepal. However, the quantity and quality of the available fodder trees depends upon the seasons, ages, species, elevations, aspects of the mountain degree of slopes and accessibility to agrosilvipastoral system (Kshatri, 2007). Several studies done in the chemical composition and polyphenolics (nitrate) indicated that the variation within and between the fodder tree species that are commonly found in the hills and mountains of Nepal. The nitrate level also varies with the fodder tree species. FAO (2012) reported 1.08 score in case of Badahar, 1.27 score for Kutmiro, and 12.7 score for Kabro using Diphenylamine Field Test (DFT) method. In spite of the importance of fodder tree in the livestock raising system in the hills and mountains, limited work has been done. This situation demands the need of study on nutrient composition and nitrate level of major fodder tree in the hills and mountains of Nepal.

MATERIALS AND METHODS

The study consisted of determination of chemical composition and nitrate content of top ranked popular three fodder tree species Badahar (*Artocarpus lakoocha*), Kutmiro (*Litsea polyanthus*) and Kabro (*Ficus lacor*) that were organized into treatments. The study was conducted at Tanahun, Dhading, Dolakha and Sindhupalchowk districts from June 15th, 2012 to December 20th, 2012. Three specific sites were selected in each district for detail study that were Kotre Bazaar, Baniyatar and Chhimkeswari of Tanahun; Khatritar, Dambardanda and Tersepani of Dhading; Vimtar, Harae and Chilaunae of Sindhupalchowk, and Biruwa, Katakuti and Darmedandagaun of Dolakha district. Total 180 samples were taken of Badahar (60 samples), Kutmiro (60 samples) and Kabro (60 samples) from Tanahun, Dhading, Sindhupalchok and Dolakha. A 3×3 factorial combination of RCBD was used considering age and species of the fodder tree as treatments and the four districts as replication. Accordingly, three categories of ages (3-6 years, 7-10 years and 11-14 years) were combined with three fodder species (Badahar, Kutmiro and Kabro). Fodder species were identified based on findings of socio-economic study and on the basis of identifying top ranked fodder tree species.

Accordingly, the following were the treatments combination:

T1=Badahar age group 3-6 years
T2= Badahar age group 7-10 years
T3= Badahar age group 11-14 years
T4=Kutmiro age group 3-6 years
T5= Kutmiro age group 7-10 years
T6= Kutmiro age group 11-14 years
T7=Kabro age group 3-6 years
T8=Kabro age group 7-10 years
T9=Kabro age group 11-14 years

Chemical composition

Selected top three fodder tree species, namely Badahar (*Artocarpus lakoocha*), Kutmiro (*Litsea polyantha*) and Kabro (*Ficus lacor*) were used for proximate analysis, by following the procedure suggested by Association of Analytical Communities (AOAC, 1980) at Animal Nutrition Division, Khumaltar.

Dry matter determination

The samples were dried at 100 ºC for 24 hours in hot air oven and dry matter was estimated by:

$$\% \text{ DM} = \frac{\text{Dry weight}}{\text{Dry weight-Wet weight}} \times 100$$

$$\%\text{Moisture} = \frac{\text{Wet weight-Dry weight}}{\text{Wet weight}} \times 100$$

Energy estimation

Foliage gross energy (GE) values were estimated by ignited the 1 g of dried sample using a Bomb Calorimeter. The ground 1g sample was placed inside the bomb calorimetry and was ignited to release the energy available in the fodder sample. The, the initial temperature was recorded and after running the stirrer for 5 min the final temp was also recorded. The difference of initial and final temperature was determined and the energy content of fodder sample was calculated.

Protein determination

Kjeldahl method was used to determine first nitrogen content of the feed sample. The ground 0.5g of sample was used to estimate the protein content. The sample was digested by adding the mixture of Na_2SO_4 and $CUSO_4$ with 25 ml con. H_2SO_4 (98%). The digested sample was distillated with 10 ml of NaOH (40%) and then it was titrated with 0.03 N of H_2SO_4. The percent nitrogen (N) of a feed sample was multiplied by the factor 6.25 because average protein contains 16% nitrogen and total protein (TP) was determined by;

$$\% \text{ CP} = \frac{\text{Units of N}}{\text{Dry weight of sample}} \times 100$$

Ether extract or fat determination

The ether soluble substances were determined by subjecting a 1g of ground sample with 2/3 petroleum benzene into Soxhlet. The distillation process was performed for 7 hours. The ether was evaporated and the extract weighted. The ether extract was determined by using the following formula:

$$\% \text{ EE} = \frac{\text{Weight EE}}{\text{Dry weight of sample}} \times 100$$

Neutral detergent fibre (NDF)

The NDF content of fodder sample was determined by taking 1g of ground sample which was subjected with 100ml of NDF solution consisting of 150g of Sodium Lauryl Sulphate, 93.1g of EDTA Disodium Salt, 34.1g of Disodium tetra borate decahydrade (Borex), and 28.54g of Sodium Hydrogen Orthophosphate. Then, the sample was boiled and kept in hot condition for 1hrs in fiber extractor and after that it was filtered in suction pump and kept for 24 hrs in oven (100 ºC). Finally, the crucibles with samples were ashed in furnace (500 ºC) for 2-3 hrs. After that the sample was transferred into desicator for ½ hrs and the weight of sample was taken to determine the NDF.

Acid detergent fibre (ADF)

The ADF content of fodder sample was determined by taking 1g of ground sample which was subjected with 100ml of ADF solution consisting of 100g of CTAB, and H_2SO_4 (1N). Then, the sample was boiled and kept in hot condition for 1hrs in fiber extractor, and after that it was filtered in suction pump and kept for 24hrs in oven (100 ºC). After that the dried sample was transferred into decicator for ½ hrs and the weight of sample was taken to determine the ADF.

Acid detergent lignin (ADL)

The ADL content of fodder sample was determined by using the ADF sample. The sample was treated with 20ml H_2SO_4 (72%) and left for 3hrs digestion. Then it was filtered in suction pump and kept for 24hrs in oven (100 ºC). Finally, the crucibles with samples were ashed in furnace (500 ºC) for 2-3 hrs. After that the sample was transferred into decicator for ½ hrs and the weight of sample was taken to determine the ADL.

Calcium determination (Ca)

The Ca content of fodder sample was determined by taking 1g dry sample, which was ashed at 500ºc then after 10ml pure HCl and 30ml water were added. Then, it was boiled for half hours and filtered to make 100ml volume. After that 3 drops (0.2%) of Methyl red indicator, 5ml (3%) of Ammonium Oxalate, and 2-4 g of urea was added and then boiled until color changes. It was

filtered with Filter Paper (42N) then washed 7-8 times with Ammonia solution. The sample along with filter paper was kept in beaker and 50ml boiled H_2SO_4 (1:24) was added. Then, the sample was titrated with 0.004N of $KMnO_4$.

Nitrate Test: A Rapid Field Test using Diphenylamine Field Test (DFT) was used to detect nitrate from selected fodder tree species as a qualitative indicator to know whether or not the fodder tree leaves of interest i.e. selected and ranked fodder tree species had dangerous nitrate levels. Color chart (Figure 1) developed by (Knight *et al.,* 2008) was used to match the color developed in the cutting open space (slant cutting of 45^0 of angle) of fodder twigs (sample of 8 cm circular measurement) within 5 seconds.

Score assigned based on the intensity of blue color that developed within 5 second as following score (Knight *et al*., 2008)

1+: Developed of light blue color within 5 seconds

2+: Intense development of blue- black color within 5 second

3+: More intense development of blue - black color within 5 seconds

4+: Very intense development of dark blue-black color within 5 seconds

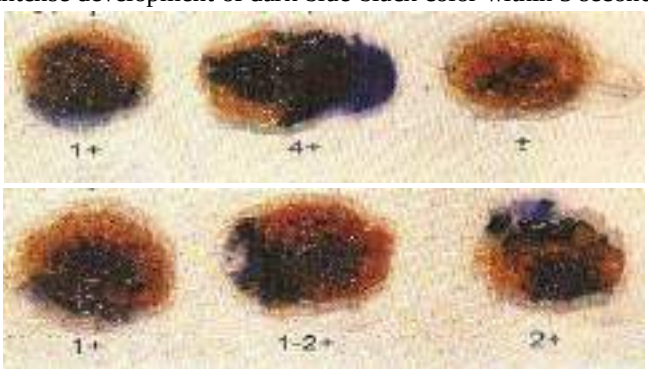

Figure 1. Colored chart indicating the concentration of nitrate level in the feed sample (Knight *et al*., 2008)

All the collected data were subjected to statistical analysis. Statistical software Genstat discovery (4) edition was used to analyze the data.

RESULTS AND DISCUSSION

Nutrient composition of selected fodder tree species

Energy: The mean energy content of fodder tree differed significantly ($p<0.001$) among the treatments considering fodder trees species. The energy content ranged from 3830 kcal to 4286 kcal per kg of fodder tree (DM). Accordingly, the Kutmiro had better (4286 kcal/kg) energy content compared to the Kabro (3955 kcal/kg) and Badahar (3830 kcal/kg. Ibrahim *et al.,* (2008) reported that the energy content in Badahar could be 0.82 ME M cal per kg fodder (DM) which is higher than the reported value in this study. Similarly, Kabro recorded a high value of ME of 0.62 ME per kg fodder (DM) than the value recorded in this study (Ibrahim *et al*., 2008). The study has indicated that the selected fodder trees are good source of energy to the livestock.

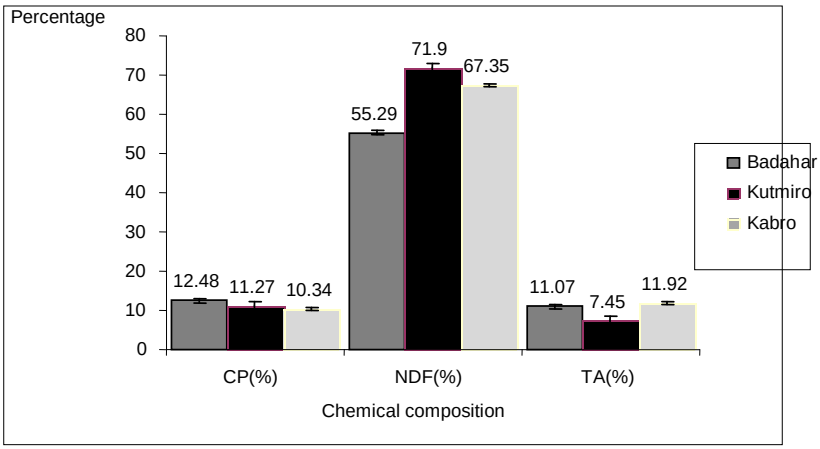

Figure 2. The chemical compositions of selected fodder tree species

Crude protein (CP): The protein level in the fodder tree was the next measured parameter for fodder quality assessment thus selected and ranked fodder tree species were assessed against the protein content. The mean protein content of fodder trees differed significantly ($p<0.05$) among the treatments considering fodder trees species. The protein content of different fodder trees ranged from 10.34% to 11.27%. Accordingly, Badahar had the higher CP content (12.48%) followed by Kutmiro (11.27%) and Kabro (10.34 %) (Figure 2). The CP content in the selected and ranked fodder tree supported the line of selection index. The CP content of these three fodder trees were higher, Badahar (13.43 %), Kutmiro (15.32 %), and Kabro (12.05 %) as reported by (Upreti and Shrestha, 2006). Subba (1995) reported even higher CP content such as 15.80% for Badahar and 16.8 percent for Kutmiro. Furthermore, Panday (1982) reported higher CP such as 15.67% for Badahar, 16.69% for Kutmiro, and 13.76% for Kabro. Several other study also revealed that the CP content in the fodder trees could greatly varies due to the differences with species, time of lopping, season of lopping etc (Subba,1998). Categorically, the CP content in these selected fodder trees goes under moderate categories (10.01 to 19.99%) as suggested by Upreti and Shrestha (2006). The stage of maturity of fodder leaves is different among the selected fodder tree species and that could be the one of the causes to have differing in the CP content.

Ether extract (EE): The Ether extract (EE) is the crude fat (CF) content in the feedstuff. The determination of EE in the fodder helps to know the energy level of the particular fodder species. The mean ether extract content of fodder tree differed significantly ($p<0.05$) among the treatments considering fodder trees species. Accordingly, Ether extract ranged from 1.64% to 2.09 % of the selected fodder tree species. Kabro had the highest EE content (2.09%) followed by Kutmiro (1.91%) and Badahar (1.64%). Upreti and Shrestha (2006) had reported higher ether extract in Badahar (1.80%), Kutmiro (2. 031%) and Kabro (2.20%) than the value obtained in the present study. A similar trend was also revealed by Subba (1998). Upreti and Shrestha (2006) had reported ether extract for Kutmiro as 2.7 %, and Kabro 2.6 percent. This also showed that there is a variation in ether extract of the selected and ranked fodder tree species.

Fiber fraction of selected fodder tree species

Neutral detergent fat (NDF): The Neutral detergent fiber (NDF) is a measure of total cell wall in tree foliage. The mean NDF content of fodder tree differed significantly ($p<0.001$) among the treatments considering fodder trees species. NDF ranged from 55.29 % to 71.90 % of the selected fodder tree species. Accordingly, Kutmiro had the highest NDF content (71.90%) followed by Kabro (67.35%) and Badahar (55.29%) (Figure 2). Upreti and Shrestha (2006) reported the NDF content of Badahar, Kutmiro and Kabro 44.69 %, 57.32 %, and 51.93 percent, respectively.

Acid detergent fiber (ADF): The Acid detergent fiber (ADF) is highly related to digestibility of feedstuff in the animal. Higher ADF content in the feedstuff is related to lower in digestibility. The mean ADF content of fodder tree differed significantly ($p<0.001$) among the treatments considering fodder trees species only. ADF ranged from 49.70% to 68.47 % of the selected fodder tree species. Accordingly, Kutmiro had the highest NDF content (68.47%) followed by Kabro (62.66%) and Badahar (49.70%). Since, the Badahar had the lowest ADF content (49.70%) the selection ranking of Badahar as top fodder species is justified. However, Upreti and Shrestha (2006) reported lower ADF content in all three species than the value presented in this study where the writers had reported 38.92%, 49.69%, and 45.95% ADF to Badahar, Kutmiro and Kabro, respectively.

Acid detergent lignin (ADL): The Acid detergent lignin (ADL), substance which is laid down in the cell wall along with cellulose and the hemicelluloses, tends to be deposited towards the later stages of growth of the plant (Coop, 1961). The mean ADL content of fodder tree differed significantly ($p<0.001$) among the treatments considering fodder trees species only. ADL ranged from 24.76% to 46.94 % of the selected fodder tree species. Accordingly, Kutmiro had the highest ADL content (46.94%) followed by Kabro (32.53%) and Badahar (24.76%). Since, the Badahar had the lowest ADL content (49.70%) the selection ranking of Badahar as top one fodder species could be well justified. Upreti and Shrestha (2006) had reported lower ADL content in Badahar (17.40%, Kutmiro 28.64%, and Kabro 21.22 percent) that differed slightly compared to the findings of this study. But, in both of these studies the trend of the ADL content was similar. The ADL reduces the digestibility of cell wall carbohydrate (primarily cellulose and hemicelluloses) with which it is bonded (Upreti and Shrestha, 2006). Higher the ADL content in the fodder species indicated lower the quality in terms of fodder utilization.

Minerals content of selected fodder tree species

Calcium: The mean calcium content of fodder tree differed significantly ($p<0.001$) among the treatments considering fodder trees species. Calcium ranged from 2.47% to 3.56 % of the selected fodder tree species. Accordingly, Kutmiro had the highest calcium content (3.56%) followed by Kabro (2.60%) and Badahar (2.47%). Upreti and Shrestha (2006) reported 1.96%, 1.66%, and 2.46 percent of calcium in Badahar, Kutmiro, and Kabro, respectively. The recorded calcium content in the present study was higher compared to the reported by the Upreti and Shrestha (2006).

Phosphorus: Phosphorus is the structural component for plant which regulates the protein synthesis. A review of phosphorus content of the Badahar, Kutmiro and Kabro revealed that the value could be 0.27%, 0.34%, and 0.25 %, respectively as reported by (Upreti and Shrestha, 2006).

Total ash: The mean total ash content of fodder tree differed significantly ($p<0.001$) among the treatments considering fodder trees species. Total ash ranged from 7.45% to 11.07 % of the selected fodder tree species. Accordingly, the ash content of Badahar and Kabro was similar (11.07 % and 11.92 %) whereas the total ash content in Kutmiro was 7.45 percent (Figure 2). Subba (2098) had reported that the total ash content of Kutmiro was 6.7 % as compared to 9.3% for Kabro. The value presented in this study was higher than the reported by (Subba, 1998).

Table 1. Chemical composition of selected fodder tree species by age without considering species

Treatments (Age*)	Dry matter (%)	Nutrient composition			Fiber fraction (%)			Mineral Composition (%)	
		Energy (kcal/kg)	CP%	EE %	NDF	ADF	ADL	TA	Ca
Age 1	94.21	3984	11.72	1.831	64.38	59.34	34.86	10.42	2.78
Age 2	94.36	3772	10.74	2.009	65.02	60.78	34.98	10.08	2.83
Age 3	94.01	3910	11.63	1.816	65.14	60.77	34.38	9.92	3.02
SEM ±	0.41	83.70	0.52	0.12	1.02	1.15	1.22	0.26	0.17
P value	NS	NS	NS	NS	NS	NS	NS	NS	NS
LSD (0.05)	1.16	235.00	1.46	0.34	2.87	3.25	3.44	0.72	0.47
CV %	2.70	12.50	27.60	38.60	9.50	11.50	21.20	7.40	35.50

*Age 1: 3-6 years; Age 2: 7-10 years; Age 3: 11-14 years.
LSD=Least significant difference, CV=Coefficient of variation, SEM=Standard error of mean, and NS=Non significant.

Table 2. Chemical composition of selected fodder tree species with total treatment combination

Treatments	Dry matter (%)	Nutrient composition			Fiber fraction (%)			Mineral Composition (%)	
		Energy (kcal/kg)	CP%	EE %	NDF	ADF	ADL	TA	Ca
T1	93.98	3807	13.09	1.74	55.65	50.08	24.63	11.62	2.38
T2	94.79	3910	12.86	1.52	54.46	50.25	25.12	10.89	2.64
T3	93.89	3372	11.49	1.68	55.78	48.93	24.52	10.69	2.39
T4	94.31	4372	12.07	1.92	71.59	67.42	46.20	7.38	3.48
T5	93.52	4097	11.02	2.17	71.56	67.58	44.56	7.45	3.64
T6	95.11	4389	10.71	1.64	72.55	70.43	50.07	7.50	3.54
T7	94.33	3772	10.00	1.83	65.90	60.52	33.76	12.26	2.47
T8	93.62	3922	10.99	2.33	69.40	64.48	33.47	11.43	2.78
T9	94.08	4171	10.02	2.12	66.74	62.97	30.37	12.06	2.55
SEM ±	0.72	145.00	0.90	0.21	1.77	2.00	2.12	0.45	0.29
P value	NS	NS	NS	NS	NS	NS	NS	NS	NS
LSD (0.05)	2.02	407.10	2.54	0.59	4.97	5.63	5.96	1.26	0.82
CV %	2.70	12.50	27.60	38.60	9.50	11.50	21.20	7.40	35.50

LSD=Least significant difference, CV=Coefficient of variation, SEM=Standard error of mean, and NS=Non significant

Nitrate content of selected fodder tree species

Nitrate content in the tree fodder is a toxic substances to the livestock if fed in large quantities, Nitrate itself is not toxic to livestock but become toxic when reduced to nitrite. Nitrate score of

selected fodder tree species remained statistically similar (p>0.05) among the treatments studied considering fodder trees species. Nitrate score ranged from 1.1 (Badahar) to 1.3 (Kabro). The Kabro had higher nitrate score (1.33) followed by Kutmiro (1.25) and Badahar (1.194) (Table 3).The score 1+, 2+ and 3+ containing nitrate level is less than 1 percent. The analyzed records indicated that selected fodder tree species (Badahar, Kutmiro, and Kabro) are very safe for ruminant feeding. Forages containing less than 5000 ppm (0.05%) are generally considered safe for all the classes of livestock, whereas concentration in the 5000 to 10,000 ppm range should not be fed to pregnant cattle. Higher than the 5000 ppm level in the animal feed are deleterious to the health and productivity of ruminant (Knight *et al.*, 2008).

Table 3. Nitrate score of selected fodder tree species

Treatments (Fodder species)	Nitrate score (1 to 4)
Badahar	1.19
Kutmiro	1.25
Kabro	1.33
SEM ±	0.07
P value	0.42
LSD (0.05 level)	NS
CV %	36.0

LSD=Least significant difference, CV=Coefficient of variation, SEM=Standard error of mean, and NS=Non significant

Table 4. Nitrate score of fodder tree species at different age groups

Treatments (Age)	Nitrate score
Age 1(3-6 years)	1.33
Age 2 (7-10 years)	1.19
Age 3 (11-14 years)	1.25
SEM ±	0.07
P value	NS
LSD(0.05 level)	0.21
CV %	36.0

LSD=Least significant difference, CV=Coefficient of variation, SEM=Standard error of mean, and NS=Non significant

Table 5. Nitrate score of selected fodder tree species with species and age

Treatments	Nitrate score
Badahar×Age 1(3-6 years)	1.25
Badahar×Age 2 (7-10 years)	1.16
Badahar×Age 3(11-14 years)	1.16
Kutmiro×Age 1(3-6 years)	1.33
Kutmiro×Age 2 (7-10years)	1.25
Kutmiro×Age 3(11-14years)	1.16
Kabro×Age 1(3-6 years)	1.41
Kabro×Age 2(7-10 years)	1.33
Kabro×Age 3(11-14 years)	1.25
SEM ±	0.13
P value	NS

LSD(0.05 level)	0.36
CV %	36.0

LSD=Least significant difference, CV=Coefficient of variation, SEM=Standard error of mean, and NS=Non significant

CONCLUSION

Variation among the top ranked fodder tree in nutrient content indicated scope to explore the best species. CP content of Badahar was higher but lower in energy and Ca content indicating that considering only one parameter for feeding animal might cause misleading in nutrient balance. Feeding mixed fodder is safe guard in energy and other nutrients requirements as nutrient content of the selected fodder did not differ significantly with respect to the age and species considered, and findings of this study clearly revealed that commonly grown and popular fodder tree are safe against nitrate toxicity reflecting the need to continue such fodder species in feeding management.

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Forage conservation and its feeding effect on growth performance of sheep in mountain region

L.N. Pandey[1], B.B. K.C.[3], D K Yadav[2] and M.R. Tiwari[1]
[1]Animal Nutrition Division, Khumaltar, Lalitpur
[2]Regional Agricultural Research Station, Khajura, Banke
[3]Goat Research Station, Bandipur, Tanahun
pandey_luma@yahoo.com

ABSTRACT

Winter feed deficit is common; and has a negative impact on animal production. In mountain region, the feed resources are limited with poor quality especially in winter. There is not scientific forage production and conservation practices. Consequently, animal production has been decreasing. Animals are dying due to starvation and malnutrition. Therefore, a study on forage conservation and its evaluation on sheep feeding was carried out at sheep farm of Jumla, Nepal. Exotic forage species i.e., Cocksfoot (Dactylis glomerata) and Rye grass (Lolium perenne) were used to make quality hay. Silage was made by chopped maize fodder mixed with 2% molasses solution. An experiment of 120 days was conducted with CRD to evaluate growth performance of sheep by feeding the hay and silage. Total 16 castrated growing male were selected. These animals were randomly and equally divided for four treatment (Diet) groups' i.e. grazing plus concentrate (control: T0), hay plus concentrate (T1), 1/2 dose hay and 1/2 dose silage plus concentrate (T2) and silage plus concentrate (T3). Result showed that the total dry matter intake (kg/day) in T1, T2 and T3 group were 1.02, 1.14 and 0.95, respectively. In case of average daily gain (g/day), in T0, T1, T2, and T3 were 15.83g, 88.75g, 83.33g and 51.67g which are significantly different between groups. It is concluded that quality hay from Cocksfoot and Rye grass and good silage from maize can be made in Jumla condition and the quality hay and silage could be recommended for sheep feeding in winter feed scarce period.

Key words: Cocksfoot *(Dactylis glomerata)*, Rye grass *(Lolium perenne)*, conservation, hay, silage

INTRODUCTION

Livestock enterprises are becoming less profitable in mountainous districts due to scarcity of forage and fodder particularly during winter and summer. In this scenario, surplus forage production in summer and scientific forage conservation for winter feed might be an important approach to solve the winter feeding. Hay and silage preparation is a common forage conservation method for livestock enterprises in the world. However, there is no practice of silage feeding in Jumla district. Silage is fermented, high-moisture stored feedstuff which can be fed to cattle, sheep and other ruminants (Wood, 1998). Usually, it is made from grass crops, including maize, sorghum or other cereals, using the entire green plant. It is generally considered as a very economical forage source for ruminant diets. Maize silage has been used in sheep diet formulations for many decades with great success. It is best suited to contribute energy (TDN or Calories) to a diet for a ewe (Held, 2012). Generally in sheep diets with high levels of maize silage supplemental sources of protein are needed, soybean meal is the typical protein sources

used to compliment maize silage based diets. Other imbalances found with maize silage based rations include level of minerals especially calcium, it is most practical to offer a commercial sheep mineral salt adlib to compliment the diet formulation. Properly fermented silage and good feeding management are critical for the use of silages in sheep diet formulation. When exposed to oxygen this bacteria population grows rapidly thus increasing the risk for listeriosis "circling disease" (Woolford, 1990 and Ryser *et al*, 1997). Hay making is another method of forage conservation. It is grass, legumes, or other herbaceous plants that have been cut, dried, and stored for use as animal fodder, particularly for grazing animals such as cattle, goats, and sheep. Hay can be used as animal fodder when or where there is not enough pasture or rangeland to graze an animal, when grazing is unavailable due to weather (such as during the winter). Hay production is common practice in Himalayan region of Nepal. But, due to inappropriate method of hay preparation, it is poor in quality. The poor quality hay is dry, bleached out, discolored (no greenish), coarse-stemmed and sometime fungal infected. Hay is a moderate source of protein and energy for sheep and lambs. While good grass hays usually have as much energy as legume hays.

Livestock production in mountain districts has to suffer acute feed deficit during winter from November to April mostly peaking in January-February when snowfall is continue and have a significant negative impact on animal production. The growth of grasses in general is from April to the mid of September, after that growth is totally checked due to frost and extremely cold temperature. However, these districts are very rich for forage particularly during rainy season. Therefore, this paper focused solve winter feed scarcity through forage conservation. For this an experiment was designed to evaluate quality hay and maize silage on growth performance of sheep in Guthichaur, Jumla.

MATERIALS AND METHODS

Study site

The study was carried out at Sheep and Goat Research Program (SGRP), Guthichaur, Jumla situated 19 km east- west of district head quarter at $29^0$15' N/$82^0$2' E and at an altitude of 2700 msl. Rainfall ranges between 1064-1300 mm (June- Sep 85%), temperature goes up to -16^0C, Average relative humidity 65 % and snowfall occurs December to march. The experiments were carried out for 129 days with seven days of adjustment period (December to march, 2014/15).

Fodder production and conservation

An about 0.5 h of SGRP farm land were used for maize fodder production to make silage and about 1 h of SGRP farm land were used for native and exotic (Cocks foot and Rye grass) fodder production to make quality hay. Quality hay was made at SGRP farm from Rye, Cocksfoot and selected native forage species. Forage was cut at flowing period (50-80%), in October and air drying grass in barn. The hay was palatable, soft and greenish with more leafy part then stem part of plant. Similarly, silage was made from tasseling stage of fodder maize. The fodder maize was chopped in small pieces (1inch sized), properly mixed with 2 % of molasses solution and ensiled in trenched silo pit.

Experimental animal

Sixteen castrated Baruwal male sheep of similar age (10-12 months) and weight (20-30 kg) were selected from SGRP farm. These sheep were grouped into four groups, i.e. one control and three treatment groups, by using Complete Randomized Design (CRD) having four in each as replicates.

They were drenched with Fenbendazole @5 mg/kg body weight against internal parasites before experiment. Experimental animals were kept in wooden cage individually and provided different diet with fresh drinking water *ad libitum.*

Experimental diets of the animals

The dry matter requirement of sheep was calculated @ 4 kg per 100 kg body weight. The diet was composed from hay (DM 84%), silage (DM 35%), and concentrate mixture. Concentrate mixture (DM 87%) was made from crushed barley mixed with 2 % mineral mixture and 2 % common salt. Following diets were formulated to the experimental animals (Table 1).

Table 1. Experimental diet composition for feeding experimental animals

Treatment	Experimental diets
T 0	6-7 hour grazing in pasture land of SGRP + 165 g concentrate
T 1	Mixed hay from Cocks foot and Rye grass + 165 g concentrate
T 2	50 % hay and 50 % silage (DM basis) +165 g concentrate
T 3	Maize silage +165 g concentrate

Feeding regime

The animals of the control group were only grazing in SGRP pastureland of severe winter and concentrate feed were supplemented in the morning before grazing. In treatments group, the animals were in stall fed system in SGRP shed. Concentrate mixture was provided to the experimental animals individually once a day in the morning in plastic vessel, whereas fodder (hay/silage) was provided twice a day individually for treatment group. . Experimental animal had free access to drinking water

Observation taken and data analysis

The trial period covered 129 days including the 7-day adaptation period. Quantity of concentrate feed and fodder offered to the animals of treatment groups was weighed daily and refusal was weighed in next morning for calculating total feed intake per day, individually. The body weight of the all experimental animals including control group was measured every 15 days interval before feeding and calculated daily weight gain individually. Statistical analysis of observed data was done by using one way ANOVA, by GenStat Release 10.3DE (PC/Windows) and Microsoft excel.

RESULTS AND DISCUSSION

Feed Intake

Concentrate DM Intake g/ d, hay DM intake g/d, silage DM intake g/d and total DM intake g/d of sheep differed ($P<0.001$) among diet groups (Table 2). The concentrate intake of T1 was significantly higher (143.9 g/d) than T2 (143.1 g/d) and T3 (142.7 g/d). Similarly, total DM intake of T1 (1019.2 g/d) was significantly higher than diet 3(950.6 g/d), but the total DM intake of the T1 and T2 (1003.5 g/m) was not differ significantly.

Table 2. Feed intake levels (g/day) of experimental animals

Feed	T1	T2	T3	P
Concentrate DM intake (g/day)	143.9	143.1	142.7	<.001
Hay DM intake (g/ day)	875.3	416.6	0	<.001
Silage DM intake(g/ day)	0	443.8	808.2	<.001
Total DM intake (g)/day	1019.2[a]	1003.5[a]	950.6[b]	<.001

Growth

Figure 1 show the growth pattern of experimental animals. The result of the experiment showed that significant effect of diet on body weight after 60 days onwards of the experiment.

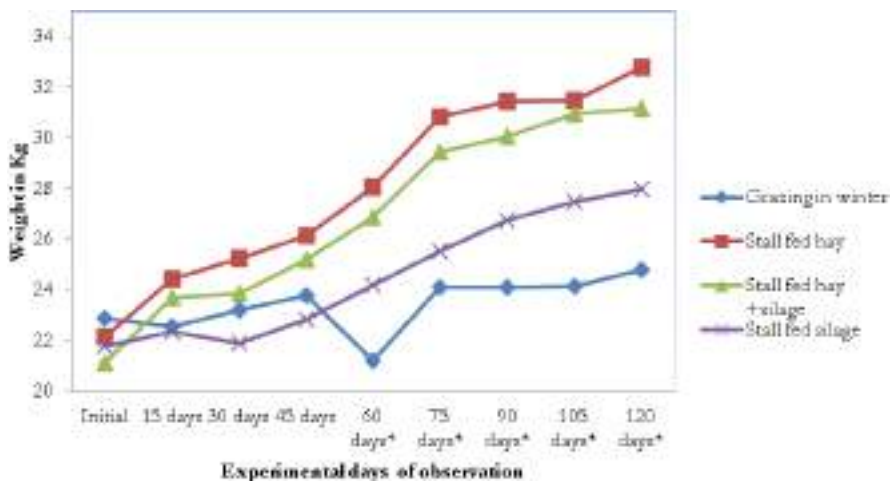

Figure 1. Growth pattern of experimental animals

Table 2 shows that the initial average weight (kg) of experimental animals among treatment groups were not differed significantly (P>0.05). By the end of experiment the final weight (kg) and daily gain (g) among groups were significantly different (P>0.001) where T1 was higher (32.8 kg and 87.92g) followed by T2 (31.15 kg and74.58g), T3 (28 kg and 49.17g) and T0 (24.8kg and 21.67g). Superscripts of the Table 3 also indicated that the final weight and daily gain between T1 vs. T2 and T2 vs. T3 groups were not differed significantly whereas T0 vs. T3 and T1 vs. T3 were significantly different.

It is well-known that animal production from a given feed/forage depends on its digestibility, the quantity consumed by the animal and the efficiency of utilization of the digested fraction by the animal. The second of these factors, feed/forage intake, has received little attention. The voluntary intake of concentrate feed, silage and hay, and their effects on weight gain of growing castrated

male sheep has shown in Table 1. In the experiment, hay and silage were major treatments in the diet of animal where concentrate was constant. The result showed that the treatment hay increased and the treatment silage reduced the total voluntary intakes and concentrate intakes. This difference may be due to differences in the pH of these two treatments, i.e., hay and silage, which is supported by many previous works.

Table 3. Average body weight and daily gain of experimental animal on different diets

Treatments	Initial weight (kg)	Final weight (kg)	Daily weight gain (g)
T0	22.9	24.8^{a}	21.67^{a}
T1	22.15	32.8^{b}	87.92^{c}
T2	21.15	31.15^{bc}	74.58^{bc}
T3	21.8	28^{c}	49.17^{ab}
P	NS	0.001	0.002

A study showed that silage pH is a factor that affects voluntary consumption of maize silage and that pH 5 to 6 is optimum, whereas silage pH above and below may reduce intake. This depression of consumption from ensiling ranges from 4 to 50%, establishing a negative relationship between ensiling and forage intake. Moreover, the voluntary intake of dry matter (DM) from silage by ruminants is less than that of the same crop fed fresh (Dinius, *et al.*, 1968) or as hay (Campling, 1966). The low intake of silages is more likely due to differences in the end products of silage as compared with fresh forages and hays. Researchers have investigated the possible relationship between specific organic acids of silage and low intake of silages. There are two major compositional changes during ensiling are degradation of plant proteins to non-protein nitrogenous compounds and conversion of water-soluble carbohydrates to short-chain organic acids, which decreases pH of silage (Thomas *et al.*, 1980). These two changes may have a marked influence on the nutritive value of ensiled maize, since there is evidence with grass silages that the level of free acidity (McLeod *et al*., 1970), the level of acetic acid and the content of ammonia-N (Wilkins *et al*., 1971) can influence voluntary intake. Silage pH or free acid content has been suggested as a possible inhibitor of silage intake (Vetter and Von Glan, 1978)

The most critical factor in meeting nutrient requirements of a grazing ruminant is knowledge of how much it will voluntarily consume. Variation in voluntary forage intake is undoubtedly the major dietary factor determining level and efficiency of ruminant production (Allison, 1985). The results (Table, 2 and Table 3) of experiment conducted in SGRP showed that positive linear correlation between feed intake and growth where control group (grazing in winter pasture) had lowest voluntary intake and consequently lowest growth performance. Similarly in hay fed group had highest voluntary intake and highest growth performance. The results are supported by this concept that if an animal could eat enough, it could satisfy its nutrient requirements on low-quality forages. In addition to support of the results, Crampton (1957) elaborated that the value of forage in animal production depends more on the amount consumed than its chemical composition. This concept led to the nutritive value index for forages, based on their voluntary intake and digestibility.

A recent study (Luims, 2011) at Ridge Town College looked into maize silage inclusion rates in market lamb rations. In this study, lambs were divided into 3 groups and fed diets containing 0%, 25% or 50% corn silage on a dry-matter basis. It was suggested that keeping corn silage at a level less than 50% of a ration on a dry-matter basis does not affect growth rates and intakes. Similar result has been found (Table, 3) in this study, where 50 % silage included T2 was not differing significantly with diet without silage (T1) and 100% silage feeding (T3) gave significant lower growth performance than T1.

CONCLUSION

Winter feed scarcity is one of the major challenges to livestock production in mountain district. Hence, forage conservation practice is might be only an option to manage livestock feeding for this, It is concluded that quality hay from Cocksfoot and Rye grass and good silage from maize can be made in Jumla condition. Feeding quality hay or mixed of hay and silage where silage at a level less than 50% of a ration on a dry-matter basis with concentrate supplementation can recommend for acceptable growth performance of sheep in severe winter.

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Management practices adopted by commercial tomato growers against *Tuta absoluta*

D. Joshi[1], B. P. Rajbhandari,[1] B.P. Bhattarai, [1] and L. Sah[2]
[1]HICAST, Kalanki, Kathmandu
[2]International Development Enterprises (iDE), Kathmandu, Nepaldivya
divyananu993@gmail.com

ABSTRACT

Tomato (Solanum lycopersicum L.) is one of the most important vegetable crops having great potential to income and employment generation to small-holders in Nepal. Potential production of this crop is limited by several biotic and abiotic factors. Among several insect pests tomato leaf miner (Tuta absoluta) has become increasingly important nuisance pest in Nepal. The field study was carried out from January to April 2017 to analyze the damage and management practices against Tuta absoluta (Tomato leaf miner) adopted by commercial tomato growers in Kathmandu, Lalitpur, Bhaktapur and Kavre districts by purposively selecting 203 households. Comparing 2015 and 2016 year tomato yield data there was huge loss in production. At first, farmers didn't know the pest management aspect so production was very low. In almost all study sites, Tuta asbsoluta outbreak was observed. Insect pests' population and diseases were found decreasing due to the improved cultivation practices and integrated pest management practices. Average loss percent in yield due to Tuta absoluta was 42.33 percent in Kathmandu, 47.16 percent in Bhaktapur, 50 percent in Lalitpur and 57.51 percent in Kavre district. Majority of the respondents in Kathmandu (55%) were using chemical pesticide plus bio- pesticides for the management of tomato leaf miner while 35 percent of respondents were using only chemical pesticides. Many respondents in Bhaktapur (45%) were using only chemical pesticides while 40 percent of respondents were using chemical plus biopesticides. Whereas in Lalitpur, 43 percent were using chemical pesticide and biopesticides for the management of tomato leaf miner; and only 31 percent of respondents were using only chemical pesticides. The chemical pesticides used included Emar, King Hunter, Kingstar, Alcora, and Biopesticdes like Dadagaurd and sex pheromones was also used. The IPM trained farmers were much aware about the safety wares.

Key words: *Lycopersicon esculentum*, *Tuta absoluta*, invasive pest, pesticides, biopesticides

INTRODUCTION

In different ecological zones of Nepal, different kinds of crops are being grown (Adhikary and Adhikari, 2014). Among them Tomato (*Lycopersicon esculentum*) is one of the most important vegetable crops grown from subsistence to commercial scale in Nepal. Vegetable is cultivated in 254,932 ha in Nepal (ABPSD, 2012/2013). Among the vegetables, tomato is cultivated in 19,726 ha in Nepal with a total production of 298,594 MT tons (ABPSD, 2012/2013). In Kathmandu, Bhaktapur, Lalitpur and Kavre districts tomato is cultivated in 210; 152; 138; and 2530 ha, respectively with a total production of 2025 MT, 8360 MT, 4140 MT, and 24035 MT, respectively (ABPSD, 2013/2014). Potential production of tomato is limited by several biotic and abiotic factors. Among several insect pests tomato leaf miner (*Tuta absoluta*) has been increasingly

important nuisance pests (Meyrick, 1917). This is considered as one of the invasive insect pests of tomato in Nepal. Its infestation has been reported across the polyhouse tomato cultivation in Nepal mainly in the vicinity of Kathmandu valley. It mines tomato fruits and has very limited options among the growers. The first record of occurrence of this pest in Nepal was reported by NARC from a tomato farm of Tarakeshwor Municipality, (27o43.661' N latitude and 85o18.895' E longitude) of Kathmandu in 2016.The chemical pesticides as well as botanical pesticides can be used to control *Tuta absoluta*. In recent years, there has been a growing IPM movement to reduce the amount of synthetic pesticides keeping in view its negative impact to the environment (Burlakoti and Rajbhandari, 2016). According to a study, only one percent of the total pesticide applied has become effective in controlling pests, remaining 99 percent goes into various environmental systems (Dhaliwal and Arora, 2001). Botanical control is therefore an alternative to chemical control that deserves elaborative research. Various management options are adopted by the farmers as per their perceived knowledge. However most of them are ineffective indicating the need of imparting knows how to them about integrated management of the pest. Most of the tomato growers are unaware about the pest biology thereby consequently the management options. The current study was carried out to quantify the damage caused by the pest *Tuta absoluta;* and to assess the management practices adopted by commercial tomato growers against tomato leaf miner on Kathmandu valley and Kavre district.

MATERIALS AND METHODS

Kathmandu, Bhaktapur, Lalitpur and Kavre districts were selected for the study because tomato is grown there commercially; and most of the farmers had problems of *Tuta absoluta* in their field. The study was carried out from January to April 2017 to analyze the damage and management practices against *Tuta absoluta* (Tomato leaf miner) adopted by commercial tomato growers.

Tomato growing farmers were the target population for this study. The informal list of tomato farmers in the selected areas was made with the help of DADO and local key informants of respective sites. After that, the respondents were selected randomly by applying random sampling method. Altogether 203 respondents were selected from four districts. The sample size by districts was as shown in Table 1. Sample size differed from from one location to another with the varied total number of commercial growers in each district. Altogether 203 respondents were interviewed for gathering primary information.

Table 1. Sample size distribution in the study area

Districts	Sample size
Kathmandu	75
Bhaktapur	25
Lalitpur	58
Kavre	45
Total	203

The farmers who grow tomatoes in selected districts were the major sources of the primary data which were collected through the pre-tested semi-structured questionnaire based survey. Various published references were reviewed for secondary information. Descriptive statistics like mean, percent, frequency and regression were used with computer software package "MS Excel 2013".

RESULTS AND DISCUSSION

Average loss in yield due to *Tuta absoluta*

According to survey, loss in yield due to tomato leaf miner ranged from 42.3 percent to 57.51 percent (Figure 1). The least yield loss (42.33%) was found in Kathmandu while the highest yield loss was found in Kavre (57.51 %) as compared to previous year (Figure 1). That was primarily owing to the lack of awareness among most of the farmers and poor management practices employed against the pest.

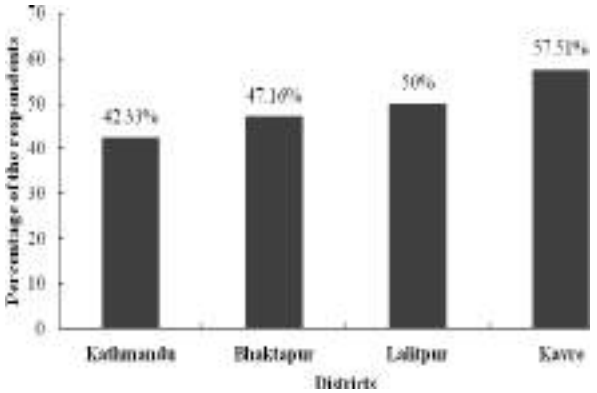

Figure 1. Average loss in yield due to *Tuta absoluta, 2017*

Figure 2. Tuta absoluta and damages caused

Management practices against *Tuta absoluta*

The study revealed that the respondents were adopting different types of method for the management of *Tuta absoluta* like chemical or / and bio- pesticide (including botanical pesticides), pheromones, light trap and net houses. Majority of the respondents (89%) in Kavre were using chemical pesticides whereas respondents using chemical pesticides were about 35 percent, 45 percent and 31 percent in Kathmandu, Bhaktapur and Lalitpur districts, respectively (Figure 3). It should be noted that Kavre is one of the districts where commercial vegetables are grown with discriminate use of pesticides (MOAD, 2016). Around 55 percent, 40 percent, 43 percent and 11 percent of respondents at Kathmandu, Bhaktapur, Lalitpur and Kavre districts, respectively used chemical pesticide (ChP) and biopesticides (BP) in an integrated way for the management of *Tuta absoluta*. While 7 percent, 12 percent, 9 percent were using ChP, BP and

mass trapping methods (MTM) in Kathmandu, Bhaktapur and Lalitpur, respectively. There was no one in Kavre who used these three methods in an integrated way.

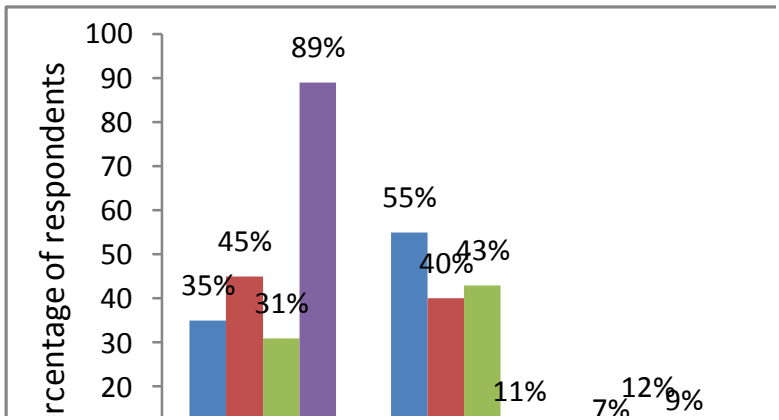

Figure 3. Management methods adopted by respondents in study areas, 2017

ChP = chemical pesticides; ChP +BP = chemical pesticide and bio-pesticide; ChP+ BP + MT = chemical pesticide + bio-pesticide + mass trapping

Regression analysis revealed significantly negative relationship between the dose and use of integrated pesticide use (ChP+BP) and yield loss (Figure 4). Lowest yield loss (42%) was in Kathmandu where 55 percent of the tomato growers used ChP+BP in an integrated way.

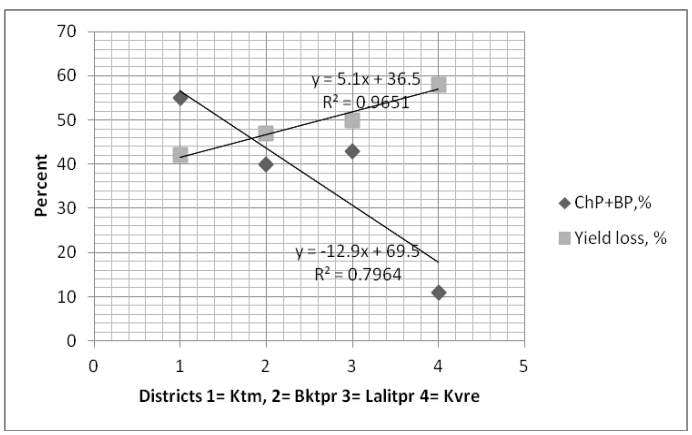

Figure 4. Relationships between the integrated use of ChP+BP and yield loss in study areas, 2017

The highest yield loss (57.8%) was found in Kavre where only 11 percent of the growers used ChP+BP in an integrated way. Yield loss and integrated use of ChP + BP were intermediate in Lalitpur and Bhaktapur districts.

CONCLUSION

Integrated use of safe chemical pesticide, biopesticide and mass traps can be useful in effective management of tomato leaf miner.

This integrated environment friendly approach is recommended to the tomato growers to manage incidence of *Tuta absoluta* in commercial tomato farms.

ACKNOWLEDGEMENTS

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Growth, yield and oil nutrient status of broad leaf mustard *(Brassica juncea var. rugosa)* under integrated nutrient management

K. Rauniyar and B.P. Bhattarai
HICAST, Kathmandu
rauniyar.krish@gmail.com

ABSTRACT

Experiment was conducted to evaluate the effect of IPNM on the growth, yield and soil nutrient status of broad leaf mustard (Brassica juncea var. rugosa) in the farmer's field at Bigam VDC of Dakshinkali municipality located in Kathmandu district during October 2016 to February 2017.The experiment was laid out in a Randomized Complete Block Design. There were 9 treatments viz. T_1 (½ NPK+6 ton/ha vermicompost), T_2 (¾ NPK+3 ton/ha vermicompost) T_3 (½ NPK+12 ton/ha FYM), T_4 (¾ NPK+6 ton/ha FYM), T_5 (½ NPK+2 ton/ha poultry manure),T_6 (¾ NPK+1 ton/ha poultry manure) T_7 (½ NPK+6 ton/ha compost), T_8 (¾ NPK+3 ton/ha compost) and T_9 (Control) with three replications. All the treatments were applied in the month of November. In the study maximum plant height, number of leaves per plant, leaves size, shelf life, yield per plant, yield per plot and yield per hectare were observed with the treatment ¾ NPK+3 ton/ha vermicompost. Similarly, the maximum plant canopy volume was found in the treatment ½ NPK+6 ton/ha compost. The maximum organic matter percentage was recorded in ½ NPK+6 ton/ha compost. The highest soil available nitrogen, phosphorous and potassium were found in the treatment ¾ NPK+1 ton/ha poultry manure, ½ NPK+6 ton/ha compost and ½ NPK+6 ton/ha vermicompost, respectively.

Keywords: Broad leaf mustard, Vermicompost, poultry manure, compost, plant canopy, yield

INTRODUCTION

Leafy vegetables are cheap source of nutrients and can be afforded by all people. When green leaves become food they have a high moisture and fiber content. Water usually makes up between 80-95 percent of leafy vegetables weight. Widely considered to be healthy food, they are high in vitamins and fiber and contain multiple nutrients and phytochemicals. One of the most important and popular leafy vegetable in terms of production includes Broad Leaf Mustard (*Brassica juncea var. rugosa*), which is a cool season crop species of mustard plant and member of Cruciferous family, also called Chinese leaf mustard which is annual, herb producing large broad rosette leaves that can rapidly produce large amount of biomass. It is native to Central and Eastern Asia. It has acquired the status of popular vegetable crop due to its wider adaptability to various agro-climatic conditions. It is grown from Mountainous to Terai geographical regions of Nepal. The strong and pungent taste of broad leaf mustard is highly preferred by the Nepalese consumers. Its popularity could be due to easy cultivation, low production risk, traditional in nature and versatile uses). It is rich in vitamin A, B, C and E; and contains iron, calcium and protein in large quantity. Morphologically the leaves are 40-50 cm long and 20-25 cm wide with flat petioles, light green color, non-hairy, fleshy smooth to crumple with wavy margins.

In Nepal it is commonly called as "Rayo". Broad Leaf Mustard is also consumed as Pickled leafy vegetable (Gundruk) which is popular and claimed to be one of the national dishes. Different varieties of Broad Leaf Mustard are released and registered viz, Marpha Broad Leaf, Khumal Broad Leaf, Khumal Red Leaf, Tangkhuwa, Mike Giant and Red Giant (MoAD, 2016).. In Nepal, it is cultivated in an area of 13,191 ha of land with the production status of 160,761 MT and yield of 12.19 MT/ha ha (VDD, 2015/16).

IPNM implies the maintenance or adjustment of soil fertility and of plant nutrient supply to an optimum level for sustaining the desired crop productivity on one hand and to minimize nutrient losses to the environment on the other hand. It is achieved through efficient management of all nutrient sources. Nutrient sources to a plant growing on a soil include minerals and decomposing soil organic matter, mineral and synthetic fertilizers, animal manures and composts, by-products and wastes, plant residue, and biological N-fixation (Singh *et al*., 2002), For sustainable crop production, integrated use of chemical and organic fertilizer has proved to be highly beneficial.

MATERIALS AND METHODS

The survey was conducted at Dakshinkali municipality, Kathmandu located in the south-west from the capital. The temperature varies from 2^{o} C in winter and 27^{o} C in summer with a rainfall about 120 mm per year.

Nursery bed preparation and seed sowing
Small plot sized of 2x1 m^2 was taken with a height of 15 cm. Initially debris was removed, ploughed and leveling was done along with the application of recommended doses of fertilizers thoroughly. Then seed (variety: Marpha Broad Leaf Mustard) was sown in lines.

Field preparation
The weed stubbles of previous crops were properly removed along with breaking the soil clods into smaller masses and field was leveled.

Selection of plot
Field plots were pegged and separated from each other. Twenty seven plots of equal size were prepared and the treatments were selected on a random basis.

Nutrient source
The Nutrient source used in this experiment were NPK (Urea, DAP, MOP), Vermicompost, Farmyard Manure, Poultry manure, Compost. There were 9 treatments combination (Table 1). The experiment was laid out in a Randomized Complete Block Design with three replications.

Name of variety used as test crop: Marpha Broad Leaf Mustard, recommended for terai, midhills and high hills in Nepal. Leaf is pale green, smooth surface, spineless, fleshy, long, and broad. Harvesting period is 55-65 days after transplanting, yields about 35 ton/ha. It is a very late bolter and has a better cooking quality.

Table 2. Different fertilizers and their combinations

Treatments	Nutrient source
T_1	½ NPK+ 6 ton/ha Vermicompost
T_2	¾ NPK+ 3 ton/ha Vermicompost
T_3	½ NPK+ 12 ton/ha Farm yard manure
T_4	¾ NPK+ 6 ton/ha Farm yard manure
T_5	½ NPK+ 2 ton/ha Poultry manure
T_6	¾ NPK+ 1 ton/ha Poultry manure
T_7	½ NPK+ 6 ton/ha Compost
T_8	¾ NPK+3 ton/ha Compost
T_9	Control (Farmer's practice)

Control: Recommended doses of NPK and FYM in the plot
Area of the experimental plots: 2x2.5 m^2
Recommended dose of fertilizer: NPK: 120:80:60 kg/ha and FYM: 20 ton/ha (Singh and Bhandari, 2015).

Table 3. Nutrient content of organic fertilizers

S.N.	Organic fertilizer	N (%)	P (%)	K (%)
1.	Vermicompost	2	0.8	4.4
2.	FYM	0.5	0.2	0.5
3.	Poultry manure	3	4.2	2.0
4.	Compost	1	0.7	2.3

Source: Khadka (2012)

Time of application
Fertilizers were applied in split doses. Basal doses were applied at the time of transplanting and remaining doses was applied 30 days after transplanting.

Method of application
The required amount of each fertilizers and manures were weighed by weighing balance separately. Organic manures were applied in the field before transplantation by mixing properly with soil. Whereas, the inorganic fertilizers were applied 10 cm away from the plant stem by broadcasting in the plant basin area and hoeing properly.

Transplantation
The spacing was maintained at 45 cm (PP) and 30 cm (RR). Seedlings were transplanted to the experimental plots 25days after sowing when the seedlings had 2-3 true leaves. Transplanting was done in the evening in order to reduce transplanting shock. The seedlings were watered immediately after being transplanted.

Intercultural operations
The details of inter cultural operations carried out during the experiment are;

- **Irrigation**

A pre planting irrigation was given to ensure the optimum moisture content for establishment for seedling. Regular watering per plot per day was given up to seven days and then watering was provided at 7-10 days interval

- **Weeding**

Weeding was done to keep the plots free from weeds, easy aeration of soil, which ultimately ensured better growth and development. Weeding and hoeing was done as when necessary.

Determination of soil nutrient status

In order to characterize the soil of the experimental field, soil sample representing 30 cm deep soil was collected from the experimental plot during the month of January (i.e. just after harvesting the crop). Three samples from each plot were taken to form composite sample. The sample were collected, dried in shade, crushed and then sieved through a 2 mm bronze sieve and stored in cloth bags for laboratory analysis.

Soil organic matter content was estimated by Walkley Black method (Walkley-Black, 1934).

Available Macro Nutrients

a) Available N was estimated by Kjeldahl's method (Jackson, 1975).
b) Available P was estimated by Modified Olsen's method (Olsen *et al.*, 1954).
c) Available K was estimated by flame photometric method (PCARRD, 1980)
d)

Observation

The observation was taken with the respect to biometric measurements (plant height, number of leaves per plant, leaves size, canopy growth and yield). Also, shelf life in room temperature, estimation and analysis of soil organic matter, soil available nitrogen, phosphorous and soil available potassium were carried out.

Statistical analysis

Data were systematically arranged on the basis of various observed parameters. Micro-soft Excel and Genstat (developed by VSN International Ltd) were used for the analysis of variance and other data analysis. The treatments were tested at 5 percent level of significance.

RESULTS AND DISCUSSION

Plant height

The maximum percent increase in plant height as compared to T_9 (Control) was observed in T_2 (18.80 %) followed by T_8 (18.77 %) (Table 3). The best result for plant height was obtained in the combination with ¾ NPK+ 3 ton/ha vermicompost. This might be due to the vermicompost providing nutrients such as zinc, copper, iron in optimum range as well as hold the nutrients accumulated in NPK, so that this combination enhanced the plant growth. Further, data revealed that combining NPK and vermicompost in equal amount give better result compared to other treatment as there might be higher chances of loss of inorganic fertilizer due to leaching and volatilization. This had been supported by Bongkyoon (2004), reported that the plant height of potato was higher in the plots where vermicompost and NPK fertilizer were applied than in the control plot.

Number of leaves/plant

The maximum number of leaves per plant was recorded in T_2 (¾ NPK + 3 ton/ha vermicompost) with value of 13 (Table 3). This might be due to the solubalization effect of plant nutrients by the addition of vermicompost leading to increase uptake of NPK.

Plant canopy volume

The maximum mean value regarding canopy of Broad Leaf Mustard was observed 0.0685 m^3 in the treatment T_7 (½ NPK+ 6 ton/ha Compost) (Table 3). The result showed that the application of 50 percent recommended doses of NPK with compost (6 ton/ha) is better growth in respect to plant canopy. This is because the compost products are rich in plant nutrients and organic matter which can improve plant growth (Wang *et al.*, 2004).

Shelf life in room temperature

Shelf life in room temperature was markedly influence by the various combinations of nutrients which are presented below. The maximum shelf life was 8.67 days recorded in T_2 (¾ NPK+ 3 ton/ha Vermicompost) (Table 3).

Table 4. Plant height, number of leaves per plant, plant canopy and shelf life of BLM

Treatments	Plant height (cm)	Number of leaves/plant	Plant canopy volume (m3)	Shelf life (days)
T1 (½ NPK+ 6 ton/ha Vermicompost)	38.33	11.67	0.0588	7.67
T2 (¾ NPK+ 3 ton/ha Vermicompost)	40.00	13.00	0.0683	8.67
T3 (½ NPK+ 12 ton/ha FYM)	33.67	11.33	0.0469	6.67
T4 (¾ NPK+ 6 ton/ha FYM)	35.67	11.00	0.0575	5.33
T5 (½ NPK+ 2 ton/ha Poultry Manure)	34.67	11.33	0.0513	6.00
T6 (¾ NPK+ 1 ton/ha Poultry Manure)	36.67	12.33	0.0590	7.00
T7 (½ NPK+ 6 ton/ha Compost)	38.67	12.67	0.0685	5.33
T8 (¾ NPK+ 3 ton/ha Compost)	39.99	11.67	0.0637	8.33
T9 (Control)	33.67	10.00	0.0453	5.00
LSD (0.05)	5.134	1.790	0.0323	3.270
F	1.91	2.34	0.62	1.54
CV%	8.4	8.9	32.4	28.3

Leaf size

The highest mean value concerning leaves size of BLM was 1064 cm^2 in the treatment T_2 (¾ NPK+ 3 ton/ha Vermicompost). The minimum value was found to be 443 cm^2 in control (T_9) (Figure 1).

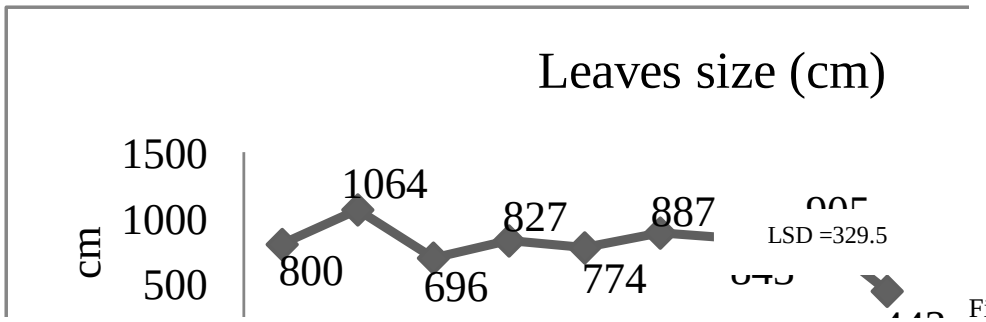

Figure 11. Leaves size (cm)

Yield per plant

The maximum yield per plant was obtained by the application of T_2 (¾ NPK+ 3 ton/ha vermicompost) i.e. 0.1527 kg/plant while the minimum yield per plant was recorded in T_9 (Control) treatment with the value of 0.0813 kg/plant (Figure 2).

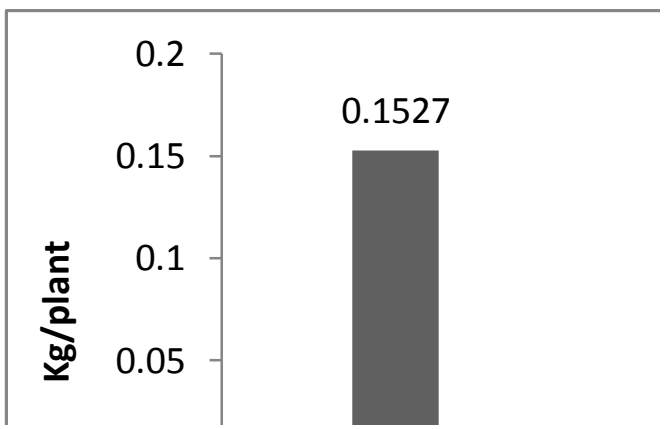

Figure 12. Maximum and minimum yield per plant

The perusal data of yield revealed that the different treatments had significant influence on yield per plot. The maximum yield was obtained by the treatment application of T_2 (¾ NPK+ 3 ton/ha vermicompost) i.e. 8.96 ton/ha while the minimum yield 4.88 ton/ha was recorded in the treatment T_9 (Control) (Table 4). Reasons for increased yield by the application of NPK and vermicompost could be the characteristics of vermicompost that could retain nutrients and increased uptake of NPK. Data recorded on effect of IPNM on morphological and yield contributing parameters of Broad Leaf Mustard suggests that for getting higher yield treatment of vermicompost at ¾ NPK + 3 ton/ha would be most suitable as it resulted in maximum yield/plot as well as yield per hectare, which was statistically higher than all treatments.

These results are in line with the findings of Sharma (2000) in which he found that integration of organic and inorganic fertilizers application significantly increased the head yield over inorganic fertilizers alone and also over control. Present investigation reveals that partial substitution of

inorganic fertilizers through vermicompost is highly effective and higher levels of vermicompost emerged as better organic source over that of farmyard manure.

Table 5. Yield of broad leaf mustard

Treatments	Yield (kg/plot)	Yield (ton/ha)
T_1 (½ NPK+ 6 ton/ha Vermicompost)	3.79	7.58
T_2 (¾ NPK+ 3 ton/ha Vermicompost)	4.48	8.96
T_3 (½ NPK+ 12 ton/ha FYM)	3.07	6.14
T_4 (¾ NPK+ 6 ton/ha FYM)	3.58	7.16
T_5(½ NPK+ 2 ton/ha Poultry Manure)	3.18	6.36
T_6 (¾ NPK+ 1 ton/ha Poultry Manure)	3.97	7.94
T_7 (½ NPK+ 6 ton/ha Compost)	3.42	6.84
T_8 (¾ NPK+ 3 ton/ha Compost)	4.32	8.64
T_9 (Control)	2.44	4.88
LSD (0.05)	1.765	3.530
F	1.19	1.19
CV%	28.5	28.5

Soil characteristics (after harvesting)

Soil organic matter content

Among the treatments, application of T_7 (½ NPK + 6 ton/ha Compost) was found maximum with 3.947 percent organic matter content. However, the minimum percentage of organic matter 3.133 was recorded in T_9 (Control). The maximum percent increase in organic matter as compared to T_9 (Control) was observed in T_7 (17.04%) followed by T_3 (22.34%) (Table 6). The higher organic matter content in compost treated soil is due to the high amount of composted materials like green waste, animal manure, humanure.

Available N

The maximum percent increase in soil nitrogen compared with T_9 (Control) was found in T_6 (44.09%) followed by T_8 (37.13%) (Table 6). The nitrogen content is maximum because in poultry manure most of the N (approximately 60 - 70%) excreted is in the form of uric acid and urea (Shuler *et al.*, 1979) and land applied poultry litter supplies nutrients necessary for crop growth, the most prevalent being nitrogen.

Available P

The maximum percent increase in soil phosphorous compared with T_9 (Control) was found in T_7 (25.98%) followed by T_5 (13.93%) (Table 6). These findings showed that the use of ¾ recommended dose of fertilizers and poultry manure retained the phosphorous in soil because of enzymatic activities of microbial organism. Phosphorous is the constituent of Adenosine Diphosphate (ADP) and Adenosine Triphosphate (ATP), which is absorbed by the plants in the form of H_2PO_4 at lower pH value and in the form of $HPO4^{2-}$ at higher pH (Asthana and Asthana, 2003).

Available K

Likewise, the maximum mean value of available potassium content 467.4 kg/ha was found in T_1 (½ NPK + 6 ton/ha vermicompost) which was followed by mean value of 413.0 kg/ha in T_5 (½ NPK + 2 ton/ha Poultry Manure), 387.9 kg/ha in T_2 (¾ NPK + 3 ton/ha vermicompost) and the minimum content was found in 136.8 kg/ha in T_9 (Control) compared with other mean values of treatments (Table 6). This showed that the combination of NPK and vermicompost gives the best result than their sole use. Potassium is essential to plants for the formation and transfer of carbohydrates in photosynthesis, and also for protein synthesis. It is needed to strengthen the plant's structure.

Table 6. Soil characteristics after harvesting of plants

Treatments	OM%	Available N (Kg/ha)	Available P (Kg/ha)	Available K (Kg/ha)
T_1 (½ NPK+ 6 ton/ha Vermicompost)	3.667	160.2	116.95	467.4
T_2 (¾ NPK+ 3 ton/ha Vermicompost)	3.333	100.6	91.74	387.9
T_3 (½ NPK+ 12 ton/ha FYM)	3.833	180.9	99.76	218.8
T_4 (¾ NPK+ 6 ton/ha FYM)	3.177	125.2	97.68	157.5
T_5 (½ NPK+ 2 ton/ha Poultry Manure)	2.887	217.6	126.65	413.0
T_6 (¾ NPK+ 1 ton/ha Poultry Manure)	2.500	246.4	107.52	375.8
T_7 (½ NPK+ 6 ton/ha Compost)	3.947	219.4	140.05	235.8
T_8 (¾ NPK+ 3 ton/ha Compost)	3.510	234.5	116.36	213.4
T_9 (Control)	3.133	171.0	111.16	136.8
LSD (0.05)	0.2480	11.26	8.747	49.54
F	31.54	177.12	26.88	54.22
CV% (between treatments)	4.3	3.5	4.5	9.9

In FYM, K remains in water soluble forms and thus does not need to be mineralized before available to plant. Here fertilizers like vermicompost makes the plant nutrient accumulated in inorganic fertilizers readily available to the plant and leaching chance is lower so that combination of vermicompost and inorganic fertilizer improve the available potassium in soil.

CONCLUSION

The study was mainly focused on the cultural practices and effect after the application of different treatments in appropriate way. The combined application of ¾ NPK+ vermicompost (T_2) was effective for improving the plant growth, leaf number, leaves size and yield of broad leaf mustard. The most optimum soil pH value (7.0) was recorded with ¾ NPK+ 1 ton/ha Poultry Manure (T_6). Organic matter is improved by the application of ½ NPK+ 6 ton/ha compost (T_7). The maximum available soil nitrogen (246.40 kg/ha) was observed in ¾ NPK+ 1 ton/ha poultry manure (T_6), available phosphorous (140.05 kg/ha) with ½ NPK+ 6 ton/ha compost (T_7) and available potassium (467.4 kg/ha) was found to be maximum with the application of ½ NPK+ 6 ton/ha vermicompost (T_1), respectively. For sustainable crop production, integrated use of chemical and organic fertilizer has proved to be highly beneficial. Several researchers have demonstrated the beneficial effect of combined use of chemical and organic fertilizers to mitigate the deficiency of

many secondary and micronutrients in fields that continuously received only N, P and K fertilizers for a few years, without any micronutrient or organic fertilizer.

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Estimation of genetic parameters and effect of non-genetic factors on weight and reproductive traits of goat from Central Terai region of Nepal

S. Sapkota[1], S. Shrestha[2], N. Amatya Gorkhali[1], N. Bhattarai[3], M. R. Kolachhapati[3] and Y. K. Shrestha[1]

[1]Animal Breeding Division, NARC, Khumaltar, Lalitpur
[2]Central Biological Production Laboratory, Tripureswor, Kathmandu
[3]Agriculture and Forestry University, Rampur, Chitwan
shrestha.sulochana1@gmail.com

ABSTRACT

A research was conducted to evaluate and estimate the effect of various non-genetic factors on the productive performance of goat from central terai region of Nepal during May 2015 to October 2015. Similarly, genetic parameters like heritability, genetic and phenotypic correlation were also estimated. For this, a well managed commercial goat farm of Eastern Chitwan district, at Sirsiyani, Khaireni Municipality-10 was selected. The farm has about 300 numbers of breedable does and 7 bucks of different genetic groups. Data on productive and reproductive traits were obtained by measurements, farm records and direct observation including questionnaire. Least square analysis was performed using Harvey 1990 computer software package based on fixed effect and sire model stated by C R Henderson. The birth weight for 50% Boer cross was found to be highest (2.510±0.13) followed by Chitwan local (2.305±0.11) and full blood Sirohi (2.281±0.21). In addition, 50% Boer cross and 25% Jamunapari cross had 9.759±0.94 kg and 9.522±0.511 kg weaning weight. The sire genetic group (P<0.05), type of birth (P<0.001), and sex of kid (P<0.001) had significant effect on birth weight whereas season of kidding (P<0.001) and parity (P<0.05) had significant effect on weaning weight. The overall least square mean for post-partum estrus (PPE) was 83.268±20.634 days. Heritability estimates for the birth weight and weaning weight are 0.105±0.146 and 0.518±0.44 respectively. Birth weight had positive phenotypic correlation with weaning weight. Thus, the results of this study showed the importance of non-genetic factors on growth traits and for newly established commercial farm, it can be suggested that selection based on the weaning weight could be beneficial for genetic improvement in its initial phase.

Keywords: Genetic, non-genetic, parity, heritability, correlation

INTRODUCTION

Goats are the important livestock commodity of Nepal contributing larger portion with respect to population distribution (10.25 millions) and meat (19% of total meat production) contribution (MOAD, 2015). Along with this, commercialization of goat has started in Nepal with many exotic breeds introduced to produce crossbreds. Due to the inadequate studies on the phenogenetic performances of these goats in our Nepalese situation and in different management condition, the optimum breeding program that a commercial farm should follow for the optimum production is limited. Thus, this study is conducted with the objective of estimating the productive and

reproductive performance of different genetic groups of goat produced through crossbreeding and also to estimate the effect of non-genetic factors on the performance traits at Terai condition.

MATERIALS AND METHODS

A commercial goat farm of Eastern Chitwan district, Janakpur Goat Farm at Sirsiyani, Khaireni Municipality-10 was selected as a study site. The farm has about 300 of breedable does and 7 bucks of different genetic groups. Data on productive and reproductive traits were obtained by measurements, farm records and direct observation including questionnaire. Least square analysis was performed using Harvey (1990) computer software package based on fixed effect and sire model stated by C R Henderson, 1953. The least square means were compared using Duncan's multiple range tests - DMRT computer software (Duncan, 1955). The non-genetic factors considered for the growth performance were dams parity, season of kidding, sire genetic group, sex of kids and type of birth. Similarly, the non-genetic factors related to post partum estrus were parity of dam, body condition score and season of kidding. The farm is performing both natural and artificial insemination. Heritability estimates and genotypic and phenotypic correlation of birth weight, litter weight at birth, litter size at birth and weaning weight were estimated using sire model.

Models used to analyze the collected data

The fixed effect model given by Henderson was used to analyze the weight and reproductive traits.

For example:

1) **Model I (fixed effect model) for birth weight traits**

$$Y_{ijklmnp} = \mu + a_i + b_j + c_k + d_l + f_m + g_n + e_{ijklmnp}$$

Where, μ is the overall mean

a_i is the effect of i^{th} parity (i=1, 2, 3)

b_j is the effect of j^{th} season of kidding (j = 1 and 2)

c_k is the effect of k^{th} sire genetic group (l= 1, 2, 3, 4 and 5)

d_l is the effect of l^{th} sex (k= 1 and 2)

f_m is the effect of m^{th} type of birth (n=1 and 2)

g_n is the effect of n^{th} body condition score (n=1 and 2)

$e_{ijklmnp}$ is the random element (error mean) assumed to be normally and independently distributed among the sampled population

2) **Model II (sire model) for heritability estimates of production traits**

Heritability estimate of some major economically important production traits was determined using the random effect (sire) model.

$$Y_{ij} = \mu + S_i + e_{ij}$$

Where, μ is the overall mean

S_i is the effect of i^{th} sire

e_{ij} is the random element assumed (error mean) to be normally and independently distributed among the sampled population.

RESULTS AND DISCUSSION

The overall mean birth weight of kids in the farm was 2.294±0.120 kg. The sire genetic group (P<0.05), type of birth (P<0.001), and sex of kid (P<0.001) had significant effect on birth weight. Among, the birth weight for different genetic group of goats 50% Boer cross was found to be highest (2.510±0.13) followed by Chitwan local (2.305±0.11) and pure Sirohi (2.281±0.21) as presented in table 1. The overall least square mean of weaning weight was 8.96±0.32 kg. Parity (P<0.05) and season of kidding (P<0.001) had significant effect on weaning weight of kids.

Table 1. Least square means and standard errors for birth weight (BW in kgs) and weaning weight (WW in kgs) of goat kids at Janakpur Goat Farm, Sirsiyani, Khaireni Municipality-10, Chitwan

Factors	LS Mean±SE for BW	LS Mean±SE for WW
Overall mean	2.29±0.11(254)	8.96±0.33(103)
Parity	NS	*
1-2 parity	2.30±0.12(117)	8.30±0.45 (43)b
3-5 parity	2.29±0.12(137)	9.63±0.39(60)a
Sire genetic group (SGG)	*	NS
Boer cross 50%	2.22±0.13(51)bc	8.33±0.57(23)
Boer cross 25%	2.51±0.14(56)a	9.76±0.94(8)
Jamunapari cross	2.16±0.13(72)c	9.52±0.52(27)
Local cross	2.31±0.12(67)b	8.24±0.42(45)
Sirohi 100%	2.28±0.22(8)b	-
Season of kidding (SOK)	NS	***
Dry (Dec-May)	2.34±0.13(118)a	7.79±0.48b
Wet (June-Nov)	2.25±0.12(136)b	10.14±0.40a
Type of birth (TOB)	***	-
Single	2.59±0.13(88)a	-
Multiple	2.01±0.11(166)b	-
Sex of kid	**	NS
Male	2.41±0.12(108)a	9.32±0.47
Female	2.18±0.12(146)b	8.60±0.37

Note: ***: Significant at 0.1% level (P<0.001); **: Significant at 1% level (P<0.01); *: Significant at 5% level (P<0.05); NS: Non-significant at 5% level; Means, within an effect, with the different superscript are significantly different.

The weaning weight was found as 8.333±0.569, 9.759±0.94, 9.522±0.511 and 8.243±0.42 kg of Boer, Boer cross, Jamunapari cross and Chitwan local respectively as presented in table 1. Bhattarai and Sapkota (2011) also found similar mean body weight of kids at birth (2.23±0.04) and slightly higher weaning weight (10.18±0.23) for terai goats at Sihara district. In addition to this, Sapkota (2007) recorded similar birth weights (2.48±0.07) but higher weaning weights

(13.22±0.33) for Chitwan local goats. The non-significant effect could be associated with the intensive husbandry system of the farm thereby minimizing the impact of sire genetic group on weaning weight.

For reproductive parameter, the overall least square mean for post-partum estrus (PPE) was 83.268±20.634 days. Season of kidding (0.001<P>0.05) had significant effect on post-partum estrus. The dams giving birth in the dry season (December-May) had relatively longer (97 days) post-partum estrus than those on wet season (June-Nov) which is relatively shorter i.e. 68 days. Similar days of PPE (87±6) were recorded by Sapkota et al. 2007 during his study in goats of Chitwan districts. Early PPE reduces the kidding interval relating directly to profit.

Table 2. Least square means and standard errors for Post-partum estrus (PPE) of does at Janakpur Goat Farm, Sirsiyani, Khaireni Municipality-10, Chitwan

Factors	No. of Observation	LS Mean	SE of LS mean	Level of significance
Overall mean	153	83.26	2.06	
Parity				NS
1-2 parity	64	77.55	1.29	
3-5 parity	88	65.40	1.38	
Body condition score (BCS)				NS
V (BCS< 2.75)	149	90.00	1.65	
U (BCS>=2.75)	4	76.53	2.98	
Season of Kidding (SOK)				**
Dry (Dec-May)	114	97.69[a]	2.02	
Wet (June-Nov)	39	68.84[b]	2.19	

Note: **: Significant at 1% level (P<0.01); NS: Non-significant at 5% level; Means, within an effect, with the different superscript are significantly different.

Table 3. Heritability estimates and genotypic and phenotypic correlation of birth weight, litter weight at birth, litter size at birth and weaning weight

Factors	Birth weight (BWT)	Litter weight at birth (LWT)	Litter size at birth (LSB)	Weaning weight (WWT)
Birth weight (BWT)	0.105±0.146 (N=254)	-0.473	-0.855	……
Litter weight at birth(LWT)	0.183	0.109±0.15 (N=254)	0.91	……
Litter size at birth (LSB)	-0.462	0.718	0.196±0.224 (N=254)	……
Weaning weight (WWT)	0.269 (N=103)	……	……	0.518±0.44 (N=103)

Note: Estimates of heritability (diagonal), genotypic correlation (above diagonal) and phenotypic correlation (below diagonal).

Heritability estimates for the birth weight, litter weight at birth, litter size at birth and weaning weight are 0.105±0.146, 0.109±0.150, 0.196±0.224 and 0.518±0.44 respectively. Birth weight had negative genetic correlation with litter weight and litter size at birth whereas birth weight had positive phenotypic correlation with litter weight at birth and weaning weight. Birth weight had negative phenotypic correlation with litter size at birth. Litter weights at birth and litter size at birth were positively phenotypically correlated. Litter size at birth and litter weight at birth had positive genetic correlation.

CONCLUSION

Low heritability of birth weight and litter traits in this commercial farm could be attributed to the changing micro-environment, especially during its initial years of establishment where there is more frequent changes in management practices while seeking for the management of input and environment factors for optimum production. Proper recording and utilization of these records in selection of goats in the farm in the subsequent days will help to improve the production. For newly established commercial farm, like this, it can be recommended that selection based on the weaning weight could be beneficial for genetic improvement in its initial phase. Veterinary care and breeding management needs to be strengthened along with other management practices to improve the overall productivity of the farm.

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Agro-morphological performance of maize inbreds

H. P. Sharma[1], J. Shrestha[1], S. Karki[1], J. Upadhyay[1] and Y. R. Dhakal[2]

[1]National Maize Research Program, NARC, Rampur, Chitwan
[2]District Agriculture Development Office, Kaski, Pokhara, Nepal
harisharma.ag@gmail.com

ABSTRACT

A field experiment was conducted at National Maize Research Program, Rampur, Chitwan, Nepal during winter season from 6th October, 2015 to 5th March 2016 to estimate agro-morphological performance of maize inbred lines. Thirteen maize inbreds were tested in randomized complete block design with three replications. The agro-morphological performances were estimated for plant height, ear height, tasseling days, silking days, ear length, ear diameter, number of kernel rows per ear, number of kernels per row, test weight and grain yield. There were highly significant variations among the tested genotypes for grain yield and other agro-morphological traits which indicated presence of high magnitude of genetic variations. The inbreds RL-153, RML-86, RML-17, NML-2 and RML-85 had produced maximum grain yield 2106, 2058, 1909, 1759 and 1630 kg ha^{-1}. They had manifested superiority in all agro-morphological, yield and yield attributing traits. Thus, they were regarded as ideal maize inbreds to be candidates for hybrid, synthetics and composite varieties development.

Key words: Maize inbreds, agro-morphological and grain yield.

INTRODUCTION

Maize (Zea mays L.) also known as corn, is the only cereal crop of American origin that is cultivated in tropical and subtropical regions throughout the world. Maize is currently produced on nearly 100 million hectares in 125 developing countries and is among the three most widely grown crops in 75 countries (FAO, 2010). In Nepal the area and productivity of maize was 8.823 million hectare and 2.43 mt ha^{-1} respectively (MoAD, 2015). Similarly, the seed replacement rate is also low in maize (11.3%) in Nepal (Pokharel, 2013). It is reported that the demand for maize has been growing by 5% over the last decade (Sapkota & Pokhrel, 2010). It contributes to about one fourth part out of total cereal production, 6.54% in AGDP and 3.15% in GDP (MoAD, 2013). It has already covered approximately 80 and 10 percent of maize production, respectively in Terai and mid hills (Adhikari, 2014). Hybrid maize concealed around 7% to 10% percent area of Nepal in 2010 (Gurung et al., 2011 & Thapa, 2013) and area under hybrid maize is increasing every year. Nepal imports almost 20% of corn seeds every year (Adhikari, 2014) and nearly 100% of hybrid seed is being imported from India (Gurung et al., 2011). However, nearly 40% to 45% of maize grains used in feed industries are being still imported from India every year (CDD, 2013).The development of inbred lines is the prime step in maize hybrid, synthetic and composite variety production. Inbreds are also extensively used for the development of linkage maps (Burr et al. 1988), quantitative trait locus mapping (Austin, 2001), molecular evolution (Ching et al., 2002), developmental and physiological genetics (Fowler & Freeling, 1996) as well as phenotype-genotype association analyses and estimation of linkage disequilibrium in maize (Remington et al., 2001 & Liu et al., 2003). Assessing genetic variability of inbred lines is essential in identifying the best parental combinations for creating hybrids, synthetic and composite

populations superior and with significantly higher yield compared to their parents. Inbreds can also be useful in describing heterogroups and defining core subsets selected for specific traits and for estimating possible loss of genetic variation during selection or conservation process (Lu et al., 2009).

Kim et al. (1999) noticed that several maize inbred lines that were developed over time have been used as parents of successful commercial hybrids synthetic and open pollinated varieties development. Inbred lines should thus be evaluated in crosses with known testers to determine the breeding values of the lines in hybrid breeding programs (Hallauer et al., 2010). Adetimirin et al. (2008) concluded that the inbred lines of temperate origins have been utilized in crosses with tropical germplasm and new inbred lines with better adaptation and good tolerance/resistance to biotic and environmental stresses have been developed from resulting populations. Clearly defined heterotic groups of maize inbreds with diverse genetic backgrounds will help maximize exploitation of heterosis in hybrids and identify new productive inbred lines it will also assist in identifying lines that possess novel alleles for introgression (Kanyamasoro et al., 2012).

MATERIALS AND METHODS

The field experiment was laid at the research farm of National Maize Research Program (NMRP) of Rampur, Chitwan, Nepal from first week of 6 October, 2015 to 5 March, 2016. The mean maximum and minimum temperature was 27.32 and 14.33 respectively. The total rainfall during crop growing season was 95.66 mm. The experiment was laid out in randomized complete block design (RCBD) with three replications consisting of 13 inbreds. The plot size was 2 rows of 3 m length and spacing was of 60 cm × 25 cm. The gross plot size was 140.4 m^2 and individual net plot was 3.6 m^2 (3 m × 1.2 m). The soil texture was sandy loam and slightly acidic. The FYM @ 10 t/ha and 120:64:40 kg NPK/ha was applied in the experiment. Half nitrogen and full dose of phosphorous and potash (60:60:40 kg N_2, P_2O_5 and K_2O per ha) was applied during sowing. Remaining dose of nitrogen is splitted into 2 parts and top-dressed during 30 DAS and 45 DAS. Data was recorded on grain yield. Grain yield per hectare was calculated by converting yield per plot into grain yield per hectare. Yield per plot was converted to 15% moisture level. Collected data were subjected to descriptive statistics and cluster analysis using MINITAB Ver. 15 statistical software (Mekbib et al., 2009).

Table 1. List of inbreds used in the experiment

S.No.	Genotypes	Parentage line
1	RML-95	PUTU-17
2	RML-96	AG-27
3	RML-32	CA00320
4	RML-5	CA00314
5	RL-105	UPAHAR-B-20-2-4-1-1
6	RML-98	L-3
7	RL-153	POOL-21-12-1-2-1-1-1
8	RML-115	PUTU-17
9	RML-85	PUTU-14
10	RML-86	PUTU-20

11	NML-2	CML-430
12	RML-4	CA00326
13	RML-17	CML-287

The statistical package MSTAT-C was applied to analyze data (Russel & Eisensmith, 1983). The significant differences between treatments were determined at probability level of 0.01 or 0.05 using least significant difference (LSD) test.

RESULTS AND DISCUSSION

Analysis of variance revealed that in tested inbred lines the plant height, ear height, ear length, ear diameter, number of kernel row per ear, number of kernel per row and grain yield were highly significant. Similarly, days to 50% silking, days to 50% tasseling, and disease scoring was significant only but non-significant result exhibited in anthesis silking interval, insect scoring and test weight (thousand kernel weight). Table 2 revealed that RML-85 manifested highest plant height (133cm) followed by RML-98 (128 cm) while inbred RML-4 exhibited the lowest plant height (82 cm). Maximum value of ear height was found in RML-85 (90.33cm) while minimum value was recorded in RML-32 (45 cm). Dirac et al. (1999) reported that significant amount of variability among long and short stature maize populations for ear and plant height. Similarly, highest value of silking was given by RML-4, RML-95 and RML-17 (60 day) and lowest value in RL-153 (43 day). There was variation in tasseling day, the highest in RML-17, RML-95 (57 days) and lowest in RL-153 (41 day). The highest Anthesis silking interval was recorded in RML-32 and RML-95 (3.6 day) while RL-153 was the lowest ASI (2 day). Ihsan et al. (2005) have also reported significant amount of variability for days to anthesis among different maize genotypes. Severity scale for northern leaf blight was recorded highest in RML-4 and RML-17 (2.5 scale) while other inbreds has the least. Similarly, the genotype RML-32 and RML-115 was high infestation (4.67 scale) while other genotypes had the low infestation. There was huge variation in number of kernel per row, the highest number of kernel per row was found in RML-96 and RML-85 (22.33cm & 18.67 cm) whereas lowest number of kernels per row (7.0) was found in RML-32. RML-153 and RML-96 had the highest number of kernel rows per ear (14) while RML-32 had the lowest value (6.0). Highest ear length was recorded in RML-153 (15 cm) while RML-115 had the lowest ear length (7.47 cm). Similarly, maximum ear diameter was measured in RML-153 (4.5 cm) whereas RML-32 exhibited the lowest (2.32 cm). There was large variation was recorded in test weight; RML-4 manifested maximum test weight (216.3 g) while RML-115 obtained the lowest (162.3 g) test weight. Highest and lowest grain yield (2106 & 755 kg was recorded in genotypes RML-153 and RML-5, respectively. Shah et al. (2000) also reported significant amount of variability for different morphological traits in maize.

Out of eleven inbreds viz., RL-153, RML-86, RML-17, NML-2 and RML-85 had yield between > 1630 kg ha^{-1} to < 2106 kg $ha^{-1.}$ Inbreds namely RML-98, RML-95, RML-115, and RML-4 had yield between >1086 to <1313 kg ha^{-1}. Above parents are regarded as best parent had medium plant height and ear height, with lesser ASI, less infestation of disease and insect, early maturity, long ear type, medium ear diameter high yielding among inbreds. They are desirable traits for ideal maize inbred lines to be candidates for hybrid, synthetics and composite varieties development. High magnitude of variability for agronomic traits in inbreds was also supported by findings of previous studies (Dijak et al. 1999; Ihsan et al. 2005; Miguel et al. 2008; Ranatunga et al. 2009 & Shrestha, 2013). Gurung et al. (2009) also noticed similar findings.

Clustering pattern of genotypes under this study revealed that all inbreds showed considerable genetic and phenotypic diversity among themselves by inhabiting three different clusters (Table 3). Singh et al. (2005) reported similar result in maize. These genotypes were grouped based on three cluster on the basis of morphological and yield attributing traits mainly plant height and ear height, days to 50% tasseling and days to 50% silking, anthesis silking interval, disease scoring, insect scoring, ear length, ear diameter, number of kernel row per ear, number of kernel per row, test weight and grain yield. The values fall within clusters presented in (Table 4).

Table 2. Summary statistics of inbreds

Inbreds	PH	EH	DTT	DTS	ASI	DSC	ISC	EL	ED	NKR/E	NK/R	TW	GY
RML-4	82	49	56.33	60.33	4	.333	4	9.03	3.38	12.67	15.67	216.3	1086
RML-17	13.3	81.67	57	60.33	3.333	.333	4	11.47	3.7	11.33	15.67	195	1909
RML-95	24.3	74	57	60.67	3.667	1.5	2.67	8.53	3.6	13.33	18.33	171.7	1253
RML-96	30.7	75.33	48.33	51.33	3	1	2	12.13	4.233	14	22.33	182.7	2058
RML-32	96.7	45	49	52.67	3.667	.333	4.67	7.72	2.5	6	7	200	845
RML-5	14.3	56.67	48.67	51.33	2.667	1.5	3.33	9	3.167	10	12.67	171.7	755
RL-105	121	70.67	55.67	58.67	3	1	3.33	7.67	2.967	10.67	10.33	186.7	872
RML-98	28.3	74	54	56.33	2.333	1.5	4	8.83	3.833	12.67	13.67	203.3	1313
RL-153	23.3	84	41	43	2	1	3.33	15	4.533	14	27.67	203.7	2106
RML-115	03.3	58.33	45.67	48.33	2.667	.333	4.67	7.47	3.333	10.67	10.67	162.3	1129
RML-85	33.3	90.33	48	51	3	.333	3	9.27	4.02	14	18.67	187.7	1630
RML-86	12.3	65.67	54.33	57	3.333	2.5	3.33	7.64	2.967	12	13.33	169.3	902
IML-2	18.3	80.33	51	54.33	3.333	.333	4	10.97	3.9	12.67	14.67	168	1759
Grand mean	15.5	69.6	51.23	54.26	3.08	1.38	3.56	9.59	3.54	11.85	15.44	186	1355
-test	**	**	ns	*	ns	*	ns	**	**	**	**	ns	**
SD0.05	16.4	11.0	10.0	10.1	1.2	0.7	1.9	2.1	0.6	2.6	6.0	42.9	524
V %	8.5	9.4	11.7	11.1	24.2	30.5	32.9	13.3	10.4	13.5	23.1	13.7	23

** Significant at 0.05 level of significance, ** Significant at 0.01 level of significance, ns=non-significant.* PH= plant height (cm), EH= ear height (cm), DTS= days to 50% silking, DTT= days to 50% tasseling, ASI= anthesis silking interval, TW= test weight (1000 kernel weight) (g), EL= ear length (cm), ED= ear diameter (cm), NKR/E= number of kernel row per ear, NK/R= number of kernel per row, GY= grain yield (kg).

Table 3 manifested that the inbreds had been classified into three heterotic groups. Cluster I comprised of 1 genotypes, while clusters II and III comprised of 8 and 4 genotypes, respectively. Among the clusters, they were allotted based on the mean cluster distance. The genotypes allotted in cluster I and III were highly dissimilar. As suggested by Betrán et al.

(2003) these two groups could be evaluated for their combining ability and could be used as parents in heterosis breeding programmes. Cluster II had medium plant height and ear height, with lesser ASI, less infestation of disease and insect, early maturity, long ear type, medium ear diameter high yielding among inbreds. They are desirable traits for ideal maize inbred lines to be candidates for hybrid, synthetics and composite varieties development. Those inbreds were RML-17, RML-95, RML-96, RML-98, RL-153, RML-115, RML-85 and NML-2. Similar clustering patterns were reported by (Gethi et al. 2002). Cluster analysis is frequently used to classify maize (*Zea mays L.*) accessions and can be used by breeders and geneticists to identify subsets of accessions which have potential utility for specific breeding or genetic purposes (Rincon, 1996).

Table 3. Distribution of inbreds in clusters

Cluster I	Cluster II	Cluster III
RML-4	RML-17, RML-95, RML-96, RML-98, RL-153, RML-115, RML-85 and NML-2	RML-32, RML-5, RL-105 and RML-86

CONCLUSION

The findings of this experiment revealed that there were significant variations among the tested genotypes for grain yield and other agro-morphological traits which indicated presence of high magnitude of genetic variations. The inbreds RL-153, RML-86, RML-17, NML-2 and RML-85 had produced maximum grain yield viz., 2106, 2058, 1909, 1759 and 1630 kg ha^{-1}. Above parents are regarded as best parent had medium plant height and ear height, with lesser ASI, less infestation of disease and insect, early maturity, long ear type, medium ear diameter high yielding among inbreds. They are regarded as ideal maize inbred lines to be candidates for hybrid, synthetics and composite varieties development. These conclusions can only be preliminary and further studies need to conduct at field condition for further recommendation.

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Correlation and path coefficient analysis of early maize genotype in Western Hill of Nepal

B. P. Kandel[1], A. Poudel[1], S. Sharma[1]and M. Subedi[2]
[1]Institute of Agriculture and Animal Science (IAAS), Tribhuvan University, Lamjung Campus, Sundar Bazaar, Lamjung, Nepal
[2]Nepal Agricultural Research Council (NARC), Regional Agricultural Research Station (RARS), Lumle, Kaski, Nepal
bkandel33@gmail.com

ABSTRACT

Coordinated varietal trail of early maize (Zea mays L) was carried out at the research block of RARS Lumle, Kaski, Nepal with an objective to study the character association between yield and yield related component of early maize from June 2016-Oct 2016. The experiment was laid out in randomized complete block design having eleven maize genotypes with three replications. Grain yield has positive and significant correlation with ear diameter, ear length, thousand kernel weight, days to physiological maturity, tassel length, ear weight, whereas plant height, number of kernel per row, ear per pant, ear height, leaf width, days to 50% silking and tasseling were positive non-significant association with grain yield ton ha^{-1}. Path analysis revealed that ear height, ear weight, ear diameter, days to maturity, thousand kernels weight, numbers of kernel per row, ear per plant, tassel length and days to 50% silking direct contribution to grain yield ton ha^{-1}, Whereas the remaining characters exhibited negative direct effect on grain yield per hectare.

Key word: Correlation coefficient, direct & indirect effect, early maize (*Zea mays* L.), Path coefficient analysis

INTRODUCTION

Maize is the third most important cereal food crop of the world after wheat and rice. It is an important staple food crops and provide bulk of raw materials for the livestock and many agro-allied industries in the world. Maize ranked in the second position after rice in term of area and production in Nepal (Adhikari, 2007). At present, the maize sown area in Nepal is 882,395 ha with a total production of 2,145,291 metric tons and productivity of 2.43 ton ha-1 (MOAD, 2014/15). In Nepal maize is one of the most important staple food crop of mountainous people and can be used for feed and fodder purpose. For planning yield improvement program, the knowledge of relationship between yield and yield component are important. Studies on correlation coefficients of different characters are useful criterion to identify desirable traits that contribute to improve the grain yield in breeding program. Therefore, correlations between yield and different yield component are an aspect, which should be kept in mind for planning yield improvement program. Path coefficient which is a standardized partial regression coefficient (Wright, 1921) and (Dewey and Lu, 1959) helps to understand various paths, i.e., the magnitude of direct influence of each character and the indirect influence through other characters. So, correlations in combination with path coefficient analysis are an important tool to find out the association and quantify the direct and indirect influences of yield contributing characters on grain yield. Hence, an attempt was carried out to study the association of grain yield and yield component of early maize

genotype to determine the correlation coefficient along with path value, showing the extent of direct and indirect effect of various yield component on grain yield of early maize.

MATERIALS AND METHOD

Coordinate varietal trail of early maize genotype was carried out at Regional Agriculture Research Station Lumle ,Kaski, during June 2016-Oct 2016 .The station is situated at an altitude of 1740 meters above mean sea level in the south facing slopes at 28.297607° north and 83.816754° east coordinates. Eleven maize genotype (viz. EARLY MID KATAMARI, RAJAHARLOCAL, S97TEYGHAYB (3), POP-445/POP-446, COMPOZ-NIPB, R.C/POOL17, SO3TETEY/LN, ARUN-4 (standard check), FARMERS VARIETY (MANAKAMANA-5), ZM-621/POOL-15, EEYC1) was laid out in Randomized Complete Block Design with three replication. The experiment was planted by using crop geometry of 75cm*25cm (RR*PP) .Each genotypes received the plots of 9 m^2 area with the net plot area of 99 m^2 per block/replication. Initially two seeds per hill were sown and later on one plant was thinned to maintain single plant per hill. Two border rows were also planted to avoid the border effect. Agronomic practices were followed as per the recommendation of National Maize Research Program (NMRP), Rampur .All the data were obtained from central two row i.e. sample row from fifteen randomly selected plant except for 50% tasseling, 50% silking and days to physiological maturity .Yield and yield component trait like; 1000 kernel weight(gm) with moisture adjustment at 15%, number of kernels per row, number of kernel rows per ear, ear length(cm), ear diameter(cm), ear weight(gm), plant height (cm), ear height(cm), ear per plant , tassel length(cm), leaf width(cm) ,ear aspect and grain yield(ton ha^{-1}) after moisture adjustment at 15% were taken. Data was statistically analyzes by using computer software's SPSS & MS-Excel.

RESULTS AND DISCUSSION

Correlation between grain yield and other traits

The phenotypic correlation coefficients among yield and yield component are presented in Table 1. The results showed that ear diameter (0.545**), ear length(0.50 7**), thousand kernel weight (0.545**), days to physiological maturity (0.441*), tassel length (0.543**) and ear weight (0.802**) showed significant positive correlation with grain yield ton ha^{-1} ,while plant height (0.190), number of kernel per row (0.530), ear per plant(0.09), ear height (0.303), leaf width (0.110), days to 50% silking(0.010), days to 50% tasseling (0.193) showed non-significant association with grain yield ton ha^{-1}. Ear aspect (-0.409**) was negative and highly significant to grain yield ton ha^{-1}.Negative non-significant association found between grain yield and number of kernel row per ear (-0.205). Ear diameter and thousand kernel weight recorded highest correlation (r=0.545) with grain yield followed by number of kernel per row (r=0.530), ear length (r=0.507), days to physiological maturity (r=0.441) and ear height (r=0.303) present in table 1.

In our study ear diameter, ear length, ear weight, tassel length, thousand kernel weight and days to physiological maturity was positive and highly significant correlated with grain yield ton ha^{-1}. Similar results were reported earlier in maize by several workers on different characters viz., for the association of grain yield with ear length (Berhanu, 2009), ear diameter (Rafiq et al., 2010), ear weight without husk (Ghimire and Timsina, 2014) , 1000 grain weight (Rafiq et al., 2010 and Dagne, 2008), and days to physiological maturity (Habtamu and Hadji, 2010) The results indicated that ear diameter, ear length , thousand kernel weight and Days to maturity are highly correlated with grain yield per hectare and need to be considered for selection.

In our study Grain yield had non-significant correlation with, ear height, number of kernels per row, number of ear per plant, Similar characters results were reported by (Sadek et al., 2006 and Aydin et al., 2007) indicating that selection for increased level of these traits may not bring significant change in grain yield. (Abadassi, 2016) reported ear per plant was positive and non-significant correlated with grain yield ton ha-^{1}which is similar to our finding. Days to 50% silking and tasseling showed positive non -significant association with grain yield, which is similar result was reported by (Selvaraj & Nagarajan, 2011).

In our study ear aspect was negatively and highly significant association with grain yield ton ha^{-1}. Ear aspect was scored on a scale of 1 to 5 where, 1 = clean, uniform, large and well-filled ears and 5 = rotten, variable, small and partially filled ears (UPOV, 2009).With increase in value of ear aspect (i.e. cob is more damage) which ultimately reduced the grain yield.

Table 1. Correlation between grain yield and yield components of eleven early maize genotypes at Lumle, Kaski, 2016.

	PH	ED	EL	NKPR	EPP	KRPE	EH	DTS	TKW	DTT	DPM	GY	EA	LW
PH	1													
ED	-0.300	1.000												
EL	0.238	0.410*	1											
NKPR	0.246	0.294	0.537**	1										
EPP	0.070	0.082	-0.071	-0.038	1									
KRPE	-0.349*	0.336	0.126	-0.301	-0.02	1								
EH	0.918**	-0.289	0.261	0.288	0.13	-0.362*	1							
DTS	-0.157	-0.020	0.326	-0.251	0.12	0.214	-0.113	1						
TKW	0.390*	0.553**	0.437*	0.473	0.02	-0.061	0.378*	-0.129	1					
DTT	-0.032	0.283	0.269	-0.029	0.17	0.100	0.040	0.559**	0.144	1				
DPM	-0.236	0.249	0.473**	0.140	0.05	0.005	-0.087	0.384*	-0.060	0.375*	1			
GY	0.190	0.545**	0.507**	0.530	0.09	-0.205	0.303	0.010	0.545**	0.193	0.441*	1		
EA	-0.327	0.005	-0.476**	-0.365	0.03	0.192	-0.409*	-0.074	-0.224	-0.347*	-0.397*	-0.409**	1	
LW	0.110	0.052	0.140	0.156	0.09	-0.012	0.137	-0.127	0.073	-0.101	0.096	0.110	-0.177	1
TL	0.228	0.342	0.443**	0.453	-0.11	-0.211	0.241	-0.122	0.376*	0.100	0.154	0.543**	-0.310	0.549**
EW	0.092	0.665**	0.553**	0.478	-0.05	0.053	0.094	0.033	0.499**	0.164	0.282	0.802**	-0.297	0.0001

PH= plant height, ED= ear diameter, EL= ear length, NKPR= number of kernel per row , EPP= ear per plant, NKRPE= number of kernel row per ear, EH= ear height, DTS= days to 50% silking, TKW=thousand kernel weight, DTT= days to 50%tasseling, DPM= days to maturity, GY= grain yield, EA= ear aspect ,LW= leaf width,TL= tassel length, EW= ear diameter,*Correlation is significant at the 0.05 level (2 tailed) and** Correlation is significant at the 0.01 level(2 tailed)

Path analysis

Ear height had maxmium positive direct effect on grain yield(0.524) followed by ear weight(0.481), ear diameter(0.310), days to physiological maturity(0.291),tassel length(0.170),days to 50% silking(0.169),thousand kernel weight(0.096), number of kernel per

row(0.087) and ear per plant(0.046). Similar results were reported earlier in maize by several workers on various paths of yield and yield component, direct effect of ear height (Rahman et al., 1995) ear weight (Gautam et al., 1999 & Tiwari and Verma, 1999). ear diameter, ear length and number of kernels per row had the highest effect on yield variation (AL- Ahmad, 2004; Sadek et al., 2006). (Amin et al., 2013) reported days to silking has small amount of direct effect on grain yield t/ha, which is similar to our finding. On the other hand, the high negative direct effect of plant height (-0.255), ear length (-0.282), number of kernel per row (-0.131), ear aspect(-0.094),days to 50% tasseling(-0.195) and leaf width(-0.072) on grain yield. Similar results were reported in previous study of path coefficient of maize grain yield directly affected by Plant height (Parh et al., 1986), number of kernel row per ear (Araias et al., 1999), days to 50% tasseling (Venugopal et al., 2003), leaf width and ear length (Taye, 2014) days to 50% tasseling, number of kernel per row, negative direct effect on grain yield (Selvaraj & Nagarajan, 2011).

Table 2. Path coefficient analysis showing direct (bold) and indirect effect of various traits in grain yield of eleven early maize genotypes at Lumle, Kaski, 2016.

	PH	ED	EL	NKPR	EPP	KRPE	EH	DTS	TKW	DTT	DPM	EA	LW	LT	EW
PH	**-0.255**	0.077	-0.061	-0.063	-0.018	0.089	-0.234	0.040	-0.099	0.008	0.060	0.084	-0.028	-0.058	-0.023
ED	-0.093	**0.310**	0.127	0.091	0.025	0.104	-0.090	-0.006	0.171	0.088	0.077	0.002	0.016	0.106	0.206
EL	-0.067	-0.116	**-0.282**	-0.151	0.020	-0.035	-0.074	-0.092	-0.123	-0.076	-0.133	0.134	-0.040	-0.125	-0.156
NKPR	0.021	0.026	0.047	**0.087**	-0.003	-0.026	0.025	-0.022	0.041	-0.003	0.012	-0.032	0.014	0.039	0.041
EPP	0.003	0.004	-0.003	-0.002	**0.046**	-0.001	0.006	0.005	0.001	0.008	0.002	0.002	0.004	-0.005	-0.002
KRPE	0.046	-0.044	-0.016	0.039	0.003	**-0.131**	0.047	-0.028	0.008	-0.013	-0.001	-0.025	0.002	0.028	-0.007
EH	0.481	-0.151	0.137	0.151	0.067	-0.190	**0.524**	-0.059	0.198	0.021	-0.046	-0.214	0.072	0.126	0.049
DTS	-0.027	-0.003	0.055	-0.043	0.020	0.036	-0.019	**0.170**	-0.022	0.095	0.065	-0.013	-0.022	-0.021	0.006
TKW	0.037	0.053	0.042	0.045	0.002	-0.006	0.036	-0.012	**0.096**	0.014	-0.006	-0.021	0.007	0.036	0.048
DTT	0.006	-0.055	-0.052	0.006	-0.033	-0.020	-0.008	-0.109	-0.028	**-0.195**	-0.073	0.068	0.020	-0.019	-0.032
DPM	-0.069	0.072	0.138	0.041	0.014	0.002	-0.025	0.112	-0.017	0.109	**0.291**	-0.115	0.028	0.045	0.082
EA	0.031	-0.001	0.045	0.034	-0.003	-0.018	0.038	0.007	0.021	0.033	0.037	**-0.094**	0.017	0.029	0.028
LW	-0.008	-0.004	-0.010	-0.011	-0.006	0.001	-0.010	0.009	-0.005	0.007	-0.007	0.013	**-0.072**	-0.040	0.000
LT	0.039	0.058	0.075	0.077	-0.019	-0.036	0.041	-0.021	0.064	0.017	0.026	-0.053	0.094	**0.170**	0.082
EW	0.044	0.320	0.266	0.229	-0.025	0.026	0.045	0.016	0.240	0.079	0.136	-0.143	0.000	0.232	**0.481**
Total	0.190	0.545	0.507	0.530	0.090	-0.205	0.303	0.010	0.545	0.193	0.441	-0.409	0.110	0.543	0.802

PH=plant height, ED=ear diameter, EL=ear length, NKPR=number of kernel per row, EPP=ear per plant, NKRPE=number of kernel row per ear, EH=ear height, DTS=days to 50% silking , TKW=thousand kernel weight, DTT=days to 50%tasseling,DPM=days to maturity, GY=grain yield, EA=ear aspect ,LW= leaf width, TL=tassel length ,EW=ear diameter

Direct contribution of plant height on grain yield was negative i.e-0.255 but indirectly positive contribution to ear height(0.481),number of kernel per row (0.021),number of kernel row per ear (0.046) ear per plant(0.003) and thousand kernel weight (0.037) to the grain yield. Similarly ear length has direct negative contribution to grain yield but indirectly increase ear diameter, ear

height, thousand kernels weight, ear weight which ultimately increase the grain yield. Number of kernel row per ear has to contribution to grain yield. The direct effect of leaf width was negative to grain yield but indirectly positive contribution to number of kernel per row, ear per plant, thousand, kernel weight, leaf width which ultimately increase the grain yield. Ear aspect was direct and indirectly negative contribution to grain yield.

CONCLUSION

To conclude, correlation studies showed that grain yield t/ha having positive association with all character except number of kernel row per ear and ear aspect, as they were negatively correlated**.** The results indicated that ear diameter; ear length, thousand kernel weight and Days to maturity are highly correlated with grain yield per plant and need to be considered for selection. Path analysis revealed that ear height, ear weight, ear diameter, days to maturity, thousand kernels weight, numbers of kernel per row, ear per plant, tassel length and days to 50% silking direct contribution to grain yield t/ha, might be rewarding for yield improvement program since they are reveled true relationship with grain yield.

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Comparative performance of Boer cross breed goat over other local and cross breeds in mid-hills of Nepal

D. Adhikari[1], D. P. Adhikari[1], R. P. Ghimire[1], S. H. Ghimire[1], P. B. Shrestha[1], H. R. Dhakal[1] and S. Sapkota[2]

1 Goat Research Station, Bandipur, Tanahun, Nepal

2 Animal Breeding Division, NARC, Khumaltar, Lalitpur, Nepal

dipsagar95@gmail.com,

ABSTRACT

Productive performance of Boer goat has not been studied well in Nepal which is the popular prolific meat type goat in the world and considered a potential breed to improve the productivity of Nepalese breeds. Hence a research was conducted from April 2013 to August 2015 at Goat Research Station, Bandipur, Tanahun to evaluate the growth performance, kidding rate and adoptability of Boer crossbred over other improved and local breeds of goat. Altogether, 245 kids were born from 175 pregnant does, out of them 37 kids from Khari, 26 from Sinhal, 36 from Barbari, 33 from Jamunapari cross, 35 from Barbari cross, 36 from Kiko cross and 42 from Boer cross were produced and the performance study was taken in these kids. The weight at birth, three month, six month, nine month and one year of Boer cross was 2.22±0.17, 11. 23±2.33, 17.80±3.31, 25.25±4.25 and 33.60±5.29 kg respectively where as in Khari 1.70±0.39, 6.33±2.10, 11.12±3.55, 16.45±3.89 and 21.30±5.01 kg which was significantly different (P<0.001) in ever y month. Likewise, the highest weight gain were obtained of Boer cross from birth to three months, three to six months, six to nine months and nine to twelve months age was 100.11g, 73.00g, 82.78g, 92.78 g/day respectively than local and crossbreds. In case of birth type, the highest triplet (5.41 %) and twin (56.05 %) in Boer cross followed by Khari and lowest in Sinhal, the triplet and twin in Sinhal was 0.00 % and 6.76 % respectively. Similarly, the highest kidding rate in Boer cross (166.87 %) followed by Khari (148.35 %) and lowest in Sinhal (106.76 %). the highest mortality was in Barbari pure (27.78%) followed by Jamunapari cross (15.15%) and lowest in Boer cross (4.76%) and Kiko cross (2.78%).Finding thus revealed potentiality and adoptability of Boer crossbreed in mid hills of Nepal.

Key worlds: Crossbred, productive performance, kidding rate, mortality

INTRODUCTION

Livestock is an important sector under agriculture enterprises in Nepal which contribute 33.1% AGDP (NPPR, 2015). Among livestock species goat farming is an emerging and important enterprise which is used mainly for meat purpose. There are 10.25 million goats in Nepal which produce 59053 MT of meat and accounted for 19.80% of the total meat production of the nation (MOLD, 2015). This production does not meet increasing demand and import from outside the country, especially from India and China due to low producing ability of the indigenous goats as compare to the exotic breeds. To overcome this situation improvement of local breeds through crossing with full blooded Boer goat or developing Nepalese pure Boer goat by upgrading. The Boer goat has faster growth rates and heavier than the Nepalese local goat breeds. The mature

Boer buck weighed in the range of 110-135 kg, and doe weighed around 90-100 kg (RADA, 2010), whereas the adult body weight of Khari goat around 20-40 kg (Joshi and Shrestha, 2003). The daily live weight gain of the Boer goat crossbreds have been found between 100 to 200 g in the farmers field (Pandey, 2008). Similarly, Boer goat and its crosses have 1.63 to 2.2 litter size and the indigenous breed and it's crossbred have only 1.0 to 1.8 (Pandey, 2008). Boer goat possesses strong disease resistance and adaptable to adverse climatic condition and has superior mothering capacity. Hence, this study was undertaken to find out the comparative performance of Boer cross goat with other indigenous and improve cross breeds goat. Similarly, the potentiality of Boer goat and its crossbred to meet the national demand of goat meat through upgrading of indigenous goat breeds.

MATERIALS AND METHODS

Site and animal selection

This study was carried out from April 2013 to August 2015 in Goat Research Station, Bandipur, Tanahun, Nepal. Altogether, 175 pregnant goats of 7 different breeds 25 from each (Khari, Sinhal, Barbari, Jamunapari 50%, Barbari 50%, Kiko 50% and Boer 50 %) were randomly selected. Total 245 kids were born from these goats, out of them 37 kids from Khari, 26 from Sinhal, 36 from Barbari, 33 from Jamunapari 50%, 35 from Barbari 50%, 36 from Kiko 50% and 42 from Boer 50% were produced and the performance study was taken in these kids..

Productive traits of goat

The birth weight, three month weight, six month weight, nine month weight, twelve month weight, birth types, kid mortality and weight gain were measured.

Data Analysis

The data were collected in monthly interval and the growth performance of kids was analyzed by using Gene stat and, birth types and mortality was by using MS-Excel.

RESULTS AND DISCUSSION

Growth performance of kids

This study revealed that the weight at birth, three month, six month, nine month and one year of Boer 50 % was 2.22±0.17, 11.23±2.33, 17.80±3.31, 25.25±4.25 and 33.60±5.29 kg respectively where as in Khari 1.70±0.39, 6.33±2.10, 11.12±3.55, 16.45±3.89 and 21.30±5.01 kg (Table 1) which was significantly different ($P<0.001$) in every month. In case of growth performance of pure Barbari, Kiko 50% and Barbari 50% were not significantly different every year.

Body weight gain of kids

This study found that the highest body weight gain was in Boer 50% then other breeds in every month and lowest in Barbari 50%. The weight gains of Boer 50% from birth to three months, three to six months, six to nine months and nine to twelve months age were 100.11g, 73.00 g, 82.78 g, 92.78 g/day, respectively where as in case of Barbari 50% the weight gain in such period was 51.67 g, 48.00 g, 57.00 g and 49.44 g/day, respectively (Table 2). Jamunapari 50% had medium body weight gain among seven breeds of goat.

Table 1. Growth performance of different goat breeds

Breeds	Body weight (kg), mean ± SD				
	Birth	3 months	6 months	9 months	12 months
Khari	1.70^{c}±0.39	6.33^{c}±2.10	11.12^{c}±3.55	16.45^{c}±3.89	21.30^{c}±5.01
Sinhal	1.94^{b}±0.21	9.21^{b}±2.81	14.43^{b}±3.13	19.32^{b}±4.12	24.65^{b}±4.54
Barbari	1.60^{c}±0.34	6.11^{c}±1.34	10.50^{c}±1.95	15.40^{c}±3.21	20.50^{c}±4.25
Jamunapari 50 %	2.24^{a}±0.58	8.45^{bc}±2.67	14.75^{b}±3.12	19.50^{b}±3.67	25.49^{b}±5.27
Barbari 50 %	1.65^{c}±0.27	6.30^{c}±1.92	10.62^{c}±2.10	15.75^{c}±3.11	20.20^{c}±4.23
Kiko 50 %	1.85^{bc}±0.73	7.63^{bc}±2.27	12.45^{bc}±3.21	17.95^{bc}±3.23	22.84^{bc}±4.61
Boer 50 %	2.22^{a}±0.17	11.23^{a}±2.33	17.80^{a}±3.31	25.25^{a}±4.25	33.60^{a}±5.29
Level of Significance	**	***	***	***	***

Note: ** Significant at 1% level (P<0.01); *** Significant at 0.1% level (P<0.001)

Birth types

In case of birth type, the highest triplet (5.41 %) and twin (56.05 %) in Boer 50 % followed by Khari and lowest in Sinhal, the triplet and twin in Sinhal was 0.00 % and 6.76 % respectively. Similarly, the highest kidding rate in Boer 50 % (166.87 %) followed by Khari (148.35 %) and lowest in Sinhal only 106.76 % (Table 3).

Table 2. Weight gain of different goat breeds

Breeds	Body weight gain (g/day), mean ± SD			
	Up to 3 months	Up to 6 months	Up to 9 months	Up to 12 months
Khari	51.44	53.22	59.22	53.89
Sinhal	80.78	58.00	54.33	59.22
Barbari	50.11	48.78	54.44	56.67
Jamunapari 50 %	69.00	70.00	52.78	66.56
Barbari 50 %	51.67	48.00	57.00	49.44
Kiko 50 %	58.67	59.11	61.11	54.33
Boer 50 %	100.11	73.00	82.78	92.78

Table 3. Birth types of different breeds of goats

Breeds	Single (%)	Twin (%)	Triplet (%)	Kidding Rate
Khari	55.21	41.23	3.56	148.35
Sinhal	93.24	6.76	0.00	106.76
Barbari	58.45	39.46	2.09	143.64
Jamunapari 50 %	69.24	28.37	2.39	133.15
Barbari 50 %	62.45	34.31	3.24	140.79
Kiko 50 %	58.35	39.23	2.42	144.07
Boer 50 %	38.54	56.05	5.41	166.87

Mortality of kids

Out of 245 kids, only 26 kids were died which became 10.61 % mortality in overall but in case of individual breeds the highest mortality was in Barbari pure (27.78%) followed by Jamunapari 50% (15.15%) and lowest in Boer 50% and Kiko 50% which was 4.76% and 2.78% respectively (Table 4). The findings of this study revealed that the birth weight of Khari, Sinhal, Barbari, Jamunapari 50%, Barbari 50%, Kiko 50% and Boer 50% was 1.70±0.39, 1.94±0.21, 1.60±0.34, 2.24±0.58, 1.65±0.27, 1.85±0.73 and 2.22±0.17 kg respectively. Such type of result was reported by Kasowanjete *et al*. (1987) in Boer and Malawi crossbreed kid which was 2.2 kg. Bharathidarshasan *et al*. (2009) reported that the birth and weaning weight of Barbari goat was 1.88±0.57 and 6.93±0.30 kg. Similarly, Joshi and Shrestha, (2003) revealed that the birth weight of Sinhal and Khari was 2.1 and 1.53 kg respectively. Likewise, Jeeva *et al*. (2011) revealed that one to six months weight of crossbreed of Boer and alpine malabari goat was 6.01, 8.92, 11.65, 13.62, 15.74 and 17.80 kg respectively which are similar to this finding. The mean yearling weight of Kahri, Sinhal, Barbari, Jamunapari 50%, Barbari 50%, Kiko 50% and Boer 50% was 21.30±5.01, 24.65±4.54, 20.50±4.25, 25.49±5.27, 20.20±4.23, 22.84±4.61 and 33.60±5.29 kg respectively. Haas (1978) found that the six and twelve month's body weight of Boer cross was 21.8 and 34.3 kg respectively. Hassan *et al.* (2010) reported that the birth weight and 12 months weight of Jamunapari goat was 1.6 and 21.4 kg respectively.

The body weight gain of Boer goat from birth to three months, three to six months, six to nine months and nine to twelve months was 100.11, 73.00, 82.78 and 92.78 g/day respectively where and in Khari goat 51.44, 53.22, 59.22 and 53.89 g/day. The weight gain from three to six months was very low which might be weaning effect. Lu and Potchoiba (1990) reported that the weight gain of Boer goat during birth to weaning was 125-150 g/day and 115 g/day four to eight months of age. Similarly, Rout et al. (1999) revealed that the average growth rate of Jamunapari goat up to three months of age was 81.3g/day and 122g/day thereafter.

Table 4. Mortality rate of kids different breeds of goats

Breeds	Kidding (No)	Death (No)	Mortality rate (%)
Khari	37	3	8.11
Sinhal	26	2	7.69
Barbari	36	10	27.78
Jamunapari 50 %	33	5	15.15
Barbari 50 %	35	3	8.57
Kiko 50 %	36	1	2.78
Boer 50 %	42	2	4.76

The twinning percentage of these seven breeds was 41.23, 6.76, 39.46, 28.37, 34.31, 39.23 and 56.05 % respectively and kidding was 148.35, 106.76, 143.64, 133.15, 140.79, 144.07 and 166.87 % respectively. Rasaili and Khanal (2002) reported that the twinning percentage of Khari goat was only 27.27 % whereas, Campbell (1984) revealed that Boer produced twinning kids up to 60 % and 10-15 % of triplets and the average litter size was close to 2. Greyling (2000) revealed that the birth types of Boer goat vary from 15.2-24.5 % single, 59.2-67.5 % twins and 15.3-16.3 % triples.

This study revealed that the mortality of these breeds was 8.11, 7.69, 27.78, 15.15, 8.57, 2.78 and 4.76% respectively. Ayoade and Kamwanja (1985) fount that the mortality rate of cross breed of local Malawi and Boer goat was 37.5% which is higher than this finding. Rasaili and Khanal (2002) reported that the mortality of Khari and Khari×Sinhal was 25.9 and 14.3%. Whereas Hailu et al. (2006) revealed that kids born in the wet season had higher survival rates. He also reported that kids born and raised single had higher survival rates that those of other birth types and male kids had lower survival than female kids. Similarly, Browning and leite-Browning (2011) indicated that similar impacts due to litter size and sex of kid on survivial.

CONCLUSION

The growth performance and growth rate of Boer crossbreed was highly significant different than local and other crossbreeds of goats which are found in Nepal. Similarly, kidding rate and twinning percentage of Boer cross reed was also better than other breeds and mortality rate was also very nominal as compared to Barbari pure and similar to Khari and Sinhal goat so this study concluded that Boer cross breed helps to increase national goat production at least 50%, if we upgrade Khari goat through pure Boer buck and 50% cross breed of Boer can easily adapt in mid-hills of Nepal. But further research should be necessary in farmers field to find out the reproductive performance of Boer cross breeds. Similarly such type of research should be continue for adaptability of Boer cross breed which has more than 50% blood level and development of Nepalese Boer goat.

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Risk factors associated with *Toxoplasma gondii* seropositivity in randomly sampled goats of Sunsari district of Nepal

R. P. Sah[1, 2], M. H. Talukder[2], M. Z. Alam[2], A. K. M. A. Rahman[3] and U. M. Singh[4]

[1]Agricultural Research Station, Pakhribas, NARC, Nepal
[2]Department of Parasitology, Bangladesh Agricultural University, Bangladesh
[3]Department of Medicine, Bangladesh Agricultural University, Mymensingh, Bangladesh
[4]HICAST, Purbanchal University, Kathmandu, Nepal
rpsnarc@yahoo.com

ABSTRACT

Toxoplasma gondii is a protozoan parasite which can infect virtually all warm blooded animals including humans. The present study was conducted to determine the seroprevalence of T. gondii infection in goats (Capra hircus) and risk factors as well. A total of 159 caprine sera samples collected randomly from Inaruwa municipality and surrounding areas of Sunsari district of Nepal, were tested using a commercial rapid diagnostic (Toxo IgG/IgM Combo Rapid Test, CTK Biotech, USA) kit for the detection of T. gondii antibodies. All the sampled goats were taken from herd history of abortion. The disease prevalence, confidence interval (CI) at 95%, and p-value (<0.05) were calculated to analyze the influence of risk factors on seroprevalence of toxoplasmosis. Out of 159 tested sera, 29.56% (47) goats (95% CI: 22.60-37.30%) were infected for T. gondii. Considering risk factors, seropositivity for toxoplasmosis was statistically significantly higher in pregnant goats 42.5% (95% CI: 27.04-59.11%; OR=2.46; p=0.0381) followed by non pregnant 27.78% (95% CI: 16.46-41.64%) and 23.08% in other male and female kids. Similarly, female goats were found 1.82 times more (prevalence: 34%; 95% CI: 24.82-44.15) seropositivity compared with males (prevalence: 22.03%; 95% CI: 12.29-34.73%). High prevalence 34.18% (95% CI: 23.87-45.71%) was found in above 18 months old goats. Additionally, presence of cats in surrounding areas, the pasturing system and the hygiene in the farms were assessed as factors for contributing the disease. Extensive field investigations in the animal population are requested in order to broaden the present results and to assess economic losses due to abortions caused by T. gondii.

Keywords: Goats, *Toxoplasma gondii*, risk factors, rapid diagnostic kit

INTRODUCTION

Toxoplasmosis is a global zoonosis occurs in almost all warm blooded animals including human beings, and birds, and is caused by *Toxoplasma gondii*. Based on serological investigations, it is reported that up to one third of the world's human population has been infected to this parasite (Montoya and Liesenfeld, 2004; Innes, 2010; Pereira *et al.*, 2010). The parasite is known to cause congenital disease and abortion both in humans and livestock (Dubey and Beattie, 1988; Remington *et al.*, 2001). In most countries, toxoplasmosis comes as the second cause of abortion in prevalence after chlamydial abortion in sheep (Dubey *et al.*, 2013). Therefore, the infection has an economic and clinical significance in many sheep and goat producing countries. A broad spectrum of animals can be infected by ingestion of raw or undercooked meat containing viable tissue cysts or by ingesting food or water contaminated with oocysts from the feces of infected cats (Dubey, 2004; Lake *et al.*, 2002). People usually acquire infection via ingestion of tissue cysts

in undercooked meat, consuming food and water that has been contaminated with sporulated oocysts, or by accidentally ingesting oocysts from the environment, or vertically by transplacental transmission of tachyzoites. The majority of infections are asymptomatic and unapparent or latent, but in sheep and goat clinical toxoplasmosis most often reported. Infections during pregnancy can cause abortions, stillbirths, mummification or resorption of the fetus (Hill and Dubey, 2002).

There are numerous serological procedures available for the detection of IgG and IgM antibodies; these include the Sabin–Feldman dye test (DT), indirect hemagglutination assay (IHA), indirect fluorescent antibody assay (IFA), modified agglutination test (MAT), latex agglutination test (LAT), enzyme-linked immunosorbent assay (ELISA) and complement fixation test (CFT) (Pal, 2007). For the diagnosis of *T. gondii* infection, detection of the organism itself is confirmative but very difficult. Seroprevalence of toxoplasmosis in goat was 30% in eastern region of Nepal according to report of Zoonotic control project (ZCP, NARC, 2014). Seroprevalence in different populations may vary according to different environments, social customs and habits. In Nepal, seropositivity rate was 57.9% by Rai *et al.* (1994); 30.6% by Upadhyay *et al.* (1989) and 50.6% by Jaiswal *et al.* (2014) in human using different serological tests. Nepal is a country of vast diversification in geotopography. The positive rate is reported to vary from place to place (Tizard *et al.*, 1977; Feldman, 1982; Suzuki *et al.*, 1987). Cats are the most popular pet in the world and are now found in almost every place where humans live (Driscoll Carlos et al., 2009; Sah *et al.*, 2016). No doubt Nepal has unknown number of domestic, stray and wild cats. Usually cats do not show the clinical signs even during shedding of oocysts. So cats have a key and crucial role in the epidemiology of toxoplasmosis. However, only a few studies investigated the risk factors that are associated with *T. gondii*-infection (Hammond-Aryee *et al.*, 2014). Besides, there has been an increasing interest in the prevalence of *T. gondii* infection in small ruminants because of their role on the dissemination of this parasite to man through direct contact or by consuming products of animal origin (Cenci-Goga *et al.*, 2011). Therefore, expanding the basic knowledge about *T. gondii* infection in animals in Nepal is a matter of importance and prevalence of toxoplasmosis investigation is essential for surveillance and monitoring for future planning control strategy. By considering these points, the present research work has been aimed with the following objectives: 1) to determine the seroprevalence of toxoplasmosis in goat in Sunsari District using lateral flow chromatographic immunoassay. 2) To identify risk factors of *T. gondii* in goats.

MATERIALS AND METHODS

Study area

Study areas lie in Sunsari district in Terai, plain region of eastern Nepal. This district is located 26.6276^0 N latitude and 87.1822^0 E longitude, having 1257 Km^2 area and consists of 763,487 human population with $610/Km^2$ population density (CBS, 2014).

Study population and collection of sample

A total of 159 blood samples of goat from Inaruwa municipality and surrounding areas were selected randomly and were examined in January to June, 2016. All the sampled goats were taken from herd history of abortion. The type of the study was cross-sectional. Basic relevant history and data like age, sex, status of body condition- pregnant, aborted, non-pregnant, availability of cats were taken from farmers during blood collection.

Lateral flow chromatographic immunoassay (LFCIA)

For rapid test Aria Toxo IgG/IgM Combo Rapid Test®, Lot. F1025L4E00, CTK Biotech, Inc. USA was used. This kit is a lateral flow chromatographic immunoassay and the test cassette consists of: 1) a burgundy colored conjugate pad containing recombinant *T. gondii* antigens conjugated with colloidal gold (*T. gondii* conjugates) and rabbit IgG-gold conjugates, 2) a nitrocellulose membrane strip containing two test lines (G and M lines) and a control line (C line). The M line is pre-coated with monoclonal anti human IgM for detection of IgM anti-*T. gondii* antibody, the G line is pre-coated with reagents for detection of IgG anti-*T. gondii* antibody and the C line are pre-coated with a control line antibody. A drop of blood (35 µl) was kept into well of kit and same amount diluent supplied by kit was put into well and development of color line was observed within 10 minutes. Presence of a burgundy colored G /M line indicated a *T. gondii* IgG/IgM positive test result. Absence of any test lines (M and G) was considered a negative result.

Figure 1. Lateral flow chromatographic immunoassay (Left one showing burgundy color on lines C and G means positive for IgG while burgundy color only on control line C means negative result)

Data Analysis

All the collected data were compiled in Microsoft Excel. Data were analyzed using R 3.2.2 (The R foundation for Statistical Computing, 2015). Seroprevalence percentage, OR values and P value at 95 percent significance level were calculated to show the association of risk factors with disease and results were tabulated.

RESULTS AND DISCUSSIONS

Toxoplasmosis in goats

A total of 159 blood samples were collected from Inaruwa municipality and surrounding areas in Sunsari district of Nepal and were examined by using LFCIA (Toxo IgG/IgM Combo Rapid Test®) kit for detection of antibodies against *T. gondii*. According to finding of the study given in Table 1, goats were found positive for toxoplasmosis and seroprevalence of toxoplasmosis was 29.56% (CI=22.60-37.30).

Distribution of *T. gondii in* goats based on risk factors

Female goats showed 34% positive for toxoplasmosis followed by male 22.03%. Here toxoplasmosis was found highly significant (42.5%, OR: 2.46, p=0.0381) in pregnant goat. Higher age group showed high prevalence of toxoplasmosis.

Table 1. Distribution of *T. gondii* in goats based on risk factors

Variables	Positive/tested animal	Prevalence %	95% confidence interval (CI)	Odds Ratio (OR)	P value at <0.05
Goats	47/159	29.56	22.60-37.30		
Sex					
Female	34/100	34.00	24.82-44.15	1.82	0.1126
Male	13/59	22.03	12.29-34.73	Reference	
Age					
Below 6 months	5/25	20.00	6.83-40.67	Reference	0.1866
6-18 months	15/55	27.27	16.14-40.96	1.5	
Above 18 months	27/79	34.18	23.87-45.71	2.07	
History of animal					
Pregnant	17/40	42.5	27.04-59.11	2.46	0.0381
Non pregnant	15/54	27.78	16.46-41.64	1.28	
Others (all males and female kids)	15/65	23.08	13.53-35.19	Reference	

Additional risk factors

Majority of farmers (80%) reported for presence of cats at their houses and surrounding areas. These cats were stray in nature and they were wandering to and fro for food and shelter. Generally goats were reared as semi-intensive type of housing.

The study revealed seroprevalence of toxoplasmosis in goats in the study area. Although toxoplasmosis is considered harmless for non-pregnant, it is potentially harmful during pregnancy, especially at the first trimester (Giannoulis *et al.*, 2008).

It was found that anti-*T. gondii* antibody is prevalent in goat (29.56%). This finding is similar to finding of NARC (30%). In general, varying seroprevalences were reported from different countries in goats, for examples Hammond-Aryee et al. (2014) found out 26.8% seropositive in Ghana, 28.07% in Chennai India (Satbige *et al.*, 2016), 27.2% in Sudan (Atail *et al.*, 2017). Many goat owners keep their animals in the house where they live, hence more contact between these animals and cats and so higher risk of contracting toxoplasmosis. Cats were wandering to and fro so that grazing areas and farm got contaminated and thus pasturing system and improper hygiene in the farm act as risk factors for the transmission of this parasite.

The higher seroprevalence in female as compared to males might be attributed to the management system in those females are retained in the farm for longer periods for breeding purpose than

males. Few males are retained for mating while the majority are culled and sold for cash purpose. However, several studies indicated that the prevalence was higher in female than a male which was probably due to the lower levels in immune response or antibody persistence of females in some periods of their lives (Van der Puije *et al.,* 2000; Lopes *et al.,* 2010; Kamani *et al.,* 2010). Pregnant goats were found 2.4 times more seropositivity compared with non-pregnant and others. The longer production life span of females in comparison to males together with being subjected to more stressors (pregnancy and lactation) might make females less resistant to toxoplasmosis. The hormonal difference in relation to stress of lactation and pregnancy leading to immunosuppression may increase susceptibility to toxoplasmosis in females (Dubey and Lappin, 1998). Higher seroprevalence in older age group compared to young is consistent with earlier studies (Dorny *et al.,* 1993; Hall *et al.,* 2001; Carneiro *et al.,* 2009; Ramzan *et al.,* 2009; Dubey, 2010; Halos *et al.,* 2010) and is the result of higher likelihood of ingestion of oocysts with increasing age. Ahmad et al. (2015) indicated that the likelihood of infection increased with age in sheep and goats.

Actually the LFCIA (Toxo IgG/IgM Combo Rapid Test®), used in goats, was a trial whether these kits work on goats or not. But the study found effective in goats although limited number of samples were examined. Therefore, LFCIA (Toxo IgG/IgM Combo Rapid Test®) kit is good for screening of toxoplasmosis in goats because it showed very good analytical sensitivity in the experiments.

CONCLUSION

Although this test procedure is designed mainly for the detection of toxoplasmosis in human, seropositivity for *T. gondii* has been detected in goats. Seroprevalence in goats was found 29.56%. Female, older goats (above 18 months old) and pregnant goats showed high seropositivity. With above results of the experiment, it is suggested that this assay is highly useful as a serodiagnostic tool for *T. gondii* infection. As this parasite has zoonotic importance, research works on isolation, identification of toxoplasma species is must as well as the knowledge should be disseminated to the people and animal raisers so that precautions can be taken in time.

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Soil fertility status of vegetable growing areas at Birendranagar, Surkhet

B. Kharel[1] and R.B. Ojha[2]

[1]HICAST, [2]NARC
Kharel_binod4@gmail.com

ABSTRACT

This study was conducted for assessing nutrient status of vegetable growing area in Birendranagar Municipality, Surkhet district, at ward number 17, 15, 4 and 14 respectively. Questionnaire survey was scheduled from 40 Vegetable growing farmer households of selected wards. Simultaneously 20 soil samples were collected from respective farmers field at 0-20 cm depth. Laboratory analysis for the determination of soil parameters like pH, OM, N, P_2O_5, and K_2O was done following standard method in the Regional Soil Testing Laboratory, Khajura, Banke. The soil test revealed that mean soil pH of ward number 17 was neutral (7.212), medium in total nitrogen (0.104□), low in organic matter (2.176□), medium in phosphorus (34.76 kg h^{-1}) and low in potassium (97 kg ha^{-1}). The mean soil pH of ward number 15 is slightly acidic (6.28), medium in total nitrogen (0.142□), medium in organic matter (2.982□), medium in phosphorus (39.56 kg ha^{-1}) and low in potassium (100.04 kg ha^{-1}). Similarly, at ward number 4, soil pH was neutral (7.02), high in total nitrogen (0.3□), high in organic matter (6.09□), high in phosphorus (56.216 kg ha^{-1}) and medium in potassium (278.8 kg ha^{-1}) and at ward number 14, soil pH slightly acidic (6.36), medium in total nitrogen (0.128□), medium in organic matter (2.672□), medium in phosphorus (50.56 kg ha^{-1}) and medium in potassium (204.4 kg ha^{-1}). Environmentally and socially acceptable integrated nutrient management practices like agro-forestry systems, crop rotation, use of organic inputs (compost and FYM), chemical fertilizers, vegetable should be grown with legumes intercropping and improved crop varieties that can be adapted to local farming situation in the study area are highly recommended.

Key words: Organic matter, potassic fertilizers, soil nutrient status, vegetable growing area

INTRODUCTION

Agriculture is a field of economic activity of many Nepalese peoples. It occupies about 33.1 percent of total GDP of the country employing 65.6 percent of total economically active population (MOAD, 2011). However, in recent decades market-oriented production has emerged as a key driving force for land-use intensification in the densely populated urban fringes of Nepal (Brown and Shrestha, 2000). Agricultural productivity is net satisfactory in the country. The total cultivated area of the country is 3.09 million hectares. The most key crops grown in Nepal are rice, maize, wheat, millet, barely, potato and sugarcane. There are different types of vegetable crops are grown all over the country as miner crops. The total vegetable crops occupy 7.3 percent of the total cultivated agricultural land (MOAC, 2008/09) which indicates that the increasing value of vegetable sector in Nepalese economy. The country Nepal has only 17 percent land area appropriate for agriculture which comes to be about 2.5 million ha (FAO and WFP, 2007). An agricultural production system in rural areas is still dominated by subsistence small holdings, and low use of production inputs as well as degradation of natural resource base. Now days, it has

been realize that agriculture is only sector which can contribute significantly positive change in national economy. This sector is not so commercialized it is only based on subsistence farming which is dominated by cereal based cropping system. Low production and productivity in agriculture is the result of lack of agriculture infrastructures (agriculture road, irrigation, electricity etc), low land holding, low technical access and low off farm income. Nowadays, there is increasing trend of private and public sector by capturing comparative and competitive advantages of agriculture sector reflecting niche and pocket based potentialities.

Surkhet district is located in Bheri zone of Mid-Western Development Region and has an area 249016 ha (District profile, 2012) with its geographical coordinates 28°20'N to 28°58'N and longitude 80°59'E to 82°02E. Surkhet municipality Birendranagar is the potential area of vegetable production. The area of vegetable in Surkhet district seems to be constant in the past six years (Giri, 2014). But the vegetable production is on incresing trend. It is because of incresing use of improved seeds, better crop husbandry (Giri, 2014). The agriculture is prime occupation of the people of Surkhet district. 77.61 percent of the total population of the district are involved in agriculture and Out of total 72,863 households 44,300 household are involved in agriculture as main occupation.

MATERIALS AND METHODS

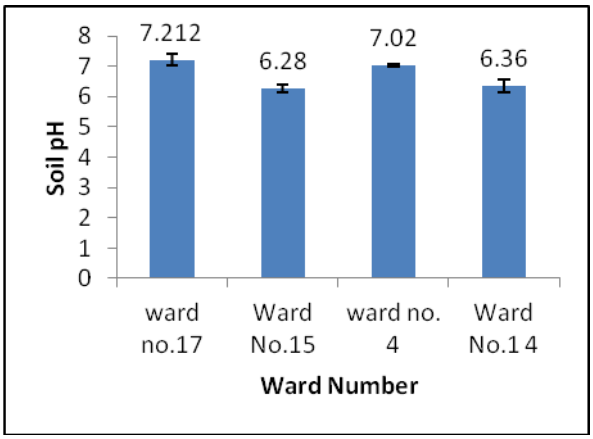
The study was conducted in four wards of Birendranagar municipality of Surkhet, district viz. ward number four, seventeen, fourteen and fifteen. Surkhet district is located in Bheri zone of Mid-Western Development region. A total of 40 HHs were selected for questionnaire survey. From the four wards (ward No. 4, 17, 14 and 15) of Birendranagar municipality, Surkhet, ten households from each was selected purposively. One composite soil sample was taken from two surveyed household by random sampling method... Soil was taken from 0 - 20 cm depth. Primary data obtained from questionnaire survey were inputted in excel and socio-economic parameter were analyzed using SPSS (Statistical package for social science) software version 16. Simple bar graphs, Mean, and standard deviation were analyzed by using excel data analysis tool bar. Soil nutrient status of several locations was compared by using GenStat software, edition 14.

RESULTS AND DISCUSSION

Soil Fertility Status

Soil pH

Soil having pH<5 is acidic, 5.5-6.5 is slightly acidic, 6.5-7.5 is neutral, 7.5-8.5 slightly alkaline and >8.5 is considered as basic (RSTL. 2015).

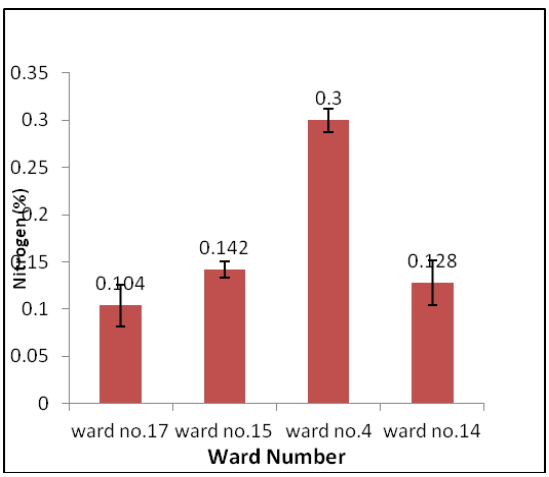


Solid line in the graphs represents standard error

Figure 1. Average soil pH in different wards of Birendranagar municipality, Surkhet

Total Nitrogen

Soil having nitrogen percentage of 0.05 percent is very low, 0.05-0.15 percent is low, 0.1-0.2 percent is medium, 0.2-0.4 percent is high and above 0.4 percent is considered as very high (RSTL., 2015)

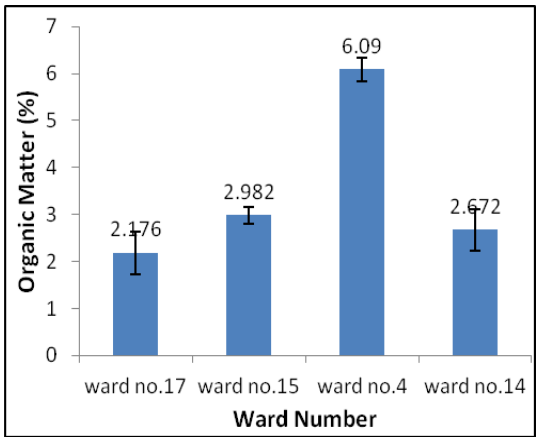


Solid line in the graphs represents standard error

Figure 2. Average percentage of N in different wards of Birendranagar municipality, Surkhet

Total organic matter

OM content varies according to the combination of the crops planted. Soil having OM below 1 percent is very low, 1 - 2.5 percent low, 2.5 – 5 percent medium, 5 – 10 percent high and above 10 percent is very high (RSTL, 2015).



Solid line in the graphs represents standard error

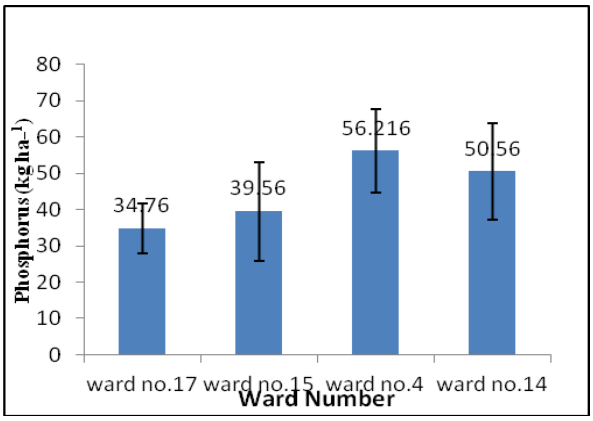
Figure 3. Average percentage of OM in different wards of Birendranagar municipality, Surkhet

Available Phosphorus

Soil having phosphorus below 10 kg ha^{-1} is very low, 10-30 kg ha^{-1} is low, 30-55 kg ha^{-1} is medium, 55-110 kg ha^{-1} is high and above 110 kg ha^{-1} is considered as very high (RSTL., 2015). Reason for higher P content could be due to higher level of pH and the high soil organic matter content (Karki, 2004).

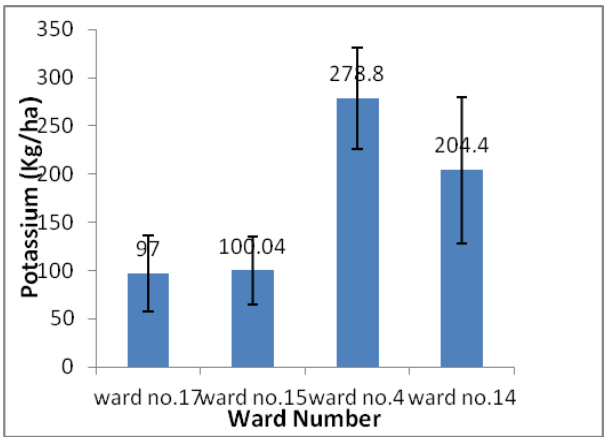
Available Potassium

Soil having potassium below 55 kg ha^{-1} is very low, 55 kg ha^{-1} -110 kg ha^{-1} is low, 110 kg ha^{-1} – 280 kg ha^{-1} is medium, 280 kg ha^{-1} – 500 kg ha^{-1} is high and above 500 kg ha^{-1} is considered to be very high (RSTL, 2015).



Solid line in the graphs represents standard error

Figure 4. Average Phosphorus (kg/ha) in different wards of Birendranagar municipality, Surkhet



Solid line in the graphs represents standard error

Figure 1. Average potassium (kg/ha) in different wards of Birendranagar municipality, Surkhet

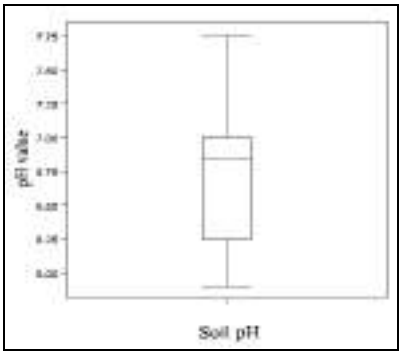


Figure (a)

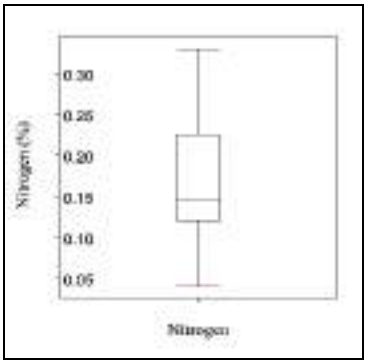


Figure (b)

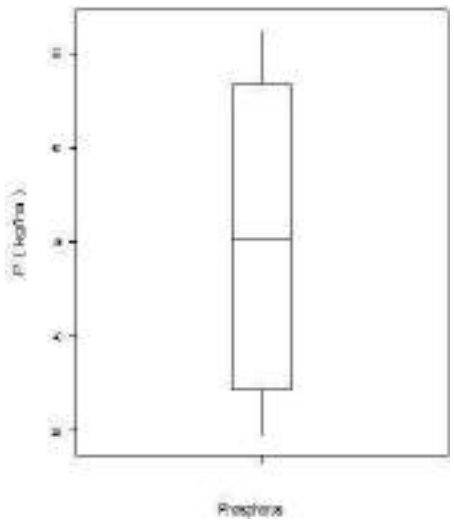


Figure (c)

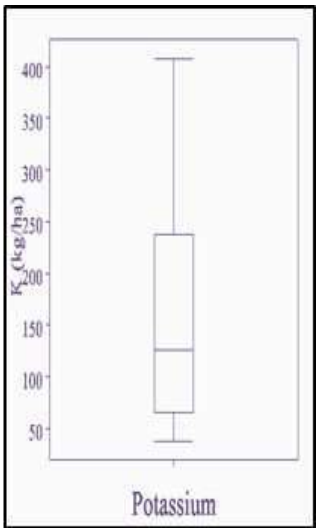


Figure (d)

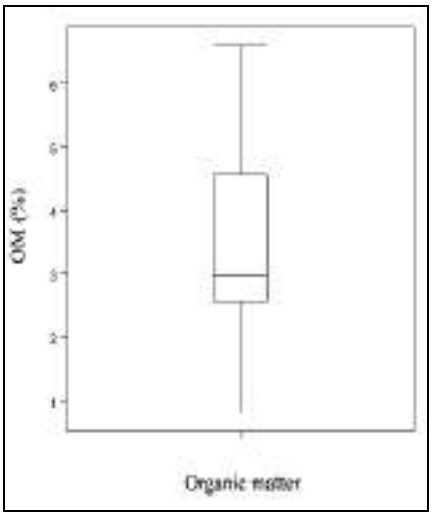


Figure 6

Figure 6. Boxplot showing the overall status of the soil nutrients (a= pH, b= total N, c = available phosphorus, d = available potassium, e = organic matter) at 4 wards of Birendranagar municipality, Surkhet

Overall Soil nutrient status in Birendranagar, Surkhet

It was found that ward number 4 and 14 has medium potassium range for proper growth of plant and ward number 17, and 15 has low content of potassium in soil.

CONCLUSION

The fertility status of the study area was medium to low, due to the imbalanced use of chemical fertilizers, mono- cropping, and use of lower amount of organic fertilizers. Out of four wards, ward number 4 has good soil fertility status for proper growth and development of crops. Peoples of this area are suggested to apply fertilizer only to maintain soil fertility. Ward number 14 have medium content of soil nutrients and p^H is acidic. In ward number 17 and 15 soil nutrients are are at low to medium range but there is low level of potassium content was recorded. So, application of high dose potassic fertilizer is recommended. Environmentally and socially acceptable integrated nutrient management practices like agro-forestry systems, crop rotation, use of organic inputs (compost and FYM), chemical fertilizers, vegetable should be grown with legumes intercropping and improved crop varieties that can be adapted to local farming situation in the study area are highly recommended.

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Collection and morphological characterization of sweet potato genotypes in Nepal

P. Bhattarai[1], B. M. Sakha[2] and M. Bhattarai[1]
[1] National Potato Research Programme (NPRP), Khumaltar, Lalitpur, Nepal,
[2] Biotechnology Division, Khumaltar, Lalitpur, Nepal
prkash235@yahoo.com

ABSTRACT

Collecting and characterizing plant material has been basic for crop improvement, and diversity has long been seen as vital for rational management and use of crops. Collecting the germplasm maintained by farmers and institution is a very important action to avoid genetic variability losses. Thirty eight local sweet potato germplasm were collected, conserved and characterized for their morphological characters using morphological descriptors. They were planted on ridges of 3 m long with distance between ridges of 0.6 m at field conditions of NPRP, Khumaltar, Lalitpur during the rainy season of 2014/15, from July to August. Four root traits and fifteen descriptors for vegetative parts were used to assess the diversity among 38 local sweet potato accessions. The results showed a large variation was observed in foliage and tuber characteristics. Five plant growth and mature vine, ten leaf and four root characters were recorded. The majority of genotypes exhibited longer vine as they showed spreading nature of growth habit. Variation in tuber shape ranged from round to long or medium long and long irregular. The skin color of tuber varied from white to red, light yellow and purple. Variation was found in flesh color from white to creamy white and milky white. Results of the present study reveal that sweet potato germplasm in Nepal presented moderate to high diversity based on phenotypic assessment approaches. The results obtained will serve as a guide for the basis germplasm management and improvement in Nepal. However, further diversity is needed that can be achieved through introduction or more collection. The power of nineteen morphological descriptors in the differentiation of cultivars was identified and could be useful in subsequent studies. In addition it can be useful for sampling in successive studies and parental selection in sweet potato variety improvement program.

Key words: *Collection, characterization, genotypes, morphology, sweet potato*

INTRODUCTION

Sweet potato (*Ipomoea batatas* Lam.), a hexaploid crop (2n = 6X = 90) is one of the most economically important crops in the world. It is world's seventh most important food crop after wheat, rice, maize, potato, barley, and cassava (FAOSTAT, 2007). China is the world's largest producer of sweet potato, accounting for over 80% of the world's sweet potato production (Chen *et al*., 2003 and Zhu *et al*., 2010). Sweet potato is among the world's most important and underexploited food crops. It is regarded as poor man's crop or small farmer's crop because of its low input requirements, ease of production and ability to produce under adverse soil and weather conditions (Ndolo *et al*., 2001). Sweet potato is considered to be a good source of dietary fiber (Vimala *et al.*, 2011), minerals, and vitamins (Low *et al*., 2007 and Nedunchezhiyan *et al*., 2010). It is an important food crop cultivated in more than 100 countries (Huang and Sun, 2000 ; Hu *et al*., 2003).

In Nepal, it is grown throughout the mid hills and Terai region in kitchen garden (Gautam, 1991). It is grown up to 1800 masl (Shah, 1991 and Gautam, 1998). It is one of the neglected crops in Nepal because Nepalese agriculture sector has not given priority to sweet potato production. Most of the mid hill and terai districts are main sweet potato growing areas of the country. From the production point of view, Nepal still lacks reliable statistics on areas and production of sweet potato. Shah (1991) reported that approximately 7000 ha of land are covered by sweet potato including some parts of river basin in terai and kitchen garden with the average productivity of 8.48 t/ha. It has religious and cultural importance and tubers are usually harvested and consumed during Thula Ekadashi and Makarsakranti (Festivals of Hindus). Farmers have been growing only local landraces since long time in Nepal. There is no any commercial and standard variety of sweet potatoes and no more systematic research in the past. Plant genetics resources are basic raw material for improvement of any crop plant. A better knowledge of germplasm diversity is critical for developing new varieties and useful for conducting basic research .A wider genetic diversity is fundamental for the development of new variety with good quality and higher yield. This diversity is contained in traditional varieties and modern cultivars, as well as wild relatives of the crop and other wild plant species, special genetic stocks as parental lines and genetic stock with known attributes that can be used now or in the future. Therefore, Germplasm of sweet potato were collected from different part of the country. Collected genotypes have been conserved and maintained under *in vivo* at NPRP, Khumaltar, Lalitpur. The detail study of these valuable genetic resources is needed so that they can be protected through *ex situ* and *in situ* conservation methods. Moreover, these genotypes may possess valuable traits, which can be utilized for varietal improvement and sweet potato breeding programme.

Collection, characterization and maintenance of local germplasm are the bases of varietal improvement (Mok and Schmiediche, 1998). The occurrence of the same cultivar with different names and vice versa is quite common (Daros *et al*., 2002). Morphological characterization is important in the identification of duplicate accessions, detection of unique traits and also the structure of the population to be conserved, thus saving on storage space and simplifying selection by plant breeders (Reed *et al.*, 2004). Morphological characterization has been used extensively on various crop plants diversity assessments in many places of the world (Bos *et al*., 2000; Kaplan, 2001; Lacroix *et al*., 2005; Li *et al*., 2009 and K'Opondo, 2011). On sweet potato, this tool has been used successfully to analyze genetic diversity necessary for the germplasm conservation, to reduce accession number by identification and elimination of duplicates and to enhance crop breeding (Huaman, 1992; Mok and Schmiediche, 1998; Tairo *et al*., 2008; Li *et al.*, 2009; Karuri *et al*., 2009 and Yada *et al*., 2010a). Generally, the sweet potato genotypes vary in morphological traits like vine, leaf and tuber characters. According to Ghos *et al.*, (1988) plant growth habit ranged from compact to spreading types and leaves are of variable shape and size occasionally in the same plant. Hence, it is essential to collect and conserve germplasm and keep it in organized collections for later characterization, evaluation and documentation (Cabral *et al*., 2010). This way it will be possible to estimate the real variability maintained to make the conserved germplasm available for effective use by researchers in several areas such as breeders and botanists or even the farmers themselves. The objectives of the present study were to conserve and characterize the indigenous collected sweet potato germplasm based on morphological descriptors.

MATERIALS AND METHODS

A total of 38 genotypes of sweet potato were collected including passport data (Table 1) from seventeen districts of Nepal during 2012 to 2014 .These genotypes were maintained at the NPRP, Khumaltar (1360 masl) of Lalitpur located in the center of the country in the Bagmati zone characterized by an annual rainfall 727 mm during 2014/15.

Un- replicated design was adopted for this study. Soil of experimental plot was sandy type. The land used for the study was cleared and ploughed. Ridges were made manually using hoes. The 38 accessions were grown at field conditions of NPRP, Khumaltar, Lalitpur during the rainy season of 2014/15, from July to August. Planting was done on ridges of 3 m long with distance between ridges of 0.6 m. On each ridge, 10 cuttings were planted at a spacing of 30 cm. Total numbers of plants per plot were 20. The 3.6 m^2 sized plots were fertilized @30:30:50 kg NPK together with 20 tons of compost per hectare as a basal dose. Fields were maintained by frequent weeding. Additional watering was done by irrigation to complement rainfall.

Phenotypic characterization in sweet potato is done by assessing leaf, flower and storage root characteristics (CIP *et al.*, 1991) and it has been traditionally used for identification of cultivars of this crop. The characterization was carried out by using sweet potato descriptor of field book for standard evaluation of potato and sweet potato germplasm (NPRP, 2014).The thirty eight genotypes were used for characterization in field work. Nineteen morphological traits for the sweet potato descriptors were scored by using a scale of zero to nine (NPRP, 2014) at 55-60 and 90-150 days after planting (DAP).These traits can be grouped into foliar morphology (90-100 DAP) and storage root (150 DAP) descriptors. Estimated percentage of ground cover was recorded at 55-60 DAP; while other morphological and storage root characters were scored at 90 and 150 DAP respectively.

The following variables were scored: Plant growth characteristics: plant type (PT), ground cover (GC); mature vine characteristics: vine internode diameter (VID), vine internode length (VIL), predominant vine color (PVC), mature leaf characteristics: general outline of leaf (GOL), leaf lobes number (LLN), leaf lobes type (LLT), shape of central leaf lobe (SCLL), mature leaf size (MLS), abaxial leaf vein pigmentation (ALVP), petiole length (PL), petiole pigmentation (PP), mature leaf color (MLC), immature leaf color (ILC), Storage root characteristics: predominant skin color (PSC), storage root shape (SRS), storage root size (SRS) and predominant flesh color (PFC). Measurements were done on five plants chosen randomly from the 20 plants per plot and averaged for the variable. With respect to the storage root characters five tubers were selected as samples and scored. Vine internode length and mature leaf size was measured using 30 cm ruler. MLS was measured as length from the basal lobes to the tip of the leaves. Length of main vine (plant type) and vine internode diameter were measured with a measuring tape and vernier caliper respectively. For the storage root attributes, visual observations were made. Vine and leaf characters were recorded as the average expression of the character observed in a section of the main stem located in the middle portion of several main stems.

Table 1. Passport information of *in vivo* conserved sweet potato germplasm used in study

S.N	Genotypes	Code	Origin	Received Date	Source
1	Sangachowk Red	KCU-12-02	Sindhupalchowk	Nov. 22, 2012	Market
2	Lamatar White	TPG-12-01	Lalitpur	Nov. 22, 2012	Farmer
3	Batakeshwor White	DC-12-01	Dhanusa	Dec. 13, 2012	Farmer
4	Barhathwa White	KCU-12-03	Sarlahi	Dec. 14, 2012	Farmer
5	Haibung White	BMS-13-01	Sindhupalchowk	Mar. 18, 2013	Farmer
6	Haibung Red	BMS-13-02	Sindhupalchowk	M ar. 18, 2013	Farmer
7	Fendikuna Red	BMS-13-03	Lamjung	Jul. 5, 2013	Farmer
8	Paundi Red	BMS-13-05	Lamjung	Jul. 5, 2013	Farmer
9	Majhigaun Red	BMS-13-06	Lamjung	Jul. 5, 2013	Farmer
10	Bensisahar Red	BMS-13-07	Lamjung	Jul. 5, 2013	DADO
11	Parewatar White	BT-13-02	Dhading	Jul. 23, 2013	Farmer
12	Kalidaha White	BT-13-03	Dhading	Jul. 23, 2013	Farmer
13	Salang White	BT-13-04	Dhading	Jul. 23, 2013	Farmer
14	Balewa White	BMS-13-14	Baglung	Nov. 22, 2013	Famer
15	Balewa Red	BMS-13-15	Baglung	Nov. 22, 2013	Famer
16	Chyanglitar White	BMS-13-16	Gorkha	Nov. 25, 2013	Famer
17	Chyanglitar Red	BMS-13-17	Gorkha	Nov. 25, 2013	Famer
18	Jorsal White	YKS-13-01	Panchthar	Dec. 9, 2013	Famer
19	Pallotar Red	YKS-13-02	Panchthat	Dec. 9, 2013	Famer
20	Limba White	YKS-13-03	Panchthat	Dec. 9, 2013	Famer
21	Chomagu White	YKS-13-04	Panchthar	Dec. 9, 2013	Famer
22	Mangalbare Red	YKS-13-05	Ilam	Dec. 11, 2013	Famer
23	Barbote White	YKS-13-06	Ilam	Dec. 11, 2013	Famer
24	Bodhe White	YKS-13-07	Ilam	Dec. 11, 2013	Famer
25	Dhukurpani White	YKS-13-08	Jhapa	Dec. 12, 2013	Famer
26	Bhangbari White	YKS-13-10	Jhapa	Dec. 12, 2013	Famer
27	Fadani White	YKS-13-11	Morang	Dec. 13, 2013	Famer
28	Lamatar Red	YKS-13-12	Morang	Dec. 13, 2013	Famer
29	Kheruwa White	YKS-13-13	Morang	Dec. 13, 2013	Famer
30	Bensisahar White	BMS-13-09	Lamjung	Jul. 15, 2014	Famer
31	Hybrid White	BMS-14-01	Kapilvastu	Jan. 11, 2014	Famer

32	Motipur White	BMS-14-02	Kapilvastu	Jan. 11, 2014	Famer
33	Motipur Red	BMS-14-03	Kapilvastu	Jan. 11, 2014	Famer
34	Thutobari White	BMS-14-05	Nawalparasi	Jan. 13, 2014	Market
35	Triveni White	BMS-14-06	Nawalparasi	Jan. 13, 2014	Market
36	Triveni Red	BMS-14-07	Nawalparasi	Jan. 13, 2014	Market
37	Bijuwar White	BMS-14-08	Pyuthan	Mar. 3, 2014	Famer
38	Bhantabari White	BMS-13-12	Sunsari	Aug. 24, 2013	Famer

RESULTS AND DISCUSSION

Plant growth and mature vine characters

Variation from erect, semi-compact to spreading plant type was observed among sweet potato genotypes. Most of the genotypes (84%) were spreading nature. Variation from compact plant type and spreading plant type among the sweet potato clones revealed the report of Ghos *et al*., (1988). Out of 38 accessions studied, 5 genotypes semi-compact, 1 genotype erect and thirty two genotypes were found spreading nature of vine (Table 2).The range of ground cover (%) was recorded from 65 to 100. Nineteen genotypes (50% of total genotypes) were found total (>90%) ground cover, while seventeen genotypes considered with high (75-90%) ground coverage. Genotypes Bodhe White and Triveni Red have medium (41-74%) ground cover. Differences were observed in VIL, VID and PVC (Table 2). The range of VIL (3.1-9.92 cm) and VID (3.68-7.44 mm) was recorded during characterization. Most of the genotypes have medium (neither thin or short nor thick or long) type of vine thickness and inter node length. Almost 58 % genotypes showed green as a predominant vine color which should be evaluated considering the whole vine from base to tip. Remaining genotypes varied greatly for the predominant vine color characteristics from green with few or many purple spots to mostly or mostly dark purple (Table 2).

Table 2. Plant growth and vine characters of sweet potato genotypes planted under field conditions at Khumaltar, Lalitpur

Genotypes	Plant type	Ground Cover (%)	Vine inter node length (cm)	Vine inter node diameter (mm)	Predominant vine color
Sangachowk Red	Spreading	80	6.1	7.44	mostly dark purple
Lamatar White	Spreading	100	5.36	3.82	green
Batakeshwor White	Spreading	90	9.92	4.52	green with many purple spots
Barhathwa White	Spreading	90	6.66	4.77	green and green with few purple spots
Haibung White	Spreading	95	5.12	5.26	green
Haibung Red	Spreading	90	6.06	5.69	green with few purple spots
Fendikuna Red	Spreading	80	5.12	5.9	green with few purple spots

Paundi Red	Semi compact	85	4.7	5.95	green
Majhigaun Red	Spreading	80	3.1	5.3	green
Bensisahar Red	Spreading	90	4.72	5.65	green
Parewatar White	Spreading	100	6.88	5.13	green
Kalidaha White	Spreading	100	4.7	4.06	green
Salang White	Spreading	95	7.18	5.32	green
Balewa White	Spreading	90	4.74	4.79	green
Balewa Red	Spreading	85	4.32	5.51	green
Chyanglitar White	Spreading	85	5.44	4.44	green
Chyanglitar Red	Spreading	80	4.4	5.16	green with few purple spots
Jorsal White	Spreading	85	5.8	3.72	green
Pallotar Red	Spreading	95	5.18	4.68	green
Limba White	Spreading	95	5.5	3.81	green with few or many purple spots
Chomagu White	Spreading	100	5.64	3.89	green with few purple spots
Mangalbare Red	Spreading	95	8.0	4.85	green and green with few purple spots
Barbote White	Spreading	100	5.86	3.88	green
Bodhe White	Spreading	70	4.94	3.68	green
Dhukurpani White	Spreading	90	6.44	4.8	green
Bhangbari White	Spreading	95	5.2	4.47	green with many purple spots
Fadani White	Spreading	100	5.26	5.39	green
Lamatar Red	Spreading	100	6.26	5.61	green
Kheruwa White	Spreading	100	7.36	4.05	green
Bensisahar White	Spreading	95	7.24	4.22	green and green with many purple spots
Hybrid White	Semi compact	100	6.5	6.7	mostly dark purple
Motipur White	Semi compact	100	6.44	7.11	mostly purple
Motipur Red	Spreading	100	7.2	5.10	green with few purple spots
Thutobari White	Semi compact	95	5.68	5.56	green with many purple spots
Triveni White	Semi compact	85	6.2	5.96	green
Triveni Red	Erect	65	2.24	4.25	mostly dark purple
Bijuwar White	Semi compact	85	5.24	5.44	Green
Bhantabari White	Spreading	90	7.3	4.74	Green

Leaf characters

Variation was observed for the ten characters of the leaf of the 38 sweet potato accessions. Local sweet potato genotypes differed in mature leaf characters presented in Table 3 and 4. The following general outline of leaf was observed: lobed (50%), triangular (28.9%), hastate (5.26%), hastate/lobed (5.26%), lobed/hastate (5.26%) and almost divided (5.26 %). Cavalcante (2008) observed the same findings in the general outline of leaf in sweet potato accessions as in the present study. The authors observed a greater frequency of the lobed shape (45.5%), followed by the triangular (27.3%), lanceolate (18.2%) and cordate (9.1%) shapes. Daros *et al*., (2002) analyzed 14 sweet potato accessions and also observed that the lobed shape was predominant, corresponding to 93.0% of the accessions. However, Ritschel & Huamán (2002) in the assessment of sweet potato germplasm at *Embrapa Hortaliças* observed predominance of the cordate shape (49.7%).

The type of leaf lobes varied greatly among the accessions studied and mainly six variations were found: moderate (31.57%), deep (28.94%), very slight (21.05%), no lateral lobes (13.15%) and one/one genotype showed slight and very deep lobe type. Maximum variation was observed in number of leaf lobes which is ranged from 1 to 9. The shape of central leaf lobe was characterized as elliptic, semi-elliptic, lanceolate, triangular, teeth, semicircular and absent showing great variability for this trait. Majority of clones showed elliptic and lanceolate shape. Mature leaf size ranged from small (7.3 cm) to large (16.2 cm) was observed during characterization (Table 3).

Abaxial leaf vein pigmentation is the distribution of anthocyanin (purple) pigmentation shown in the veins of the lower surface of leaves. Variations were observed from green to purple spot observed at main rib and in several veins or all veins. Most of the accessions showed a predominantly green mature leaf coloring (63.15%), and there were also some accessions with a purple under surface. For the immature leaf coloring, green and green leaves with purple edges were predominant and rest were represented by slightly or mostly purple. Augustin *et al.,* (2000) obtained 90% frequency for mature leaf green coloring. The petiole coloring showed small variability of types where green petiole (65.78%) was predominant and remaining accessions have green with purple near leaf and at both ends. The petiole length ranged from 4.18 to 18.2 cm recorded among different genotypes of sweet potato, where the longest petiole was observed in Paundi Red and shortest was in Jorsal White (Table 4).

Table 3. Leaf characters of sweet potato genotypes planted under field conditions at Khumaltar, Lalitpur

Genotypes	General outline of leaf	Type of leaf lobes	No. of leaf lobes	Shape of central leaf lobes	Mature leaf size (cm)
Sangachowk Red	Triangular	No lateral lobes	1	Absent	8.1
Lamatar White	Lobed	Moderate	4-6	Elliptic	9.4
Batakeshwor White	Triangular	very slight	3-5	Teeth	8.0
Barhathwa White	Hastate/lobed	Deep	5-8	Elliptic/ lanceolate	8.8
Haibung White	Lobed	Moderate	5	Elliptic	9.2

Haibung Red	Lobed	Moderate	5-6	Elliptic/ lanceolate	10.5
Fendikuna Red	Hastate/lobed	Moderate	4-7	Lanceolate	10.0
Paundi Red	Lobed	Moderate	5-6	Lanceolate /elliptic	16.2
Majhigaun Red	Lobed/hastate	Moderate	5-7	Elliptic	9.4
Bensisahar Red	Lobed	Deep	5-6	Elliptic	9.4
Parewatar White	Triangular	Very slight	3-7	Teeth/semi-circular	9.0
Kalidaha White	Lobed	Deep	6	Lanceolate/elliptic	8.4
Salang White	Lobed	Very slight	3-5	Teeth	13.0
Balewa White	Lobed/hastate	Deep	5	Elliptic	7.3
Balewa Red	Lobed	Slight	5	Semi-elliptic	14.0
Chyanglitar White	Triangular	Very slight	4-5	Teeth	9.7
Chyanglitar Red	Triangular	Very slight	4-9	Teeth	8.7
Jorsal White	Lobed	Deep	5-7	Elliptic/ lanceolate	9.5
Pallotar Red	Hastate	Moderate	5-6	Lanceolate / elliptic	13.0
Limba White	Almost divided	Deep	5-7	Elliptic / lanceolate	9.9
Chomagu White	Lobed	Deep	5-7	Elliptic	8.0
Mangalbare Red	Lobed	Moderate	5-7	Lanceolate / elliptic	12.1
Barbote White	Lobed	Deep	5-6	Elliptic/ lanceolate	10..0
Bodhe White	Lobed	Moderate	5-7	Elliptic	9.2
Dhukurpani White	Lobed	Moderate	5-6	Elliptic/ lanceolate	11.7
Bhangbari White	Lobed	Deep	5-7	Elliptic	9.2
Fadani White	Triangular	very slight	3-6	Teeth	11.3
Lamatar Red	Lobed	Deep	5-6	Lanceolate / elliptic	11.2
Kheruwa White	Lobed	Moderate	5-6	Lanceolate /elliptic	9.9
Bensisahar White	Almost divided	Very slight	5-9	Teeth/semi-elliptic	8.7
Hybrid White	Triangular	No lateral lobes	1-3	Teeth	10.8
Motipur White	Triangular	No lateral lobes	1-3	Absent	11.5
Motipur Red	Lobed	Very deep	5-7	Linear (narrow)	8.0
Thutobari White	Triangular	No lateral lobes	1	Teeth	11.1
Triveni White	Triangular	No lateral lobes	1	Absent	8.0
Triveni Red	Hastate	Deep	5-7	Elliptic	7.5

Bijuwar White	Lobed	Moderate	5-6	Elliptic/ lanceolate	10.1
Bhantabari White	Triangular	Very slight	5-6	Teeth	9.8

Table 4. Leaf characters of sweet potato genotypes planted under field conditions at Khumaltar, Lalitpur

Genotypes	Abaxial leaf vein pigmentation	Mature leaf color	Immature leaf color	Petiole pigmentation	Petiole length (cm)
Sangachowk Red	Main rib mostly or locally purple	Green or slightly purple	Green or slightly purple	green	15.0
Lamatar White	Purple spot at the base of main rib	green	slightly purple	green	8.2
Batakeshwor white	green	green	Mostly purple	green	13.04
Barhathwa White	Main rib partially purple	Yellow-green	Slightly purple	green with purple at both ends	13.6
Haibung White	Main rib partially purple	green	slightly or mostly purple	green with purple near leaf	14.6
Haibung Red	Purple spot at the base of main rib	green or slightly purple	green with purple edge	green	10.5
Fendikuna Red	Purple spot at the base of main rib	green	green with purple edge	green	13.1
Paundi Red	Green	green	green or slightly purple	green	18.2
Majhigaun Red	green	green	slightly or mostly purple	green	13.0
Bensisahar Red	green	green or slightly purple	slightly purple	green with purple near leaf	8.1
Parewatar White	green	yellow-green	yellow- green	green	13.0
Kalidaha White	Purple spot at the base of main rib	green	slightly purple	green with purple near leaf	8.7
Salang White	green	green	green or slightly purple	green	14.4
Balewa White	Purple spot at the base of main rib	green	green with purple edge or slightly purple	green	9.24
Balewa Red	green or main rib partially purple	green	green with purple veins on upper surface	green with purple near leaf	12.18
Chyanglitar White	Purple spot at the base of main rib	green	green with purple edge	green with purple near leaf	16.9
Chyanglitar Red	Purple spot at the base of main rib	green or slightly purple	green	green	5.0
Jorsal White	green	green	yellow-green	green	4.18

Pallotar Red	green	green	slightly or mostly purple	green	11.5
Limba White	Purple spot at the base of main rib	green or green with purple edge	slightly or mostly purple	green with purple at both ends	
Chomagu White	All veins partially purple	green or green with purple edge	green or slightly purple	green with purple at both ends	15.44
Mangalbare Red	Purple spot at the base of main rib	yellow-green	green with purple edge	green with purple near leaf	16.6
Barbote White	Purple spot at the base of main rib	green or yellow-green	Slightly purple	green	9.7
Bodhe White	Purple spot at the base of main rib	green or yellow-green	Slightly purple	green	11.42
Dhukurpani White	green	green	green with purple edge	green with purple near leaf	10.54
Bhangbari White	green	green	green	green	9.34
Fadani White	green	green	green with purple edge	green	9.7
Lamatar Red	green	green	green with purple edge	green	11.44
Kheruwa White	Main rib partially purple	green	green with purple edge	green with purple near stem	10.02
Bensisahar White	green	green	Mostly purple	green	12.46
Hybrid White	All veins mostly purple	green or slightly purple	green with purple edge	green with purple near leaf	14.0
Motipur White	All veins mostly or totally purple	green upper, purple lower	green with purple veins on upper surface	green with purple spots throughout petiole	12.1
Motipur Red	green	green	slightly purple	green	9.9
Thutobari White	Purple spot at the base of main rib	green	slightly purple	green	15.9
Triveni White	Main rib mostly or locally purple	green	green or slightly purple	green	12.7
Triveni Red	green	green	slightly or mostly purple	Green	11.0
Bijuwar White	Purple spot at the base of main rib	green	slightly purple	Green	10.6
Bhantabari White	Green	yellow-green	slightly purple	Green	12.4

Root characters

Generally the skin color and root shape characteristics showed the greatest variability, and can be considered an important descriptor in accession characterization contributing with significant differentiation to the sweet potato genotypes. The predominant color of the root skin of the

accessions characterized was classified as red (31.57%), white (47.36%) along with the colorings light yellow (13.15%), light red (5.26%) and genotype Sangachok Red showed purple root skin color (Table 5).

Table 5. Storage root characters of sweet potato genotypes planted under field conditions at Khumaltar, Lalitpur

Genotypes	Root skin color	Root shape	Root size	Root flesh color
Sangachowk Red	Purple	Long elliptic	small	White
Lamatar White	Light yellow	Long irregular	Medium	White
Batakeshwor white	White	Obovate	Large	White creamy
Barhathwa White	White	Long irregular	Medium	White
Haibung White	White	Long irregular	Medium	White
Haibung Red	Red	Round	Large	White milky
Fendikuna Red	Red	Long round	Medium	White
Paundi Red	Red	Round	Small	White
Majhigaun Red	Red	Long irregular	Medium	White
Bensisahar Red	Red	Long round	Large	White
Parewatar White	White	Round	Large	White
Kalidaha White	Light yellow	Long irregular	Large	White
Salang White	White	Elliptic	Large	White
Balewa White	White	Long irregular	Medium	White
Balewa Red	Red	Long irregular	Large	White
Chyanglitar White	White	Long irregular	Large	White creamy
Chyanglitar Red	Red	Long	Small	White
Jorsal White	White	Round	Medium	White
Pallotar Red	Red	Round	Large	White
Limba White	White	Long irregular	Large	White
Chomagu White	White	Long irregular	Large	White
Mangalbare Red	Red	Long irregular	Medium	White
Barbote White	White	Long irregular	Medium	White
Bodhe White	White	Medium long	Medium	White
Dhukurpani White	White	Elliptic	Medium	White
Bhangbari White	Light yellow	Round	Medium	White
Fadani White	Light yellow	Round	Large	Milky white
Lamatar Red	Red	Long irregular	Large	White
Kheruwa White	Light yellow	Long irregular	Large	White
Bensisahar White	Light red	Round irregular	Large	White
Hybrid White	Light red	Long	Medium	White
Motipur White	White	Long	Medium	White

Motipur Red	Red	Long	Medium	Milky white
Thutobari White	White	Long round	Large	White
Triveni White	White	Elliptic	medium	White
Triveni Red	Red	Long elliptic	Large	White
Bijuwar White	White	Long round	Medium	White
Bhantabari White	White	round	small	White

Great variability was detected for root shape with main classes of long, round, medium long, long irregular, obovate and elliptic. Size of root was characterized with three classes: small, medium and large. Low variability for the root flesh coloring characteristic was detected, 86.84 % of the accessions had white colored flesh and 7.89 % had milky white pulp, remaining two had creamy white colored flesh was characterized (Table 5). High phenotypic variability was observed for the root descriptors. Similar results were reported by Daros *et al*., (2002) and Chávez *et al.*, (2006) when they assessed 14 and 52 accessions, respectively, based on morphological descriptors for the roots.

CONCLUSION

Large variation was observed among thirty eight genotypes in the vine, leaf and tuber morphological characters. Findings of the present study revealed that sweet potato germplasm in Nepal presented moderate to high diversity based on phenotypic assessment approaches. The results obtained will serve as a guide for the basis germplasm management and improvement in Nepal. However, further diversity is needed that can be achieved through introduction or more collection. The power of nineteen morphological descriptors in the differentiation of cultivars was identified and could be useful in subsequent studies.

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Pest and disease surveillance of vegetable crops and farmer's pest management practices in Banke and Surkhet districts

K. Bhusal[1], B. P. Bhattarai[1] and L. P. Sah[2]
[1]HICAST and [2] iDE Nepal

ABSTRACT

This study was carried out from 9th January to 30th April 2017. Altogether 158 respondents were selected for primary data and information collection among them 90 vegetables producers and 4 agro-vets from Banke and 60 vegetables producers and 4 agro-vets were from Surkhet. The primary information indicated that male farmers respondent were higher as compared to female respondents in both districts. In case of the age group, 40-50 years age group in Surkhet and 30-40 years age group in Banke were engaged in vegetable farming. Majority of farmers of Banke district was dominated by the Tharu caste where as in the Surkhet district Brahmin caste was dominated. Agriculture was the major occupation in both Districts. Majority of the farmers had average land holding was 1-3 ha. Sixty five percent of the farmers were selling vegetables through the channel of commission agent. Insect pests and diseases were major problems of vegetables farming in both districts .In case of the onion, onion thrips and onion maggot were the major insect pests and purple blotch and onion smut were the major disease in both districts. In case of okra, okra fruit and shoot borer, flea beetle was the major insect pests and yellow vein mosaic, powdery mildew were the major diseases. In case of chili, chili thrips, fruit and shoot borer were the major insect pest while major diseases were damping off and anthracnose. In case of French bean major insect pests were chickpea pod borer, chili thrips and diseases were alternaria leaf spots, anthracnose, Fusarium wilt were found in the both districts .Majority of the farmers (75%) were using chemical plus cultural, 18% were using biological plus chemical and few (5%) were using chemical pesticides for insect pests and diseases management in both districts.

Key words: Pests, diseases, vegetable crops, Fusarium wilt, thrips, pesticides

INTRODUCTION

Nepal is a small, diverse and landlocked country lies between the two big economies of the world china and India. Nepal has three distinct physiographic regions namely Terai, hills and mountain with high climatic variation. It is highly dominated by the hills. Agriculture is the major source of food, income, employment for the great majority of the population. The contribution of agriculture sector to the national GDP is 33.1 Percent (MoAD 2014). The composition of GDP as 49.41 Percent from cereals, 25.68 from the livestock, 9.71 Percent from vegetable and 7.04 Percent from fruit and spices (MoAD, 2014). Nepal has its topography determines that only less than 20 Percent land is cultivable.

Vegetables play an important role in the Nepalese economy. It occupies an area of 266937 ha with the total production of 3580085 MT and total yield is 13412kg/ha in the year 2014/ 2015 (VDD, 2015). Vegetable farming is one of the major enterprises of agriculture in Nepal. Horticulture sector contribute about 16% contribution of the horticulture sector to GDP. There are 3.2 million

vegetable holdings that accounts to about 69 percent of the total households. The vegetable sector contributes more than Rs.36 billion of value in the country, with cauliflower, tomato and cabbage as the lead contributors with values of Rs.4.9 billion, Rs.4.4 billion and 2.8 billion respectively (CBS, 2010). Vegetable plays a vital role in the food front, as it reduces the demand of cereal and is the cheapest source of natural protective food contributing carbohydrate, vitamins and mineral salts in the human diet, which are very essential for maintaining a good health. It is also one of the best enterprises for those resource poor rural farmers having less land holding, as it does not require more land as required for growing cereal crops. Pests and plant diseases have been associated with agriculture (and therefore human culture as such) since its beginning many thousands of years ago. Pests are organisms that injure humans, animals, crops, structures or possessions, compete with humans, domestic animals or crops for food, feed and /or water or spread disease to humans, domestic animals or crops. A number of actions against these undesired organisms were developed over time, such as crop-rotation, tillage, intercropping and selective breeding. Disease as an impairment of the normal state of the living (plant) that interrupts, modifies, (or stresses) vital functions. Disease is a response to specific causal agents (biotic or abiotic), inherent defects of the organism, or combinations of these factors. IPM is an interdisciplinary approach to reduce crop losses through the use, by farmers, or optimum mixes of pest control techniques. It combines the aims of agricultural productivity, environmental sustainability and cost effectiveness. It has arisen out of the need to avoid the problems of pest resistance build-up (leading to pest resurgence), secondary pest outbreaks, human health problems, the high cost of pesticide control and environmental degradation caused by excessive and inappropriate chemical pesticide use. The approach has become closely associated with enabling farmers to make crop protection decisions in full awareness of factors operating in their agro – ecosystems.

MATERIALS AND METHODS

The survey was conducted in the Banke and Surkhet districts. The total duration of the study was 6 months from January 2017 to May 2017. Altogether 158 respondents were selected to complete the study. Among them 150(90 from Banke and 60 from the Surkhet) vegetable producer Household and 8 Agro vets (4 from Banke and 4 from Surkhet). Primary data were collected through the Household survey with structured questionnaire, interviewing the farmers and field observation. For secondary or supplementary information, many concerned organizations such as (DADO) of the respective districts, Nepal Agricultural Research Council (NARC), Ministry of Agriculture Development (MoAD), Plant Protection Directorate (PPD), Vegetable Development Directorate (VDD), Central Bureau of Statistics (CBS), (AICC), Himalayan College of Agricultural Sciences and Technology (HICAST), iDE Nepal, Caritas Nepal, Institute of Agriculture and Animal science (IAAS), and different websites of the related field were also visited to collect publications for secondary information. The information collected from the survey were coded first and entered into the computer. Descriptive statistics like mean, standard deviation, percentage and frequency will be used to process the data. Data entry and analysis will be done by using computer software package such as Microsoft Excel. Analyzed data will then present in tables, graphs and pie chart.

RESULTS AND DISCUSSION

Insect pest and disease of vegetable crops (onion, okra, French bean, chili)

Pest and disease are the serious problem of the crop yield loss. Likewise, Disease of the selected vegetable was found in the survey site. According to Survey most of farmer noted about most common disease of onion are purple blotch, Onion Smut occur frequently whereas basal rot bulb canker, found less as compare to other disease. Similarly in Okra yellow vein mosaic and Die back occur frequently Other disease Like Powdery Mildew, Leaf Blight found less. Chili is highly Susceptible by the Damping Off, Anthracnose occur frequently French bean are also susceptible by the different disease in the study area such as Alteraria leaf spot, Fusarium wilt Anthracnose are the highly occur as compare to other disease (Table 1).

Table 1. Disease of vegetable crops (onion, okra, French bean, and chili)

Name of crops	Disease	Occurrence*		
		High	Medium	Low
1. ONION	Purple blotch/blight *(Alternaria palanduii)*	√		
	Onion smut *(Uracystis cepule)*	√		
	Downy mildew (*Peronospora destructora)*		√	
	Basal rot *(Fusarium oxysporum*)		√	
	Black mold *(Aspergillus niger)*			√
2. OKRA	Yellow vein mosaic (virus)	√		
	Powdery mildew (*Erysiphe cichoraceum)*		√	
	Leaf blight *(Rhizotonia solani)*		√	
	Die back *(collectotrichum capsici*)	√		
3. CHILI	Damping off (Phytopthora sp. Phythium sp.)	√		
	Anthracnose (collectotrichum capsici)	√		
	Bacterial blight (Xanthomonas campestris)		√	
	Powdery mildew *(Laveillula sp.)*		√	
	Bacterial wilt *(Pseudomonas solancearum*)		√	
4. FRENCH BEAN	Alteraria leaf spot (alternaria sp)	√		
	Anthracnose (Glomerella lindemuthianum)	√		
	Fusarium wilt (Fusarium sp.)	√		
	Blight (xanthomoas sp.)			√

Note: *Occurrence high=60%, medium=30% low =10%,

Insect pest of onion, okra, French bean, chili

Insect pest are important biotic factors of crop loss. There were different pest noted in the field during the survey. Onion must be susceptible by the onion thrips, and onion maggot. Pests were the high severity in study area. Similarly crop okra are highly infected by the fruit and shoot borer, flea beetle, white flies with high severity. Chili was more infect by the fruit and shoot borer, white flies, pepper weevil, and aphids. French bean are more infect and loss by the pest chickpea pod borer, soybean hairy caterpillar, chili thrips (Table 2).

Table 2.Iinsect pest of onion, okra, French bean, chili

Name of crops	Name of pest	Occurrence		
		High	Medium	Low
1. Onion	Onion thrips (*Thrips tabaci)*	√		
	Onion maggot *(Delia antiqua)*	√		
2. Okra	Okra fruit and shoot borer	√		
	Flea beetle	√		
	White flies	√		
	Cotton jassids		√	
	Cotton aphids		√	
3. Chili	Aphids (myzus persicae)			√
	Fruit and shoot borer	√		
	Thrips		√	
	Pepper weevil		√	
	White flies		√	
4. French bean	Chickpea pod borer	√		
	Chili trips	√		
	White flies		√	
	Soybean hairy caterpillar		√	

Note: *Occurrence high=60%, medium=30% low =10%,

Management practices of insect pest and disease

A variety of insect pest management practices such as cultural, chemical and other mixed methods were being practiced among the different levels of farming communities of the survey area. In survey area, majority of the commercial growers (75%) apply only cultural plus chemical and very miner (5%) growers used chemicals methods for insect pest and disease management. Similarly, 18 Percent of growers integrated biological with chemical measures but there was no evidence of using biological tactics in combination with others (Figure 1).

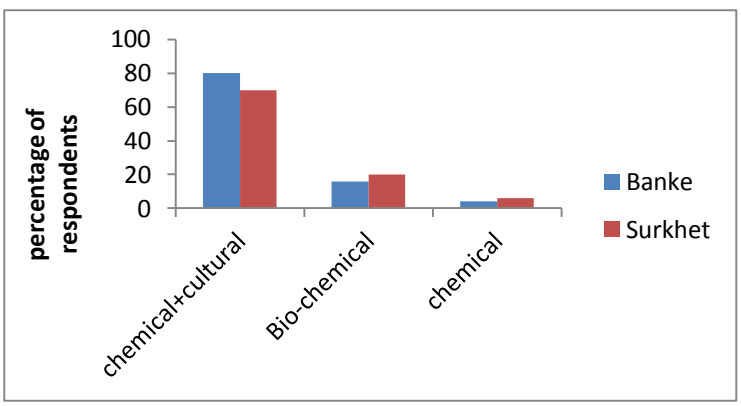

Figure 1. Management practices of insect pest and disease in Banke and Surkhet districts

Pesticide use by the farmers

It was found that farmers seldom used traditional as well as the newly commercialized bio pesticides for insect pest management. Moreover, they preferred to use chemical pesticides of synthetic parathyroid, organophosphate, carbamate and even organ chlorine groups whichever available at local Agro-vets. Pesticide use pattern varied with crop and season. Different types of pesticides ranged from medium toxic to high toxic which were commonly used by the growers in the survey area. Use of Cypermethrin (synthetic pyrethroid) was the highest (39.51%) followed by Organophosphate and mixed type (Cypermethrin + Chloropyriphos)

Table 14. Major chemicals used by farmers in Banke and Surkhet

Trade name	Common name	Formulation	Group	Percent use (%)
Anumite, Cyperin 10, Ripcord, Cyperkill	Cypermethrin	10% EC	OP	49.51
Stem Pade	Chloropyriphos + Cypermethrin	(50%+5%) EC	SP + OP	11.62
Krenoxyl Gold	Metalaxyl + Mancozeb	-	Fungicide	9.30
Decis	Deltamethrin	28% EC		2.32
Dithan M-45	Mancozeb	-	Fungicide	13.25
Roger	Dimethoate	30% EC	OP	4.46
Nuvan, Nuril	Dichlorovos	76% EC	OP	6.96
Others	-	-		4.64
OP= organophosphate, SP = Synthetic Pyrathroid, OC= Organochlorine				

Common Biological agent used by the farmers

Farmers were using different types of bio-agent for good agriculture practices. Majority of the respondents were in the study area using Pseudomonas bio-agent followed by the B.T and Trichoderma (Fig 11).

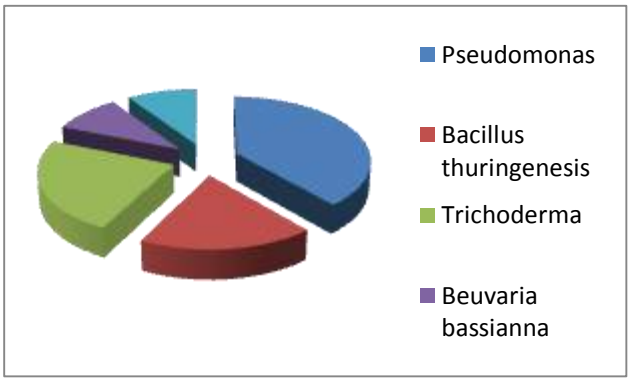

Figure 11. Common Biological agent used by the farmers

CONCLUSION

IPM is a program that is particularly suited to poor farmers because it does not require the use of external resources and is compatible with the integrated farming systems associated with poor subsistence farmers. It can increase agricultural productivity, reduce production risks, increase farmer's income, improve their health, protect their environment and over all empower the farmers therefore it has become a successful and popular program in Nepal.

The use of chemical pesticides was accounted in surveyed area which had majority of highly commercialized farmers of higher land holding. The cultivated area was suffered from major insect pests however; effective control was limited to chemicals derived from local agro-vets. The farmers had poor knowledge about pesticides use but some has perfect knowledge about the use and its bad impact on non-target organisms. However, they are reluctant to leave the ruined practices. Any practices alternatives to chemicals are rapidly disappearing. If recent advances mainly through the changes in agriculture with the heavy use of agro-chemicals are allowed to continue in these alarming areas, there would be havoc situation in agriculture, animal health and environment in future.

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Evaluation of packaging materials for transportation of apple

G. D. Subedi[1], D. M. Gautam[3], D. R. Baral[3], G. B. K. C. [3], K.P. Paudyal[1] & R. K. Giri[2]

[1]Nepal Agricultural Research Council, HRD, Khumaltar, Lalitpur, Nepal
[2]Nepal Agricultural Research Council, HRS, Rajikot, Jumla, Nepal
[3]Tribhuvan University, IAAS, Kritipur, Kathmandu, Nepal
subedigiridharinarc@gmail.com

ABSTRACT

Studies were carried out for two consecutive years (2013-2014 AD) to identify appropriate packaging materials for transportation of apples. Fruits of Red Delicious cultivar harvested on 3rd week of September were packed in different types of Corrugated Fiber Board boxes and transported from Jumla (2390m asl., $29^0$17' N, $82^0$13' E) to Kohalpur, Banke (215 km mountainous gravel road, 48 hours) by truck. The treatments were 10 kg capacity 5 Ply and 7 Ply CFB boxes having 140, 160 and 180 PSI bursting strength. To compare with conventional and government recommended practices, the fruits were also packed in 3 Ply ordinary Beer cartons (conventional practice) and 7 Ply 20 kg capacity CFB boxes (Government recommendation). After transportation, fruits were stored as such condition in cold store at 5±1°C and 95% RH for one month. After storage, observations were made on physiological loss in weight (PLW), percent damage fruit, fruit quality and economic analysis. There was more than 50% reduction in PLW in all packaging treatments as compared to conventional one (3.8%). Similarly, total damaged fruits were highest (21.6%) in conventional practice which was reduced to 6 to 12 % in other treatments. Among the treatments, 7 Ply 180 PSI bursting strength CFB boxes were the best to retain fruit quality. Besides reduction in postharvest loss and better quality fruits, higher gross return, higher Benefit Cost Ratio was received from the improved technology. The use of 7 Ply 180 PSI CFB boxes has an additional benefit of NRs. 43650 (US $ 400) per 5000 kg fruits (1 truckload load). Higher cost of CFB boxes could be an important obstacle in adaption of improved technology; hence provision should be made from the government to subsidize for packaging materials to encourage adaption of improved technology.

Key words*:* Brushing, Bursting strength, CFB boxes, Hedonic rating, Potential Added Benefit

INTRODUCTION

Apple (*Malus domestica* Borkh.) is a deciduous plant in Rose family, an economically important pomaceous fruit. Apple fruits have colorful appearance, crispy flesh, pleasant flavor and sweet taste. It has been originated in Central Asia, where its wild ancestor *Malus sieversii* is still found today (https://en.wikipedia.org/wiki/Apple). Apples have been grown for thousands of years in Asia and Europe; were brought to Indian sub-continent by European colonists. There are more than 7500 cultivars and it is one of the most grown fruit in the temperate zones of all over the world (Martinelli *et. al*. 2008). Apples have religious and mythological significance in many cultures including Norse, Greek and European Christian traditions. The proverb "An apple a day keeps doctor away" addresses the health effect of the fruit. Consumption of apple has shown better health to prevent a variety of chronic diseases and lung cancer, asthma, diabetes and ischemic heart disease which is mainly due to large content of structural cell walls and polysaccharides

along with the various phyto-chemical antioxidants (Device *et. al*. 2010). Apple is a leading deciduous fruit grown successfully in high hill areas from east to far west of Nepal. In Nepal, apple can be grown in 54 districts; however, only 12 districts grow apple commercially of which Jumla ranked the number one in terms of area and production (Subedi *et. al.* 2012). Red Delicious is the widely adapted commercial cultivar of apple. Apple growers of Nepal have not been receiving anticipated level of income because of higher postharvest loss due to in appropriate traditional postharvest handling practices. Large amount of fruit losses occurs after harvest and minimizing this loss could save over 25% of produce (Gurung, 1998). Gautam *et al.* (2004) reported that 58.2% apple fruits damage during harvesting, handling, transportation and distribution due to inadequate postharvest handling technology. All the apple production areas are located in higher hills, from where usually the fruits are harvested and transported to collection centers on conical bamboo baskets by the porters and thereafter to distance market in different CFB boxes and gunny sacks. Fruits bruise easily due to scratch, compression, impact and vibration forces during transportation also lead to the damages. The damages may not be apparent and visible to naked eyes immediately after transport; however become visible after storage. Moreover scratches and wounds created during transport are the avenue for the entry of microorganism for the development of disease and rotting. Thus damaged fruits have short storage life as compared to undamaged healthy fruits. In Nepal, present packaging system for apple fruit is unsuitable and unscientific. The use of traditional forms of packages like bamboo baskets; reused Beer cartons, noodle cartons, Chinese apple cartons & gunny sacks are still prevalent which are not convenient containers for packaging, handling, transporting and marketing of fresh apple for distant market. Rough surface & sharp edge of bamboo baskets cause bruising and scaring; inconvenience in handling and stacking during transportation. Among different packaging containers, CFB boxes are capable of withstanding various shipping and transportation hazards (impact, compression & vibration damages, moisture, etc.), attractive, light weight; provide cushioning and good stacking strength and excellent cushioning for product protection, offers better retention of shelf life and quality of product & better printability which helps in efficient marketing (D. K. Salunkhe *et al.* 1995). One of the important functions of CFB boxes is to provide crush resistance/product protection and adequate strength for stacking in warehouses. The use of CFB boxes is being made to limited extent in Nepal. Some traders and cooperatives have initialed to use CFB boxes for packaging and transportation of apple to long distance market; however packaging containers and packaging methods have not been standardized yet. Apple growers, cooperatives and traders still use 3 Ply Beer cartons and 7 Ply CFB boxes of 20kg capacity recommended by Fruit Development Directorate/Department of Agriculture development (FDD/DOAD) to pack and transport apples. At present, nearest cold storage is located in Kohalpur, Banke which is far from the production site. Fruits are usually stored in cold storage by traders and released periodically for marketing. Thus, the main objective of this investigation was to identify appropriate packaging materials for transportation of apple fruits from the production center to the distant market and thereafter on storage in a prime form and fresh condition.

MATERIALS AND METHODS

Studies were carried out for two consecutive years (2013-2014 AD) to identify appropriate packaging material for transportation of Red Delicious apple from Jumla to Nepalgunj, Banke. Fruits were harvested at commercial maturity stage from Jumla (2390m asl. 29^0 17'N, $82^0$13'E) and transported to Kohalpur market, Banke in different types of packing containers. Six different

types of 10 kg capacity CFB boxes (300 mm x 250 mm x 295 mm) having different plies with different bursting strength were manufactured at Sahara Packaging Private Limited, Jorpati, Kathmandu. They were; 5 Ply CFB boxes (two outer plies and one intermediate ply of cardboard papers, two plies of fluted paper glutted alternately) with 140 PSI, 160 PSI, 180 PSI bursting strength, 7 Ply CFB boxes (two outer plies & two intermediate plies of cardboard papers, three plies of fluted papers glutted alternately) with 140 PSI, 160 PSI, 180 PSI bursting strength. To compare with conventional and other methods, two existing practices were also included as treatments; these were 7 Ply CFB boxes of 20 kg capacity recommended by FDD/DOAD and 3 Ply Beer cartons as local practice (two plies of cardboard papers and one ply of fluted paper glutted alternately). Eight holes of 20mm diameter were made on the two sides of the boxes for exchange of gases. Uniform sized 64 and 140 fruits were packed according to capacity of boxes. Fruits were arranged in layers separated by 3 Ply 120 PSI deck plate. CFB boxes were sealed with carton tape first, then diagonally sealed by carton sealing and strapping machine (Golden Eagle); transported to truck by porters on their head (200m). CFB boxes were loaded randomly; staked in 4 layers inside the truck after spreading of HDPE tarpaulin at the base; shipped by truck to Kohalpur, Banke (215 km mountainous gravel road, 48 hours) and then stored for one month in cold storage at 5±1°C and 95% RH. Since the effect of packing material is not prominent immediately after transportation, the fruits were stored for one month for observation.

After one month storage, consumer's acceptability (Juyun Lim, 2011) was recorded by a panel of five judges on the basis of hedonic rating (9-like extremely; 8-like very much; 7-like moderately; 6-like slightly; 5-neither like nor dislike; 4-dislike slightly; 3-dislike moderately; 2-dislike very much; 1-dislike extremely). Firmness of fruit was measured with hand Penetrometer (FT-327, Italy) having plunger diameter of 11 mm. Total Soluble Solids (^{0}Brix) was recorded with hand Refractometer (Erma, Japan) calibrated at 20°C. Titratable acidity was determined by titrating a 5 ml juice with 0.1 N NaOH using Phenolphthalein as an indicator (AOAC, 1990). Starch iodine test was performed to determine the conversion pattern of starch into sugars (M. S. Reid *et. al*. 1982). Iodine solution was prepared by dissolving 10g of Iodine crystals and 25g of Potassium Iodide in 1 liter of water. Fruits (n=10) were cut at right angles to the core, approximately halfway from stem to calyx end; Iodine solution was applied to cut surface, drained away any excess and rated fruit staining after 2 minutes by using 0 to 6 scales [0-all tissue zones stained (all starch); 1-clearing within the core flesh, particularly between adjacent seed carpel; 2-clearing has extended to the core line and started to extend into the regions between core line vascular bundles; 3-clearing has continued between the core line vascular bundles, while tissue surrounding the core line vascular bundles and in the outer cortex remain stained; 4-clearing has continued into the outer cortex, but not to the skin. Most core line vascular bundles and associated tissue which remain stained are surrounded by unstained cortical tissue; 5-clearing has extended to within a few mm of the skin and unstained zones around the core line vascular bundle, where they exist, started to contract; 6-no staining (no starch)]. Observations were recorded for physiological losses in weight, damage incurred due to bruising and spoilage during transportation and storage. Physico-chemical studies on quality parameters were performed at RARS, Khajura, Banke. Data were analyzed statistically using GenStat software version 10.3 (VSN, 2011).

RESULTS AND DISCUSSION

Physiological losses in weight (%)

PLW during transportation and storage was highly significant among the tested packaging materials. Maximum PLW (3.8%) was observed in 3 Ply Beer cartons followed by 7 Ply FFD CFB boxes (1.9 %) while minimum (1.5%) in other treatments (Table 1). Maximum PLW in 3 Ply Beer cartons mighty be due to inadequate thinness and strength which increased the damage to the carton surface resulted more water loss due to higher evapo-transpiration and respiration during transportation and storage.

Table 1. Effect of packaging materials on physiological losses in weight, total damage, spoilage and acceptable damage on Red delicious apple during transportation and after storage for one month at Bheri cold store, Kohalpur, Banke for 2 consecutive years (2013-2014 AD)

CFB boxes	PLW (%)	Total Damage (%)	Spoilage (%)	Acceptable Damage (%)
5 Ply 140 PSI Carton	1.5	8.8	3.6	5.2
5 Ply 160 PSI Carton	1.5	7.6	2.9	4.7
5 Ply 180 PSI Carton	1.5	7.3	2.6	4.7
7 Ply 140 PSI Carton	1.5	6.6	2.4	4.2
7 Ply 160 PSI Carton	1.5	6.2	2.2	4.0
7 Ply 180 PSI Carton	1.5	6.0	2.0	4.0
7 Ply FDD Carton	1.9	12.0	6.2	5.8
3 Ply Beer Carton	3.8	21.6	10.7	10.9
F- test	***	***	***	
LSD (P< 0.05)	1.4	7.6	2.9	
CV (%)	1.5	7.3	2.6	

Total damage, spoilage and acceptable damage

Total damaged fruits due to bruising, scaring and spoilage during transportation and storage was highly significant among the tested packaging containers (Table 1). Minimum number of total damaged fruits was observed in 7 Ply 180 PSI CFB boxes (6.0%) followed by 7 Ply 160 PSI CFB boxes (6.2) while maximum in 3 Ply Beer cartons (21.6%). Likewise, minimum spoilage (2.0%) was observed in 7 Ply 180 PSI CFB boxes followed by 7 Ply 160 PSI CFB boxes (2.2%) while maximum in 3 Ply Beer cartons (10.7%). Minimum acceptable damaged fruits were observed (4.0%) in 7 Ply 180/160 PSI CFB boxes while maximum (10.9%) in 3 Ply Beer cartons. Maximum damages in 3 Ply Beer carton might be due to inadequate cushioning and strength which increased the damage to internal tissues during transportation. The scratches or miner wounds may not be apparently visible immediately after transportation however it has significant influence during storage. This evidence indicates that 7 Ply 180 PSI CFB boxes have high shock bearing capacity during long distance transportation in rough road. The fruit skin in apples consists of the cuticle, epidermis and several layers of hypodermis. Both skin and its waxy coat are of significant importance during transportation and storage. The most important function of the epidermis and cuticle is to protect the fruit surface against environmental stresses such as wind, temperature, drought, chemicals, insects, and microorganisms throughout the fruit life on the tree and later, after harvest, during transportation and storage (Tukey *et al.,* 1942, Babos *et al*., 1984).

Compression damage may occur in lower depth of the container as a result of load of upper fruits, while impact damage may occur due to rough handling on t,he surface of fruits, and vibration forces usually occur during transportation. Packaging container might have effect on the damage of fruits. The fruits are compressed in the bottom layers as well as sides of the carton during transportation and storage which caused damages. There have been several other studies related to the damage caused by transportation hazards. The highest bruising and spoilage damages on 3 Ply Beer cartons obtained from this study are also supported by the finding by Gautam *et al.* (2004) and Shrestha (1996). Joshi *et al*. (1988) suggests for using CFB cartons with a 15 kg or 8 kg capacity to reduce the brushing losses of Red delicious apples. Paudyal *et al.* (2016) reported that maximum spoilage (32.5%) was observed on control while minimum (17.5%) on paper wrapped apple fruits after 60 days of storage.

Total Soluble Solids, Titratable Acidity and TSS:TA Ratio

At maturity stage, mean TSS, TA and TSS/TA were 10.6%, 0.25% and 43 respectively (Figure 2B, 2C, 2D). TSS of the fruits increased during storage. Highest TSS was noticed in 3 Ply Beer cartons and 7 Ply FFD CFB boxes (14.5%) while lower in other treatments (14.1-14.2%). TSS of apple is a major quality parameter which is correlated with texture and composition. Increase in TSS could be attributed to breakdown of starch into sugars or hydrolysis of cell wall polysaccharides (Weibel *et. al*. 2004).

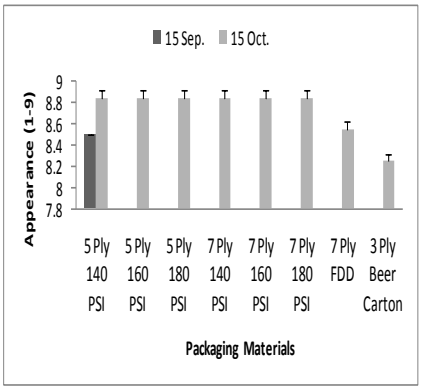
The level of TA decreased during storage. Lowest TA was recorded in 3 Ply Beer cartons (0.20%) and highest in other treatments (0.22-0.24%). Malic acid is the major acid in apple juice plays a major role in flavor attribute (Ben *et. al.* 1985). Reduction of TA during storage might be due to conversion of organic acid into reducing sugars during fruit ripening process.

The level of TSS:TA ratio increased after storage. Higher TSS:TA ratio (74.4) was recorded 3 Ply Beer cartons while lower (59.0-67.3) in others treatments. This might be due to conversion of acid into sugars. Excessive increase in TSS:TA ratio in 3 Ply Beer cartons caused imbalance resulting poor sensory rating due to development of slight bitterness and mealiness. Mahajan (1994) reported that many biochemical changes take place during storage which disturbs the TSS:TA ratio ultimately rendering the fruit unacceptable.

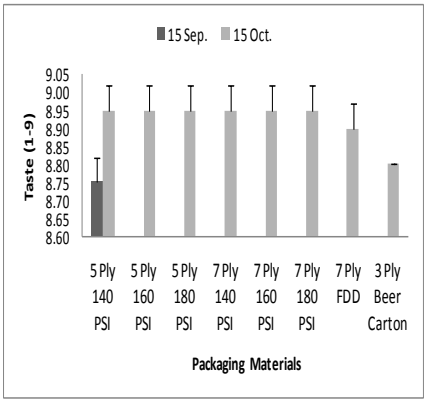
Fruit firmness and juice content

At maturity stage, average firmness was 8.1 kg/cm^2. Firmness of the fruits decreased after storage. Lowest firmness was recorded in 3 Ply Beer cartons (6.2 kg/cm^2) while higher in other treatments (Figure 2A). This evidence indicates that fruits packed in 3 Ply Beer cartons degraded faster due to low aeration as well as more physical damage during transportation. The softening of flesh during storage could be due to the degradation of soluble pectin by high activity of endo-poly-galacturonase enzyme in fruits (Mann *et. al.* 1990). Apples that have crisp, juicy texture and prolong shelf life are highly preferred by the consumers (Jaeger *et. al.* 1998).

At maturity stage, average juice content was 69.5% while juice content of apples decreased during storage ranging from 60.5 to 66.0% irrespective of the packaging materials and it was higher in 7 Ply 140 PSI CFB boxes while lowest in 3 Ply Beer cartons (Figure 1F).



A



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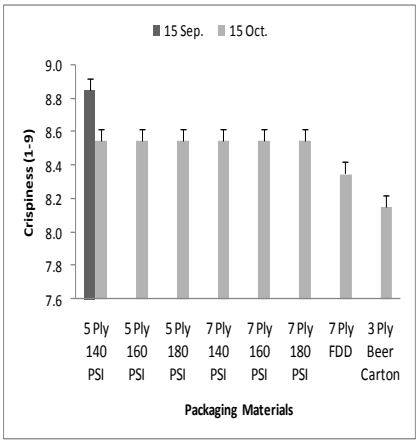
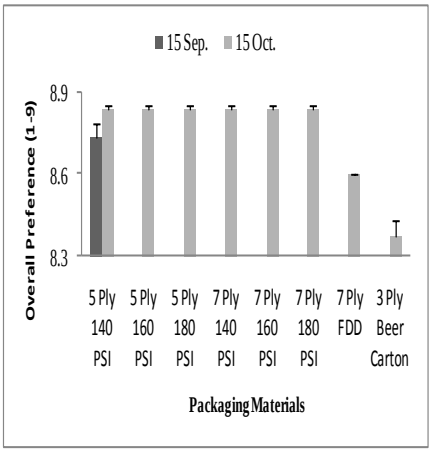
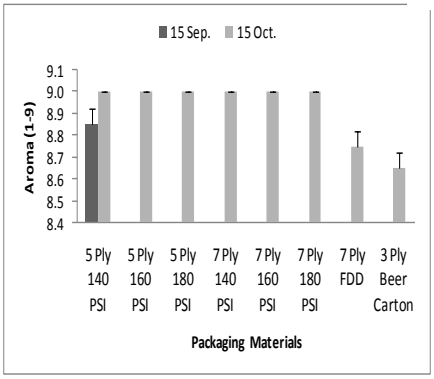


B



E



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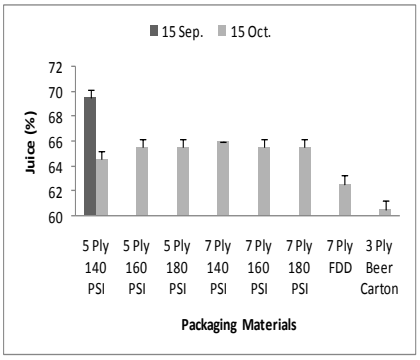

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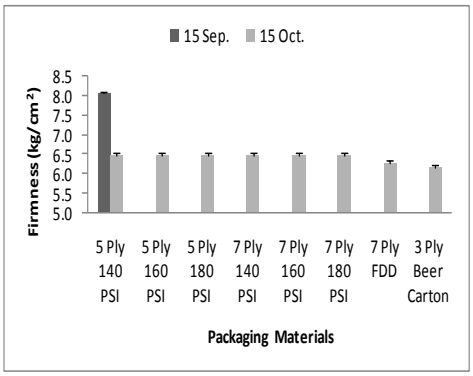
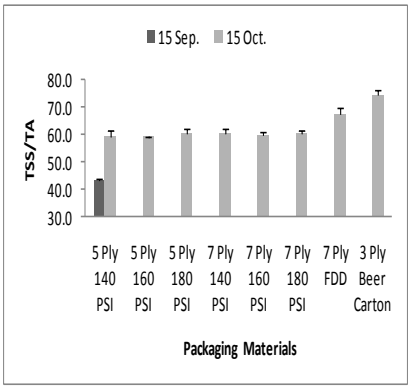
Figure 1. Hedonic rating and juice content of Red delicious apple cultivar before transportation and after one month storage (5±1°C, 95% RH) at Bheri Cold Store, Kohalpur, Banke for two consecutive years (2013-2014 AD)



A



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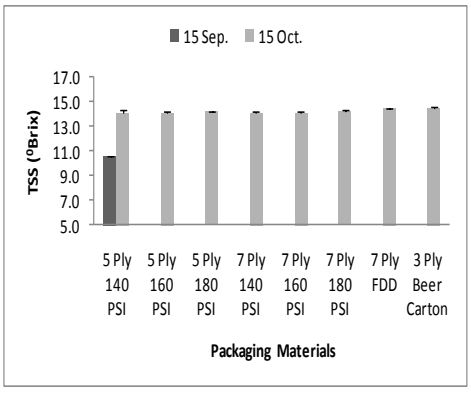

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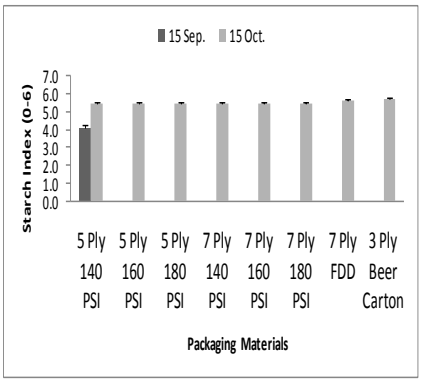

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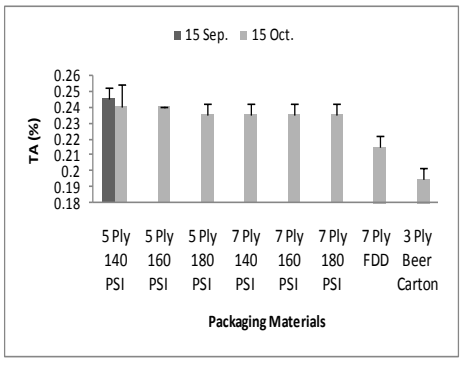

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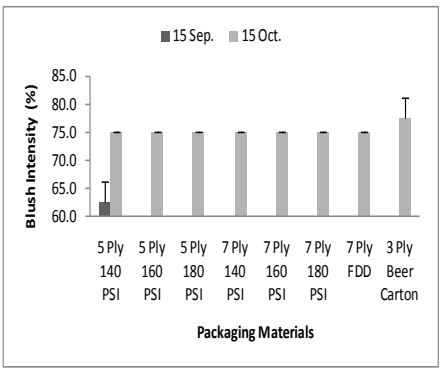

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Figure 2. Quality parameters of Red delicious apple cultivar before transportation and after one month storage (5±1°C, 95% RH) at Bheri Cold Store, Kohalpur, Banke for two consecutive years (2013-2014 AD)

Starch Index and Blush intensity

At maturity stage, average starch index was 4.1. Starch index increased during storage (Figure 2E). Higher starch index (5.8) was recorded in 3 Ply Beer cartons followed by 7 Ply FDD CFB boxes (5.7) while lower (5.5) in other treatments. This might be due to conversion of starch into reducing sugars during ripening of fruits. The level of starch decreased after storage. Saleh *et. al*. (2009) reported that fruits stored at 90% RH and 0ºC for 6 months exhibited significant differences in physiological and anatomical parameters may be due to ethylene production, responsible for changes in texture and firmness.

At maturity stage, average blush intensity was 62.5% with respect to packaging materials. The level of blush intensity increased during storage (Figure 2F). Highest blush intensity (77.5%) was recorded in 3 Ply Beer cartons while lowest (75.0%) in other treatments. This might be due to conversion of chlorophyll into colored pigments during ripening of fruits.

Overall preference and acceptability

At maturity stage, mean overall preference was 8.7. Overall preference increased during storage (Figure 1E). Minimum overall preference (8.4) was recorded in 3 Ply Beer cartons followed by 7 Ply FFD CFB boxes (8.6) while maximum in other treatments. Minimum sensory score maintained by 3 Ply Beer cartons might be due to inadequate strength and thickness which increased the physical damage to apple fruits during transportation. 7 Ply CFB boxes of 20 kg capacity recommended by FFD/DOAD was not appropriate container because of more postharvest losses, inconvenience in handling and unaffordable price for the consumers. Thus, CFB Box of 10 kg capacity having 7 Ply 180 PSI bursting strength was easily accepted by the farmers groups, cooperatives, traders and consumers in Nepalese context because of convenience in handling; minimum brushing, scaring, spoilage damage; high storability, affordable price, better retention of physical appearance, crispiness, taste, aroma and firmness.

Table 2. Postharvest losses of Red delicious apple fruits in existing and improved value chains in the mid western development region of Nepal during 2013-2014 AD

Loss Parameters	Existing Value Chain (%)	Improved Value Chain (%)
1. PLW	3.8	1.5
2. Total Damage	21.6	6.0
3. Spoilage	10.7	2.0
4. Acceptable Damage (2-3)	10.9	4.0
5. Equivalent percent loss of the acceptable damaged fruits [(Price loss due to total damage /Total price of whole lot) x 100]*	2.7	1.0
Net loss (1+3+5)	17.2	4.5

*Damaged fruits were priced 25% lower than sound fruits

Economic analysis

Minimum postharvest losses (4.5%) was observed in 7 Ply 180 PSI CFB boxes (improved practice) while maximum (17.2%) in 3 Ply Beer cartons (conventional practice). Lowest net return

(NRs. 238850/truckload) was observed in 3 Ply Beer cartons while highest (NRs. 282500/truckload) in 7 Ply 180 PSI CFB boxes. With prospects of loss reduction, improved packaging method sounds the best technology. Physiological losses in weight (3.8%), spoilage loss (10.7%) and losses due to 25% decrease in the market value of the fruits was 2.7% in 3 Ply Beer cartons making a total of 17.2% loss which was reduced to 4.5% in 7 Ply 180 PSI CFB boxes. Economic analysis shows that higher benefit cost ratio (1.9) in 7 Ply 180 PSI CFB boxes as compared to 3 Ply Beer cartons (1.8). If the traders replace the conventional system of packaging fruits in 3 Ply Beer cartons by improved one (7 Ply 180 PSI CFB boxes), they can gain additional benefit of NRs 43650 (US$ 400) per truckload.

Table 3. Benefit Cost Ratio and Potential added benefit of Red delicious apple Packaging and Transportation from HRS, Rajikot, Jumla to Bheri cold store, Kohalpur, Banke, Nepal in Existing and Improved Value Chain Scenarios during 2013-2014 AD

Particulars	Unit price (NRs)	Total price (NRs)
Existing value chain (EVC): Packaging in 3 Ply ordinary Beer cartons		
A. Gross return (1 truckload)		
1. Selling price of 5000 kg apple fruits at cold store	125	625,000
2. Postharvest loss, 17.2% of 5000 kg = 861.5kg	125	86150
3. Gross return after loss (A1-A2)		538,850
B. Cost		
1. Cost of 3 Ply Beer carton (500 cartons)	20	10000
2. Cost of fruits at collection centre (NRs 50/kg)	50	250000
3. Labor cost for packaging and handling (NRs 30/box)	30	15000
4. Warehouse cost (NRs 40/box)	40	20000
5. Labor cost for unloading and handling (NRs 10/box)	10	5000
6. Total cost (B1+B2+B3+B4+B5)		300000
C. Net Return (A3-B6)		238,850
D. Benefit Cost Ratio (A3/B6)		1.80
Improved value chain (IVC): Packaging in 7 Ply 180 PSI CFB boxes		
A. Gross return (1 truckload)		
1. Selling price of 5000 kg apple fruits at cold store	125	625000
2. Postharvest loss, 4.5% of 5000 kg = 225kg	125	22500
3. Gross return after loss (A1-A2)		602500
B. Cost		
1. Cost of 7 Ply 180 PSI CFB box (500 boxes)	60	30000
2. Cost of fruits at collection centre (NRs 50/kg)	50	250000
3. Labor cost of for packaging and handling (NRs 30/box)	30	15,000
4. Warehouse cost (NRs 40/box)	40	20000
5. Labor cost for unloading and handling (NRs 10/box)	10	5000

6. Total cost (B1+B2+B3+B4+B5)		320000
C. Net Return (A3-B6)		282500
D. Benefit Cost Ratio (A3/B6)		1.9
E. Potential Added Benefit per truckload (C of IVC – C of EVC)		43,650
F. Potential Added Benefit per truckload (US$)		400
G. Potential Added Benefit per kg fruit (E/5000)		8.73

CONCLUSION

Because of convenience in handling and stacking; minimum scratching, brushing and spoilage damages; high storability; better retention of physical appearance, crispiness, taste, aroma and fruit firmness; high benefit cost ratio and affordable price for the consumers 7 Ply CFB box of 10 kg capacity having 180 PSI bursting strength was identified as the most desirable, efficacious and appropriate container in Nepalese context for packaging and transportation of apple fruits from production sites to distant markets and warehouses by truck. Economic analysis showed that If the traders they can gain additional benefit of NRs 43650 (US $ 400) per truckload by using improved 7 Ply 180 PSI CFB boxes.

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Assessment of farmer's perspective on backyard poultry production and impacts of vaccination against Ranikhet disease in Jhapa district, Nepal

S. Acharya[1], S. Karki[2], K.P. Sah[3] and S. N. Mahato[3]
[1]5348 Manayunk Road Apt C, Harrisburg, Pennsylvania, USA
[2]Department of Pathobiology, University of Illinois, Urbana-Champaign, Illinois, USA
[3]Heifer International Nepal, Hattiban, Lalitpur, Nepal
acharya.sita.nepal@gmail.com

ABSTRACT

Backyard poultry farming is one of the important sources of cash income for rural women in Nepal. However, they are facing a myriad of challenges to make their farming profitable. One of the several reasons might be their lack of scientific knowledge on backyard poultry farming that include unawareness and poor access to preventive measure such as vaccines to prevent and control frequently occurring disease outbreaks. Among the diseases observed in backyard poultry, Newcastle disease, also known as Ranikhet, is the most frequent and deadly disease that can wipe out poultry across villages. The objectives of the study were to understand the women farmer's level of awareness and their perception on backyard poultry farming and to evaluate the impacts of vaccination against Ranikhet disease in backyard chicken in household farm economics. A total of 54 women farmers were randomly selected from two village development committees of Jhapa district, Nepal and interviewed using semi-structured questionnaire before and after the final vaccination program. The result showed that farmer's level of awareness on backyard poultry farming increased after the vaccination program which changed some of their pre-existing perceptions. We also observed increased average flock size, egg production, and annual sale of eggs and poultry meat after the vaccination program which indicated that their farming became more profitable after the program. On average the transaction of farmers increased by NRs 23,029 (around US dollars 225) compared to previous year without vaccination. The observed increased average meat consumption after the intervention indicated that rural food security was also enhanced. We conclude that the vaccination program against Ranikhet disease in backyard poultry farming together with extension program was effective in increasing women farmer's knowledge and to make their enterprise more profitable. We suggest Nepal government and other non-governmental organizations extend similar programs to other farmer groups and districts of Nepal.

Keywords: Backyard poultry, Extension, Farm economics, Jhapa, Newcastle or Ranikhet disease, Vaccination.

INTRODUCTION

Livestock farming is an important component of the agricultural system of Nepal. The primary livestock species raised in Nepal include cattle, buffaloes, sheep, goat, poultry, Himalayan goat (Chyangra), and yak depending upon the local agroclimatic conditions. Livestock farming offers cash income to the farmers which are crucial to run their day-to-day financial activities (Karki and Bauer, 2004; Bhatta et al., 2015). Among these several livestock species raised, poultry, especially chicken, is one of the common species raised in the hills and terai areas of Nepal (Bhurtel and

Shaha, 2000). While poultry farming is one of the rapidly commercialising livestock subsectors in the peri-urban areas of Nepal (Sharma, 2010), backyard poultry farming is still an important source of cash income and protein supplement in rural areas of Nepal and developing world (Bhurtel and Shaha, 2000; Dolberg, 2003; Mack et al., 2005; Mandal et al., 2006).

In Nepal, backyard poultry is generally raised in a traditional way following scavenging system. Mostly, chicken is considered an important asset for women and girls in rural households in developing countries (Guèye, 2005). Backyard poultry farming has also been widely used as a tool for poverty alleviation (Dolberg, 2003; Mack et al., 2005; Dolberg, 2007). However, there are numerous challenges faced by farmers while raising backyard poultry such as predation from wild animals, theft, and frequent disease outbreaks that can wipe out birds across villages. Due to lack of epidemiological studies and poor veterinary network across rural areas, sometimes such outbreaks might even go unnoticed. However, anecdotal evidence suggests that Newcastle or Ranikhet disease, Fowl pox, and parasitic infestations are commonly prevalent in rural poultry in Nepal (Bhurtel and Shaha, 2000; Sharma, 2010). More recently, highly pathogenic avian influenza outbreaks was also recorded in backyard poultry including chicken and ducks in Nepal which caused substantial direct and indirect financial losses to the farmers (Karki et al., 2015).

Among several diseases prevalent in the backyard chicken, Ranikhet disease is considered to be one of the deadliest and most prevalent diseases in developing world (Awan et al., 1994). Ranikhet is caused by a paramyxovirus and is characterized by high mortality up to 100%, depression, greenish diarrhea, respiratory signs including gasping, twisted necks, drooping wings and paralysis (Alexander, 2001). However, this disease is vaccine preventable and several vaccines are available for commercial poultry but there is no specific recommendation for backyard chickens (Shrestha et al., 2017). Recently, some of the vaccines against Ranikhet diseases have been successfully applied in backyard chickens (Shrestha et al., 2017). Vaccinating backyard chicken is not a very common practice in Nepal, partly because of the lack of awareness and partly because of the unavailability of suitable vaccines, and poor access, if any available. To address this gap, a pilot project was launched by the Heifer International Nepal in collaboration with GALVmed in Jhapa district, Nepal to vaccinate backyard chicken against the most common Ranikhet disease. Additionally limited studies have been conducted to understand the level of awareness and perception of rural women farmers on backyard poultry farming in Nepal. We selected a subset of the women farmers involved in the pilot project of Heifer International Nepal and GALVmed to understand their level of knowledge and perception on backyard poultry farming, and the impacts of vaccination intervention on their farm economics. The objectives of this study were to (i) understand the women farmer's level of awareness and their perception on backyard poultry farming, and (ii) to evaluate the impacts of vaccination against Ranikhet disease in backyard chicken in household farm economics.

MATERIALS AND METHODS

Study design and questionnaire survey

This study was conducted from May 2011 to May 2012 in two village development committees, Arjundhara and Khudunabari, of Jhapa district, Nepal. A total of 54 farmers were randomly selected from more than 1,900 farmers who participated in a pilot project of Heifer International Nepal and GALVmed to vaccinate their backyard chickens against Ranikhet disease. A semi-structured questionnaire was prepared to interview farmers for collecting information on basic

demographics, their perspective and knowledge on backyard poultry farming, and impacts of vaccination in backyard chicken against Ranikhet disease. A face-to-face interview was conducted at the farmer's house. The first interview was conducted before the vaccination program while the second interview was conducted after the final vaccination program. Pre-questionnaire testing was conducted in a subset of the participating farmers (10%) to evaluate the effectiveness of the questionnaire developed. We chose following five variables to compare the effect of vaccination program by recording them before and after the campaign: flock size of the backyard chicken, chicken meat consumption produced at home, annual number of eggs produced, annual number of eggs sold, and annual number of backyard chicken sold.

Vaccination schedule

Backyard chicken from 54 households included in this study and additional 1,846 households from Arjundhara and Khudunabari VDCs were vaccinated against Ranikhet disease using commercially available La Sota strain at every three months interval for four times. Before each vaccination, birds were treated with anthelmintic medication one week earlier.

Statistical analysis

The questionnaires were entered in Microsoft Excel 2007 until further processing of the data. The basic demographic information on age, civil status, education level, primary and secondary occupations of the farmers were summarized by percentage. A paired t-test was conducted to evaluate the differences between before and after vaccination program for following variables: flock size of the backyard chicken, chicken meat consumption produced at home, annual number of eggs produced, annual number of eggs sold, and annual number of backyard chicken sold.

Ethical consideration

Farmers were informed about the objectives of the study and consent were obtained to use the information collected. All the individual identifiers were removed before analyzing the data to safeguard the privacy of individual farmers.

RESULTS AND DISCUSSION

Farmer's knowledge and perspective related to backyard poultry farming

Farmer's perception on the primary reason responsible for the loss in their poultry farming before the vaccination program showed that 24% (n= 13) of farmers perceived infectious diseases, 18.5% (n= 10) predation, 5.5% (n= 3) parasitic diseases, 1.8% (n= 1) theft, and 50% perceived a combination of factors as the primary reason for the loss in their poultry business. However, by the end of the program, the majority of the farmers perceived that infectious and parasitic diseases were the primary problems responsible for their loss in poultry farming. Before the vaccination program, none of the farmers had heard about the Ranikhet disease but 42.5% (n= 23) and 24% (n= 13) were familiar with Fowl pox and parasitic diseases respectively. By the end of the program, all the participating farmers became familiar with Ranikhet, Fowl pox and major parasitic diseases affecting the backyard chicken.

When asked about the signs and symptoms they had observed in their farms, farmer's reported that depression, greenish and whitish diarrhea, ruffled feather, twisted neck, stopping to eat feeds, pox lesions and yellowish diarrhea were the major signs and symptoms observed in their farms (Figure 1). They reported that by the end of the program, they did not observe many of these signs

in their farms which were frequent before the vaccination program. The observed changes in farmers' perception might be due to increase in farmer's knowledge through outreach and extension activities conducted in the study site through the Heifer International Nepal office.

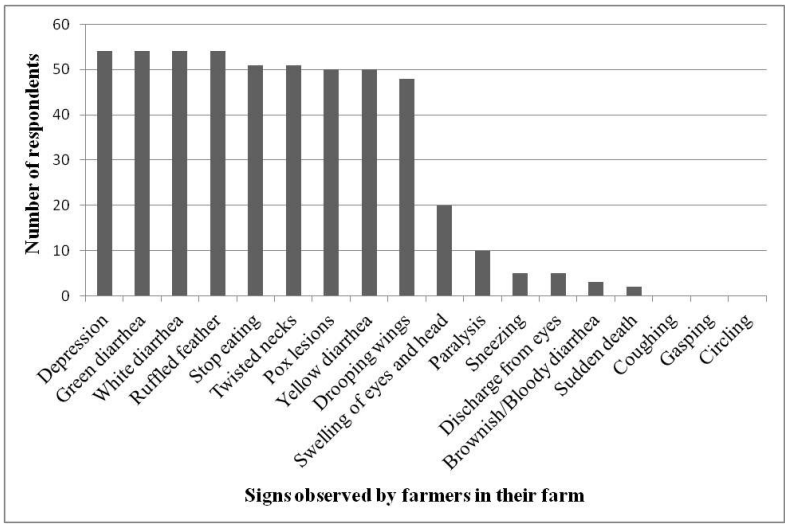

Figure 1. Signs observed by the farmers in their farms

We found significant changes in management practices farmers were practicing before and after the vaccination campaign. Before the program, all of the farmers (n= 54) responded that they used to treat their sick chickens either by buying medicine at local veterinary retailers or through traditional medications they are aware of. However, after the campaign, farmers responded that in addition to treating their sick birds, they started to practice several biosecurity related measures such as spraying disinfectants, applying lime paints on the walls, floors, and premises, separating sick chicken, isolating new chicken before introducing to the flock, and vaccinating their birds as a preventive measure (Figure 2). It was interesting to observe farmers sticking with our vaccination schedule and taking proactive roles to make the program a success despite research in our neighboring country India and Bangladesh showing health-care related practices as the least adopted ones by the farmers (Khandait et al., 2011; Nath et al., 2012).

We found that none of the farmers vaccinated their backyard chicken before our campaign. All the farmers responded that they were not aware that they should vaccinate their backyard chicken. By the end of the campaign, all the farmers became acquainted with Ranikhet vaccine and all of them vaccinated their backyard chicken against this disease. None of the farmers observed signs and symptoms that match Ranikhet disease after the vaccination program.

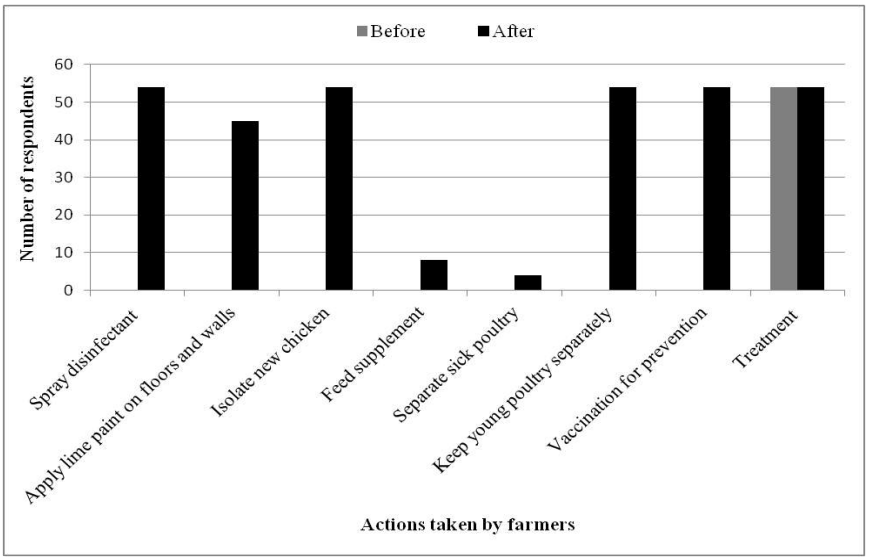

Figure 2. Farmer's response to their actions during the observance of sick birds in their farm

Impacts of vaccination program on farm economics

The before and after comparison of the five variables chosen to evaluate the effects of Ranikhet vaccination in the economics of backyard poultry farming showed that vaccination program was successful in enhancing profit to the farmers. By the end of the program, the average flock size increased and there was an increase in the annual number of eggs produced (Table 1).

We also observed on average farmers were selling higher number of chicken and eggs annually (Table 1). In addition, there was an increased consumption of home grown chicken meat (Table 1). The paired t-test comparing before and after situation of these five variables indicated that all of these increases observed after the vaccination program were statistically significant (Table 2).

Specifically, after the vaccination program, average flock size increased from 10.2 per household to 31 per household. The average number of eggs sold annually increased from 39.6 to 69.5 eggs while the average number of chicken sold increased from 34.7 to 80.3 annually. A simple financial analysis indicated that at the rate of NRs 500 per chicken, farmers were able to sale chickens worth (80.3- 34.7) chickens*NRs 500= NRs 22,800 more compared to previous year.

Likewise, at the rate of NRs 10 per egg, farmers were able to generate (69.5- 39.6) eggs * NRs 10= NRs 229 more from selling eggs compared to the previous year. In total, on average farmers were able to generate NRs 22,800 + 229= NRs 23,029 additional transaction annually. The increased cost to raise these additional birds is not considered here which warrant for detailed cost-benefit analysis to exactly know how much additional income farmers were able to generate. In general, we found from interviewing farmers that they were earning more compared to previous year without vaccination. In addition, we believe that the increased consumption of home-produced chicken meat enhanced the household food security by providing additional protein

sources. Though we did not quantify how much food security was increased by this study, previous studies have indicated that rural poultry farming contributes significantly in enhancing the household food security (Osei et al., 2015).

Table 7. Description of farm characteristics before and after vaccination against Ranikhet disease

Variable		N*	Mean	SD**	Minimum	Maximum
Chicken meat consumption (kg)	Before	54	3.7	1.2	1.1	6.0
	After	54	4.6	1.3	1.3	8.0
Flock size	Before	54	10.2	7.3	1.0	42.0
	After	54	31.0	12.5	12.5	73.0
Annual number of eggs sold	Before	54	39.6	44.2	7.9	242.3
	After	54	69.5	58.6	8.0	340.0
Annual number of eggs produced	Before	54	104.4	55.7	43.8	284.7
	After	54	204.0	112.0	35.0	545.7
Annual number of chicken sold	Before	54	34.7	19.7	12.0	120.0
	After	54	80.3	35.2	19.9	180.0

*N= Number of farmers; SD= Standard deviation

Table 8. Comparison of farm characteristics before and after vaccination against Ranikhet disease

Variable	N*	Mean difference (after – before)	t-value	P-value
Chicken meat consumption	54	0.89	7.07	<0.001
Flock size	54	21.26	11.96	<0.001
Annual number of eggs produced	54	29.6	3.17	0.002
Annual number of eggs sold	54	93.07	6.82	<0.001
Annual number of chicken sold	54	42.27	9.66	<0.001

*N= Number of farmers

The observed increases in the indicators we evaluated might be because of the reduced outbreaks of disease in the study area. In fact, there was no outbreak of Ranikhet disease after the vaccination program. Farmers had indicated that before the program, the signs that match Ranikhet disease were frequent in that area. A laboratory study conducted in the same area had also indicated that the vaccine we used in the field produced protective titer and was effective when challenged against the field strains of Ranikhet disease (Shrestha et al., 2017).

CONCLUSION

This study evaluated the women farmer's perception of the problems they were facing in backyard poultry farming and how it changed after the intervention with vaccination program against Ranikhet disease. In addition, this study also evaluated the impacts vaccination program had on the household farm economics. We found that the level of awareness related to backyard poultry

farming increased after the vaccination program and farmers were able to produce more chicken and eggs which made their farming more profitable. This showed that vaccination against Ranikhet disease in backyard chicken together with extension campaign targeting women farmer's group might be an effective tool for poverty alleviation of rural women involved in backyard poultry farming. Extension of similar approaches in other farmers group and other districts of Nepal might be helpful to reduce poverty in Nepal.

ACKNOWLEDGEMENTS

We acknowledge all the farmers who participated in this survey. This survey was conducted as a part of MA (Rural development) thesis for first author SA submitted to the Tribhuvan University. We would also acknowledge the Heifer International Nepal and GALVmed for providing us an opportunity to conduct this study.

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Marketing opportunities and strategies for integrated pest management grown produce

A.P. Giri[1], B. P. Bhattarai[2], B. P. Rajbhandari[2] and L. P. Sah[1]
[1]International Development Enterprises (iDE) Nepal, Bakhundol, Lalitpur
[2]HICAST, Purbanchal University, Kathmandu
nameazay@gmail.com

ABSTRACT

This study was carried out in six districts namely Banke, Surkhet, Rupandehi, Nawalparasi, Kaski and Syangja of Nepal in the year 2015. The major objective of the survey was to assess the market opportunities for IPM grown produce. The method of survey was mainly focused on collecting data by directly interviewing targeted groups such as farmers, consumers, traders and agro-vet owners through random selection. The total sample size of the survey was 990 including 300 farmers, 600 consumers, 60 traders and 30 agro-vets. During the field survey, it was found that the price of the produce was mainly fixed by negotiation between the parties but farmers were not getting any regularity of premium price. The cost of production of IPM farming in comparison to conventional farming was found to be almost similar but not expensive. Farmers were attracted towards IPM approaches because of the low pesticide exposure which accounted 60 percent. The majority of consumers was concerned about the health effects of pesticide residues on produce and would prefer to purchase the produce grown using IPM approach. Moreover, consumers were willing to pay premium in price for IPM produce if quality assuring label is given at the point of sale. Although majority of farmers were involved in IPM farming in groups and sold their vegetables through collection center, still the volume of IPM produce were insufficient to stand its ground against other vegetables. From the field survey, it was found that the major problem in marketing IPM produce were small volume of production, inadequate access to market and proper certifying mechanism. The solution to marketing problems of IPM vegetables may be establishing IPM farmer groups so that the IPM produce can be produced and collected in huge bulk, proper differentiation between IPM and non IPM vegetables through labeling and certification, and also establishing separate stalls to sell the IPM produce.

Key words: Integrated Pest Management, Traders, Consumers, Premium price, Pesticides

INTRODUCTION

Vegetable farming is one of the major enterprises in Nepal. The vegetable sector contributes more than Rs.36 billion of value in the country annually, with cauliflower, tomato and cabbage as the lead contributors with values of Rs.4.9 billion, Rs.4.4 billion and 2.8 billion respectively (CBS, 2010). One of the main constraints to increase vegetable production is yield losses due to diseases, insects, pathogens, weeds, nematodes, mites, rodents and birds. An estimated annual yield loss is about 24.75 % of the total production with high value crop suffering the greatest insect pest attack (JO Ogendo, EO Omolo, 2006, Kenya). To reduce this loss farmer use synthetic pesticides, which are expensive, cause environmental pollution consequences and are health hazardous to the growers and consumers. With the overwhelmingly increased awareness of the growers, consumers, traders and scientific communities in developed and developing countries, enormous number of efforts has been made to look alternatives to the chemical pesticides. Integrated Pest Management (IPM) as one of the approach has come up for reducing damages caused by pests

without harming the environment. IPM is also considered as the transitional phase between the conventional and organic agriculture. Conversion of conventional agricultural farm to organic farm is a long process. Thus, IPM has been one of the best alternatives to gradually reduce chemical fertilizers and pesticides from the farmer's field.

Adopting IPM approach in vegetable production is the best practice to prevent the numerous health hazards caused by conventional way of farming. The global market had experienced high growth in IPM grown vegetables in the United States, Europe and in other developed countries, yet market shares remain quite small (Piyasiri and Ariyawardana, 2002). In Nepal, the growth of this sector is quite slow and faces tremendous challenges. Adoption of IPM approaches by farmer is quite slow, market of IPM grown vegetables is not well developed and no market statistics are available in Nepal (Bhatta et al., 2008a). Nevertheless, there is a growing trend among urban consumers to consume safe and healthy vegetables, from places where they could get an assurance about the quality of the products. Market features of such vegetable in Nepal shows that it is still in the "formative stage" of the product life cycle (Bhatta *et al*., 2008a). Despite these facts, there are some rays of hopes among the IPM producers and traders in the country.

Growth of IPM sector requires producer's and consumer's awareness, availability of sound infrastructures and consumers' willingness to pay for the IPM grown vegetables. Nepal, being a developing country, definitely majority of the consumers is not well off. However, a large chunk of consumers are clustered in and around urban areas of the country and they could pay for the IPM grown vegetables if quality is assured. Market potentials are mainly determined by consumer expectations of the product attributes, such as quality (Ramesh *et al*., 2005), price (Roddy *et al*., 1996; Fotopoulos and Krystallis, 2002), certification (Kotler, 2001), and price and quality (Boyle and Lathrop, 2009). Also consumers' awareness of health, food safety, environmental, and technology issues related to food products as well as the industrialization of agriculture and globalization, have been identified as diversification factors of food consumption (Senauer, 1994). There is the need to investigate wider perspective of IPM farming through producers' and consumers' view point.

MATERIALS AND METHODS

This study was conducted in six districts namely Banke, Surkhet, Rupandehi, Nawalparasi, Kaski and Syangja where iDE/USAID had implemented IPM program. This study was conducted in the year 2015. A total of 990 respondents were randomly selected for this study. Number of respondents in all six districts included 300 farmers, 600 consumers, 60 traders and 30 Agro-vets. Of which each district consists 50 farmers, 100 consumers, 10 traders and 5 Agro-vets.

Farmers adopting IPM approach were mainly targeted in this study. The respondents were selected purposively by applying simple random sampling method. A semi-structured interview schedule was prepared containing a set of both closed and open-ended questions. Questions were designed to obtain the information about market condition, farmer's perception towards IPM produce, consumer's preference, production status and challenges of IPM producers and products. Respondents were interviewed by visiting their field and household. Collected information was immediately filled in questionnaire format and results were analyzed through Microsoft excel.

Table 1. List of municipalities and VDCs surveyed in each district

District	Surveyed Municipality/VDC	District	Surveyed Municipality/VDC
Banke	Nepalgunj Sub-metropolitan	Nawalparasi	Ramgram Municipality
	Bageshwori VDC		Daunne VDC
	Sitapur VDC		Sanai VDC
	Kamdi VDC		Jamuniya VDC
	Naubasta VDC	Kaski	Pokhara Sub-metropolitan
Surkhet	Birendranagar Municipality		Lumle VDC
	Chhinchu VDC		Dhikurpokhari VDC
	Dasarathpur VDC		Dhital VDC
	Mehalkuna VDC		Lahachowk VDC
Rupandehi	Siddarthanagar Municipality	Syangja	Waling Municipality
	Basantapur VDC		Jagatbhanjyang VDC
	Sikthan VDC		Chhangchhangdi VDC

Beside this, secondary information were also collected from concerned organizations such as District Agriculture Development Office (DADO) of the respective district, Nepal Agricultural Research Council (NARC), Ministry of Agriculture Development (MoAD), Central Bureau of Statistics (CBS), Agriculture Information and Communication Center (AICC), Himalayan College of Agricultural Sciences and Technology (HICAST), iDE Nepal, Caritas Nepal, Institute of Agriculture and Animal science (IAAS), and different websites of the related field. All information collected from various sources was entered into MS Excel. Data tabulation, categorization was used to analyze data. Analysis was done using percentage, graphs and charts. Based on the figures of analyzed data, the results were interpreted and discussed accordingly.

RESULTS AND DISCUSSION

1. Status of IPM farming approaches

1.1. Understanding of IPM farming

This question was introduced in the survey to know the general understanding of IPM by the respondents. In which, 37 percent of the farmer respondents said that IPM means farming without the use of pesticides. And only 23 percent of the farmers replied IPM to be an integrated approach of farming. Similarly, 43 percent of the respondents from traders said that IPM to be a farming without the use of pesticides, while 43 percent of the respondents from agro-vet said it to be an integrated approach of farming. But still, 57 percent of the agro-vet was not able to provide the true concept of IPM. Use of crop management practice in IPM model is easy method of pest management (Satpathy and Mishra, 2011).

Table 2. Understanding of IPM farming by the farmers in survey districts

Understanding of IPM farming by the farmers	Farmers (%) (n=300)	Traders (%) (n=60)	Agro-vets (%) (n=30)
Farming without the use of chemical fertilizer	15.00	25.00	7.00
Farming without the use of pesticides	37.00	43.00	30.00
Integrated approach of farming	23.00	12.00	43.00
Farming without the use of chemical fertilizers and pesticides	25.00	20.00	20.00
Total	100.00	100.00	100.00

1.2. Adoption and involvement in IPM farming approaches

In this survey farmers were asked, do they follow any IPM approaches in their farm? Where, 95 percent of the farmers reported following IPM practices or using IPM tools in their farming system. And 5 percent were reported to have never used such tools and approaches. Of those following IPM practices, 64 percent were involved in producer groups and 31 percent were doing it individually. The study revealed that farmer were using following tools and approach (in Table 2) to manage pest.

Table 3. IPM practices adopted by farmers

SN	IPM practices under use	Yes (%)	No (%)
1	Botanicals such as Neemazin, Ultineem, *Jholmol*	100.00	0.00
2	Pheromones such as Heli-lure and Baco-lure	68.00	32.00
3	Yellow Sticky Trap and Light trap	70.00	30.00
4	Animal products such as cow urine and cow milk	100.00	0.00
5	Bio-pesticides such as *Trichoderma*	33.00	67.00
6	Cultural practices like soil treatment, solarization and flooding	91.00	9.00
7	Trap crops such as marigold, chrysanthemum and coriander	88.00	12.00
8	Conserving natural enemies	47.00	53.00
9	Crop rotation	79.00	21.00

1.3. Source of information

Various governmental and non-governmental organization were involved in disseminating the knowledge of IPM such as iDE Nepal, Caritas Nepal, RIMS Nepal, Rupantaran, etc. So, the majority, 57 percent respondents have learned about IPM farming approaches from NGO/INGOs. Whereas, 30 percent respondents have learned about IPM farming approaches from some governmental programs and rest of the respondents have learned from friends or neighbors.

Table 4. Source of information on IPM farming approaches

Learned about IPM farming approaches	Number	Percentage
Government programs	90	30.00
NGO/INGO's	170	57.00
From TV/Radio programs	15	5.00
From friends/neighbors	11	4.00
Total	286	95.0

1.4. Area under IPM practices

The survey was mostly conducted among smallholder farmers in IPM project district of iDE Nepal. So, the landholding of farmers was comparatively less than the other commercial vegetable growers. The majority of farmers, 48 percent had devoted less than a ropani (<0.05ha) of their land for growing IPM crops. Whereas, only 14 percent had more than 5 ropani (>0.25ha) land separated for growing IPM vegetables.

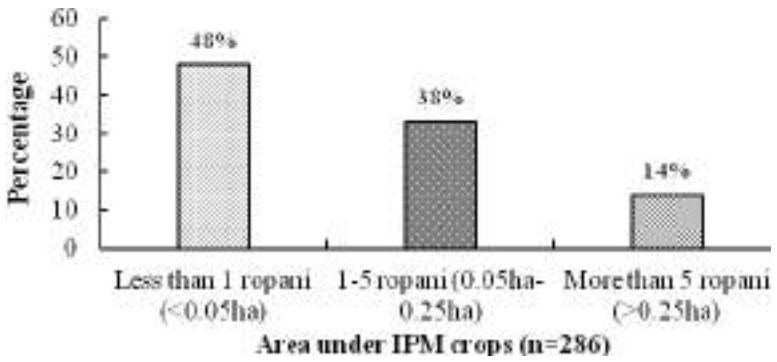

Figure 1. Area under IPM crops

1.5. Marketing of IPM produce

During the field survey, it was found that 38 percent of the farmer sold their IPM produce through collection center. Whereas, 20 percent farmers sold their produce to local consumer as a bicycle vendor, 13 percent sold their produce to middleman, 12 percent sold it to hotels and another 12 percent sold it in haat bazaars.

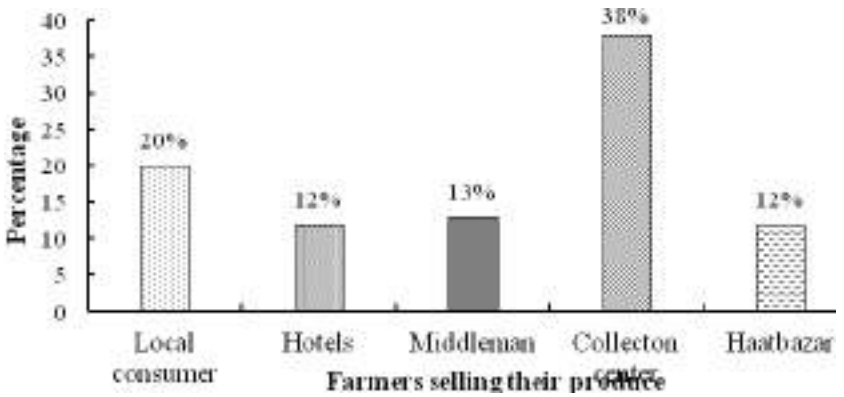

Figure 2. Marketing of IPM produce

1.6. Marketing of IPM tools

During the field survey, it was found that the majority, 60 percent agro-vets were selling different kinds of IPM tools. Such IPM products consists of: botanical pesticides such as Niconeem, Neemazin, Neemate-10G and Ultineem; Bio-pesticides such as Trichostar and Biocide-Trivi consisting *Trichoderma viride*, Biocide-Manic consisting *Metarhizium anisopliae*; Pheromone trap

such as Heli lure and Baco lure; Delta trap (yellow sticky trap), Effective Microorganism solution (EM.1); Bio-fertilizers such as Jibatu Fertilizer, Poshan, Bio-Orgo, Potash solubilizing liquid bio-fertilizer, etc.

1.7. Cost of production: IPM Vs conventional

During the field survey, majority of farmers (77%) reported that the cost of production in IPM farming was almost similar to the conventional farming. Even 15 percent reported it to be cheaper as it was focused on better cultural practices and utilization of local resources. Only 5 percent feels that IPM was an expensive approach as they have to spent more on bio-pesticides. The paper on Pesticide Use Situation reported that the use of pesticide in cotton (2560 g/ha), tea (2100g/ha) and vegetables (1400g/ha) appears excessive and without the consideration of applicators (farmers) and consumers (G.C, 2011).A field study on Knowledge, Practice and Use of Pesticides was conducted to evaluate knowledge, practice and use of pesticides among thirty commercial vegetable growers of Dhading district of Nepal. The finding of this study is oriented to the following recommendation: the need for awareness, education and training on the uses of pesticides to the farmers and effective monitoring program for pesticide residues in vegetables.

Rice, maize, wheat and mustard are treated 1 - 3 times per crop cycle whereas potato, tomato, cabbage, bitter gourd and cucumber are treated 2 – 15 times. Farmers have low knowledge on pesticides and their uses, as a result, general precautionary measures are also lacking (Shrestha & Neupane, 2002). Use of pesticides in cash crops like off-season vegetables, fruits, cotton and tea have experienced an increase of 10 to 20 per cent (Upadhyaya, N. S. 2003)

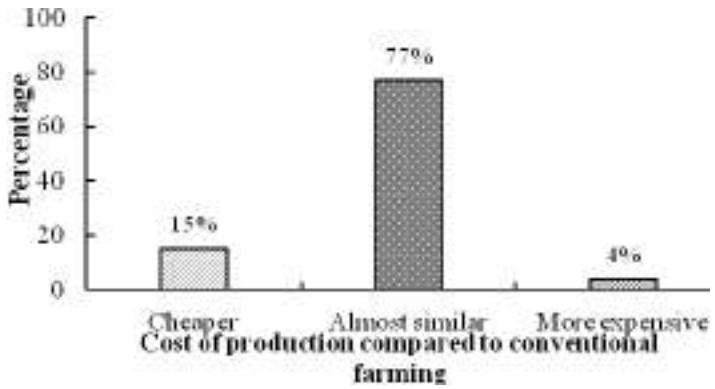

Figure 3. Cost of production of IPM farming compared to conventional

2. Opportunities for IPM grown produce

2.1. Attraction of farmers toward IPM approaches

From this survey, it was found that the main reason of attraction toward the IPM approaches were low pesticide exposure to the farmers. 60 percent farmers were attracted toward IPM because of low pesticide exposure. Whereas, 15 percent farmer were attracted because they had a strong sense of a good citizen (or morality) and 11 percent farmers were attracted as they were aware about the harmful effect of chemical pesticides.

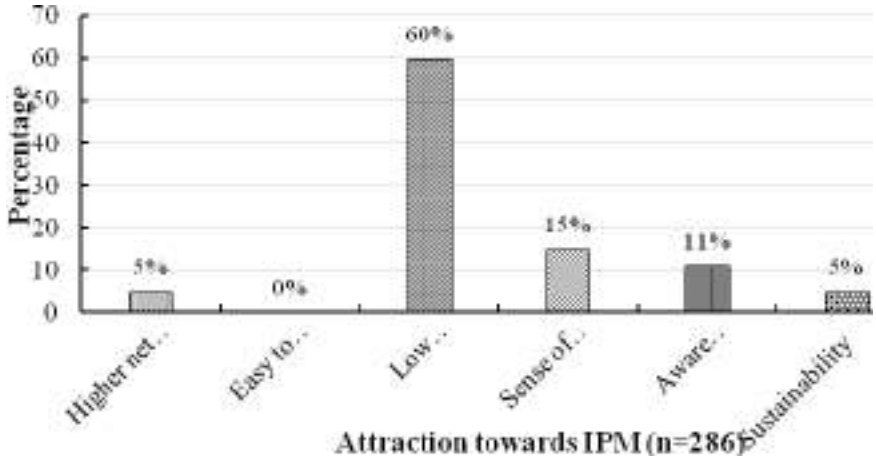

Figure 4. Reason of attraction of farmers toward IPM approaches

2.2. Health hazards experienced by the consumers

The health effects related to pesticide residues are vast but due to lack of knowledge and awareness, majority of the consumers were unknown about the health effects. In this survey, 72 percent consumers replied that the health effects can't be explained and were not sure about it. Whereas, 13 percent visualized vomiting, headache or diarrhea. Similarly, 16 percent experienced skin problems like allergies.

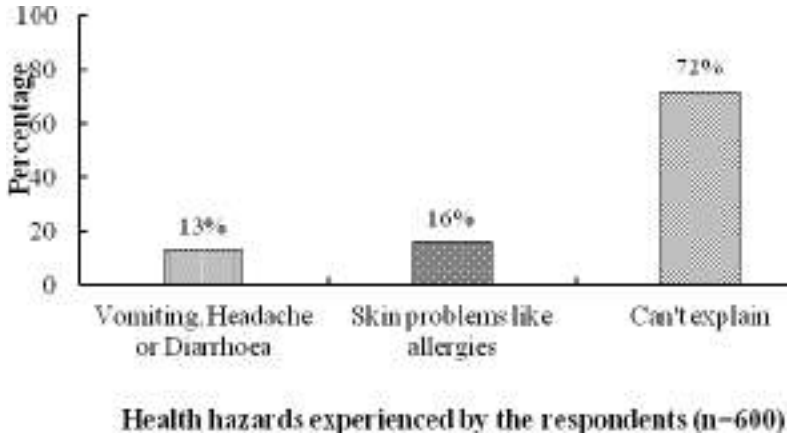

Figure 5. Health hazards experienced by the consumers

2.3. Pesticide related awareness

During the field survey, it was found that 56 percent consumer inquiry about the use of chemical pesticides on vegetables while buying. Whereas, 44 percent consumers did no inquiry. The information asked/inquired by the consumers to the traders while buying vegetables were the

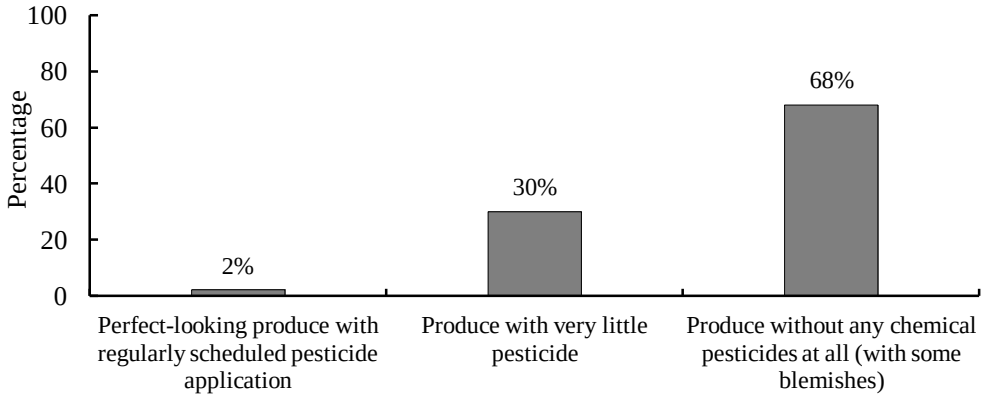

Figure 6. Types of vegetable likely to be purchased by consumers

number and types of pesticides application, whether the products were fresh or not and waiting periods after pesticide application. Also in the field survey, it was found that 68 percent consumers were most likely to purchase the vegetables without any chemicals. And, 30 percent consumers were more likely to purchase vegetables with very little application of pesticide. During the field survey, it was found that 56 percent consumer inquiry about the use of chemical pesticides on vegetables while buying. Whereas, 44 percent consumers did no inquiry. The information asked/inquired by the consumers to the traders while buying vegetables were the number and types of pesticides application, whether the products were fresh or not and waiting periods after pesticide application. Also in the field survey, it was found that 68 percent consumers were most likely to purchase the vegetables without any chemicals. And, 30 percent consumers were more likely to purchase vegetables with very little application of pesticide, whereas, 2 percent of the consumer would like to purchase the perfect-looking produce with regularly scheduled pesticide application. Fourteen hazardous pesticides including persistent organic pollutants (POPs), phosphamidon and organo-mercury fungicides and insecticides have already been banned in Nepal (PPD, 2017). Although pesticide use in Nepal is low relative to many other countries in the world, this study, which is the first of its kind work on Pesticide Use in Nepal: Understanding Health Costs from Short-term Exposure in Nepal, suggests that farmers and policy makers need to become aware of the health impacts of pesticide use as they continue to promote its use in Nepal (Atreya, 2007).

2.4. Product quality and willingness to pay premium price

During the field survey, 100 percent of the consumers said that they were not assured by the quality of vegetables that they were buying. The thing that would make them more assured was the quality assuring label at the point of sale, which accounts 51 percent. Another thing that would make them more assured was buying from a trusted farm or stall, which accounted 41 percent.

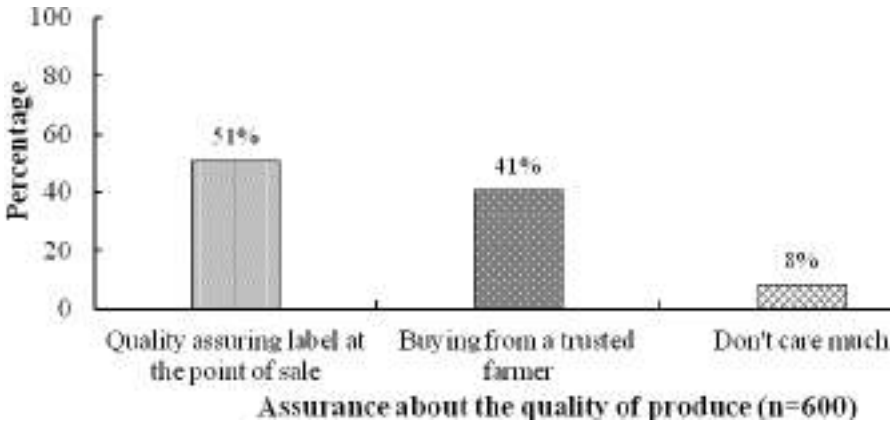

Figure 7. Assurance about the quality of produce

Also during the field survey, it was found that 71 percent consumers were willing to pay 10% premium in price for IPM vegetables. Moreover, 29 percent consumers cold pay more than 15% premium in price for the IPM vegetables if quality assuring label is given to the products. These figures were quite encouraging for the farmers but the issues were the proper product certification and labeling which concerned stakeholders should keep account for.

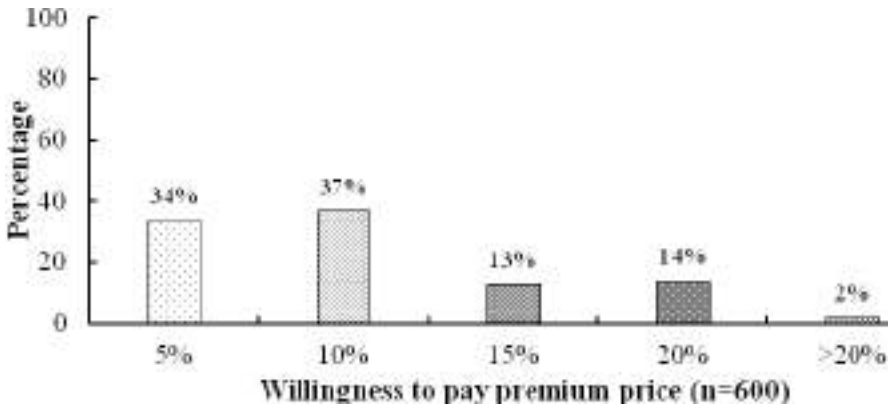

Figure 8. Willingness of consumers to pay premium price for vegetables grown with little or no pesticides

3. Marketing problems

The major problem faced by the traders while selling IPM grown produce were listed below in table 5. Although majority of farmers were involved in IPM farming in groups and sold their vegetables through collection center, still the volume of IPM produce were insufficient to stand its ground against conventional vegetables. Lack of product certification had cased problem in convincing consumer of its healthiness.

Table 5. Problems faced by traders while selling IPM produce

S.N.	Problem faced by traders while selling IPM produce	Percentage (n=20)
1	Inadequate access to market.	42.00
2	Small volume of production resulting in high cost of transportation	23.00
3	Lack of product certification	20.00
4	Consumers are not selective (whether healthy or not, does not matter)	15.00

CONCLUSION

The indiscriminant use of pesticide in agriculture and storage has resulted higher amount of residues in foods. There is an increased risk of pesticides in foods as the residues of pesticides are detected in a variety of foods. Residues of pesticides were found higher in vegetables than other foods. At the same time, consumption of vegetables is high as it provides nutrients especially vitamins and minerals. There is a need of combined and coordinated efforts of all the stakeholders associated with it to discourage misuse of pesticides. Various governmental and non-governmental organizations were involved in disseminating the knowledge and techniques of IPM. Majority of farmers were involved in IPM farming in groups and sold their produce through collection centers. The cost of production of IPM farming in comparison to conventional farming was found to be almost similar but not expensive. Farmers were mainly attracted towards IPM approaches because of the low pesticide exposure and sustainability of their agricultural land. There exists a great market opportunities for IPM grown produce in these surveyed districts. The majority of consumers was concerned about the health effects of pesticide residues on produce and would prefer to purchase the produce grown using IPM approach. Moreover, consumers were willing to pay premium in price for IPM produce if quality assuring label is given at the point of sale. Although, the traders selling IPM grown produce were few in numbers, there exists a great scope to expand the market of IPM produce.

Agencies including governments and I/NGOs, academic institution with a suitable intervention program may help to solve it. Appropriate awareness campaign at all levels might help to prevent the problems on pesticide misuse. Additionally, Government needs to provide subsidies on IPM components, so as to promote it among small and medium farmers. Government and NGOs need to promote programs on education about basic pesticide use and also concept of eco-friendly farming, which will ensure long-term food security and environmental safety.

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Effect of Different Crude Protein Levels Feeding On Growth Performance of Growing Baruwal Sheep

M.R. Tiwari[1] and H.R. Dhakal[2]
[1]Animal Nutrition Division, Khumaltar, Lalitpur
[2] Sheep and Goat Research Program, Guthichaur, Jumla
drmeghraj238@gmail.com

ABSTRACT

Two consecutive experiments of 90 days for each after an adaptation period of 7 days were done at Sheep and Goat Research Program (SGRP), Guthichaur, Jumla to determine the optimum dietary protein level for growing sheep. In both experiments, twenty growing sheep of similar body weight and age were divided into four treatments having five animals in each treatment by using complete randomized design (CRD). Four types of rations containing 16, 18, 20 and 22% crude protein were composed for T1, 2, 3 and 4, respectively. Compound feed was provided once a day in the morning that after animal were allowed to graze for 6 hours. Body weight of experimental animals was measured in 15 days interval and refusal of concentrate mixture was weighed in next morning. Experimental animals were drenched against internal parasites with Febendazole @ 5mg/kg body weight. Experiment revealed that highest body weight gain was obtained for T4 (9.6 kg) followed by T1 (9 kg) in female. Similarly, in case of male, highest body weight gain was noted in T2 (9.4 kg) followed by T4 (8.6 kg). In Female, highest average daily gain was observed in T4 (106.67 g) followed by T1 (100 g). Likewise, in male, highest average daily gain was noted for T2 (104.44 g) followed by T4 (95.55 g).

Key words: Baruwal sheep, crude protein, daily gain, body weight, growth performance

INTRODUCTION

In Nepal, sheep raising has been practiced since the beginning of agriculture itself, especially in mountain region. Sheep are gregarious animals; they like to flock in a common group, sheep is growing for meat, milk, wool, manure, skins and transport. There are 0.87 million sheep in Nepal (MoAD, 2011/12). Five to ten percent of this is exotic (pure or crossbred) and rest is indigenous (Anon, 2004). The populations of indigenous sheep breed Bhyanglung, Baruwal, Kage and Lampuchhre are estimated to be 4, 63, 21 and 12%, respectively. They are producing 2,720 mt mutton and 587,017 kg wool per annum.

In mountain region, nearly half of the animal feed comes from residues. There is an acute shortage of feed during winter and dry season and the livestock are generally underfed to the extent of one third of the required amount. Nepal as a whole has a feed shortage of 20-36 percent; and the problem is more acute in the hills and mountains.

Protein is an essential nutrient for animal growth and development, and thus a sufficient protein supply is a crucial factor for normal growth. Protein requirement depend on stage of production. If available forages are unable to supply adequate dietary crude protein, protein supplements such as

oilseed meals or commercially blended supplements should be fed to meet the nutrient requirement.

Optimum protein levels for achieving high growth and performance efficiency are variable. Prieto *et al*. (2011) reported that optimum crude protein levels for growing kids were about 14%, while Tite *et al*. (2000) reported that optimum protein levels for feedlot goats ranged from 16 to 20.3%. Negesse *et al*. (2000) showed that the kids fed with 8% dietary crude protein level had lower average daily gain and dry matter intake than that of the kids fed with 10.5, 12.8, 15.5 dietary crude protein levels. Hwangbo *et al.* (2009) reported that the kids fed with 18% crude protein in diet had significantly higher average daily gain compared with the kids fed with 14, 16 and 20% crude protein in diet. Therefore, the objective of this study was to investigate the effect of different crude protein levels on the growth performance of Baruwal hogget.

MATERIALS AND METHODS

Experimental animal

Two consecutive experiments were carried out at Sheep and Goat Research Program (SGRP), Guthichaur, Jumla. First experiment was carried out on twenty growing female of average 10 months old with average body weight of 21 kg in autumn while second experiment was carried out on twenty growing male of average 11 months old with average body weight of 22 kg in spring season. The experimental animals were grouped into four groups having five in each group, as replicates, using Completely Randomized Design (CRD). They were drenched with Fenbendazole @ 5 mg/kg body weight against internal parasites before assigning in experiment.

Concentrate mixture composition

Sixteen percent crude protein containing concentrate feed and soybean cake for both experiments was procured from Karnali Feed Industry, Manikapur, Banke. To maintain the 18, 20 and 22 percent crude protein level for T2, T3 and T4; 4.54, 9.1 and 13.63 kg, respectively soybean cake of 44% crude protein was added in 100 kg concentrate feed.

Experimental diet of the animals

The dry matter requirement of hogget was calculated @ 5 kg per 100 kg body weight. Following diets were formulated for experimental animals (Table 1).

Table 1. Experimental diets of the goats

Treatment	Experimental diet
1 (control)	16% crude protein containing concentrate feed + 6 hrs. grazing
2	18% crude protein containing concentrate feed + 6 hrs. grazing
3	20% crude protein containing concentrate feed + 6 hrs. grazing
4	22% crude protein containing concentrate feed + 6 hrs. grazing

Feeding regime

Compound feed @ 1.5 percent per kg body weight was provided to the experimental animals individually in plastic vessel once a day in the morning. After concentrate feeding, experimental animals were allowed to graze in the pastureland of Sheep and Goat Research Program. Quantity

of concentrate feed refusal was weighed in next morning. Experimental animals had free access to drinking water.

Chemical analysis

The samples of concentrate feed and soybean cake was sent to Animal Nutrition Division, Khumaltar, Lalitpur for proximate analysis. Representative samples were analyzed for dry matter (DM), crude protein (CP), crude fibre (CF), organic matter (OM) and total ash contents (TA). The DM was determined by oven drying at 100°C for 24 hrs. Crude protein of the samples was determined using the Kjeldahl method. Ash content was determined by ashing at 550°C in a muffle furnace for 16 hrs (AOAC, 1980). Crude fibre of the samples was determined using the Van Soest method (Goering, H.K. and Van Soest, 1970).

Observation recording

The trial period consisted 90 days after an adaptation period of 7 days. Total feed intake by the hogget was recorded daily during entire experimental period. The body weight gain of individual animal was measured fortnightly in the morning before feeding.

Statistical analysis

Data of feed intake and body weight gain were analyzed using *One Way Annova* test for every measurement using computer statistical package Minitab 2003, versions 13.20.

RESULTS AND DISCUSSION

Chemical composition of feedstuffs

The nutrient content of concentrate feed has been given in Table 2.

Table 2. Chemical composition of concentrate mixture (on DM basis)

Treatment	DM	OM	TA	CP	CF
1	96.01	92.76	7.24	16.35	6.27
2	96.03	92.79	7.21	18.21	6.51
3	96.17	92.77	7.23	20.2	6.37
4	96.08	91.88	8.12	22.26	6.58

Feed intake

Average feed intake of experimental animals is presented in Table 3 and 4.

Table 3. Feed intake of experimental animals (Female)

Feedstuffs	Mean ± SD			
	T1	T2	T3	T4
Feed intake, g	389.55±73.91	383.09±59.19	373.16±43.17	372.86±46.07
Dry matter intake/day, g	374.0	375.54	358.86	353.04
Crude protein intake/day, g	59.84	67.59	71.77	79.87
Total dry matter intake (DMI), kg	33.66	33.59	32.29	32.21
Total crude protein intake, kg	5.39	6.08	6.46	7.18
Feed conversion ratio (FCR)	3.74:1	3.84:1	4.25:1	3.35:1

Table 3 showed that in case of growing female, feed intake per day was found highest for T1 (389.55 g) followed by T2 (383.09 g). Similarly, total crude protein intake was observed increased according to increased level of crude protein in diet. Likewise, FCR was noted lower in T4 group (3.35:1kg) followed by T1 (3.74:1 kg). Increased crude protein level in diet affected significantly ($p<0.01$) on daily feed and crude protein intake, dry matter intake, DMI, total crude protein intake and FCR.

Table 4. Feed intake of experimental animals (Male)

Feedstuffs	Mean ± SD			
	T1	T2	T3	T4
Feed intake, g	386.08±43.57	331.95±56.08	320.04±47.2	313.57±52.98
Dry matter intake/day, g	370.67	325.41	307.7	378.14
Crude protein intake/day, g	60.6	65.66	62.51	84.09
Total dry matter intake (DMI), kg	33.36	29.28	27.7	27.09
Total crude protein intake, kg	5.45	5.51	5.63	7.57
Feed conversion ratio (FCR)	4.12:1	3.11:1	3.55:1	3.15:1

In case of growing male, highest feed intake per day was observed in T1 (386.08 g) followed by T2 (331.95 g). Likewise, resembling trend was monitored in growing male for total crude protein intake as in female hogget. The lowest FCR was noted for T2 (3.11:1kg) followed by T4 (3.15:1 kg). Average feed and crude protein intake per day, DMI, total protein intake and FCR was affected significantly ($p<0.001$) with increased crude protein level in diet.

Growth performance

Average growth performance of experimental goats as per treatments is presented in Table 5 and 6.

Table 5. Body weight gain trend of experimental animals (Female)

Parameters	Treatment (Mean ± SD)			
	1	2	3	4
Initial body weight, kg	21.6±3.05	21.8±2.08	21.8±2.28	21.3±0.83
Initial metabolic body weight, kg	10.01	10.08	10.08	9.91
Final body weight, kg	30.6±4.95	30.6±2.38	29.4±2.1	30.9±1.43
Final metabolic body weight, kg	13.01	13.01	12.62	13.1
Total weight gain, kg	9	8.8	7.6	9.6
Average daily gain, g	100±26.05	97.78±15.01	84.44±17.3	106.67±21.65

The initial body weight of experimental growing female was similar (21 kg) and was found also almost similar (30 kg) by the end of the experiment (after 90 days) for T1, T2 and T3 groups, respectively (Table 5) which was non-significant among diet groups. Highest body weight gain

was observed in T4 (9.6 kg) followed by T1 (9 kg). Similarly, average daily gain was observed higher in T4 (106 g) followed by T1 (100 g).

Table 6. Body weight gain trend of experimental animals (Male)

Parameters	Treatment (Mean ± SD)			
	1	2	3	4
Initial body weight, kg	22.1±1.34	22.7±1.92	22.9±1.51	22.5±2.15
Initial metabolic body weight, kg	10.19	10.4	10.46	10.33
Final body weight, kg	30.2±2.16	32.1±3.0	30.7±2.19	31.1±3.36
Final metabolic body weight, kg	12.88	13.48	13.04	13.16
Total weight gain, kg	8.1	9.4	7.8	8.6
Average daily gain, g	89.99±13.82	104.44±29.23	86.66±13.38	95.55±14.91

In case of growing male, initial body weight also was similar (22 kg) for all groups; however, by the end of the experiment (after 90 days) it differed among diet groups (Table 6). Highest final body weight was obtained in T2 (32.1 kg) followed by T4 (31.1 kg) though was non-significant among diet groups. The highest body weight gain was recorded for T2 (9.4 kg) followed by T4 (8.6 kg). Similarly, highest average daily gain was noted in T2 (104 g) followed by T4 (95.55 g).

In both experiments, there was significant ($p<0.01$) effect of increased level of crude protein in diet in dry matter intake. Experiment on female indicated that increased crude protein level in diet decreased the total dry matter intake (32.67, 32.29, 33.59 and 33.66 kg, for T4, T3, T2 and T1, respectively). Similarly, experiment on male also revealed that increased crude protein level resulted lower dry matter intake (27.09, 27.7, 29.28 and 33.36 kg for T4, T3, T2 and T1, respectively).

Increased crude protein level in diet could not perform better in body weight gain of experimental animals. Total body weight gain of female was found highest in T4 (9.6 kg) followed by T1 (9 kg). Similarly, highest body weight gain was recorded for T2 (9.4 kg) followed by T4 (8.6 kg) for male. In both experiments, there was noted non-significant effect of increased crude protein level on body weight gain. Similar findings were obtained by Marcia *et al*. (2004). In their experiments, they concluded that there were no differences in average daily gain: values of 228, 220, 230 and 231 g d^{-1} were obtained for diets containing 14, 16, 18 and 20% crude protein, respectively.

In another experiment, no differences were obtained between lambs fed with 16 and 18% crude protein ration. However, both groups had higher ($p<0.001$) body weight gain than lambs in other groups. Kids had higher ($p<0.001$) body weights gain when fed with 16% ration. There were no significant differences among kids of other groups (Titi *et al*., 2000)

An experiment was conducted by Karbir *et al.* (2004) to determine the effect of protein supplementation on growth performance in female goats and sheep. Experimental animals were allocated to two feeding regimes [low protein (LP), 168g and high protein (HP), 208g per kg DM] in a randomized block design according to live weight. HP diet did not significantly ($p>0.05$) increase live weight gain (33.0 vs. 25.2 g/d) in goats.

Haddad *et al.* (2001) conducted an experiment on Awassi lambs to evaluate the optimum crude protein level for growth that contained 10, 12, 14, 16, and 18%. Lambs fed diets that contained 10, 12, and 14% CP gained less weight than those fed the 16 and 18% CP diets ($p<0.05$). Crude protein intake increased ($p<0.05$) with increasing levels of dietary CP. No difference ($p>0.10$) was observed in feed to gain ratio between diets except for the diet that contained 10% CP ($p<0.05$) which had a lower ratio. Organic matter and CP digestibility were lowest in lambs fed the 10% CP diet. Results suggest that the optimum CP concentration is 16% and that any increase above this level will not result in any improvement in production.

Mahmod (2013) conducted an experiment on lamb with dietary crude protein levels 11, 14 and 17% in Egypt and found that dry and organic matter digestibility were significantly lower ($p<0.05$) with 17% ration compared with 11 and 14% rations. Digestion coefficient of crude protein was lower with 11% ration compared to others without significantly differences between 14 and 17%. The average final body weight was greatest ($p<0.05$) for the 17% ration. The feed conversion 17% crude protein ration had the best values of feed conversion as dry matter.

CONCLUSION

Among four dietary protein level, 18% dietary protein level performed better body weight gain in both male and female than others. Therefore, it is suggested that 16-18% dietary protein level is optimum for growing sheep of Karnali region. However, it should be verified in other mountain zones of Nepal.

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RESEARCH NOTE

Production practices, marketing and problems in broad leaf mustard cultivation in Bhaktapur district

S. Bharati and S.M. Shakya
HICAST, Kalanki, Kathmandu

ABSTRACT

The study was carried out from December 2016 to March 2017 to assess the production techniques, marketing and problems of Broad Leaf Mustard Cultivation in Bhaktapur district. Hundred farmers from Madyapur Thimi Municipality and Anantalingeshwor Municipality were selected and interviewed with the help of a questionnaire. Socio-demographic study revealed that more number of male farmers (65%) was found to be involved in production of Broad Leaf Mustard (Rayo). Majority (40%) of the respondents per house had 1-2 ropani of land. Only 30% of the respondents had short term training vegetable cultivation. The cost of production of Rayo in the main season was NRs. 35,703.12 per ropani (0.05 ha.). The average yield of Rayo was 1430.35 kg per ropani. The average farm gate selling price of Rayo was NRs. 38 per kg. Gross return from the broad leaf production was NRs.54,353.3 per ropani. The net return was NRs. 18,650.18 per ropani and an average B/C ratio was 1.522. The major problems faced by the respondents were lack of irrigation, technical support, unavailability of inputs, efficient market, collection center; disease and pest problem and involvement of middle men etc.

Key words: Broad leaf mustard, cultivation, yield, net return.

INTRODUCTION

Nepal is an agricultural country where about 65.5 percent of the country's 27.8 million people depend on the agriculture (MoAD, 2013). The share of agriculture in the national GDP is 29.23 percent (AICC, 2073). Agriculture has been the backbone of the national economy, a means of livelihood for a majority of the population and a source of employment opportunities in Nepal. In Nepal the total land under the vegetable production is 246392 ha, with the production of 3301684 mt. with the yield of 13400 kg/ha (MOAC, 2012/13). Agro-ecological variation in our country is high from terai to high hills where many vegetables can be grown successively. Production of agriculture commodities in our country is low so that we have bright scope in agriculture to increase production and the productivity of agriculture commodity. Vegetable farming is one of the major agricultural enterprises becoming popular owing to a greater appreciation of their food value. Their cultivation occupied an important place in the agriculture development and economy of the country. Vegetable crops are regarded as the foremost important crops after cereals and pulses. They have a vital role to play on the food front in, as much as they reduce the demand of cereals and one of the cheapest sources of natural protective foods contributing carbohydrate, vitamins and minerals salts in the human diet, which are very essential for maintaining a good health. The per capita vegetable requirement per day is 300 grams among which requirement should be fulfilled by 125 grams of leafy vegetables,85 grams of stem and fruit vegetables and 80 grams of tuber vegetables. However, the average daily consumption of fresh vegetables by Nepalese people at the end of the government's 7th five-year plan was in sufficient (Horti Master

Plan, 1990). To fulfill the demand of vegetables it has been estimated that the national requirement per day is 2873MT.

Leafy vegetables are sources of minerals and vitamins. Dieticians recommended daily consumption of 100 – 120 gm leafy vegetables for a balanced diet. Varieties of leafy vegetables are cultivated in Nepal. Certain plants which grow wild are also used as leafy vegetables. Almost all the leafy vegetables are propagated through seeds which are sown in the field. Vegetable production plays an important role in promoting household food security and nutrition, and provides sustainable solution to micronutrient malnutrition which is affecting the health of 2 billion people on the planet including children. Vegetables production generates employment and income of small scale farmers especially women, and offers one of the highest impacts to reducing poverty and hunger (FAO, 2012).In Nepal, broad leaf mustard commonly known as 'Rayo', occupies first position in term of hectare and production among the leafy vegetables. It is widely adapted and can be grown from terai to the hills of Nepal.

MATERIALS AND METHODS

The survey was conducted in Bhaktapur district. It lies in the Eastern part of Kathmandu Valley. Bhaktapur district was selected for the study because it has high potential of BLM (rayo) production in Madyapur Municipality (Ghattaghar) and Anantalingeshwor Municipality (Balkot). These locations are leafy vegetable growing areas, mainly BLM. The data were collected primarily with the help of a semi-structured questionnaire. The gathered information through questionnaire was entered and analyzed by using Microsoft Excel.

RESULTS AND DISCUSSION

Major cultivars grown by the respondents

Farmers in Bhaktapur district were using different varieties of broad leaf mustard and some of the varieties of broad leaf mustard were as given below;

1. Khumal broad leaf
2. Marpha broad leaf
3. Khumal red leaf
4. Local

Economics of broad leaf production

Broad leaf production, land, production, cost of production, return from the product and benefit-cost ratio was calculated. On an average the farmers of study sites have higher ropani of irrigated land (5.65 ropani = 0.28ha) as compared to un-irrigated land (3.5 ropani = 0.17ha). Analysis of land holding size indicated that most of the land was irrigated. There was high variation of land holding size among farmers of study sites.

Cost of production

Cost of production was analyzed in two parts viz. variable cost and fixed cost. All fixed costs were calculated for the production of broad leaf of mustard per ropani.

Fixed cost

Fixed cost are those that donot vary with size of enterprise and have limited bearing upon decisions to increase or decrease production. Land tax, pipe, electricity motor, sparyers and fitting

material etc were kept on fixed cost (Table 1). There was depreciation at 10 percent and interest rate at 12 percent on fixed assests.

Table 1. Fixed cost of BLM

Particulars	Amount (NRs/ropani)
Land tax	32.08
Pipe	950
Fitting material	100
Electricity motor	10000
Sprayers	800
Labour wage	700
Deprecciation (10%)	1244.46
Interest (12%)	1493.59
Total Fixed cost	15167.128

Variable cost

All the costs incurred in all variable inputs such as seed, fertilizers, manures, pesticides, labors, lease etc. were taken as variable costs (Table.2)

Total cost of production

Total cost of production per ropani BLM includes variable cost and fixed cost of all inputs used in broad leaf production was NRs 35703.12 per ropani

Production of BLM

From the study, it was found that the average production of BLM was found 1430.35 kg per ropani in study area.

Return BLM

Gross return from broad leaf production was calculated. The gross return is the monetary value of the total product. The study revealed that the gross return from the broad leaf production was NRs.54353.3 per ropani.

Profit from BLM

The profit is the difference between total revenue and the total cost incurred. Total cost included fixed cost and variable cost. Cost incurred to fixed costs included depreciation in fixed assets like different tools used for its production and land rent. Thus, the study revealed that the net return from BLM production was NRs 18650.18 per ropani.

Table 2. Variable cost of BLM

Particulars	Amount (NRs/ropani)
Seed cost	1000
Compost/FYM	966
DAP	1300

Urea	875
Potash	100
Chemicals	1520
Others (Doko, Namlo, Harvesting equipments)	1500
Electricity	600
Sub total	8011
Labor cost	-
Male	1400
Female	5500
Sub total	14911
Rent	5775
Total variable cost	20536

Benefit cost ratio of broad leaf production

Benefit cost ratio simply gives an idea about recovery of cost incurred during the production by return from products. It is a simple method to know the ratio at which return is obtained with respect to cost invested. It measures the worth of the project or business. Benefit cost ratio of BLM production was calculated by using total cost of production and gross return from one ropani of land.

The study revealed that on an average B/C ratio of BLM cultivation per ropani was found 1.522. This tells us that by investing NRs. 1, the business (enterprise) can earn NRs. 1.522. As per decision rule, the B/C ratio is greater than 1 thus the production BLM is the right choice as the investment is capable of giving benefits.

Marketing

Agriculture marketing is a key factor for the development of agriculture sector. So, marketing management and assured market facility for producer is instrumental for increased production and productivity. The motive of this part of the study was to find out where farmers sell their product (BLM). Among the 100 respondents, 39 percent of the respondents sold their produce wholesaler, 33 percent sold to local trader, 17 percent to retailer and only about 11 percent of the farmers sold their product from farm gate. (Figure 5)

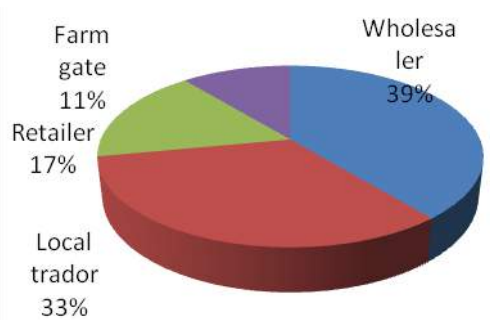

Figure 5. Marketing of BLM

Problems faced by the producers

During the study period, farmers of Bhaktapur district were facing different problems which are listed below:

1. The respondent was facing the problem of irrigation.
2. Incidence of pest and disease
   Farmers were facing problems of pest and diseases in the study area and respondents indicated disease like Club Root, Berna Kuhine Rog, Pat ko thople, Dath kuhinu dhalnu. There were also some problems of pest like Lahi, Hairy caterpillar.
3. Technical support from different organization was not enough.
4. After the production of the commodity they were facing the problem of marketing and involvement of different intermediaries.
5. There was a problem of availability of inputs (fertilizer, pesticides, seed, etc).

CONCLUSION

Broad leaf Mustard (Rayo) was produced one of the most important leafy vegetable crops. BLM was produce all around in the year and had high nutritional value, it was consumed by poor to rich level people. So, it helps in Nutritional and livelihood improvement of farmers. The study revealed that B/C ratio obtained was 1.522 and B/C ratio will be increased by solving the problems such as marketing through co-operatives, developing collection centers and proper Agricultural training and technical support should be given to the farmer.

Bhaktapur district was the major vegetable producing district all around the year. Despite tremendous scope for vegetable production the farmers still adopt traditional methods of cultivation using indigenous tools. If the traditional farming system could be changed into commercial farming by introducing modern improved tools and technologies then the production could be maximized and increased exportable quantity of vegetables outside the valley.

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Prevalence of brucellosis in goats at Dolakha district

S. Paudel and S. Thapa
Himalayan College of Agricultural Sciences and Technology
sudikshyapaudel@gmail.com

ABSTRACT

A study was conducted during March to May 2017 to find the prevalence of Brucellosis in goats (Jamunapari cross, Khari and Sinhal) of Dolakha district. Out of 110 serum samples collected a total of 5 (4.5%) samples were found to be positive for antibodies against Brucella spp. with Rose Bengal Plate Agglutination Test (Prionics AG, Switzerland). The prevalence was found higher in males (6%) than in females (3%). The percentage of prevalence of Brucellosis in Jamunapari cross breed goat was found higher (6%) than in Khari goats (5%) while all goats of Sinhal breed were found to be negative. Age wise prevalence of Brucellosis revealed higher positivity in goats of 7 years age (50%) followed by 5 years age (14%) and then 3 years age (8.33%) and lowest among goats of below 1 year age (5.8%). in VDC's and Municipality-wise, higher prevalence of Brucellosis was found in Melung VDC (20%) followed by Bhieshwor municipality (10%) and samples from rest of the VDC's (Bhedapu, Bhirkot, Jhule, Kshetrapa, Malu) were negative There was no significant differences between different age, sex, breed and prevalence of Brucellosis ($p>0.05$). Considering the result of this study in the goat population of Dolakha district, suitable preventive and control measures of Brucellosis should be carried. Effective quarantine, legislative measures and awareness program for farmers, meat sellers are recommended.

Key words: RBPT: Rose Bengal Plate Agglutination Test, zoonotic disease, *Brucella spp*

INTRODUCTION

Brucellosis is an ancient and one of the world's most widespread zoonotic diseases. Brucellosis, a highly infectious (Munir *et al*., 2010), re-emerging bacterial anthropozoonotic disease of global significance, is important public health and economic point of view. This disease is caused by aerobic gram-negative bacteria of the genus Brucella. Among the genus, *B. abortus* and *B. melitensis* are the leading cause of Brucellosis in livestock (Karaca *et al*., 2007). This organism is also important causal agent of Brucellosis in humans (Gul and Khan, 2007). Infection in animals frequently results in abortion and diminished milk production (Cutler, Whatmore & Commander, 2005). Goat may be infected with both *B. melitensis* and *B. abortus*. However, no proper data has been produced due to lack of proper disease diagnosis and irresponsibility of farmers. Besides, Brucellosis is a zoonotic disease rendering serious health hazard and easily transferred from feed material like raw cheese, meat and other contaminated materials. Considering the animal and human health disorders, occupational risks, and the economic burden it imparts, knowing the status of Brucellosis infection in animals and establishing the epidemiology could be valuable for farmers, veterinarians, researchers, consumers, disease prevention and control program planners and any others concerned with better animal and human health. The occurrence and epidemiology of Brucellosis in goats in high hills in Nepal is also poorly understood.

MATERIALS AND METHODS

Blood was collected from jugular vein of goats by random sampling.

Laboratory examination of serum samples

Serum samples were examined in the Microbiology Laboratory of Himalayan College of Agricultural Sciences and Technology (HICAST) Kalanki, Kathmandu, Nepal using Rose Bengal Plate Test (RBPT) (Prionics AG, Switzerland). The samples containing antibody against *B. melitensis* and *B. abortus* were considered as positive. Standard protocol of the manufacturer was followed.

Procedure for RBPT

- The test procedure for the Rose Bengal Plate Test (RBPT) is as follows.
- 30 µl of serum sample was placed on a white tile and equal volume (30 µl) of Rose Bengal colour antigen was added and mixed with a sterile stick to produce a zone approximately 2 cm in diameter.
- The mixture was agitated gently for four minutes at ambient temperature, and then observed for agglutination.
- Any visible reaction was considered positive.

Data analysis

Tabulation of data obtained from survey was done in Microsoft Excel 2007 and analysis was done by online epi-table, to find out the linear by linear association regarding Breed, age and sex with occurrence of Brucellosis.

RESULTS AND DISCUSSION

The total samples of 110 were taken among which 49(45%) were male and 61 (55%) were female goats. Out of 110 samples, RBPT showed 5 samples (i.e. 4.5% ~ 5 %) to be positive (Figure 1). Out of 110 samples, 61 samples were of females among which 2 (3%) were positive for Brucellosis (Figure 2). And 49 samples were of males among which 3 (6%) were positive for Brucellosis (Figure 3).

A total of three breeds were considered for sample collection; Jamunapari cross breeds (18), Khari (74) and Sinhal (18). There was only one Jamunapari cross breed. Four samples were found to be positive among Khari breeds among which 3 were male and 1 was female. Similarly among Sinhal breed all the samples were found to be negative for Brucellosis. Study showed 6 percent prevalence within Jamunapari Breed (Figure 4). Similarly there was 5 percent prevalence of Brucellosis among Khari breeds and all Sinhal breeds were found to be negative for Brucellosis.

Two samples of below 1 year age were found to be positive which were both males (Figure 5). Similarly one sample each of the age 3 years, 5 years and 7 years were found to be positive. The percentage prevalence was higher in older age i.e. Maximum in 7 years age followed by 5 years and then 3 year and lastly goats below 1 year age. There was no significant difference with increase in age and prevalence of Brucellosis ($P>0.05$). Among 7 VDCs and 1 municipality studied there were 4 samples positive out of 40 in Bhimeshwor municipality and one sample was found positive (20%) in Melung VDC (Figure 6). However there was no significant relation between the places and prevalence of Brucellosis ($P>0.05$).

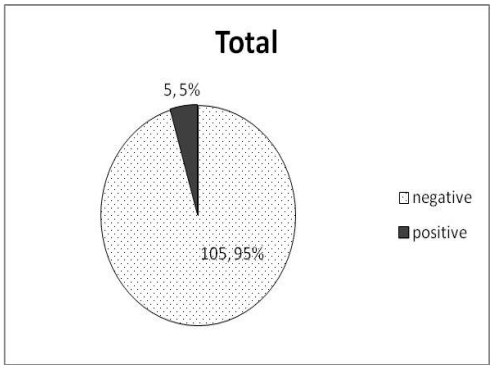
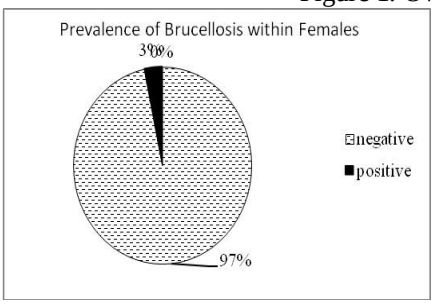


Figure 1. Overall prevalence of Brucellosis



Figures 2. Prevalence of Brucellosis within females

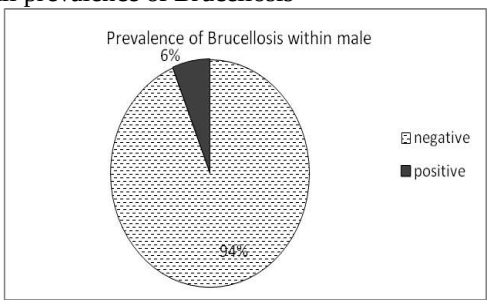
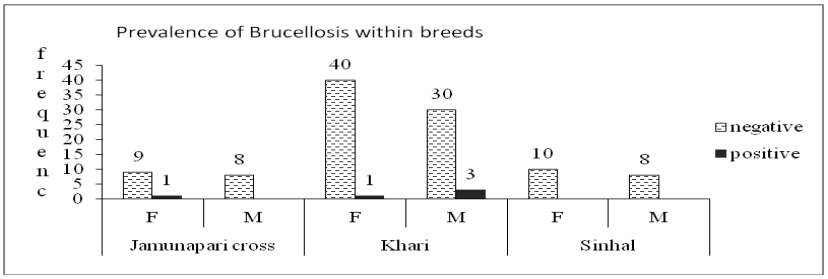
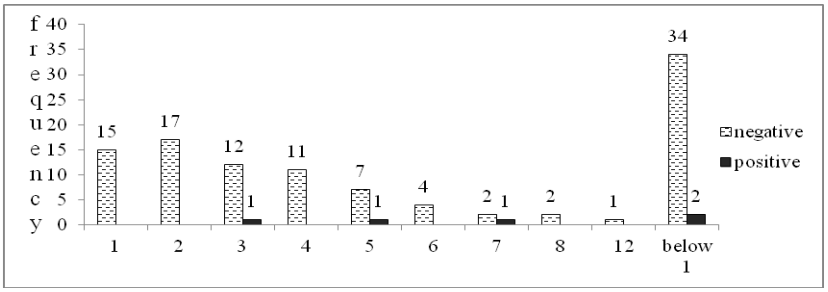


Figure 3. Prevalence of Brucellosis within males



Figures 4. Breed wise distribution of Brucellosis



Figures 5. Age wise prevalence of Brucellosis

The findings of this study revealed the prevalence of Brucellosis on goats of the Dolakha district to be 4.5% with higher prevalence among males (6%) than in females (3%). The prevalence was higher (6%) in Jamunapari cross bred goats compared to Khari goats (5%) while all goats of Sinhal breeds were found negative. Prevalence was higher in older goats than in the goats of below 1 year age. So the loss incurred by the disease could not be overlooked.

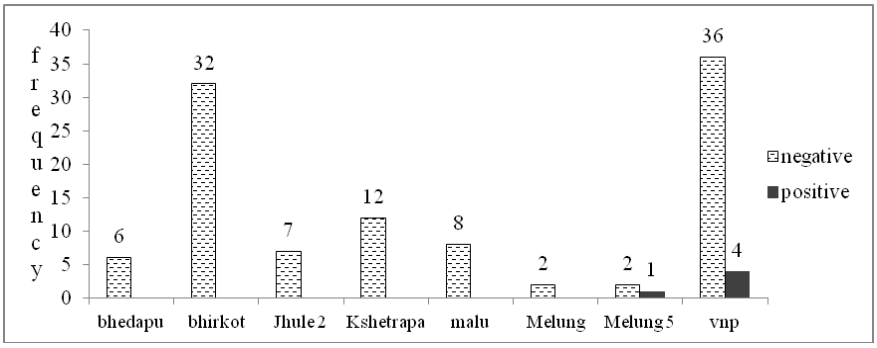


Figure 6. Place wise prevalence of Brucellosis

CONCLUSION

As caprine Brucellosis agent was most invasive and pathogenic and of zoonotic significance attention has to be paid regarding the effect on goats and human.

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Prospects of pineapple based micro-enterprise in Sindhuli district, Nepal

D. Adhikari[1] and S. Amgai[2]
[1]DADO, Kavre
[2]DoA, Hariharbhawan, Lalitpur

ABSTRACT

Pineapple (*Ananas comosus) is important cash generating fruit crop in Sindhuli district. The survey was conducted in pineapple growing VDCs of Sindhuli district in 2016. Semi-structured questionnaire was used to interview the pineapple growers and key informants. This survey report highlights the status of pineapple cultivation, postharvest management and pineapple based microenterprises in Sindhuli district. From the study, it was found that in Sindhuli district pineapple was grown in 148 ha. with the productive area 100.64 ha. The total production of pineapple was 1557.78 mt. Out of total production 25-30 % pineapple was used as home consumption and rest was found to be sold in the market. Nearly 10-20 % of pineapple that was reached to market was used for processing and rest was consumed as fresh fruit. Furthermore cultivation, processing and marketing practices were found pineapple based micro-enterprises developed in Sindhuli district.*

Key words: Pineapple, enterprise, cultivation, marketing, processing

INTRODUCTION

In Nepal due to the wide variation in altitude, and climate ranging from tropical to alpine types, varieties of horticulture crops (fruits, vegetables, spices, herbs and flowers) can be grown successfully. Sindhuli district lies between the latitude 26°55”- 27°22” north and longitude 85°25”-86°15” east. Altitude varies from 168 to 2797 masl. This district is divided into three topographical ranges–Mahabharat, Chure range and Inner Terai. The demand of fruits is increasing day by day in both internal and international markets. Considering the tremendous scope and potential of horticulture crops for generating better income, horticulture sector occupies special position compared to other sectors of agriculture in Nepal. Pineapple (*Ananas comosus)* a non-climacteric fruit is grown commercially not only for the local fresh market but also for processing (Adhikary *et. al.,* 2004). The fruit is a good source of Vitamin A, B and C and rich in calcium. It also contains phosphorus, iron and the protein digesting enzyme, bromelin. Pineapples is the important commercial fruit crops and grown successfully at Sindhuli. Because of the increasing trend in the consumption of fruits and possibility of processing through micro enterprises the domestic demand has increased these days. Fruits are perishable in nature and cannot be kept for longer time without proper storage facility. The fruit processing enterprises can be operated by the utilization of surplus fruits. Due to growing demand for juice, jam and jelly as a result of urbanization and tourism industry in the country, such products are being imported in larger quantity. So, from the viewpoint of import substitution and postharvest loss, establishment of pineapple processing micro industry is a need in the present context. Thus, this study would help the promotion of pineapple cultivation and develop the pineapple based micro enterprises in Sindhuli district.

MATERIALS AND METHODS

All together 21 VDCs of Sindhuli district was purposively selected for the purpose of the study based on the relatively higher area coverage by pineapple. Samples were taken by simple random sampling techniques. Among selected VDCs at least 10 Households (HHs) from each VDC were selected for study. Semi structured questionnaire was used for information collection. The data were collected from randomly selected respondents by visiting every HH. Moreover, check lists were filled to collect information from JT/As of ASC and key informants / leader farmers from VDC level. FGDs were conducted in village where it was necessary. The secondary data were collected from the various publications of related organizations like Fruit Development Directorate (FDD), DDC Sindhuli Profile, Ministry of Agricultural Development (MoAD), District Agriculture Development Office (DADO) Sindhuli. All information collected from various sources was entered into MS Excel. Data tabulation, categorization was used to analyze data. Analysis was done using percentage, graphs and charts. Based on the figures of analyzed data, the results were interpreted in a logical manner.

RESULTS AND DISCUSSION

General Information

Pineapple (*Ananas spp.*) is an excellent fruit which is called as *Bhuikatahar or Kabelikatahar or Anaras* in Nepalese language. Fruit production is during rainy season (Asar, Sawan months). Pineapples are rich in both vitamin C and dietary fiber. Along with fresh consumption, it can be utilized to make squash, juice and jam. Historical evidences showed that the pineapple originated in Brazil in South America. Then, it was brought to Europe later. It is also believed that Christopher Columbus and his crew members were probably the first few people from the European continent to have tasted the fruit. Then, it was believe that the European people disseminated this fruit to India and that brought to Nepal. Pineapple is considered as one of the most wanted tropical fruit and is a major fruit crop grown in topical and sub-tropical areas. It's habitat is humid tropical region (15.6-32^{o}C). Pineapple is being successfully cultivated in more than twenty one VDCs of Sindhuli district. Pineapple in Sindhuli district was found to be grown in fallow, sloppy and marginal land. Pineapple growing in that type of land contributes for soil conservation. Instead, Pineapple fruit production fulfill requirement of nutrients to human and generate income to households. The Pineapple growers of Sindhuli district were found cultivating it since earlier traditionally. Pineapple fruit is commonly used for fresh consumption. These days, pineapple fruit is also used for processing to make juice, squash and jam etc.

Table 1. Prioritization of pineapple fruit in Sindhuli (2016)

SN	Criteria	Indicators	Score (1=low, 5=high)
1	Market / economy	Margins / profitability	4.5
		Sale quantity	4.5
		Market demand (easiness to sell)	5
		Market constraints	1
		Price fluctuation (seasonality issue)	4
2	Involvement with produce	Experience with produce	3.5
		Contribution to income	3.5
		Employment opportunity	3

		Involvement of farmers/people	2.5
3	Value addition and Processing (VAP)	Extent of VAP	3
		Availability of VAP facilities/infrastructure	3
		Potentiality of diversification/value addition	3
4	Business service	Availability of input suppliers	2
		Availability of technical services (Public/Private)	4/1
		Availability of traders/seller	5
		No. of farmer group involved	1
5	Organizations	No. of cooperatives involved	1
6	Environmental aspect	Extent of chemical fertilizers use	1
		Extent of pesticides/PGR use	1
		Environmental hazard	1

Cultivation practices: as the first micro-enterprise

The table 2 shows the area and number of pineapple plants in Sindhuli. There are all together 21 VDCs where pineapples are successfully grown. This cultivation practice of pineapple can be considered as one of first enterprises which provide an employment opportunity at first level i.e. farmers level, altogether there are 1212 households of Sindhuli district who are engaged in pineapple production. This enterprise fulfills their basic needs and others too.

Table 2. Area, production and productivity of pineapple in Sindhuli (2016)

Total area covered by pineapple	148 ha
Productive area	100.64 ha (Found @ 68 % of total area)
Total no. of plants	3054471
Productive plants	2077040
Production (@ 0.75 kg / fruit)	155778 kg
	1557.78 mt
Productivity	1557.78 mt. / 100.64 ha
	15.58 mt. / ha.

Harvesting and utilization of pineapple

Pineapple growers of Sindhuli district were found to harvest only after ripening. The fruit ripening was determined when the base of the fruit turns into yellowish color and the hair of eyes get loose and brownish. In Sindhuli, The fruit harvesting was generally done during Jestha and Sawan months.

The survey showed that out of total production of pineapple, 25-30 percent consumed at household level. Among 70-75 percent sold pineapple fruits only 10-20 percent fruits were found used in processing where there is local processing enterprise were available.

Postharvest handling

Sorting and Grading was found to practice by farmers for marketing. The undersized, infected and decayed fruits were found discarded and grading was done on the basis of size and colour. Packing was generally done in jute sacks, crates and Doko. Transportation of fruits was performed on Doko by porter, on tractors and pick up etc. Post harvest loss is a serious problem for horticultural

crops marketing in Nepal. Rate of quantitative or physical losses are different depending on types of crops, perishability, distance between collected points and retail outlets, packaging handling during transaction and storage and display systems. Post harvest losses of pineapple fruit was found around 5-10 percent experienced by farmers while handling after harvesting till market.

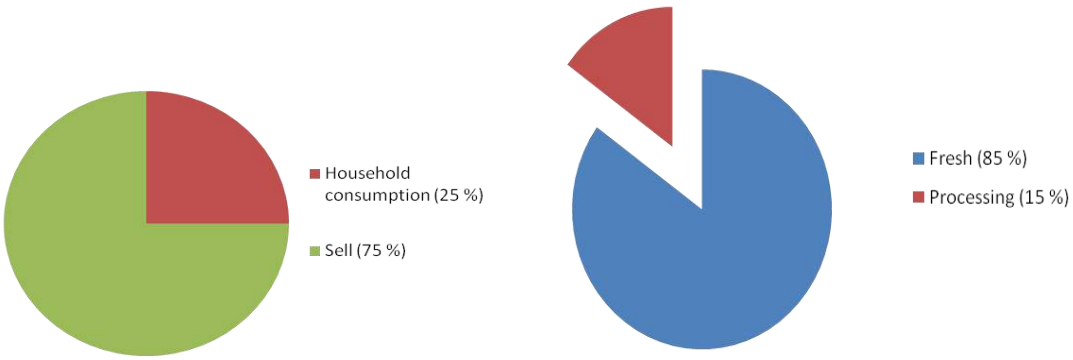

Figure 1. Utilization of pineapple fruit (2016)

Processing practices: as second micro enterprise

The table below shows the processing enterprises of pineapple in Sindhuli district. The surplus amounts of pineapple are process in processing center and produce juice, jam and jelly product from pineapple. Which add value to pineapple; these activities are being performed in season only as pineapple cultivation practices are seasonal in Sindhuli district. But there is potentiality to store the fresh pineapple in newly constructed Jucar cold storage building and utilized the pineapple throughout the year, so processing practices can be taken as second pineapple based enterprise in Sindhuli district.

Table 3. Pineapple processing enterprises of Sindhuli (2016)

S N	Pineapple processing enterprises	Address
1	Fikkal Fruits Processing Centre	Kamalamai Municipality, Majhitar
2	Bhagawati Women Pineapple Processing Centre	Dadiguranse
3	Kamala Pineapple Processing Centre	Ranibas

Marketing practices: as third micro enterprise

The produced pineapple fruits of districts brought to local market centers through marketing agents or farmers themselves. Then from local market centers these fruits sold to retailer, and distant wholesaler. Sindhuli Madi and Bhiman were found local market centre whereas, markets outside district were Dhalkebar, Bardibas and Kathmandu. Price of pineapple was determined on the basis of bargaining between farmers and traders by weighing and counting.

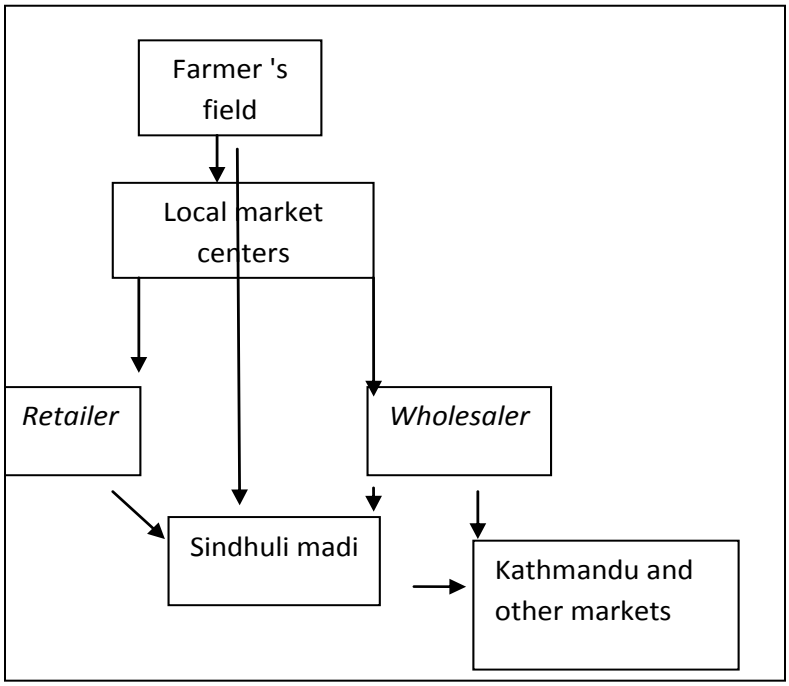

Figure 2. Marketing channel of pineapple fruit in Sindhuli

Average farm gate price was Rs 15 per piece of fruit ranging from Rs 20-30 for local variety. Improved varieties fetch higher price i.e. Rs 40-50 as compared to local. The local varieties were found smaller in size, deep eye in fruit, less flesh than improved varieties. In this marketing practices different actors like retailers, wholesaler sand middle mans were engaged and trading this commodity. So they were able to earn profit and making marketing as one market enterprise for them.

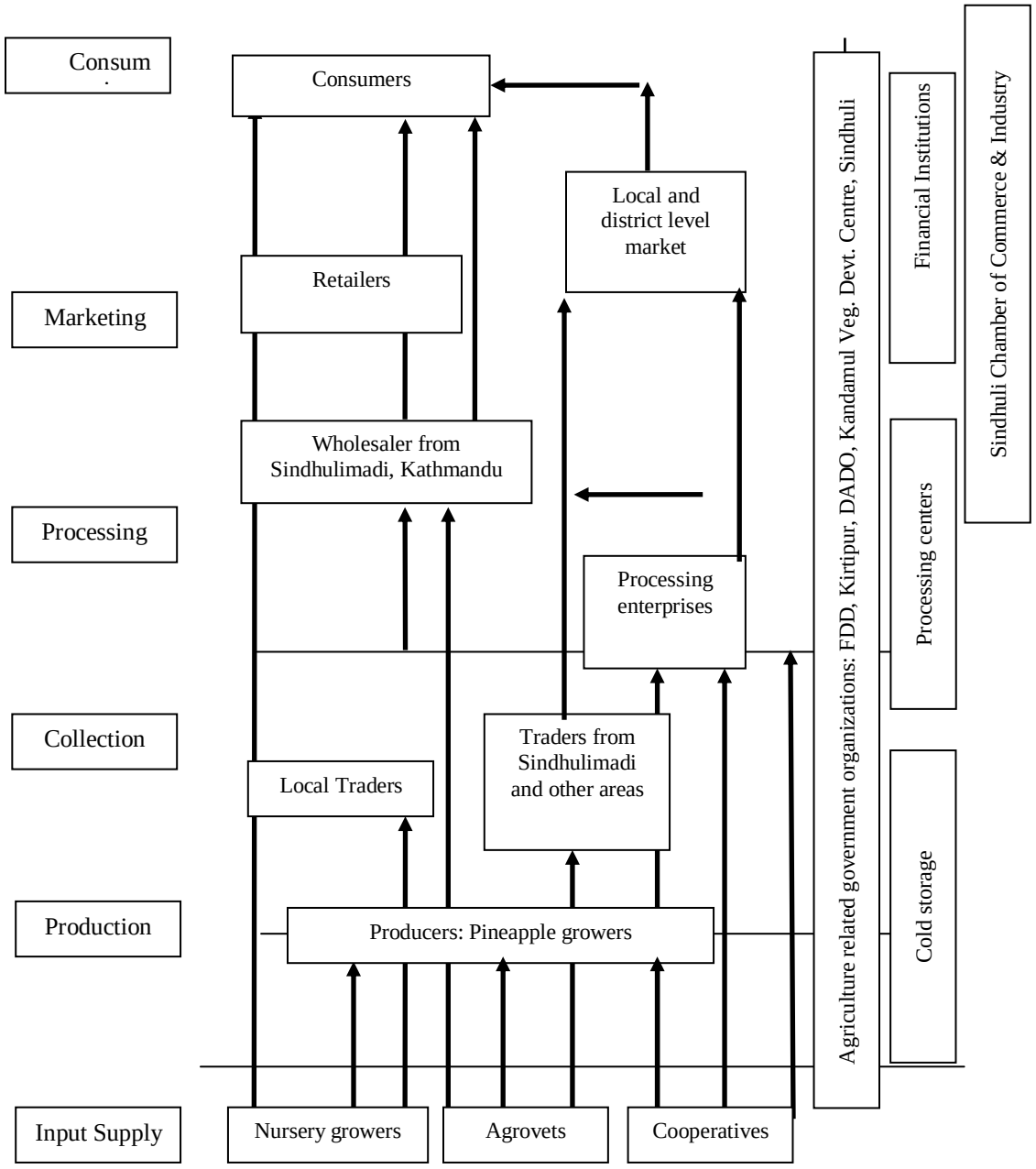

Figure 3. Sub sector map of Pineapple in Sindhuli district

CONCLUSION

Pineapple is a one of the major source of income of farmers in Sindhuli district. Productive pineapple plants cover 100.64 ha out of 148 ha of pineapple growing area. The pineapple farming in Sindhuli is traditional. There should be focus on more commercialization and increase area under pineapple cultivation in feasible locations. Most of the fruit was found used for fresh consumption. Minimization of 10% post harvest loss is wise than producing 10 % more fruits. Thus, knowledge on postharvest management should be provided. Moreover, existing pineapple based micro enterprises should be promoted. Entrepreneurship development is a key of self employment. It will contribute for the solution of unemployment problem. Thus, micro enterprise should establish at large volume pineapple producing areas. The enterprises will produce low volume value added product so; the program is sustainable in long run.

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CASE STUDIES

A case report on wound healing activity of honey dressing

R. Shrestha
HICAST, Kalanki, Kathmandu, Nepal
raju.word@gmail.com

ABSTRACT

Honey is an ancient method of treatment for various diseases and conditions, including wound dressing due to its known antibacterial, bactericidal and anti-inflammatory properties. Honey has been known for replacing sloughs with granulation tissue, rapid epithelialization, and absorption of edema. This study was attempted for the first time in Nepal to explore the use of honey dressing for wound healing. It was a Community dog case that was hit by a car. On examination, an open fracture wound was found on left forelimb. As the dog was anxious and in pain both allopathic and traditional approaches were used for treatment. Allopathic treatment included the analgesic whereas wound healing was enhanced using local honey. Although, the honey dressing took up to 88 days to complete healing of the fractured open wound of a dog, the result was good, and could be used as an alternative medicine in future for wound healing, particularly in the shortage of Veterinary medicine.

Keyword: Honey dressing, alternative medicine, wet / dry bandage

INTRODUCTION

Honey is an ancient treatment that is increasingly earning its place in modern wound care. Evidence suggests it compares with other dressings in terms of its antibacterial properties, ease of use and ability to promote a moist environment (Molan, 2004). The physicochemical properties (e.g., osmotic effects and pH) of honey also aid in its antibacterial actions. Research has also indicated that honey may possess anti-inflammatory activity and stimulate immune responses within a wound. The overall effect is to reduce infection and to enhance wound healing in burns, ulcers, and other cutaneous wounds (Lusby *et al*., 2002). Honey is known to have antimicrobial properties; recently it has been shown to have bactericidal properties against biofilms of *Pseudomonas aeruginosa* and *Staphylococcus aureus* (Aron *et. al*., 2012). Honey debrided wounds rapidly, replacing sloughs with granulation tissue. It also promoted rapid epithelialization, and absorption of edema from around the ulcer margins (Efem, 1988). Honey dressing is one of the methods in secondary infection healing of wound. Secondary intention healing is a simple method of wound management that can provide excellent cosmetic results (Zitelli *et al*., 1983). New stroma, often called granulation tissue, begins to invade the wound space approximately four days after injury. Numerous new capillaries endow the new stroma with its granular appearance. Macrophages, fibroblasts, and blood vessels move into the wound space at the same time (Singer *et al*., 1999).

CLINICAL HISTORY OF A CASE

A community dog named "Masini" was brought to HICAST Veterinary Hospital for the treatment of a wound. It was hit by a car.

Diagnosis

On examination, it was an open fractured wound, which was subjected to X-ray for further investigation if there were other abnormalities. A fracture was seen on metacarpal bone of left forelimb and was exposed

Treatment

Firstly, wound was cleaned with Ringer's Lactate and wet to dry dressing was continued for seven days with antibiotic (Ceftriaxone). Ringer lactate was used to clean the wound because Ringer's lactate does not induce any significant fibroblast injury, whereas normal saline and sterile tap water cause mild and severe cytotoxic effects (Buffa *et al.*, 1997). After seven days, Honey dressing was applied. Exposed bone fell off and Granulation was observed in fifteen days and antibiotic was discontinued. Honey dressing was done daily and it took almost three months to heal the wound. Bandaging was done in such a way that it supported the fractured bone. Splint bandage was applied for the immobilization. Figure 1 shows the healing of the treated fracture wound.

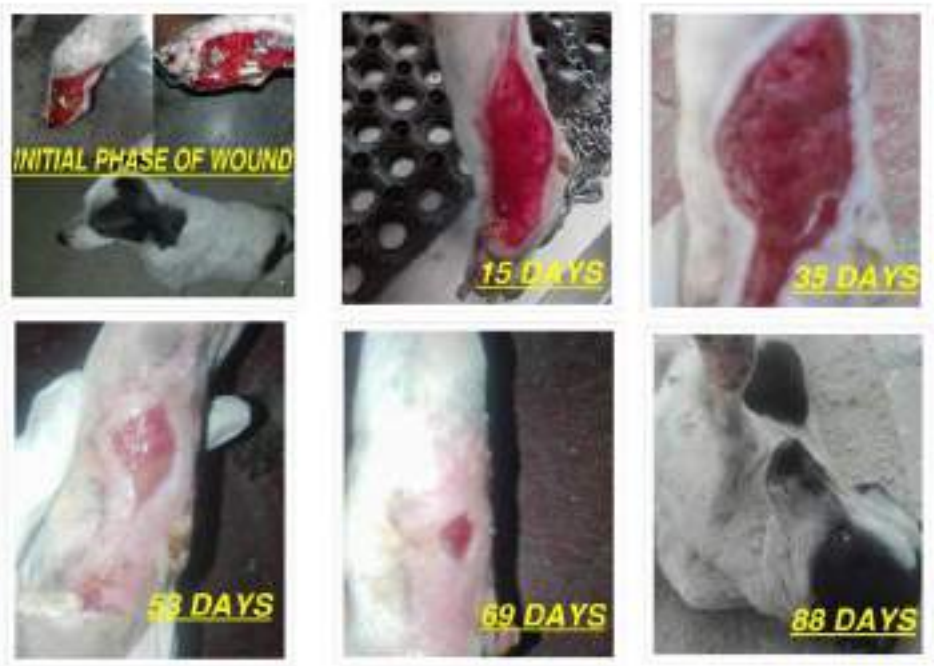

Figure 1. Development of healing of the treated fractured wound

RESULTS AND DISCUSSION

Wound healing by honey dressing or wet to dry dressing is secondary intention healing and this is applied in contaminated wound that cannot be closed by suture. In secondary healing, wound heals by granulation and contraction of wound edge.

As the granulation started antibiotic treatment was discontinued and only honey dressing was carried out. Antibiotic was not given after 15 days and there was no sign of infection. It Suggests that it may have antimicrobial properties. This supports Aron *et al.*, 2012. According to Singer *et al.*, 1999 granulation starts after four days of injury but in this case granulation was seen in fifteen days. This might be due to the chronic wound. In eighty eight days, the wound was healed completely and showed good cosmetic result as shown in Figure 1. This supports Zitelli *et al., 1983*

In this case, exposed bone was supposed to be kept in normal position and pining would have been the best treatment. But, this was not followed due to the lack of financial issue and callus was already formed in between the fragmented bone. The wound was cleaned with Ringer Lactate saline and dressing was applied. After the few days of treatment, exposed bone fell off and cutting of exposed bone was not required. There was no exposed fractured bone and granulation was started (Figure 1)

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ACKNOWLEDGEMENT

The author is thankful to Ms. Ayusha Karki for taking care of sick dog and for follow up treatment and Special thanks goes to Dr. U.M. Singh, Dr. R.D. Shrestha and Dr. Bishwas Sharma for technical advice.

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Local innovation documentation: a case study of Mustang district, Nepal

S. Amgai[1], S.M. Bhattarai[2] and D.R. Dangol[3]
[1]Department of Agriculture, Hariharbhawan, Lalitpur, Nepal
[2]KISAN (Knowledge based integrated sustainable agriculture and nutrition project, Nepal
[3]Natural History Museum, Tribhuvan University, Kathmandu, Nepal

ABSTRACT

Local innovation documentation should be driven on the needs and ideas of the whole community. Documentation of local innovation requires active participation of farmers. Local innovation documentation follows three stages namely; identification possible users of local innovation and stakeholders, finding suitable method to access the target group and planning and implementation for documentation process. To investigate into the fact, the study was conducted in Mustang district to document the local innovation in 2016 so as to suggest appropriate policy implications. Name of innovator, district, type of innovation, status of innovation, description of innovation, innovativeness, uses, benefits and dissemination process were recorded by interviewing the innovator. Digital camera was used to take photographs of local innovations. Underground apple storage, apple core remover, glass solar drier and plastic solar drier were major innovation related to apple were found in that district.

Key words: Apple, Innovator, Local innovation, Documentation and Dissemination

INTRODUCTION

Local innovation refers to the dynamics of indigenous knowledge that grows within a social group, incorporating learning from own experience over generations but also knowledge gained from other sources and fully internalized within local ways of thinking and doing. Local innovation is the process through which individuals or groups discover or develop new and better ways of managing resources building on and expanding the boundaries of their indigenous knowledge (Water-Bayers and van Veldhuizen, 2004).Local innovation through informal experimentation has always been happening, but only recently, increased attention has been given to identify and documentation of the local innovations and the innovation processes. Documenting local innovation is not enough. In rural development, the challenge is to move beyond the existing local innovations that farmers have developed, using their indigenous knowledge and creativity, and to develop these ideas further in joint experimentation, integrating relevant information and ideas from elsewhere (Bruce and Karbo, 2004). Identifying local innovations is a first step toward changing the way development workers regard farmers and interact with them. They start to see farmers as partners with something to offer, not just to receive. A positive approach that starts from local ideas, which focuses on local people's strengths and explores the particular opportunities, open to them rather than dwelling on their weaknesses and problems is a key to stimulating local innovation processes. An innovator has been defined as "someone who develops or tries out new ideas without having been requested by outsiders to do so". "New" is something that was started in the innovators' lifetime and not inherited from parents, like a farming technique or a different way of organizing things. In Nepal, the first definition of innovations was coined and adopted as "New ideas based on local resources evolved

through the experimentation of local people to address the specific local constraints and opportunities". Innovativeness refers to the process and capacity of creating something new- better said "creativity", whereas innovations refers to the actual products of this process- the technologies or instruments that are produced through the process of creating (Rai and Shrestha, 2006). The documentation to be done by individual farmers or farmer groups, but the process can be encouraged or facilitated by NGOs and technical experts as required by the community (PROLINNOVA, 2006).

The purpose of identifying local innovation is not primarily to disseminate them in a transfer-of-technology mode of extension. Such an approach is not suited for the highly diverse environments in which many smallholder farmers live. A local innovation is developed to fit a particular biophysical and socio-economic setting and usually cannot be transferred "as is" to other settings. However, the documentation and sharing of local innovations can provide ideas and inspiration for others to try out and adapt new ideas to their own setting (*Waters-Bayer and van Veldhuizen, 2004).*

MATERIALS AND METHODS

Mustang district was purposively selected for the purpose of the study. Documentation was carried out through innovator's interview and using information from District Agriculture Development Office (DADO), Mustang. Photographs, booklet, pamphlets and paper publication were found to be the best methods for effective documentation and dissemination. Name of innovator, districts, type of innovation, status of innovation, description of innovation, innovativeness, uses, benefits and dissemination process was recorded by interviewing the innovator. Digital camera was used to take photographs to document the local innovations.

RESULTS AND DISCUSSION

Local innovation of Mustang district

Underground apple storage

Name of Innovator: Shrawan Sherchan
District: Mustang
V.D.C: Kobang, Ward No: 6
Status of Innovation: Under experimentation
Type of Innovation: Improved modified

Figure 1. Underground apple storage

About innovation:

Shrawan Sherchan developed innovative method for apple storage by using underground room in 2064 B.S. In spite of higher production of apple in Mustang district, majority of the apple growers were forced to sell their product from their orchard at very low price and if stored in housing condition, it will shrunk and damaged within 2-3 weeks. So the concept of using underground room was practiced to minimize those losses during storage. It was found that it helped to keep the apple safely for at least 3-4 months and ultimately apple growers were able to fetch reasonable price during off- season.

Innovativeness: Use of natural land and low temperature of high altitude for apple storage.
Use: Use for the storage of apple and potato.
Benefits:

- Storage for longer period of time.
- Low cost of construction.
- No need of skill manpower.
- Minimize the forced selling of apple from the orchard.
- Fetch reasonable price during off-season.
- Low level of damage and losses during storage.

Material Required: Wooden pillars, wooden sheets, ladder, door and stone
Procedure:

1. Prepare the underground room.
2. Place the pillars in the four corners.
3. Keep the wooden sheets by making three layers in the underground room, where apples are to be stored.
4. Make round wall in upper part of the room and covered the open roof.
5. Place door and ladder for entry and exit into/from the room.

Cost: NRs. 70,000/-
Dissemination: The innovation was under experimentation so improvement could be made and the innovator had thought of making concrete floor to maintain high moisture, to avoid muddy condition and plaster the wall above the ground to minimize mice problem.

Name of Innovator: Lal Bahadur B.K.
District: Mustang
V.D.C: Marpha, Ward No: 8
Status of Innovation: Already in use
Type of Innovation: New

Figure 2. Apple core remover

About innovation
Most of the apple growers of Mustang district were suffering from the lack of transportation and market for their product. So they had to prepare *sukuti* from surplus apple. For the preparation of *sukuti*, apple core must be removed which was time consuming and tedious job. So apple producers requested Mr. Lal Bahadur B.K, professionally an iron worker to make an instrument that remove apple core easily without degrading the quality of final product i.e. *sukuti*, this lead Mr. B.K. towards the invention of this innovation in 2064 B.S.
Innovativeness: Use of simple iron sheet for removing apple core instead of high cost technology.
Use: Used for removing apple core.
Benefits:

- It is easy to use.
- Low cost for construction.
- Does not require high skill manpower.

Material Required: Simple iron sheet, wood

Cost: NRs. 100/-
Dissemination: The innovation was disseminated in the Chimang village of Marpha V.D.C. About 20-25 households within this village were using this innovation.

Glass solar drier

Name of Innovator: Prem Thakali
District: Mustang
V.D.C: Tukuche, Ward No: 1
Status of Innovation: Applied refineme
Type of Innovation: Improved n

Figure 3. Glass solar drier

About innovation
There is windy environment with chilled temperature in Mustang district all over the year. However, apple growers had to prepare apple *sukuti* in the peak production period of year i.e. in Kartik and Mangsir. In the case, due to the existing environmental condition, there were chances to degrade the quality of final product from the dust blowing as they were dried in open space. Similarly, it took a longer time to full dry. So to get rid from such problems Mr. Thakali had innovated glass solar drier in 2061 B.S.

Innovativeness: Efficient use of solar radiation.
Use: Use to dry *sukuti* of apple and apricot.
Benefits:

- Drying of apple *sukuti*, apricot and other vegetables during windy and dusty environment.
- Prepared high quality *sukuti*.
- Higher return per unit.
- Dry in shorter period of time.
- Drying of larger amount of *sukuti* at once.
- Low cost of construction.

Material required: Wooden frame, glass, steel wire net, lockers, steel sheet and trey
Sized used: 3*7*4 feet (back frame) and 3*3*3 feet (front frame)
Procedure
1. Prepare the front and back wooden frame.
2. Cover both sides (right and left) of back frame by steel sheet.
3. Cover the upper part by glasses.
4. Place opening system in the front side of front frame through which one can enter and exist for cleaning the drier.
5. Insert the treys (made of steel wire net) from back side of the back frame.
6. Cover all remaining sides by wooden frame.

Cost: NRs. 8,000/-
Dissemination: Villagers surrounding the innovator were familiar with the use of this innovation.

Special problem in innovation: Due to single opening system of front frame, it was felt difficult in cleaning the drier.
Improvement to be made: Placing of opening system in both sides (right and left) of back frame.

Plastic solar drier

Name of Innovator: NimaGurung
District: Mustang
V.D.C: Jomsom, Ward No: 9
Status of Innovation: Already in use
Type of Innovation: Improved modifi

Figure 4. Plastic solar drier

About innovation
Nima Gurung, a carpenter of Dumba village of Mustang district, had innovated plastic solar drier to dry the apple *(call apple sukuti).* The most of the apple growers of Mustang district sell their product making apple *sukuti*. It provided an opportunity to fetch reasonable price instead of selling fresh apple into market. Different organization like Annapurna Conservation Area Program, District Agriculture Development Office of Mustang had distributed the solar drier to the farmers in subsidized price. During the operation of this drier, one had to face many technical and user problems like electricity problem and over drying of *sukuti*. Therefore in order to overcome these problems the innovator had started using this innovation in 2065 B.S.

Innovativeness

- Efficient use of solar radiation.
- Low cost and use of simple technology.

Use: Drying of *sukuti* of apple, apricot and different vegetables.

Benefits

- Improve the quality and get reasonable price of final product.
- Require lesser time to dry.
- Large quantity can be dried at once time.
- No fear of over drying and technical problems.
- Use of solar radiation instead of electricity to dry.
- Low cost for construction.
- Doesn't require high skill manpower.

Material Required: Wooden frame, plastic, steel wire net, lockers and iron nail
Sized used: 3*15*12 feet
Procedure:
1. Prepare the wooden frame.
2. Place the steel wire net 10-15 cm below from the upper part, where apple *sukuti* are placed.
3. Fit required numbers of window (opening system) made of plastic on upper part of wooden frame.

Cost: NRs. 10, 000/-
Dissemination: The news of this innovation had been widely disseminated in the village. Many apple growers also requested Mr. Nima Gurung to make such drier for them as well.

***Ghilik* (Threshing equipment)**

Name of Innovator: DhanmayaThakali
District: Mustang
V.D.C: Marpha, Ward No: 8
Status of Innovation: Already in use
Type of Innovation: Improved traditiona

Figure 5.*Ghilik* (Threshing

About innovation

DhanmayaThakali, 32 year, simple farmer of Syang village of Marpha V.D.C. whose main source of living is agriculture. In Mustang district traditional *Ghilik* is used for threshing barley and necked barley, which had lesser number of teeth, so it required enough time and manpower for threshing. Therefore to correct this problem and to make the work efficient the innovator had improved the traditional *Ghilik* by increasing the number of teeth in 2059 B.S.

Innovativeness: Use of greater number of iron teeth for efficient threshing.

Use: It is used for efficient threshing of barley and necked barley.

Benefits:

- Save the time and manpower.
- Easy to work.
- More quantities of barley and necked barley can be threshed.
- Made by using locally available material.
- Comparatively more comfortable compared to traditional *Ghilik*.

Material Required: Wooden head, wooden legs, iron teeth, rope, stone and wooden driller

Cost: NRs. 1,500/-

Dissemination: The farmers of Marpha and Jomsom V.D.C. of Mustang district have been using this innovation.

CONCLUSION

Documentation - a process is in written, visual, audio and electronic forms that provide information about a place, an object, a practice, a product or an event for learning and sharing or for recording intellectual property. Most of the local innovations in Mustang district were related to the commodity produced in that district like apple, barley and necked barley. Underground apple storage - to minimize the forced selling of apple from the orchard, Apple core remover - for removing apple core, Glass solar drier and Plastic solar drier - to dry *sukuti* of apple and apricot were innovation mostly related to apple fruit. Similarly, Ghilik (threshing equipment) - used for efficient threshing of barley and necked barley. Furthermore, these local innovations of Mustang district should be promoted and disseminated by concerned agencies.

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Efficacy of IPM practice over farmer's practice in cauliflower: a study in Kathmandu Valley

S. Oli, P. Ghimire and S. Gajurel
HICAST, Kathmandu
olisuresh420@gmail.com

ABSTRACT

Study assessed the efficacy of the IPM practice over the farmer's practice in terms of growth yield and crop protection strategies for Cauliflower production in Kathmandu valley during 2016/2017. Altogether 100 farmers were selected randomly but purposively for interview. Field experiment was carried out in Tinpiple of Kathmandu district by making two different plots for IPM and farmer's practice, ten plants per plots were selected as sample plants and observation was done for growth, yield and crop protection strategies. Data collected were analyzed with the aid of Microsoft excel, and SPSS. Increased productivity (35%) was found after the adoption of IPM technology. Before IPM training the percentage of respondents who were using the Crop rotation, Intercropping botanical pesticides, bio pesticides, various lure and integration of more than one techniques were 14%, 34%, 8%, 5%, 2%, 10% respectively whereas, the percentage of farmers increased significantly to 72%, 80%, 88%, 55%, 58%, 85% respectively after IPM. Maximum plant height (39.06cm) and maximum increase in plant canopy 530.2 percent was observed in IPM practice at 75 DAT while at the same time plant height and increase in plant canopy in farmer's practice was 27cm. and 312.2 percent respectively. The average yield of a cauliflower was found higher in IPM practice (38.88 tons per ha) than farmer's practice (23.33 tons per ha). Maximum number and type of beneficial insects including Ladybird beetles, predatory wasp, spiders, and dragonfly were observed in IPM practice as compared to farmer's practice. Maximum number of Aphids (14 insects per plant) and DBM (5 insects per plant) were observed in IPM practice whereas in farmer's practice maximum number of aphids were reached to 45 insects per plant and that of DMB reached to 6.5 insects per plant.

Key words: IPM, pests, cauliflower, lure, biopesticides

INTRODUCTION

The cauliflower (*Brassica oleracea L. var. botrytis*) is a cool weather vegetable popularly grown in Nepal grown for harvest of large tight heads of aborted white flower buds (curds). It belongs to the family Brassicaceae native to Western Europe. It is top most grown vegetable in Nepalese land. Here is hardly any house where it is not regularly used as vegetable. As there is also the development of new tropical varieties, in addition to the temperate type, it has now become possible to grow the cauliflower almost all the year around. Nepalese people commonly use it as a cooked vegetable either singly or mixed with potato in curry or fried form. Cauliflower is grown in wider area in Kathmandu i.e. 387 ha followed by Lalitpur and Bhaktapur i.e. 310 ha and 235 ha respectively. In spite of the area, production is highest in Lalitpur followed by Kathmandu and Bhaktapur i.e. 5735 MT, 5041mt and 4418 MT respectively. Yield in metric ton per hectare is same in Lalitpur and Bhaktapur followed by Kathmandu i.e. 19 MT/h and 13 MT/h respectively (ABPSD, 2014). Seedlings of Cole crops are grown in nursery beds. In Nepal, three situations exist for raising of seedlings of cauliflower in the nursery bed. In high hills seedling are raised in

nursery bed during summer month, rainy season in mid hills and plains but these seasons are not appropriate season. Seedling raised in nursery bed for late variety in mid hill and plains is the optimum season (Singh and Bhandari, 2015). Integrated Pest Management (IPM) is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. Although the IPM Program in Nepal has made tremendous progress since its launch in 1997, it is still vulnerable and needs further support in order to sustain the activities (Upadhyay, 2002.). IPM is not a blind approach or blanket recommendation of pest management rather a combination of experience and intelligence (G.C., 2011). Most of the botanical pesticides are low in toxicity and are biologically degradable in the nature and they do not persist for long in the environment (G.C., 2013). The most common pesticides value of Nepal's indigenous plants include (*Allium sativum*) which has anti-fungal, anti-bacterial, nematicidal and insecticidal properties, a leaf extract *of Artemesia vulgaris* for the caterpillar and storage grain pests, *Acirus calamus* is an insect repellent contact poison and ash wood also use for different crops storage grains and field condition crops (Palike, 2000).

MATERIALS AND METHODS

This study was conducted during October 2016 – April 2017 in two phases; at first phase survey on IPM farmers was conducted and second phase field experiment was carried out to support the result. Purposive household survey was conducted in Nakhel and Balkot of Bhaktapur, Lele and Tikathali of Lalitpur and Bajrayogini and Kirtipur of Kathmandu district including two IPM farmers group in each districts. Total of 100 farmers were interviewed by administrating validated semi structured questionnaire from all farmer's group. Farmers with IPM practice were the target of the study. Primary data were collected through the personnel interview with the help of pre-tested semi-structured questionnaires administered to selected IPM farmers of respective IPM farmer's group. Various published and unpublished sources such as related journals, books, reports, unpublished reports of NARC, MOAC, Central Bureau of Statistics (CBS), Agriculture Information and Communication Center (AICC), HICAST, IAAS, and different websites visited to collect publications for secondary information. Field experiment was carried out in Tinpiple of Kathmandu district by making two plots; one plot as IPM practice and another as farmer's practice, measuring 9 sq. meter of each. Field preparation was done as per the requirement of commercial cauliflower production. In the IPM practice, bio fertilizers including compost, poultry manure, Agri- Zinc @10 kg/ha were used. Bio pesticides including *Trichoderma viridae* @5g/ lit water was drenched at the time of transplanting as a biopesticide considering the history of the experimental area on incidence of damping off of seedling whereas, in framer's plot only compost was used. In IPM practice, nursery bed was prepared by mixing soil, sand, well decomposed poultry manure and wood ash in the ratio of 3:2:2:1. The nursery soil was also mixed with *Trichoderma viridae* @ 25g per 100 per sq.m. The cauliflower variety Snow Mistique was sown in row at a depth of 1.5 cm in well prepared nursery bed and seed bed was protected with poly tunnel. In farmer's practice field preparation was done by mixing soil and FYM. Similar cauliflower variety was used in farmer's plot. Twenty five days old seedlings, at the spacing of 60cm × 45 cm, in ridge and furrow method in IPM practice while, in farmer's practice spacing was not made accurate and seedlings were transplanted in flat bed at the same time. In IPM practice, intercropping cauliflower with tomato and mustard was carried out. Mustard was planted for attracting Aphid species while tomato was planted to trap the DBM in the field. In farmer's practice no intercropping was carried out. Ten plants from each plot were selected as sample

plants by zig- zag method and observation was done every fortnightly. In IPM practice, Gitimal both foliar spray and soil drenching was applied at a regular interval of 15 days, new Bajura Botanical Pesticides (BBP) was obtained from a Ratakot Hebs and Agriculture Research Center, Bajura district of Far Western region, that was diluted with water @ 1:10 and applied on IPM plot for controlling Aphid, DBM and other insects. Fresh cattle urine was used in seedlings (1:10) as well as in the transplanted plant (1:4), which was applied as per the recommendation of TNAU (2013). Gmax tricon (*Trichoderma viridae)* @5g/lit water was drenched at the time of transplanting; BT (*Bacillus thuringiensis*) @ 2g per liter water was sprayed over the plant canopy. In farmer's practice chemical fungicide Carbendazim (Bavistin) @ 1.5g per liter of water was drenched @ 100ml per plant in a regular interval of 5 days for three times when the post emergence damping off disease was found (Dussad, 2009). Chemical insecticide Malathion @ 2ml per liter of water was sprayed when the DBM was seen in the field with the help of hand sprayer. The observation and measurement with respect to plant height (cm), plant canopy (% increase), yield (tons per ha), incidence of disease and movement of beneficial and harmful insects before and after application of management techniques were recorded in each plot. Harvesting was done based on harvesting indices of cauliflower with sharp knife when the curd attained the characteristic dumb shape and pure white color. The statistical analysis of data collected from both survey and experiment was carried out by using MS excel and SPSS.

RESULTS AND DISCUSSION

Survey on IPM practicing farmers

Occurrence of pest and their damage in IPM adopted site

Majority of insects recorded were lepidopteron pest while in terms of disease damping off, club root of crucifer and other leaf diseases were found. Before adoption of IPM, in the case of any pest appeared in the field majority of respondents ma (38%) reported that, there was a loss higher than 50 percent when the pest attack occurred in the field. While after the adoption of IPM technology, in case of any pest appeared in the field, majority of the respondents (35%) reported that, loss due to pest attack was below 15% (Figure 1). This result implies that damage caused by pest was lower in most of the study area which may be due to the adoption of IPM technology by the farmers as IPM works on the principle that pests can be better managed by prevention rather than control.

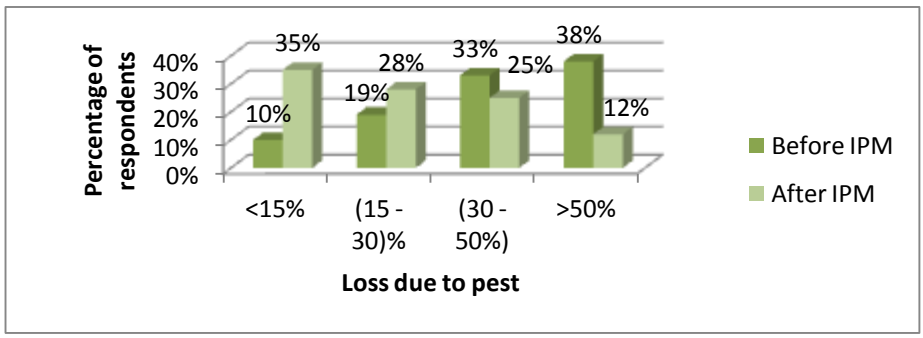

Figure 1. Loss due to pest damage

IPM tools adopted by farmers after taking training

Farmers in the study area were found to be using various tools of IPM in their field both before and after adoption of IPM but after the commencement of IPM practice, considerably higher number of farmers was using these tools (Figure 2).

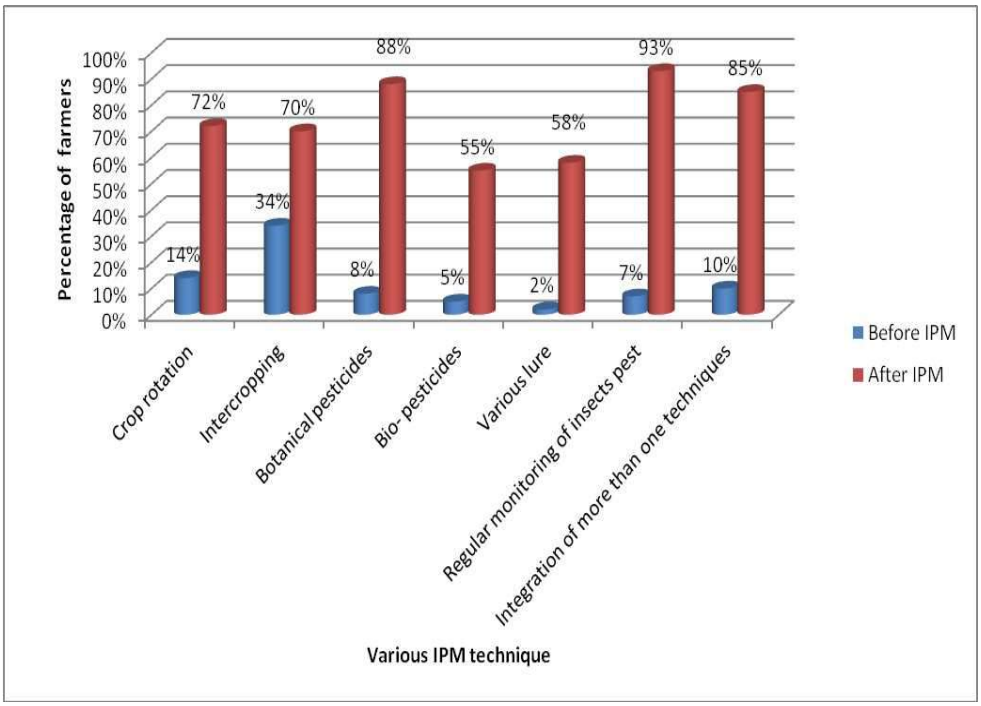

Figure 2. Major IPM tools adopted by respondents

Field experiment

Plant growth

It was found that, the growth of plant height in both IPM and farmer's practice was with similar trend. Nevertheless, rate of growth of plant height after first fortnight was relatively higher in IPM practice than farmer's practice (Figure 3).

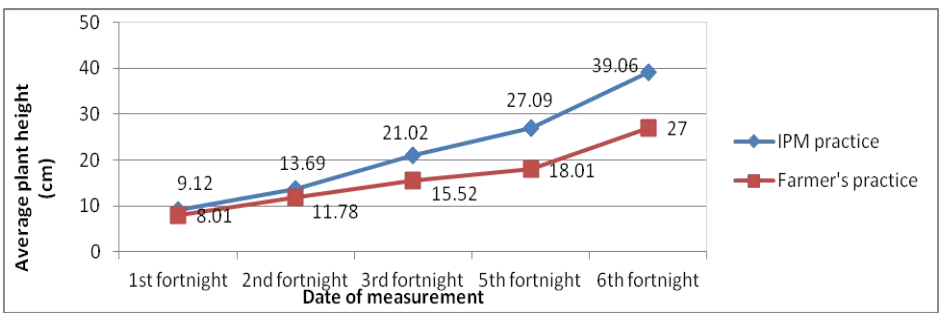

Figure 3. Average plant height at different day after transplanting

The average plant height was reached to 39.06 cm till 75 days after transplantation (DAT) in IPM practice where as it was reached to 27 cm at the mean time in farmer's practice.

Yield

In crop plants, yield formation is complex eco-physiological phenomenon which is determined by genotype, environment and interaction among them (Rajbhandari, 1988). Effect of interaction among them in average yield was found significantly higher in IPM practice than that of the farmer's practice (Table 1).

Table 1. Yield of Cauliflower per sample plants in IPM and Farmer's practice

Practices	N	Mean	SD	Std. error	95% confidence interval of the difference	
					Lowercase	Uppercase
IPM practice	10	1.7290	0.15836	0.05008	1.6157	1.8423
Farmer's practice	10	1.1010	0.32661	0.10328	0.8674	1.3346

In reference with table 2, yield per plot in IPM practice was 35 kg and that of Farmer's plot was 21 kg. Yield per hectare in IPM practice was 38.88 tons and that in farmer's plot was 23.33 tons.

Table 2. Yield of cauliflower per plot and per hectare

Yield	IPM practice	Farmer's practice
Kg per sample curd	1.75	1.06
Kg per plot	35	21
Tons per ha	38.888	23.333

Types and numbers of insect pests

Aphid and DBM occupied the predominant position both in IPM practice and farmer's practice. Relatively higher numbers of insect pests were observed in Farmer's practice as compared to IPM practice (Figure 4). Nevertheless, considerable reduction in number of pest was found after the application of chemical pesticide in farmer's practice. If more than 20% of leaves are infested with aphids, then an insecticide application is recommended (Opfer and McGrath, 2013). Reduction in number of pest in IPM practice may be due to the presence of NEs. In IPM practice number of Lady Bird beetles per plant were highest followed by Spiders, Predatory wasps and Dragon flies. In contrary to that, movement of natural enemies was significantly lower in farmer's practice as compared to IPM practice. The most important tools for aphid management are natural enemies that prey on aphids, such as Lady beetles, Lacewings, Soldier Beetles and small parasitic Wasps (Savonen, 2008).

Disease incidence

Incidence generally refers the numbers of individual showing the disease (Sing, 1995). Both in IPM as well as farmer's practice post emergence damping off was appeared soon after the transplanting. However, level of disease incidence was considerably higher in IPM practice (60%) as compared to farmer's practice (10%) at first fortnight after transplantation (Figure 5). Anderson (1985) conducted pathogenicity of *Rhizoctonia solani* and observed typical symptoms of the fungus on root and lower stem of Mungbean.

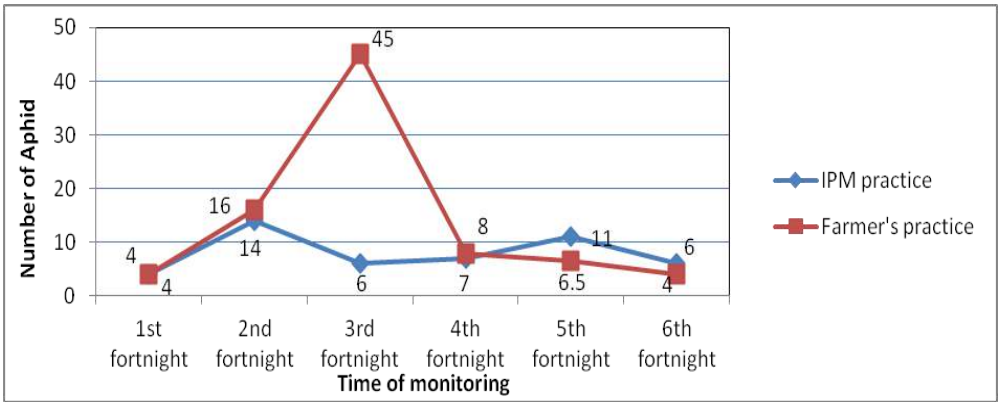

Figure 4. Number of Aphids in IPM and Farmer's practice

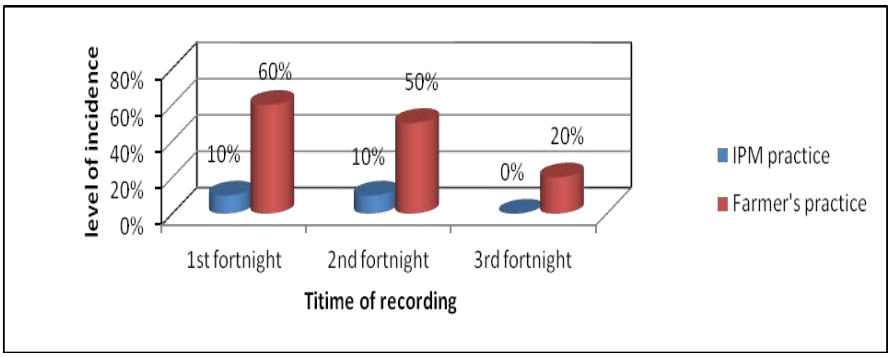

Figure 5. Level of incidence of Post emergence Damping off

CONCLUSION

Growth and yield in IPM practice was found higher than farmer's practice while at the same time incidence of insects' pest and diseases was lower in IPM practice as compared to farmer's practice. Bio-pesticides such as new BBP and *Trichoderma viridae* were found effective to manage aphids and *Trichoderma viridae.* Thus, it can be concluded that IPM is an important tool that aid not only for profit maximization but also to lower the pesticide exposure to human as well as environment thereby making the healthy human life as well as ecosystem.

Despite of being an effective approach for pest management, concerned agencies should pay due consideration to provide knowledge and training on IPM to the farmers along with appropriate market and research policies to promote and expand the IPM innovation within and outside Kathmandu valley.

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A study on negative impacts and coping strategies of chemical inputs at Karpok and Godak VDCs of Ilam district

M. Basnet [1] B. Khanal1[1] D.R. Dangol[2] and S.M. Shakya[3]
[1] Institute of Science and Technology, Tribhuvan University, [2] Natural History Museum, Kathmandu, and [3]Institute of Agriculture and Animal Science, T.U.
manojbasnet99@gmail.com

ABSTRACT

A study was conducted in two VDCs (Godak and Karpok) of Ilam district in order to identify the negative impacts of chemicals and the coping strategies developed by the farmers against these chemicals. The study was carried out through individual questionnaire method including 50 vegetable farmers from each VDC. It was found that the farmers had enough number of livestock per household. Dung and urine were used to produce organic manure. However, due to poor knowledge about preparation of organic manure the farmers have been able to reap low level of production. This showed that farmers need some sort of training on organic manure preparation. Farmers have been experiencing negative impacts on their health, soil health and environment health. Despite the low level of production, farmers were getting higher price for the organic products at market. The demand for organic products is also increasing day by day at Ilam municipality due to heath consciousness among the consumers. The farmers were motivated towards organic farming but the number of such farmers was very few. In order to transform Ilam into an organic district there is a need of immediate action plan on organic farming both from the government as well as non government organisations.

Keywords: Organic, inorganic, impacts, coping strategies, input, chemicals.

INTRODUCTION

Nepal is sandwiched between two largest South Asian countries, China and India. Geographically, it is divided into three major zones, high hill, mid hill and terai. Agriculture is the major sources of livelihood for more than 65.5% people. It contributes more than 35.3% GDP of the country (MoAC, 2011/2012). Government of Nepal, has given due emphasis for the promotion of high value but low volume cash generating crops. Vegetable crops are important crops for vital nutrients and vitamins. Different vegetables; Cauliflower, cabbage, broccoli, radish, Rayo (Cruciferous), tomato, brinjal, chili (Solanaceae), cucumber, bottle gourd, sponge gourd, bitter gourd, squash chayote (Cucurbitaceae), beans, okra, garlic, onion and asparagus are cultivated in the country. The total area coverage under vegetable is 244100 ha with annual production of 3.2 million metric tons. Ilam, with vegetable cultivation area of about 3085 ha stands in the second position among Eastern region hilly districts of Nepal. The annual fresh vegetable production is 43608 mt (MoAC, 2011/2012). Most of the farmers residing in Godak and Karpok VDCs of Ilam district are supplying fresh vegetables to nearby municipalities. The potential productions of vegetables are limited by several groups of insect pest. The losses of vegetables caused by them are poorly quantified. These pests are a serious constraint to production in smallholder peri-urban

areas of Nepal. The trend of using chemical pesticides has been increasing in last few decades. The total pesticides imported and formulated was 56172 kg a.i. in 1997/98 which has reached 335673 kg a.i. in 2010/11 that is worth of about NRs 40 million (PPD,2011) Although all the dirty dozen POPs (Persistent Organic Pollutants) and non POPs have been band, 102 pesticides (common names) have been registered for import and use in Nepal. They include several pesticides of Class Ib, II and III under WHO category. Magnitude of the problem has been widespread over the past years. The average use of pesticides in vegetable field is 1400 gm/ha (PPD, 2011). This has to be minimized through novel pest management technology. Hence this project proposal was purposed to carry out the use of chemical trends and the coping strategies against the negative impacts of chemical inputs used.

The purpose of this project is to know the trend in the use of chemical inputs in Ilam district and to identify the coping strategies against the negative impacts of chemical inputs on vegetable farming. Besides, the use of chemical inputs on vegetable farming is hazardous to our health and environment. Ilam district is also one of the potential vegetable export districts on eastern region of Nepal. In this district in the name of increasing vegetable production are using pesticides indiscriminately. But, at the same time, it has also shown some sparse negative impacts on human health as well as environment. So, the third purpose of this study was to identify possible way outs to mitigate this problem.

MATERIALS AND METHODS

This study was conducted on two VDCs, Karpok and Godak VDCs of Ilam district during 2014. A total of 100 commercial farmers (50 from each two VDC) were included as respondents. Before identifying the respondents, an interaction workshop was organized with the concerned stakeholders at Ilam district. Household survey tool was executed after the preparation of comprehensive questionnaire. The data were analyzed through SPSS package.

RESULTS AND DISCUSSION

Average land holding percentage

Only 20 percent of the average land owned by the farmers had the irrigation facility which seems to explore the rain water harvesting techniques (only 20% irrigated land) in order to practice vegetable cultivation since these crops require intense water for their growth and development.

Table 1. Average land holding percentage

Particulars	Own land (%)	Land rented (%)	Leased land (%)	Total land (%)
Year round irrigation	18	1	1	20
Rain fed farm	45	0	5	50
Non-irrigated	20	0	0	20
Upland	5	0	0	5
Kitchen garden	4.95	0	0	4.95
Own forest	0.5	0	0	0.5
Total	93	1	6	100

Source: Field Survey, 2014

Livestock domestication status

From the table 2 it is clearly seen that the cattle manure was predominant both in production (90%) as well as trading (95%). But it seems to capacitate the farmers through organic manure production techniques for the increased level of productivity at Ilam district.

Table 2. Livestock domestication status

Livestock	Average manure production (%)	Average sale of the manure (%)
Cattle/buffalo	90	95
Pigs	3	0
Chicken	7	5
Total	100	100

Source: Field Survey, 2014

Overall vegetable production status (types of the commodities and organic vs. inorganic)

The table 3 clearly describes that the level of organic vegetables production was very low as compared to inorganic fertilizers. The major revenue comes from the cucurbitaceous vegetables and cole crops. Inorganic practices have dominated on both of these commodities. Out of the total revenue of NRs. 681100 only 11% (NRs. 77350) is from organic cultivation whereas 89% (NRs. 603750) comes from inorganic practices. There seems a huge gap between organic and inorganic at Godak and Karpok VDC of Ilam district which seems to implement various organic and sustainable types of projects immediately.

Table 3. Overall vegetable production status (types of the commodities and organic vs. inorganic)

Vegetables	Cultivation status (%)		Average production per household (kg)		Average revenue per household (NRs.)	
	Organic	Inorganic	Organic	Inorganic	Organic	Inorganic
Solanaceous	20	80	300	2000	15000	80000
Cole crops	5	95	150	3000	7500	120000
Root crops	50	50	200	700	8000	17000
Cucurbitaceous	2	98	500	4500	15000	225000
Leafy vegetable	25	75	150	1200	6000	30000
Bulb crops	25	75	100	500	6000	15000
Spice crops	50	50	200	800	10000	35000
Okra	5	95	135	675	8100	33750
Peas and beans	40	60	350	1200	1750	48000

Source: Field Survey, 2014

Reason for inorganic cultivation and source of inorganic fertilizers

The above table 4 illustrated that 95 percent of the farmers at Godak and Karpok were practicing inorganic cultivation because of increased level of production with the use of chemical inputs whereas 4 percent were using it as an easy technology and 1 percent were practicing it unknowingly (copy from the other farmers). The major source (95%) of chemical inputs was the local market. Only 5 percent of the total inputs supply was from the distant market. The study revealed that all VDCs were using heavy doses of chemicals. In order to control the chemical inputs the government and non-governmental organisations have to conduct health awareness activities as well as strict monitoring of the local service providing agencies (Agro-vets,

cooperatives). Besides that, the local traders need to be aware of the plant protection act as well as the charge of violating the law.

Table 4. Reason for inorganic cultivation and source of inorganic fertilizers

Reason beyond inorganic cultivation (%)			Source (%)	
Increased production	easy practice	Unknowingly	Local market	District market
95	4	1	95	5

Source: Field Survey, 2014

Increased level of production with the exploration of inorganic technologies

The below table 5 shows that all farmers are using chemicals with the aim of increasing the level of production. Similarly, cent per cent farmers are also increasing the dose of the chemicals each year for the same level of production. This seems that their cultivation practice is being dependent only on the chemical inputs. Among the chemical users, few (20%) are well known about chemical whereas 30% have good knowledge whereas 50% have poor knowledge about the chemicals and their impacts. As we are familiar with the proverb "Little knowledge is dangerous" which seems to exist on the farmers perception towards the chemical they are using on their field to grow the edible vegetables to humans. We can easily assume the farmers knowledge and their health awareness attitude.

Table 5. Increased level of production with the exploration of inorganic technologies

Increased production level with use of chemicals (%)		Increased use of chemicals each year (%)		Information about chemical inputs		
Increase	Decrease	Increase	Decrease	Well known	Good	Poor
100	0	100	0	20	30	50

Source: Field Survey, 2014

Information on the chemicals and the suggestions from DADO

Although the majority of the farmers are using chemicals with the intention of increased level of production, very few (5%) have well knowledge regarding on the symbolic information the color of the pesticide bottles. 85% have little knowledge on the bottle color of the pesticides which clearly indicate that they are ruining their own health, consumers health as well as environment health. Moreover they are also unknown about the precautions to be followed during the use of chemicals on their field. This ignorance about the chemicals might have increased the health problems on farmer's family. Similarly the same i.e. 100 percent surveyed farmers have concluded that the health problem has been increasing each year after the use of chemical inputs. Even though this situation exist at Godak and Karpok VDC, the below table 6 shows that only 5% get informed about the negative impacts of chemicals on human health, soil health as well as environment health. This seems DADO has to take immediate attention towards these VDCs to keep the agriculture environment safe.

Organic training status

The above table 7 shows that the farmers are producing vegetable without the use of chemical inputs (organic concept) 5 years earlier but the organic trend moved towards inorganic only before 2.5 years which seems to be various chance of moving towards organic again. The above table

also clarifies that only 5% farmers are organic trained and only 20% are aware about the organic concept which seems to implement the training as well as awareness program immediately on these two VDCs.

Table 6. Information on the chemicals and the suggestion from DADO

Information on color of chemical containing bottles (%)			Health status within the family after inorganic cultivation (%)		Suggestions from DADO (%)	
Well known	Good	Poor	Increase	Decrease	Yes	No
5	10	85	100	0	5	95

Source: Field Survey, 2014

Table 7. Organic training status

%age of the organic trained farmers	Starting of vegetable production (in years)	Starting of inorganic vegetable production (in years)	Awareness on organic vegetable production (%)
5%	5 years	2.5	20

Source: Field Survey, 2014

Use of organic manure

From the table 8 it is clearly seen that the use of organic and organic manures comprised the same percentage i.e. 50% for both. This seems to promote the organic manure production technique at farmers' level in order to promote the organic vegetable production at Ilam district. Similarly, Farm Yard Manure (FYM) is the dominating manure (50%) used at farmers field.

Table 8. Use of organic manures

Use of fertilizers		Types of OM used	Average % used
OM %	Inorganic manure %		
50	50	FYM	50
		Urine	5
		Ash dust	5
		Neem	5
		Poultry manure	10
		Compost	25%

Information on decomposed manures

Even though the farmers are producing FYM, compost and other organic manures, only 20% have the knowledge of decomposed organic manure whereas 80% don't have such information. This figure illustrates the need of executing organic manure related training activities at these two VDCs. The below table 9 shows that there is 80% demand of organic vegetables and similarly the market price is also 2 times greater than inorganic vegetables. To meet this demand organic manure production training is must at Godak and Karpok VDC of Ilam district.

Information on negative impacts of chemical use

The below table 10 shows that only 20% of the farmers are aware about the pesticides whereas 80% are still unaware about the pesticides. Similarly, the above table illustrates that 20% farmers

are attracted to organic, 30% are no attracted to organic and majority of the farmers (50%) don't have any idea about the organic concept. Since majority population are on dilemma stage about organic concept there is chance of establishing organic concept through organic awareness and training related activities at Godak and Karpok VDCs of Ilam district.

Table 9. Information on decomposed manures

Information on decomposed organic manures (%)		Market demand of vegetables (%)		Market price of organic vegetable	
Yes	No	Organic	Inorganic	Organic	Inorganic
20	80	80%	20%	100%	50%

Source: Field Survey, 2014

Table 10. Information on negative impacts of chemical use

Aware about pesticides		Attraction towards organic (%)		
Yes	No	Attracted	Not attracted	Don't have any idea
20	80	20	30	50

Source: Field Survey, 2014

Vegetable seed status

From the above table 11 it is clearly concluded to promote the cultivation of local vegetable seeds since its use at farmers' level is just 20%. In order to address this problem community based seed production activities have to be carried out immediately. Similarly, training on seed storing and IPM vegetable production techniques have to be explored at production site since treating seed during storage and implicating IPM techniques at farmers' level is very low i.e. only 20% for both.

Table 11. Vegetable seed status

Average %age using local varieties	Average % using improved varieties	Average % treating seed during storage	Average % using IPM on vegetable production
20	80	20	20

Source: Field Survey, 2014

Problems faced and the immediate action needed (suggested by farmers) for promoting organic vegetable production

There is a huge problem of marketing of organic vegetable at Ilam municipality since organic vegetable products are less attractive as compared to inorganic products. Moreover, there is lack of specific organic marketing agents at Ilam municipality. Besides, even those consumers having organic awareness are also not interested on organic products because of the higher price. Despite these problems, the demand of organic vegetable is increasing at higher rate day by day. Installment of the organic vegetable stall at Ilam municipality and promotion of health awareness among the consumers might help on organic promotion. Similarly, training the farmers on organic vegetable production technique will help in motivating the farmers towards organic vegetable production techniques.

CONCLUSION

The study found that the farmers have enough livestock from which Farm Yard Manure and urine can be converted to organic manure but have incomplete knowledge for the organic manure preparation and its use. There is need of some training related activities at farmer's level regarding on organic manure preparation. In the name of increasing production level, farmers are using the chemicals as well as hybrids (high input requiring varieties) to meet the market demand but now are experiencing sparse negative impacts on their human health, soil health and environment health. The farmers even don't know the application procedure of the chemicals and the safety determination of the color of the bottle. Despite the low level of production, farmers are getting higher price for the organic products at market. Moreover, the demand of the organic products is also increasing day by day at Ilam municipality due to heath consciousness among the consumers. The farmers are motivating towards the organic farming but the number is negligible. In order to establish Ilam as organic district there seems immediate action on organic farming to be exploited by government as well as non government agencies.

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REVIEW ARTICLE

Conservation biocontrol in an agricultural system: limitations and prospects

S. Sharma[1], S. Tiwari[1] and L. Kafle[2]
[1]Bio-protection Research Centre, Lincoln University, New Zealand
[2]Department of Tropical Agriculture and International Cooperation,
National Pingtung University of Science and Technology, Taiwan
kafleln@gmail.com

ABSTRACT

The agricultural practices particularly in western agriculture system needs to be improved by changing the current large scale mono-cropping practices by polyculture with selection of best candidate crops which provides multiple ecosystem services. Increasing the habitat heterogeneity between and within landscape level and field level could be best option for Conservation biocontrol (CBC). Exogenous application of food sources particularly honey dew and sucrose with supplement of protein for natural enemies enhances the activity and abundance of natural enemies (NEs). Promoting the non-crop habitat for instance, fallow land, pest nursery, field margins, hedge rows and beetle bank might improve the shelter and overwintering sites for carabidae, staphylinidae and spiders. In conclusion, habitat management not only useful from the point of view of conservation bio-control but also improve the indirect ecosystem services like increasing biodiversity, photosynthesis, reduce erosion, increase the working capacity of soil micro-organisms, improve soil health and promote agro tourisms. Besides it, it also ultimately reduces the herbivores problems, increase the yield and profit for farmers and stabilize the sustainable pest management system in agroecosystem.

Key Words: Conservation biocontrol, multiple ecosystem services, natural enemies

INTRODUCTION

Studies have demonstrated that plant diversification positively influences the arthropod diversity (Haddad, Crutsinger, Gross, Haarstad, & Tilman, 2011; Parker, Salminen, & Agrawal, 2010). The traditional mix-cropping are estimated to be contributed about 15-20% of the world food supply (Altieri, 1999). In Latin America, 60% farmers still grow their beans mixing with maize, potatoes and other crops. In general mix-cropping supports the lower herbivore pressure which supports more stable natural enemies populations because of regular food availability and micro-habitats (Altieri, 1999). Moreover, increasing plant diversity and managing habitat for natural enemies reduces the pest population and lower down the pesticide consumptions in farming (Hatt, Lopes, Boeraeve, Chen, & Francis, 2017).

But in negative side, mix vegetation reduces the searching efficiency of natural enemies and destabilize the predator-prey interaction (Sheehan, 2014). Most importantly, simply increasing the diversity increases the pest problems hence key elements of diversity should be identified before enhancing diversity. In monoculture, the rate of establishment of imported natural enemies (NEs)

and their success rate for controlling target pest are low than in more stable system and negatively influences the overwintering survival of NEs. Most crop habitats, especially annual crops, are not favourable for natural enemies because they are instable and have low heterogeneity with frequent disturbances (Patt, Hamilton, & Lashomb, 1997).

Pest abundances tend to be low in mix-culture than in mono-culture because in case of specialist herbivores, the insect can confused and sometimes repelled because of visual and chemical cues. Mix vegetation provides suitable resources such as shelter, nectar, alternative host and pollen along with moderated microclimates for natural enemies. These effects moderately operate simultaneously and finally promote NEs and lower down the pest population (Tscharntke, Klein, Kruess, Steffan-Dewenter, & Thies, 2005). Similarly, population of generalist predators and parasitoids in mix cropping are more abundant because there is high chances of switching and feed on greater variety of herbivores at different times and lower down the herbivorous pest (Andow, 1991; Risch, Andow, & Altieri, 1983).

DO NATURAL HABITATS STIFLE PEST SUPPRESSION?

Natural vegetation in around field provide the alternative food sources such as nectar and pollen, shelter, an improved microclimate, and by enhancing over-wintering survival and reproduction for natural enemies (Landis, Wratten, & Gurr, 2000; Rusch, Valantin-Morison, Sarthou, & Roger-Estrade, 2010). It also provides supplementary resources to support the population of alternative prey and host population. If the network of vegetation link from crop area to nearby natural habitat which acts as a source habitat for many species of natural enemies and suppress the pest population. One good example is the proportion of natural habitat surrounding the farm directly influenced the abundance of syrphid fly larvae (Chaplin-Kramer, de Valpine, Mills, & Kremen, 2013). The greater abundance of the predator increased the higher rates of predation of the European com borer (*Ostrinia nubilalis*) in monoculture because it supplies very low amount of natural resources (Andow & Risch, 1985). Moreover, effective biological control is possible in complex landscape which contain high proportion of semi-natural habitat and less intensively managed farmland (Landis et al., 2000).

Competition and predation

Interspecific competition between the species has reciprocal negative effects of one species to other another which determine the structure of natural communities. In general, competition within insect species happens for resource, food, space and mate. Predation may promote, hinder or have no effect on interspecific competitive interactions and the probability of prey coexistence (Chase et al., 2002). Higher predation influences the population growth rate of a prey species by consuming part or all of prey individuals (e.g. herbivores, parasites) (Zehnder et al., 2007).

Available resources, natural enemies and pests

The activity of natural enemies in farming systems not only influences by available resources but also other factors as pesticide residues, availability of foods and alternative hosts including shelter, alternative food sources, and refuse of extreme environments (Landis et al., 2000)). Similarly, uncultivated fallow patches or preserved adjacent habitats also influences the natural enemy communities in crop fields (Wallin, 1986). Simply increasing diversity, sometimes increase certain pest problems but useful resources for natural enemies should be considered while increasing the diversity (Baggen & Gurr, 1998).

Spatial and temporal mobility of natural enemies

In principle, the mobility of the various natural enemies in a given crop habitat have profound effect for adjustment of habitat. For example, the deployment of habitat should be managed based on the mobility of parasitoids (Gurr, van Emden, & Wratten, 1998). The abundance and diversity of NEs directly influenced by spatial distribution of habitat, proximity to natural habitat, lower coverage of flowering habitat in the main field, selection of non-selective food plants for pest and natural enemies (Gurr et al., 1998). The spatial distribution of non-crop habitat and the structure of vegetation which are connected with cropping field provide refuges, feeding areas and dispersal corridors (Benton, Vickery, & Wilson, 2003). Different organisms required different habitat, which are likely to change over time (Benton et al., 2003). Similarly, the location of flowering strips should be based on knowledge of the dispersal ability of the targeted natural enemies, which can be obtained in studies labeling the plant's nectar with markers such as rubidium chloride (Halley, Thomas, & Jepson, 1996).

Natural enemies and candidate habitats

The general public assumes that all flowering plants can be used for habitat enhancement. For example, respectively, the longevity of female and male parasitoids in alyssum flowers can be seven and three times greater than without flowers (Berndt & Wratten, 2005). Not all flowering plants, however, are equally suitable for providing nectar to natural enemies (Pfiffner, Luka, Schlatter, Juen, & Traugott, 2009). Many factors influence flower species suitability: morphology of parasitoids (Vattala, Wratten, Phillips, & Wäckers, 2006), floral architecture (Vattala et al., 2006; Wäckers, 2004), flower colour (Begum, Gurr, Wratten, & Nicol, 2004), floral area (Fiedler & Landis, 2007b), flowering time (Hogg, Bugg, & Daane, 2011), nectar chemistry and availability (Wäckers, 2004) etc. Extra floral nectar, which is often found on vegetative plant parts, also extends availability compared with floral nectar, which is available only during blooming (Géneau, Wäckers, Luka, Daniel, & Balmer, 2012). It can act as an important food source and an indirect defense allowing plants to recruit predators and parasitoids (Géneau et al., 2012)

In general, best candidate plants possesses some special characteristics as they should be attractiveness to natural enemies, prolific producers of pollen and/or nectar, accessibility of floral resources, prolonged flowering periods, promoting the use of flowering species which are already known to attractive to natural enemies (e.g., Asteraceae, Apiaceae), right selection of plants which are more attractive to NEs and less attractive to pest, easily availability of seed, use of plants already present in, or adapted to, agricultural areas, native plants useful in restoration of rare ecosystems (Fiedler, Landis, & Wratten, 2008). The candidate crops should be a broad range of functional groups including trees, shrubs, vines, grasses, legumes, and forbs, perennial, native to exotic (Fiedler et al., 2008).

Floral resources, pests and natural enemies

Some plants used in habitat management may compete with crops for pollinators (Holzschuh, Dudenhöffer, & Tscharntke, 2012). Similarly, the pest may also feed the added floral resources (Gurr, Wratten, Landis, & You, 2016). Sometimes, flowering plants can also attracted the pest, could be the best alternate host for plant pathogens, nectar rich plants can also attract the some lepidopteran pest (Gurr et al., 1998).

ECOSYSTEM SERVICES AND CONSERVATION BIOCONTROL

Use of flowering plants and other plant communities in a managed landscapes to promote natural enemies termed as habitat management and which is fundamentally important for conservation biological control (Fiedler et al., 2008). Ecosystem services (ES) in relation to conservation biocontrol can be improved by habitat management. Mix and permanent habitat mainly woody vegetation increased the abundances of natural enemies of crop pest. Hence, best candidate flowering crops should be selected in and around field with considering their long blooming period, narrow and deepest corolla, prolific nectar and pollen etc. (Fiedler et al., 2008).

Ecosystem services and crop yield

Push pull strategy is the most successful habitat management programme in East Africa (Khan, Midega, Pittchar, Bruce, & Pickett, 2012) which has been adopted by 45,000 farmers. Recent work on habitat management in Britain demonstrated promotion of beneficial insects by agri-environmental programs and ultimately, yield enhancement (Pywell et al., 2015). Thus, habitat management strategies also advantageous even when the focal crop produces a lower yield, provided that the secondary crop produces a valuable commodity or other ecosystem services or that it is the target of conservation efforts and potentially attract payments to the farmer (Fiedler & Landis, 2007a). The participatory farmers work in Asian rice with stripes of flowering crops such as sesame and sunflower in bunds increased rice pest parasitism, leading to reduced plant hopper densities and reduced the pesticide spray by 70% and increased rice yields by 5%. The ecosystem services provided by pollinators and pest predators can be either additive or synergetic and affect different yield parameters like fruit set and quality and finally effects on crop production (Classen et al., 2014).

Agricultural practices

Chemical fertilization, monoculture, total weed removal, conventional tillage and pesticides decreases the abundance and diversity of natural enemies (Altieri, 1999). Provision of additional floral resources in the crop is a successful strategy of conservation biological control for attracting several natural enemies including predatory syrphids. However, the selection of flower species is mainly based on visiting preferences, paying little attention to the link between preference and performance (Amorós-Jiménez, Pineda, Fereres, & Marcos-García, 2014). Furthermore, moderate shade, adequate labor, and input level can be combined with a complex habitat structure to provide high biodiversity as well as high yields (Clough et al., 2011).

CONCLUSION

Ecosystem services (ES) or the benefits (i.e. crops, aesthetics, recreation) that humans derive from nature or natural capital has been found to be highly undervalued. If ES were more readily implemented and respected in agroecosystem, it has been shown that these can support a stable environment and increase productivity and decrease inputs. The integration of ES in agroecosystem may be one methodology to successfully implement conservation biological control, as many ES can be implemented using habitat management techniques.

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EDITORIAL

Nepalese agriculture in the pretext of climate change and sustainability

B. P. Chaulagain and B. P. Rajbhandari
Nepalese Journal of Agricultural Sciences (NepJAS), Kathmandu, Nepal
http://njas.hicast.edu.np/

Nepalese traditional agriculture is characterized by subsistence oriented mixed farming with crop and livestock as major components. Due to lack of improved technologies, required inputs, poor communication and extension services in the pretext of climate variability and global warming both of these major components have been facing challenges in increasing productivity and sustainable yield. This issue of the Nepalese Journal of Agricultural Sciences (NepJAS) has a good collection of 22 original articles, 3 research notes, 4 case studies and 1 review article to address various questions, limitations and challenges. We have made a brief review of these articles and summarized hereunder.

Livestock and poultry production and health management

Nepalese traditional livestock and animal husbandry is facing problem with low productivity. In this issue, Tiwari et al. have worked on the performance of milk production by dairy cattle through bypassing the protein supplementation. They have taken into account a total of eight lactating cattle for calving date and milk production during the experiment. Comparing the supplementation with modern feed formulations as case to the traditional basal diets straw/stovers and grasses grazing, the case group significantly ($p<0.001$) improved the milk production. Thus farmer's investment in livestock is hampered by limiting factors like essential amino acids and protein supplies with their lesser knowledge on livestock nutritional management.

Adhikari and Storebakken have studied the effect of different levels of starch gelatinization in feed for omnivorous fish *Nile tilapia*. In their study, wheat, as the source of starch, was extruded with different moisture addition (20%, 25%, 30% and 35%), to obtain different degrees of starch gelatinization. It is interesting to note from their work that at little addition of moisture around 20 percent in maximum and less than it is the best in extruding wheat for complete gelatinization. The work has significance as advancement in engineering in the field of feed manufacturing technology, which can be beneficial to feed producer and farmers.

There are many enhancer molecules that can bring changes in metabolism of living system. Brining positive changes in quality of livestock produce like meat and milk has significance in economy and consumer health through low cost and high quality. Tiwari et al. studied the lemon grass oil (LGO) feeding in relation to growth and carcass characteristics of broiler chicken. Their findings suggested that inclusion of LGO improved the weight gain, reduce mortality and reduced the period of broiler harvesting. However, further studies needed to be carried out for precision level of oil inclusion and impact on cost benefit ratio.

Livestock is an important component of subsistence farming in the crop livestock mixed agricultural system in Nepal. It occupies third place after rice cultivation and [poultry. But the source of livestock diet is usually of traditional types and mostly composed from green grasses, crop residues, crop byproducts and tree foliage with little or no concentrate feed and without or least supply of dietary requirements. Thus the livestock feeding only with cellulose and starch rich feed and expecting returns as protein and lipid rich meat and milk is not justifiable as well as scientific. Upreti and Devkota have analyzed the nutrient composition and nitrate content of top ranked fodder tree species in the hills and mountain of Nepal in this regard. If farmers are heavily reliant on foliage and fodder feed, those plant based sources must be high in functional nutrients required by livestock. They found in the study that variation among the top ranked fodder tree in nutrient content which also indicated to explore the best fodder species. They reported here crude protein content of Badahar tree was higher but lower in energy and calcium content indicating that considering only one parameter for feeding animal might cause misleading in nutrient balance. Feeding mixed fodder is safe guard in energy and other nutrients requirements as nutrient content of the selected fodder did not differ significantly with respect to the age and species considered, and findings of this study clearly revealed that commonly grown and popular fodder tree are safe against nitrate toxicity reflecting the need to continue such fodder species in feeding management.

Oat (*Avena sativa* L.) is a valuables fodder crop available in winter and has excellent growth habit, quick recovery after cutting and good quality herbage. It is a palatable, succulent and nutritious crop. Oat can be grown all part of Nepal from Terai to high hill contributing for forage/fodder to reduce the feed deficient for ruminant animal. Khanal et al. have evaluated different varieties of oat at high hill of Rasuwa district of Nepal. Among ten oat varieties cultivated at highland of Rasuwa district, significantly the highest plant height, leaf area, green mass (GM) and dry mass (DM) was obtained from 83INC19G3 followed by Awapuni. The study showed that 83INC19G3 and Awapuni are suitable varieties for higher GM and DM production at highland of Nepal. The study also revealed that plant height and leaf area affected on amount of green matter and dry matter production.

Similarly, Pandey et al. have worked on forage conservation and its feeding effect on growth performance of sheep in the mountain region of Nepal. It can be concluded from their work that quality hay from Cocksfoot and Rye grass and good silage from maize can be made a good feed stuff in mountain regions like Jumla condition and the quality hay and silage could be recommended for sheep feeding in winter feed scarce period. Sapkota et al. (a) studied the genetic parameters and effect of non-genetic factors on weight and reproductive traits of goat from Central Terai region of Nepal. The study showed the importance of non-genetic factors on growth traits and for newly established commercial farm, it can be suggested that selection based on the weaning weight could be beneficial for genetic improvement in its initial phase.

Goat meat is much popular among Nepali people but Nepal is not self-reliant on goat meat production. Nepal is also doing poor performance on improvement of local breed and their management. In this issue, Sapkota et al. (b) studied on comparative performance of Boer cross breed goat over other local and cross breeds in mid-hills of Nepal. This study is focused to find out the comparative performance of Boer cross goat with other Nepali indigenous breed and improve cross breeds of goat. The potentiality of Boer goat and its crossbred to meet the national demand of goat meat through upgrading of indigenous goat breeds will improve the situation. The result

highlights the importance of cross breeding since the growth performance and growth rate of Boer crossbreed was highly significant than local and other crossbreeds of goat found in Nepal.

Acharya et al. did assessment of farmer's perspective on backyard poultry production and impacts of vaccination against Ranikhet disease in a district of Eastern Nepal. This study showed that vaccination against Ranikhet disease in backyard chicken together with extension campaign targeting women farmer's group might be an effective tool for poverty alleviation of rural women involved in backyard poultry farming. Their result suggests for extension of similar approaches in other farmers group and other districts of Nepal might be helpful to reduce poverty in Nepal.

Veterinary and public health

Nepali farmers living in close connections with livestock bear threat of zoonotic diseases. Poor awareness among farmers, lack of veterinary health education and service to local level has posed threat to farmers as well as health problems for livestock. Sah et al. studied risk factors associated with *Toxoplasma gondii* seropositivity in goats of eastern Nepal. They randomly collected a total of 159 caprine sera samples from some parts of eastern and samples were tested for the detection of T. gondii antibodies. All the sampled goats were taken from herd history of abortion. The study showed that seroprevalence in goats was found 29.56%. Female, older goats (above 18 months old) and pregnant goats showed high seropositivity. From their result, it is suggested that this assay is highly useful as a serodiagnostic tool for *T. gondii* infection. As this parasite has zoonotic importance, research works on isolation, identification of toxoplasma species is a must as well as the knowledge should be disseminated to the people and animal raisers so that precautions can be taken in time. In a case study R. Shrestha from HICAST Veterinary Teaching Hospital reported the wound healing activity of honey dressing. The honey dressing took up to 88 days to complete healing of the fractured open wound of a dog. The result on efficacy of honey is very impressive, and it could be used as an alternative medicine in future for wound healing, particularly in the shortage of veterinary medicine.

Threats to public health do not come only from heavy pesticides uses, deteriorating urban environment and degrading village ecosystem but also poses great threats from negligence in food processing protocols. Industrialized world is heavily dependent upon processed food while least developed countries like Nepal do not follow the strict rules and regulations in clean and sterile products, work place safety and health hazards management. The food borne diseases and the consequent illnesses are some of the major challenges that lead to high mortality and economic loss in both kinds of society. In the industrialized world, food borne disease is one of the major causes of illnesses that heavily affect healthcare systems. Food borne diseases occur from ingestion of infectious microbes, toxins and other metabolites produced by microorganisms present in food (Clarence et al., 2009). In this issue, Parisha Thapa has assessed microbial hazard based on HACCP module on chicken sausage production plant in Kathmandu valley. Materials like raw meat, batter, ingredients, casing, water and finished product were analysed for total viable count, *Staphylococcus aureus* count, coliform count and *Clostridium* count. Highest microbial load in increasing order from raw meat, batter to after stuffing samples were observed which can be attributed to contamination during slaughtering, rough handling of meat and cross contamination from water and equipments. Thapa reported the problem of poor hygienic, sanitation and operating condition in the food industry related with the insufficient knowledge among owners, employee, and lack of safety training, proper facility, and irregular microbiological

analysis of samples and lacking of treated water in industries. Similarly, Paudel and Thapa reported the prevalence of brucellosis in goats in Dolakha district of Nepal. They reported and suggested that as caprine Brucellosis agent was most invasive and pathogenic and of zoonotic significance, attention need to be paid regarding the effect on goats and impact on human health.

Crop production, management and marketing

Rice

Rice is the first major staple food crop in Nepal which is one of the centres of origin of rice. Thousands of indigenous rice biotypes have useful traits and genetic potential for developing rice varieties tolerant to various unfavorable conditions including pests and diseases. Ghimire et al. did screening of rice genotypes against leaf and neck blast disease. They have screened one hundred two rice genotypes against leaf and neck blast under natural condition. The quantitative resistance in rice against blast was assessed based on area under disease progress curve. Out of 102 rice genotypes, 72 were found resistant to leaf blast, and 29 as moderately resistant to neck blast, while 27 rice genotypes were moderately resistant to both leaf and neck blast. In their report, none of the genotype was found immune to both the blast. Thus, the study revealed rice genotype 11100-B-B-3-3-2 as potential genetic resource of resistance to both types of blast in field condition. Furthermore, it revealed that genotypes e.g.Taichung-176, NR 11165-B-B-22 and NR 11165-B-B-24 were observed highly susceptible, which may be used as susceptible check for leaf and neck blast research in Nepal. On the other hand, Shrestha et al. studied the impact of climate change in rice yield trends in Western Nepal. They have summarized the meteorological data from 1995 to 2016 recorded at weather station in that region and have analyzed its influence in rice yields. The work revealed that the average rainfall during the monsoon months over 16 years was not consistent. Among the monsoon months, June rainfall significantly related to rice yield. Years with higher rainfall in June had higher rice yield. Average maximum temperature increase in September was found significant whereas sudden increase in maximum temperature caused significant decline in rice yield. They also carried out field study simulation experiment on impact of temperature and drought in rice with open top chamber (OTC). The study was carried out with three types of OTC and four rice cultivars during the rainy season in 2016. The important point to note in the context of global warming and climate change from this experiment is that the drought tolerant varieties were able to cope with the increase in average daily temperature within 1 to 3°C but could not cope with the temperature rise above 4°C. The result was in line with the modeling studies conducted using Decision Support System for Agro-technology Transfer model. It gives a signal for search for drought and heat tolerant varieties in future to adapt with climate change.

Maize

Maize is not an indigenous crop to Nepal but with its popularity it is the second major staple food crop in terms of area and production in Nepal. The varied topography and climatic differences of Nepal has forced to adapt different strategies for farmers of different agro-ecozones to cultivate this crop. Kandel et al. has done variability studies in yield attributing traits of early maize genotypes in western hill of Nepal. They have studied to determine various parameters of genetic variability, broad sense heritability and genetic advance estimations in early maize genotypes. The study observed high to moderate phenotypic coefficient of variation and genotypic coefficient of variation for grain yield, ear height, plant height, 1000-kernel weight, and number of kernels per row, ear length, ear weight, ear aspect and ear per plant suggested prevalence of sufficient

variability that offered scope for selection. The significance of the study is that traits were less influenced by environmental factors. These traits can therefore be used for crop improvement program by concerned agencies in future to cope with changing climate due to global warming and varied eco-climatic conditions of Nepal which is ranked on 24th position in Global Climate Risk Index. Similarly, Sharma et al. studied the agro-morphological performance of maize inbreeds. The agromorphological performances were estimated for plant height, ear height, tasseling days, silking days, ear length, ear diameter, number of kernel rows per ear, number of kernels per row, test weight and grain yield. The study found highly significant variations among the tested genotypes for grain yield and other agro-morphological traits which indicated presence of high magnitude of genetic variations. They had manifested superiority in all agro-morphological, yield and yield attributing traits. Inbreeds were can regarded as ideal candidates for hybrid, synthetics and composite varieties development.

Minor crops

There are many crops which have higher nutrients content, adaptability to local conditions and helpful to maintain local agrobiodiversity and ecosystems but still are neglected by local people and mainstream producers and sellers. Sweet potato is among them and it is the World's most important but underexploited food crop. It is regarded as marginalized farmer's crop because of its low input requirements, ease of production and ability to produce under adverse soil and weather conditions. Bhattarai et al. worked on collection and morphological characterization of sweet potato genotypes of Nepal. They collected thirty eight local sweet potato germplasm and characterized their traits using morphological descriptors. They noted a large variation in foliage and tuber characteristics. The majority of genotypes exhibited longer vine as they showed spreading nature of growth habit. Variation in tuber shape ranged from round to long or medium long and long irregular. The skin color of tuber varied from white to red, light yellow and purple. Variation was found in flesh color from white to creamy white and milky white. The results obtained will serve as a guide for the basis germplasm management and improvement in Nepal.

Fruit production and processing

Nepal has good potential of producing and trading tropical to temperate fruits. However, it has problems not only in mass scale productions of fruits but it also lacks professionalism in handling to maintain the freshness and quality of perishable items during transport, processing and storage. Apple is grown commercially in remote mountainous areas such as Mustang, Manang, Jumla, Humla and Bajura districts with lesser or no access to electricity, and poor market infrastructures and automobile transportation. Subedi et al. did evaluation of packaging materials for transportation of apple to address the issue. They attempted to identify appropriate packaging materials for transportation of apples. Similarly Amgai et al. reported a case study in Mustang district of Nepal about the importance of local innovation documentation. Underground apple storage, apple core remover, glass solar drier and plastic solar drier were major innovation related to apple industry in that district.

Pineapple is a fruit crop that can be grown in from southern plain (Terai) to hills up to 1600 meter above sea level. Adhikari and Amgai studied the prospects of pineapple-based micro-enterprise in Sindhuli district of Nepal. This report highlights the status of pineapple cultivation, postharvest management and pineapple-based micro-enterprise developments in Sindhuli district and similar topographies. The study found that in Sindhuli district pineapple was grown in 148 ha with the

productive area 100.64 ha. The total production of pineapple was 1557.78 mt. Out of total production 25-30 % pineapple was used for home consumption and the rest was sold in the market. Nearly 10-20 % of pineapple that reached to market was used for processing and the rest was consumed as fresh fruit. According to the paper, cultivation, processing and marketing practices for pineapple-based micro-enterprises were found rapidly developed in the Sindhuli district.

Soil fertility and health

Nepali soil has different physical, chemical and biological characteristics because of varied topography and micro-climatic conditions. Crop choices of farmer and changing farming practices have added another dimension in soil parameters changes. In this regard, soil fertility status of vegetable growing areas in an area of Surkhet, western Nepal was carried out by Kharel and Ojha. This study is focused in assessing nutrient status of vegetable growing area. The fertility status of the study area was medium to low, due to the imbalanced use of chemical fertilizers, mono-cropping, and use of lower amount of organic fertilizers. People of this area are suggested to apply fertilizer only to maintain soil fertility. In one area the pH is found acidic. The paper high lights that environmentally and socially acceptable integrated plant nutrient management (IPNM) practices like agro-forestry systems, crop rotation, use of organic inputs (compost and farm yard manure), and chemical fertilizers, vegetable should be grown with legumes intercropping and improved crop varieties that can be adapted to local farming situation in the study area is important and recommendable. Rauniyar et al. have studied the growth, yield and soil nutrient status of broad leaf mustard (*Brassica juncea* var. rugosa) under integrated nutrient management system. The experiment was conducted to evaluate the effect of integrated plant nutrient management (IPNM) on the growth, yield and soil nutrient status of broad leaf mustard (*Brassica juncea* var. rugosa) in the farmer's field located in South of Kathmandu district.

Pest management

Insect pest and diseases have been posing substantial threat to increased crop yield. Joshi et al. have assessed occurrence and management of *Tuta absoluta* in Kathmandu valley and Kavre, and have reported integrated safe chemical plus bio-pesticides along with use of netting and different traps as the most effective management practice to reduce damages of the pest substantially. Similarly, Bhusal et al. have worked on pest and disease surveillance of vegetable crops and farmer's pest management practices in Banke and Surkhet districts of Nepal. They found that majority of the farmers (75%) were using chemical plus traditional agricultural practice, 18 percent were using biological plus chemical pesticides and few (5%) were using chemical pesticides alone for insect pests and diseases management in both districts. In another work, Oli et al. reported the efficacy of integrated pest management (IPM) practice over farmer's practice in cauliflower in Kathmandu valley. The study reports maximum number and type of beneficial insects including Ladybird beetles, predatory wasp, spiders, and dragonfly were observed in IPM practice as compared to farmer's practice. Maximum number of Aphids (14 insects per plant) and diamond black moth (DBM) (5 insects per plant) were observed in IPM practice whereas in farmer's practice, maximum number of aphids reached up to 45 insects per plant and that of DMB reached to 7 insects per plant.

Marketing

Sharma and Shakya in a short note reported the production practices, marketing and problems in broad leaf mustard cultivation in Bhaktapur district of Nepal. The report summarizes that the major problems faced by the respondents were lack of irrigation, technical support, unavailability of inputs, efficient market, collection center; disease and pest problem and involvement of middle men.

Sustainability

While talking about sustainability, the growers / entrepreneurs should be made aware of the importance of paying due consideration to social acceptability, ecological sustainability, economic feasibility as well as technological appropriateness and its wider adaptability. Agriculture Development Strategy (ADS) has emphasized to pay due consideration and implement programmes by the Government of Nepal (GoN) for sustainable production systems in wider scale. So far very few studies have been conducted with such holistic production system approach in Nepal. In this issue Basnet et al. have presented negative impacts of chemical inputs at Karpok and Godak VDCs of Ilam district. Farmers have been experiencing negative impacts on their health, soil health and environment health. Organic agriculture has been resuming good space in the district as an effective alternative to chemical inputs-bsed conventional agriculture. They have reported that despite the low level of production, farmers were getting higher price for the organic products at market. The demand for organic products is also increasing day by day at Ilam municipality due to heath consciousness among the consumers. The farmers were motivated towards organic farming but the number of such farmers is still very few. In order to transform Ilam into an organic district there is a need of immediate action plan on organic farming both from the GoN as well as non-governmental or private organisations with a holistic and sustainability-based approach. Sharma et al. have presented review on important issue of conservation biocontrol in agricultural system with their limitations and prospects.

GUIDELINES TO THE AUTHORS

Himalayan College of Agricultural Sciences and Technology (HICAST), the pioneer private college of agriculture in Nepal, has been publishing Nepalese Journal of Agricultural Sciences (NepJAS) annually with an objective of providing space for publishing original research articles. It is a reviewed journal of international standard. This is the 15th volume of this journal. It is also available online at *http://njas.hicast.edu.np/*. One hard copy of the journal is provided to the main Author and Members free of cost.

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