ISSN 2091-042X

NEPALESE JOURNAL OF AGRICULTURAL SCIENCES

1 September 2014, volume 12

Himalayan College of Agricultural Sciences and Technology
Purbanchal University affiliate
Kathmandu, Nepal

Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Published on: 1 September 2014

Price	Nepal	NRs 500.00
(Including postage charge)	SAARC Countries	US $ 15.00
	Other countries	US $ 25.00

Publisher

Himalayan College of Agricultural Sciences & Technology (HICAST)
Post Box 25535, Kathmandu, Nepal
Tel: 977-1-4273341
Email: info@hicast.edu.np
URL://www.hicast.edu.np/

Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

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Reproductive performance of Baruwal sheep under migratory system in Lamjung district of Nepal

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ABSTRACT

The detail reproductive performance of Baruwal sheep was not evaluated so far in Nepal. Hence, a study was carried out to reveal the effect of non-genetic factors on reproductive performance of Baruwal sheep at Yutarkanya and Gharmu Village Development Committees (VDCs) of Lamjung district of Nepal from August 2008 to May 2009. Altogether 192 ewes and 156 rams were included in this study. The information of individual ewes and rams were collected from migratory flocks through direct observation and survey with the help of semi-structured questionnaire. The age at conception, age at first lambing, gestation period, lambing interval and post partum estrus were 628.95±05.83, 863.78±2.54, 146.76±0.11, 338.21±4.65 and 179.35±2.78 days, respectively. These traits were not significantly different (p>0.05) with parity of dam and season of lambing. But in the second to fourth parity, Baruwal sheep performed better than others. The major breeding period of sheep was identified in July to September. During this period 51 percent of the sheep were conceived while it was nil from January to March. Likewise the highest lambing was occurred in October to December (38%) followed by January to March (27%), July to September (12%) and April to June (4%). The bredable period of ram was 1144.80±23.25 days and used in breeding purpose at 536.89±8.31 days after birth.

Key words: Baruwal sheep, reproductive performance, non genetic factors, migratory system

INTRODUCTION

Sheep is an important domestic animal in most part of the world, which is the main source of income and employment for landless, marginalized and resource-poor farmers in Nepal. Besides meat, sheep produce wool and manure also, which is equally important for carpet industry and fortification of soil. Thus the sheep industry can play important role in poverty alleviation. The total population of sheep in Nepal was 807,267 which produced 2,720 MTMT meat and 587,017 kg wool per annum (MoAD, 2012). The sheep population of Nepal was comprised of 12 percent Lampuchhre, 21 percent Kage, 63 percent Baruwal and 4 percent Bhyanglung (LMP, 1990). Sheep make very effective use of different grazing lands, including mountain terrain and alpine pastures, which can not be utilized by other domestic animals. Due to their hardy nature, they can adapt to different climatic conditions and suitable for stall-feeding, semi-stall-feeding, grazing and migratory management.

Migratory system of animal keeping was considered to be one of the oldest forms of livestock husbandry and this pattern remains unchanged in Nepal, due to interdependency of crops and livestock in agriculture (Karki, 1985). In migratory flocks, sheep and goats are run together, with the sheep acting as the lead animals (Karki, 1985). Baruwal sheep and Sinhal goats are the main breeds of this system in Nepal. A typical migratory flock consists of 200–250 animals (Karki, 1985), but the flock size can vary within the range of 50–600 animals (Karki, 1985; Ghimire *et al*., 1991).

Reproductive traits such as age at conception, age at first lambing, gestation period, lambing interval and post partum estrus are important traits of sheep, which influence productive performance as well as economy of sheep production. Both genetic and non-genetic factors affect reproductive performance of sheep. The detail reproductive performance of Baruwal sheep was not evaluated so far. Hence, a study was carried out to reveal the effect of non-genetic factors, such as parity of dams and season of lambing at Yutarkanya and Gharmu Village Development Committees (VDCs) of Lamjung district of Nepal.

MATERIALS AND METHODS

Site and animal selection

This study was carried out at Yutarkanya and Gharmu Village Development Committees (VDCs) of Lamjung district of Nepal from August 2008 to May, 2009. Twenty migratory flocks having more than 50 sheep were included in this study, ten from each VDC. All together 192 ewes and 156 rams were randomly selected.

Reproductive traits of ewes and ram

The age at first conception, age at first lambing, lambing interval, gestation period, post partum estrus, pattern of conception and lambing pattern of ewes were recorded. In case rams age at suitable for breeding (age when ram is used first time for breeding), total bredable period (period between first time uses in breeding to dispose) and age of castration were taken.

Result recording

The study period consisted of ten months; and the information of individual ewes and rams was collected from migratory flocks through direct observation and survey with the help of semi-structured questionnaire.

Data analysis

The collected data were analyzed by using descriptive data analysis technique and Harvey (1990) statistical package after category of information on the basis of parity and season (season was divided on the basis of movement i.e. downward- Sept.1-Feb. 29, and upward- March 1-Aug. 30).

Model for reproductive traits

Lambing interval, gestation period, age at first lambing and post partum estrus was analyzed by using the following model

$$Y_{ijk} = \mu + a_i + b_j + e_{ijk}$$

Where, μ is the overall mean

a_i is the effect of i^{th} parity (i=1, 2, 3, 4, 5 and 6)

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

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

RESULTS AND DISCUSSION

RESULTS

A) Reproductive performance of ewe

Age at first conception

The study revealed that the average age at first conception of Baruwal sheep was 628.95±05.83 days with the range of 450-750 days. It is very high. Tiwari and Shrestha (2004) reported similar values for age at first conception of Baruwal sheep in migratory system, i.e. 588±5.31 days.

Age at first lambing

The findings of this study revealed that the Baruwal sheep had first time of lambing at the age of 863.78±2.54 days with the range of 600-900 days (Table 1). The age of first lambing was insignificantly different ($p>0.05$) with respect to season which they were born in. In case of age at first lambing, the season did not affect significantly ($p>0.05$) but Dixit (2001) reported that the year and season of birth of ewe lamb and its yearling weight influenced significantly the age at first lambing. The autumn born ewe lambs lambed 88 days earlier than the spring born ewe lambs.

Gestation length

The overall mean gestation length of Baruwal sheep as reflected in this study was 146.76±0.11 days. Gestation length insignificantly differed ($p>0.05$) with respect to the lambing season and parity (Table 2). The gestation length, post partum estrus and lambing interval also was not significantly different ($p>0.05$) with respect to parity of dam and season of lambing. The gestation length of ewe is genetically determined but it can be modified by fetal, maternal and environmental factors. In the case of maternal factors, the age of the dam influences the duration of gestation period. Hafez (1987) reported that a two-day extension from the normal occurs in the 8 year ewe. But Dixit (2001) reported that decreasing trend in the gestation length with increase in the parity of the ewe, and concluded that the service period was highest (282 days) after first lambing and lowest (108 days) after sixth lambing. He also reported that the parity of the ewe had significant influence on the lambing interval and accounted for 1.7 percent of the

variation and the ewes lambing for the first time had longer lambing interval than those of subsequent lambing. Sinha *et al.* (1979) and Gupta and Reddy (1986) also reported significant (P<0.05) effect of the year of lambing on the lambing interval.

Table 1. Age of first lambing (days) of ewe, days (LS means ±S E)

Factors	LS means ±S E	Significant level
Season:		NS
Downward	866.72±2.02(150)	
Upward	860.83±4.66(28)	
Overall means	863.78±2.54(178)	

Note: NS: Non-significant, *Numbers in parenthesis are number of observations,*

Table 2. The gestation length of ewe, days (LS means ±S E)

Factors	LS means ±S E	Significant level
Parity:		NS
1	146.91±0.24(35)	
2	146.36±0.26(30)	
3	147.17±0.23(39)	
4	146.55±0.25(31)	
5	146.91±0.26(29)	
6	146.65±0.27(28)	
Season:		NS
Downward	146.62±0.17(66)	
Upward	146.90±0.12(126)	
Overall means	146.76±0.11(192)	

Note: NS: Non-significant. *Numbers in parenthesis show the total number of observations.*

Post-partum estrus

The overall mean of post-partum estrus of the Baruwal sheep was 179.35±2.78 days; and insignificantly differed (p>0.05) with respect to parity of dams and season of lambing (Table 3), but was lower in second, third and fourth parity and lambing in downward season.

Lambing interval

The overall mean of lambing interval of Baruwal sheep was 338.21±4.65 days and insignificantly differed (p>0.05) with respect to the parity of dam and lambing season (Table 4).

Pattern of conception

This study found that the conception of Baruwal sheep was highest in July to September (51%) followed by April to June (39%), October to December (10%) and January to march (00%), the difference were highly significant (P<0.001) (Table 5).

Table 3. The post-partum estrus of ewe, days (LS means ±S E)

Factors	LS means ±S E	Significant level
Parity:		NS
1	185.63±6.15(35)	
2	172.61±6.78(30)	
3	177.46±5.84(39)	
4	176.60±6.62(31)	
5	181.32±6.82(29)	
6	182.51±6.86(28)	
Season:		NS
Downward	176.94±4.52(66)	
Upward	181.77±3.25(126)	
Overall means	179.35±2.78(192)	

Note: NS: Non-significant *Numbers in parenthesis show the total number of* observation.

Table 4. The lambing interval of ewe, days (LS means ±S E)

Factors	LS means ±S E	Significant level
Parity:		NS
1	329.04±8.05(34)	
2	337.55±9.26(25)	
3	331.31±8.19(35)	
4	356.25±8.53(30)	
5	346.03±9.14(28)	
6	329.09±9.14(25)	
Season:		NS
Downward	334.92±3.58(151)	
Upward	341.50±8.59(26)	
Overall means	338.21±4.65(177)	

Note: NS: Non-significant.

Numbers in parenthesis show the total number of observation.

Table 5. The pattern of conception (LS means ±S E)

Factors	LS means ±S E	Significant level
Month		***
January-March	00.00^{d}±2.61 (00%)	
April-June	38.75^{b}±2.61 (39%)	
July-September	51.00^{a}±2.61 (51%)	
October-December	10.33^{c}±2.61 (10 %)	
Overall means	25.02±1.30	

Note: ***: Significant at 0.1% level (P<0.001).

Lambing pattern of ewes

This study revealed that only 81% conceived ewes were lambed and the highest lambing was found in July to September i.e. 38% followed by January to March i.e. 27% and April to June i.e. 4%, the difference were highly significant (P<0.001) (Table 6).

B) Reproductive performance of ram

This study showed that ram was ready to use in breeding purpose only 536.89±8.31 days after birth and was used for 4-5 years regularly, with the high chance of inbreeding. The

breedable period of ram was 1144.80±23.25 days and most of the rams were castrated in 344.33±23.25 days of age.

Table 6. The lambing pattern of sheep (LS means ±S E)

Factors	LS means ±S E	Significant level
Month:		***
January-March	27.50^{b}±2.00 (27%)	
April-June	04.12^{d}±2.00 (04%)	
July-September	11.67^{c}±2.00 (12%)	
October-December	37.95^{a}±2.00 (38%)	
Overall means	20.31±1.00	

Note: ***: Significant at 0.1% level (P<0.001).

Epstein (1977) indicated that the main breeding season of Baruwal sheep was from May to September, being highest in July when they were in the alpine pastures. Similarly, Karki (2004) reported that the lambing pattern was consistent and widespread for six months, i.e. from September to February but the peak was from November to January. However, autumn (September to October) lambing (56%) seems to be more common than spring (March to April) lambing (Pradhan, 1986). In case of reproductive performance of ram, there is not any study and experiment conducted so far in Nepal.

CONCLUSION

The study revealed that age at first conception, age at first lambing, post partum estrus and lambing interval are very high which might be due to both genetic as well as non genetic factors. In migratory system, sheep are reared in natural forest without providing additional diet that is why the reproductive performance of Baruwal sheep becomes very poor. Hence reproductive efficiency of Baruwal sheep can be enhanced by reducing age at first conception, age of first lambing, the post partum estrus, lambing interval and inbreeding.

ACKNOWLEDGEMENT

The authors would like to express their most sincere gratitude and appreciation to Dr. Sundar Man Shrestha, Dean, IAAS, Rampur, Chitwan for his encouragement, help, suggestion and support during study period. Similarly works of Mr. Bel Bahadur Gurung and Mr. Khardhoj Gurung (Enumerators) deserve high appreciation without which this study would have been impossible. Dr. Naba Raj Devkota, IAAS, Rampur, Chitwan and our friends Mr. Saroj Sapkota, Shambhu Raj Pandey and Dhan Bahadur Thapa also deserve appreciation for dedicated work in survey and data analysis. Likewise, our thanks also go to all staffs of Agriculture Research Station (Goat), Bandipur, Tanauan and all shepherds of Yutarkanya and Gharmu VDCs of Lamjung district for their help during study period.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Effect of *Aloe vera*, amala (*Embilica officinalis*) and mannan oligosaccharide (*Saccharomyces cerevisae*) on the performance of Cobb-400 broiler

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ABSTRACT

A study was conducted at IAAS, Rampur, Chitwan from July 6, 2011 to August 17, 2011 to compare the effect of Aloe vera, Amala and Mannan oligosaccharide on the performance of Cobb-400 broiler. The experiment was carried out in Completely Randomized Design (CRD) having 5 treatments replicated 3 times. Each experimental unit consisted of 10 birds. The treatments were Basal diet (BD) (T1), BD+ Aloe vera (T2), BD + Amala (T3), BD + (Aloe vera + Amala) T4, BD + Mannan oligosaccharide (T5). Aloe vera was used at the rate of 1000ml per ton of feed. Amala was used at the rate of 1000 ml per ton of fee; and Amala + Aloe vera was used each at the rate of 500+500 ml/ton of feed. Mannan oligosaccharide was used at the rate of 500g per ton of feed. The birds were offered ad lib feeds and water under uniform management conditions. Significantly ($p<0.05$) maximum body weight (368g) was recorded under treatment T2 while minimum body weight (361.33g) under treatment T4 during 2nd week. The trend of differences in growth among the treatments observed during first week stage was found similar to the 2nd week. During the final week stage, i.e. 6th week stage although the differences were non-significant ($p>0.05$), maximum body weight (1850g) was recorded under the treatment T2 while minimum body weight (1820 g) under T4 treatment. Maximum weight gains of 390.00 g, 427.66 g at 5th and 6th week stage, respectively were recorded under treatment T2 while, minimum weight gains of 380.00 g, 410.00 g at 5th and 6th week stage, respectively were under treatment T4. Minimum feed consumption of 340.00 g, 533.33 g, 635.00 g, 880.00 g and 910.00 g were recorded under treatment T2 while maximum feed consumption at all the weekly stages were recorded under treatment T4. Minimum feed conversion ratio of 1.61, 1.67, 1.82, 2.25 and 2.13 were recorded under treatment T2 at 2nd, 3rd, 4th, 5th and 6th week stage, respectively indicating the superior feed efficiency at all stages of broiler growth in treatment T2 over rest of the treatments. The effect of different treatment on dressing percentage was non-significant ($p>0.05$) with maximum dressing percentage under T1 and T2 (84%) followed by T2 and T3 (83%). The net income per bird calculated was maximum under treatment T2 (Rs.82.21) while net return per bird calculated was minimum (Rs 75.68) under treatment T1 (Basal). It has been concluded that Basal diet supplemented with Aloe vera is superior over other diet included in the experiment and can boost up poultry production. However, it needs further investigation to confirm before recommending to farmer / poultry grower for adoption.

Key Words: Weight Gain, Feed consumption, Feed conversion ratio, Economics

INTRODUCTION

Poultry industry in Nepal is growing at a fast rate of about 15 percent per annum in which over 30,000 farm families are involved directly or indirectly (Nakarmi, 2000). The contribution of poultry to the national GDP is nearly 4 percent of the total GDP and 8 percent of the agriculture GDP with an output of 10 billion rupees from this sector (Dhakal, 2000). Chitwan district among the limited poultry pockets in Nepal, shares around 30 percent of the boiler and 80 percent of the total layer chicks product throughout the country. Poultry industry in Chitwan district is growing day by day from small scale farmer rearing 500 commercial birds to big farms having upto 50,000 birds.

Meat and meat products are a good source of protein which is very essential for growth and the maintenance of the human body. Due to increased awareness on the nutritional value of meat among the consumer process of rapid urbanization, increased income level of people, gradual change in food habits, rapid population growth, inflow of tourist and easy access to marketing facilities, the demand of poultry meat and meat product is increasing every year not only in Chitwan district but also in the whole country. Chitwan district shares 8.48 percent of total chicken meat produced in Nepal (MoAC, 2004/2005).

Chicken is of the most popular avian species in Nepalese society. Poultry sector in Nepal has two characteristics: rural and commercial. Rural system is practiced since the beginning of recorded history. Commercial poultry production was started in 1960. As poultry bird are non-ruminant, their food source mainly depends on crop grains or their by products as concentrate feed. There are two issues in poultry feeding firstly; these feed stuffs are also largely required by human being and other species. Secondly, higher cost involved in feed as about 70 percent of the egg production and 55 percent of the broiler production include total cost of production. Therefore, it is important to develop a low costs feeding package to reduce the cost of production for poultry raiser. High feed cost has caused to raise the price of poultry meat. The feed cost alone accounting 65 to 70 percent of total was of broiler production.

The poultry industry in Nepal has emerged as the most dynamic and fastest expanding segent in animal husbandry sector. There has been a phenomenal growth in the Nepalese poultry industry in the last three decades. The contribution of Agriculture to Gross Domestic Products (GDP) is 38.15 percent and contribution of livestock to Agriculture Gross domestic product (AGDP) is 27.66 percent (MOAC, 2006).The net meat production during the year 2006/07 was 227,105 metric ton, out of which contribution from chicken was 1,6.126 metric ton (MoAC, 2006/2007).

Food safety has been recognized as one of the major drivers of modern feed industry. A solution to this dilemma may be the use of herbs to enhance growth, without any adverse effect in human health. The basic strategy for using these herbs in poultry diets is for using these herbs in poultry diets for influencing growth and in modifying metabolism by combating stress and microbes.

The use of antibiotic growth promoter in poultry diet has been banned in many countries because of the potential development of antibiotic-resistant pathogenic bacteria after long use of antibiotic growth promoter in livestock and poultry diet. Therefore, alternative non-antibiotic growth promoter of broiler chickens includes herbs/plants such as *Aloe vera*, Amala, Mannan Oligosaccharide and organic acid mixture to corn soybean meal based broiler diet. Mannan Oligosaccharides (MOS) derived from the cell wall of the yeast *Saccharomyces cerevisae* have shown promise in suppressing enteric pathogens modulating the immune response and the morphology and structure of the intestinal mucosa. Mannan oligosaccharide supplemented diets increase the lactic acid content and decreases pH of and has specific effect on bacterial pathogens. Most gram-negative microbial pathogens cannot grow in acidic environment. As a result, the addition of organic acids to the broiler diets improves growth performance and prevents diarrhoea.

MATERIALS AND METHODS

A study was conducted at IAAS, Rampur, Chitwan from July 6, 2011 to August 17, 2011 to compare the effect of *Aloe vera*, Amala and Mannan oligosaccharide on the performance of Cobb-400 broiler. The experiment was set on completely randomized design (CRD) consisting of 5 treatments each replicated thrice. Each experimental unit consisted of 10 birds. The trial was laid on experiment after one week of brooding on 150 unsexed day old Cobb-400 broiler chicks of similar weight. Each dietary treatment was of similar nutrient composition. The experimental treatments were as follows:

T1 = control= Basal diet (Standard ration)
T2 = Basal diet + *Aloe vera* @ 1000 ml/ton of feed.
T3 = Basal diet + Amala @ 1000 ml/ton of feed
T4 = Basal diet + Amala + *Aloe vera* each@ (500ml +500ml) /ton of feed.
T5 = Basal diet + Mannan Oligosaccharide@ 500g/ton of feed.

RESULTS AND DISCUSSION

The results of feeding broilers starter and finisher diet containing *Aloe vera*, Amala and Mannan oligosaccharide on mean weekly feed consumption, mean weekly cumulative body weight, mean weekly weight gain, feed conversion ratio, chemical composition of diets, carcass traits and economic analysis over feed cost have been presented and discussed in this section.

Body weight

The average weekly body weights of Cobb-400 broiler fed with different diet are presented in table 1. Accordingly, the body weight of bird in the initial stage, i.e. at the end of first and 2nd week, differed significantly while in all rest of growth stages body weight remained statistically at par among the treatments. Significantly ($p<0.05$)

maximum body weight (158 g) was recorded under treatment T2 while the minimum body weight (152 g) under the treatment T4. The body weight under T2 and T5 being statistically at par proved significantly superior over T4. However, the body weight recorded under T1, T3 and T5 did not differ significantly. The trend of differences in growth among the treatments observed during 2nd week stage was found similar to the 1st week stage. Significantly maximum body weight (368.00 g) was recorded under the treatment T2 while minimum body weight (361.33g) under T4.

The body weight of birds during 3rd, 4th, 5th and 6th week stage under different treatment did not differ significantly ($p>0.05$). However, the maximum body weight of 685.66 g, 1032.33 g, 1161.66 g and 1850.00 g were recorded under treatment T2 at 3rd, 4th, 5th and 6th week stages, respectively. The minimum body weights of 680.66 g, 1028.00 g, 1155.33 g, 1820.00 g were recorded under treatment T4 at 3rd, 4th, 5th and 6th week stages, respectively. The comparison of trend of growth under different treatments at all stages indicated that diets supplemented with *Aloe vera* proved outstanding for promoting the highest growth and weight gain among the treatments under study.

Since *Aloe vera* contains 75 potentially active constituents: Vitamins, enzymes, minerals, sugars, lignins, saponins, salicylic acids, amino acids and Vitamin A, C and E which are antioxidants and enzyme bradykinase which reduce excessive inflammation, glucoprotein with anti-allergic properties, lupeol with antiseptic and analgesic properties, auxins and gibberellins with wound healing properties, salicylic acid with antibacterial properties results in growth promoting (Delmar T. *et. al,* 2007).

Table 1. The average weekly body weight of Cobb-400 broiler fed with *Aloe vera*, Amala, *Aloe vera* + Amala and MOS at 7 days interval in g

Treatments	Periods in week and weight gain(g)					
	Initial	2nd	3rd	4th	5th	6th
T1= Basal Diet	154.00^{bc}	363.00^{bc}	680.00	1028.00	1155.33	1805.00
T2 =Basal diet+ *Aloe vera*	158.00^{a}	368.00^{a}	685.66	1032.33	1161.66	1850.00
T3= Basal diet+ Amala	153.33^{bc}	364.00^{bc}	683.66	1032.00	1032.00	1840 .00
T4=Basal diet+ *Aloe vera*+ Amala	152.00^{c}	361.33^{c}	680.66	1028.00	1028.00	1820.00
T5= Basal diet+ MOS	156.00^{ab}	366.00^{ab}	682.00	1030.00	1030.00	1840.00
Probability	<0.05	<0.05	-	-	-	-
SEm±	0.99	1.33	1.32	1.22	1.28	13.78
LSD at 5%	3.116	4.201	ns	ns	ns	ns
CV	1.11	0.63	0.33	0.21	19.61	1.30

Bejar and Copa (2007) stated in their study that *Aloe vera* utilized as growth enhancers is safe for animal intake. It further revealed that the final weight and gain in weight of broilers (5-10 ml) was enhanced compared to plain water.

Body weight gain

The average weekly weight gain of Cobb-400 broiler fed with standard ration, *Aloe vera*, Amala, *Aloe vera* + Amala and MOS are presented in table 2. The weight gain of bird at all stages under treatment did not differ significantly. A perusal of the data in the table 7 indicates that there was gradual increase in weight gain under all treatments from 1st week to 6th week; and maximum weight gain under all treatments in general were recorded during 6th week stage. However, the differences in weight gain among the treatments recorded were non- significant. Maximum weight gain of 390.00 g and 427.66 g at 5th and 6th week stages, respectively were recorded under treatment T2 while minimum weight gain of 380 and 410 g at 5th and 6th week stages, respectively under the treatment T4 indicating the superiority of treatment T2 in promoting weight gain over rest of the treatments under study. Higher body weight gain of birds fed with Amala (*Embilica officinalis*) in combination with basal diet might be due to higher feed consumption. Incorporation of Vitamin C, the major constituent of Amala improved a positive linear co-relation between the supplemental levels and weight gain. Feed intake significantly increased when birds gained weight. Higher weight gain was followed during the finisher phase (4 -6 weeks) in broilers supplied with Vitamin C as reported by Kassim *et al.* (1995), Kutlu and Forbes (1993). These results were also in agreement with McKee and Harrison (1995).

Table 2. Average weekly weight gain of Cobb-400 broiler fed with *Aloe vera*, Amala, *Aloe vera* + Amala and MOS at 7 days interval in g

Treatments	Periods in weeks and body weight in g				
	2nd	3rd	4th	5th	6th
T1	209 .00	317.00	348.00	384.33	392.66
T2	210.33	317.33	346.66	390.00	427.66
T3	210.66	319.66	348.33	382.33	425.66
T4	209.33	319.33	347.33	380.00	410.00
T5	209.66	316.00	34800	382.33	427.66
SEM±	1.70	1.67	1.90	2.37	14.47
LSD at 5%	ns	ns	ns	ns	ns
CV	1.40	0.91	0.95	1.07	6.01

Feed conversion ratio

The average weekly feed conversion ratio of broiler fed diet supplemented with *Aloe vera*, Amala, *Aloe vera* + Amala and MOS are presented in Table 3 and the analysis of variance for feed conversion ratio (FCR) showed non- significant difference ($p>0.05$) throughout the experimental period except 5th week stage.

During the 5th week stage, significantly lowest feed conversion ratio (2.25) was recorded under the treatment T2 while the highest feed conversion ratio (2.32) was recorded under the treatment T4 indicating maximum feed utilization efficiency of diet T2 and lowest

feed utilization efficiency of T4. In other words, the lower feed conversion ratio indicates higher feed utilization efficiency while higher feed conversion ratio indicates poor feed utilization efficiency.

During 2nd, 3rd, 4th and 6th week stage, the differences among the treatments for feed conversion ratios were non-significant ($p>0.05$). Minimum feed conversion ratios (1.61, 1.67, 1.82, and 2.1) were recorded under treatment T2 at 2nd, 3rd, 4th and 6th week stages, respectively indicating higher feed utilization efficiency than rest of the treatments. The result of this study is in agreement with Wheeler, (1993). It was recorded that birds showed a decrease of feed conversion ratio (FCR) following the use of antistress and immunomodulating herbs in the bird's diets. Similarly in small scale trials, using additional known stressors on chicken production, an increase in daily live weight gain of 6 percent and decrease in feed conversion ratio of 7 percent was demonstrated. Reddy (2005) also reported better FCR in Vitamin C supplemented diet. Although the FCR was highest in Vitamin C supplemented diet, it was not significantly different as reported by (Lohakare, 2005).

Table 3. Average weekly feed conversion ratio of Cobb-400 broiler fed with *Aloe vera*, Amala, *Aloe vera*+Amala and MOS

Treatments	Periods in weeks and feed conversion ratio				
	2nd	3rd	4th	5th	6th
T1	1.63	1.68	1.82	2.29ab	2.32
T2	1.61	1.67	1.82	2.25b	2.13
T3	1.62	1.65	1.82	2.30ab	2.14
T4	1.65	1.68	1.83	2.32 a	2.23
T5	1.61	1.68	1.82	2.30ab	2.12
SEm±	0.02	0.02	0.01	0.01	0.07
LSD at 5%	ns	ns	ns	0.057	ns
CV	1.87	1.60	0.99	1.10	5.84

Feed consumption

The average weekly feed consumption of broilers fed diets supplemented with *Aloe vera*, Amala, *Aloe vera* + Amala and MOS are presented in table 4. The analysis of variance showed no significant differences in weekly feed consumption throughout the experimental period except 2nd week stage. During the 2nd week stage, significantly maximum feed consumption (345.66 g) was recorded under treatment T4 while minimum feed consumption of 340 g was under T2.

During 3rd, 4th, 5th and 6th week stages, the differences in feed consumption under different treatments were non- significant. Minimum feed consumption of 340.00 g, 533.33 g, 635.00 g, 880.00 g and 910.00 g were recorded under the treatment T2 while maximum feed consumption at all the weekly stages was recorded under treatment T4 reflecting maximum feed utilization or feed conversion efficiency under treatment T2 or

minimum feed conversion ratio. In other words, the minimum feed conversion ratio indicates maximum feed utilization efficiency.

The average weekly feed consumption of broilers fed diets supplemented with *Aloe vera*, Amala, *Aloe vera* + Amala and MOS are presented in table 4 and figure 1. The analysis of variance (Appendix 3) showed no significant differences in weekly feed consumption throughout the experimental period except 2nd week stage. During the 2nd week stage, significantly maximum feed consumption (345.66 g) was recorded under treatment T4 while minimum feed consumption of 340 g under T2.

Table 4. Average weekly feed consumption of cob-400 broiler fed with Aloevera, Amala, Aloevera+ Amala and MOS at 7days interval in g

Treatments	Periods in weeks and feed consumption in g				
	2nd	3rd	4th	5 th	6th
T1	342.00	535.00	636.33	882.00	912.00
T2	340.00	533.33	635.00	880.00	910.00
T3	343.66	536.66	638.00	884.00	913.66
T4	345.66	538.33	640.00	885.00	914.66
T5	340.66	535.00	634.00	881.00	909.33
SEM	1.26	2.53	1.47	1.47	1.47
LSD at 5%	3.986	ns	ns	ns	ns
CV	0.64	0.82	0.40	0.27	0.25

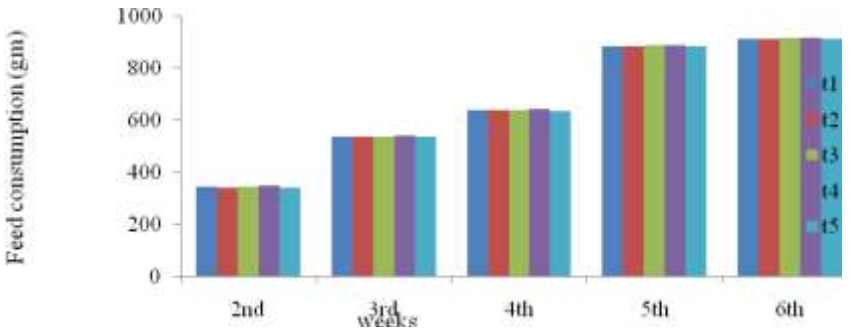

Figure 1. Average weekly feed consumption of cob-400 broiler fed with *Aloe vera*, Amala, *Aloe vera* + Amala and MOS at 7 days interval in g

During 3rd, 4th, 5th and 6th week stages the differences in feed consumption under different treatments were non- significant. Minimum feed consumption of 340.00 g, 533.33 g, 635.00 g, 880.00 g and 910.00 g were recorded under the treatment T2 while maximum feed consumption at all the weekly stages were recorded under treatment T4 reflecting maximum feed utilization efficiency under treatment T2 or minimum feed conversion ratio.

Table 5. Economics of Cobb-400 broiler fed diet supplemented with *Aloe vera*, Amala, *Aloe vera* + Amala and MOS

Particulars	T1	T2	T3	T4	T5
Feed kg	99.22	98.85	99.48	99.73	99.00
Cost@ Rs.26.15	2594.60	2584.92	2601.60	2608.13	2589.04
Feed cost /bird	66.52	66.28	66.70	66.87	66.38
Chicks	45.00	45.00	45.00	45.00	45.00
Medicine	5.00	5.00	5.00	5.00	5.00
Labour	30.00	30.00	30.00	30.00	30.00
Litter	7.00	7.00	7.00	7.00	7.00
Miscellaneous	5.00	5.00	5.00	5.00	5.00
Gross expenditure	158.52	158.28	158.70	158.87	158.38
Live weight	54.05	55.50	55.20	54.60	55.20
Live weight/bird	1.80	1.85	1.84	1.82	1.84
Gross income/bird	234.21	240.50	239.20	236.60	239.20
Net income/bird	75.68	82.21	80.49	77.72	80.81
Income over control	-	6.53	4.80	2.03	5.12
% Income over control	-	8.62	6.34	2.69	6.77
B:C Ratio	1.47	1.51	1.50	1.48	1.51

Economics of Cobb-400 broiler production

The average gross expenditure and gross income of experimental Cobb-400 broiler supplemented with *Aloe vera*, Amala, Amala + *Aloe vera* and MOS are presented in table 5. The gross expenditure per bird under all the treatment are almost similar approaching to Rs. 158 while gross return per bird under different treatment varied from minimum value of Rs. 234.21 under T1 to maximum value of Rs.240.50 under T2. The net income per bird calculated was maximal under T2 (Rs.82.21) while the net income per bird calculated was minimal under T1 (Rs.75.68). The percentage increase in net income over control was to the extent of 8.62, 6.34, 2.69 and 6.77 percent indicating the superiority of economics under T2 than the rest of the treatments.

CONCLUSION

Based on the findings of this study, it can be concluded that growth performance of broilers improves when fed with diet supplemented with *Aloe vera*. Hence, use of *Aloe vera* in the diet can boost up the poultry production. Since this is a new area of research, and a limited study has been conducted in this aspect, this study needs further verification

of the results covering wider areas at large scale before the technology could be recommended for adoption by poultry growers and manufactures.

ACKNOWLEDGEMENT

The research was supported by National Agriculture Research and Development Fund, Ministry of Agriculture and Cooperatives, Government of Nepal. The authors also thank Ishwar Chandra Adhikari and Institute of Agriculture and Animal Science, Tribhuvan University for their technical assistance and providing the laboratory facility.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

A study on characteristics of gerbera cultivars in Kathmandu

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ABSTRACT

The study was carried out to assess varietal characteristics of Gerbera grown in Kathmandu, Nepal under plastic shed condition. The experiment was conducted at Sasita's Agri Farm, Bhaktapur, Nepal. The data revealed that amongst ten gerbera varieties under study, Pirineo recorded significantly more number of flowers per plant and more number of leaves per plant. Maximum flower diameter was recorded in varieties Aqua, Pompei and Bayadere. Highest plant survival rate (about 95%) was found in Pirineo at the age of 10 months after transplantation. Considering the more number of flowers per plant and least mortality rate, Pirineo variety was found promising.

Key words*: Gerbera jamesonii, variety, transplantation, mortality rate,*

INTRODUCTION

Gerbera (*Gerbera jamesonii)* is an ornamental plant grown for the cut flower market on a large scale (Teeri et al., 2006). Flowers are available in a wide range of colors, including yellow, orange, pink, crimson, red, purple, and white (Emongor, 2004). Looking at the global trend, Gerbera comes in the 4th place among cut flower (Sujatha *et al.,* 2002). It is grown in the open field as well as in the polyhouse condition. Gerbera stands in top five commercial cut flowers in Nepal in terms of the area under cultivation (FAN, 2013). However, there is lack of published data on characteristics of different varieties of gerbera cultivated and its performance in Nepal.

Due to the lack of knowhow on varietal characteristics and their performance, most of the farmers have lost their flower production business mostly due to varietal failure owing to poor adaptability. Anyone who is doing such business is working under high risk. In fact, according to FAN (2013) cut flower growers, especially gerbera growers, have to invest about 50 percent of their initial cost for farm establishment. Therefore, this study has attempted at least to fill this gap and make aware the future investor of gerbera farming about characteristics of some gerbera varieties grown under plastic house in Nepal.

MATERIALS AND METHODS

Plant materials were the tissue cultured plants imported from Schreurs Holland. Ten different cultivars of gerbera viz. Alamo, Aqua, Essandre, Pirineo, Bayadare, Pompei,

Crusader, Estoria, Ruble and Bionda were studied. Six weeks old seedlings were transplanted on 15th August 2012 in Sasita's Agri Farm in Kamalbinayak, Bhaktapur. The farm is located at a distance of 20 km East from Kathmandu district, Bagati zone, Nepal. The farm lies at Latitude 27°41'00.48" and 85°26'46.44"E. Its elevation is 1356 meter above sea level. Average temperature at the middle part of the tunnel at plant height during the day around 12 hours was 30 degree celsius and at night it was 10 degree.

Gerberas were grown under plastic shed of 20 meter long and 5.5 meter wide with side height 1.81 meter and centre height of 3 meter. Bed sizes were 65 cm wide and 45 cm elevated from ground and each bed was spaced on 40 cm apart. Plant to plant spacing was 30 cm in a triangular plantation. Fertimax-K (0:0:50) was foliar sprayed @ 1.5 g/l in two days interval, and MAP (mono ammonium phosphate) @ 1.5 g/l in alternate three days. NPK (20:20:20 kg/ha) in four days interval @ 2g/l. Micro nutrients once a week @2ml/l. Chelated Calcium 10% CaEDTA and Magnesium Nitrate were sprayed once a week @ 2g/l. Above mentioned fertilisers were imported from Indian Aries Agro Ltd.

Organic matter (vermin compost) half kg per plant was applied once in 90 days together with urea, DAP and Murate of Potash @ 2:3:4 g per plant. Water was applied through drip irrigation at the rate of 300 ml per plant every alternate day. Flowers were considered as full bloom when the outer rows of the disc florets were perpendicular to the stalk. In each readiing, twenty flowers per plant per cultivar were selected randomly for the measurement of the traits. Major traits measured were: number of flowers per plant, number of leaves per plant, flower stalk length, flower diameter, plat height. Plant height was measured from the base to the tip of the longest leaf. The measurement was carried out in May, 2013 and March, 2014. Data from two measurement dates were combined and averaged.

RESULTS AND DISCUSSION

Estoria, Pirineo and Alamo were bright red colored varieties (Table 1). Essandre was dark Yellow whereas Bionda was light yellow. Pompei and Crusader were orange in color. Other varieties were Aqua (pink), Ruble (purple), Bayadare (bicolour-pink and white). There was variation in the color of the flower centre as well. Estoria, Pompei, Pirineo, Aqua and Bayadere had the green flower centre whereas rest of the cultivars were black centered.

It was found that maximum number of flowers per plant was in Pirineo (9.56) and Crusader (7.72) which was significantly superior over other varieties Aqua (5.56), Alamo (5.43), Estoria (5.37), Pompei (5.32), Ruble (4.83), Essandre (4.77), Bionda (4.67), Bayadere (2.08) (table 2). Mahanta et al. (2003) recorded similar observations in gerbera varieties.

Maximum number of leaves per plant was recorded in Pirineo (33.21) and Crusader (30.02) which was significantly superior over all the varieties. Less number of leaves was observed in Bayadere (16.23) and Bionda (15.14). Optimum number of leaves was recorded in Pompei (23.43), Essandre (23.31), Alamo (22.11), Ruble (21), Aqua (20.45),

and Estoria (Table 2). A study conducted by Kumar and Kumar (2001) revealed that the highest number of leaves per plant (32.86) was recorded in cv. Goldspot grown under summer shading, while the lowest leaf number was observed in cv. Lilly (15.21) grown under control. Similar results were obtained by Shruti et al. (2013) in gerbera varieties. Pompei (30.73) and Ruble (30.32) were found to be the highest plant type. Shortest plant was Bayadare being just 24.31 cm tall. In the trial of Parthasarathy and Nagaraju (2003), growth, development and flowering were found faster during warmers period (April-May, and June-July).

Table 1. Petal color and center color of different cultivars

Cultivar Name	Petal color	Centre color
Essandre	Yellow	Black
Bionda	Yellow	Black
Pompei	Orange	Green
Crusader	Orange	Black
Aqua	Pink	Green
Ruble	Purple	Black
Bayadare	Bicolor (Pink and White)	Green
Estoria	Red	Green
Pirineo	Red	Green
Alamo	Red	Black

Table 2. Varietal characteristics of ten different cultivars of Gerbera

Cultivars	Number of flowers/plant	Plant height (cm)	Number of leaves/plant	Flower stalk length (cm)	Flower diameter (cm)
Aqua	5.56	28.87	20.45	57.78	12.00
Ruble	4.83	30.32	21.00	50.75	12.00
Alamo	5.43	29.54	22.11	55.43	11.31
Essandre	4.77	28.55	23.31	56.89	11.45
Pompei	5.32	30.73	23.43	57.01	12.00
Crusader	7.72	28.11	30.02	53.34	12.00
Pirineo	9.56	28.23	33.21	60.07	10.05
Bionda	4.77	29.07	15.14	55.23	11.13
Estoria	5.37	25.55	20.33	45.34	9.34
Bayadere	2.08	24.31	16.23	50.63	11.32

This study revealed that varieties like Aqua, Pompei and Bayadere had the highest flower diameter (12 cm) whereas smallest floral diameter was found in Pirineo (10.05 cm) and Estoria (Table 3). Similar observations were recorded by Shruti et al. (2013) and Reddy

et al. (2003). Variation in width of flower structure (disc, trans and ray florets) has been detailed in table 3.

In cut flowers, longer stalk length is a desirable trait. Pirineo recorded highest stalk length (60.07cm) whereas Estoria (45.34 cm) was the shortest flower among all varieties. Rest of all varieties were found middling in stalk length that is Aqua (57.78 cm), Pompei (57.01 cm), Essandre (56.89 cm), Alamo (55.43 cm), Bionda (55.23 cm). In the performance study of nine gerbera cultivars under naturally ventilated greenhouse by Reddy et al. (2003), the cv. Sangria was best with stalk length of 69.46 cm.

Figure 1. Pictures showing experimental plots

Diseases and pest

The promising disease and pest found in the gerbera farm were whitefly and crown rot. According to the farmer's experience, preference of whitefly was most in Pompei than

Ruble and Bionda. While looking at the leaf surface, about 70 percent of leaves were black at both sides due to development of sooty mould in the residue of whitefly in Pompei whereas in other varieties its intensity was about only fifty percent. Until the ten months of transplantation, 30 percent of Essandre, Bionda and Estoria plants died due to crown rot infection whereas mortality was least (only 5%) in Pirineo and Pompei due to this disease.

Table 3. Flower head with their disc, trans and ray floret width

Variety	Disc, Trans, Ray floret width (cm)	Variety	Disc, Trans, Ray floret width (cm)
Alamo	2.1, 2.1, 7.0	Pirineo	2.5, 4.0, 4.0
Aqua	20, 4.0, 6.0	Pompei	2.0, 4.0, 6.0
Bayadere	2.1, 3.7, 5.4	Ruble	3.0, 4.0, 5.0
Crusader	1.0, 4.5, 6.5	Bionda	1.8, 4.2, 5.0
Essandre	2.3, 4. 3, 6.1	Estoria	1.6, 2.3, 5.4

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Climate change, food production and food security in Rupa lake wetland area

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ABSTRACT

A research was conducted in the Rupa Lake area in Lekhnath Municipality of Kaski district, Nepal in 2012-13 with the objective of exploring the impacts of climate change (CC) on crop production and food security (FS) of local people. Twenty percent of the wetland dependent communities constituted the sampled households (HHs). It was found that majority of population (87%) of Lake basin was dependent on agriculture for FS and livelihoods. About 74 percent of households were aware of the effect of CC, and therefore had adopted different strategies to adapt to its effect. Most of them were adopting mixed cropping; were using short duration crops; organic manure / compost and bio-pesticide. The status of community forest and lake environment has improved in the period of last 10 years because of conservation practices initiated by local communities including the Rupa Lake Restoration and Fishery Cooperative. There was a year-round FS for 50 percent of sampled HHs (it was 57% by HFIAS method), with 22 percent of those HHs having surplus food. Five percent of HHs had FS for less than three months while 19 percent of the HHs had FS for more than six months. Over 90 percent HHs responded to CC variously: i. e in the form of rise in temperature (by 74% of the respondents); unpredictable rainfall (by 77%); shift in rainfall (by 64%); and phonological changes in plants (by 51%). Of the total sampled households (50), 92 percent shared their experiences regarding the change and impacts of climatic parameters, wetland ecosystem, agriculture system, FS and livelihoods. Rise in temperature, unpredictable rainfall, shift in rainfall pattern and phenological changes in plants were the indicators of CC. Meteorological data supported these observations and showed that during the last 30 years average temperature rose by 2^0 C while fluctuation of annual rainfall had abrupt pattern with only 5000 mm/year during the year 2005 to 2010 except in the year 2007 (6000 mm/year) and 2010 (5800 mm/year).

Key word: Food security, livelihoods, climate change, bio-intensive farming

INTRODUCTION

Climate change affects green sectors more than other sectors of the economy. Agriculture production depends on nature and gets affected by the change in the climatic parameters such as extreme weather events. Studies report expected changes in frequency, duration intensity and geographic distribution of rainfall and snowfall and increased frequency,

duration and intensity of droughts (FAO/SAARC, 2008). Climate change is becoming the real threat to the lives in the world that largely affects water resources, agriculture, coastal regions, freshwater habitats, vegetation and forests, snow cover and melting and geological processes such as landslide, desertification and floods, and has long-term affects on food security as well as in human health. According to FAO (2004) agriculture, forestry, and fisheries are highly sensitive to climate change and climate change is very likely to have a serious impact on their productive functions. As a consequence, production of food, feed, fiber, energy, or industrial crops, livestock, poultry, fish and forest products may decrease. Effects of climate change on agriculture are particularly sensitive as the agriculture produces food and provides the primary source of livelihood for large sections of the society. Climate change is reported to influence crop and livestock production, hydrological balances, input supplies and other components of agricultural systems (Moench et al., 2003). FAO (2012) reports that climate change will affect all four dimensions of food security, namely food availability, access to food, stability of food supplies, and food. Climate change has also created risks to the food security of the large number of population. Glacier retreat and glacier Lake outburst flood (GLOF) are the most important and widely discussed issues as the potential risks. Compared to other sectors under impacts of climate change in Nepal, more studies have been carried out on glacier, their retreat and formation of glacial Lakes which are vulnerable to outburst. With melting of glaciers, risk of glacier Lake outburst flood (GLOF), water availability will rise and decrease sharply. It has effect on irrigation, power supply and aquatic ecosystem (IPCC, 2007). Nepal will be hit hard by climate change. Atmospheric temperature in Nepal is rising at a rate higher than the global average, with a 1.8°C increase between 1975 and 2006, while precipitation has become increasingly unpredictable. Furthermore, threats to biodiversity, deforestation, and increased frequency of extreme weather events have affected agricultural production and undermined the livelihoods of the rural poor. High levels of poverty and the dependency on subsistence farming by a large portion of Nepalese farmers have limited the coping ability of the rural poor and increased the percentage of those who are food insecure (Rajbhandari, 2011).

Wetlands influence the climate as integral parts of river basins through their impact on the hydrological cycles at both global and regional scales and through regulating the atmospheric chemistry to a disproportionate extent in terms of their area. Some wetlands sequester large amounts of carbon (mostly as peat but also in biomass) over very long periods (from centuries to millennia), whereas others produce significant amounts of methane and nitrous oxide. Thus, wetlands can both mitigate climate change and act as its drivers. Wetlands have many direct and indirect benefits. Direct benefit of wetland is use of wetlands resources and services such as the fishing, food, medicine and wildlife harvesting. Wetland is source of education and research for academician, students and environmentalists. It also provides timber and fuel wood. It is a source of transport and water which is potential source of hydro power. Proper management of wetland supports recreation and tourism promotion. Indirect benefit of wetland is higher. It maintains support system such as nutrient cycling, bio-diversity, productivity, groundwater discharge; erosion protection and flood control have to be properly addressed. Landscape and aesthetic value have their importance as gift of nature in this particular area. It maintains micro-climate with unique eco-system and supports in integrated water supply

with Carbon sink. Therefore, wetlands are potential and very important for maintaining eco-system for present and future generation. Furthermore, wetlands are rich in biodiversity, good habitat and source of genetic resources.

Food insecurity and malnutrition are perhaps the most important consequences of climate change (IPCC, 2007). Indeed, between 1970 and 2000, climate change is estimated to have caused at least 160,000 deaths and 5 million disability-adjusted life years from four factors alone: malnutrition, malaria, diarrhea, and flooding (Cohen et al., 2008). According to the Food and Agriculture Organization's (FAO) 2012 "The state of Food Insecurity in the World" (SOFI) report, approximately 868 million people were undernourished between 2010 and 2012 (FAO, 2012). 852 million of these undernourished people live in developing countries with over sixty percent residing in South Asia and Sub-Saharan Africa (Cohen et al., 2008). Nepal is a country highly vulnerable to food security issues – a situation which impacts health, nutrition, livelihoods, and overall national security. The Food and Agricultural Organization of the UN considers Nepal to be a low-level food security country. Over 50 percent of all households in Nepal are not food sufficient for even half the year (FAO, 2012). Food deficiencies are most pronounced in hill and mountain-areas with 13 of 16 mountain and 21 of 39 hill districts having a severe food deficit. Nineteen of 24 districts in the mid- and far- western regions of Nepal are food deficit. Vulnerability to food insecurity is also on the rise because of climate change. Climate change impact is more visible in low land or disaster prone areas. At present, approximately 3.4 million Nepalese require food assistance and a staggering 6.4 million are chronically food insecure (FAO, 2004). As domestic food production is insufficient to meet per capita caloric needs, Nepal has become a net importer of food. Reliance on imports has made the poor increasingly vulnerable to price shocks and has exacerbated food insecurity. The majority of Nepal's population depends on smallholder farming for its livelihood. Many households operate on landholdings that are inadequate to produce enough annual food for survival. Certain families, particularly those from lower caste groups, manage landholdings within the *adhiya* (sharecropping on 50-50% basis) system; and are obliged to turn over a significant portion of their harvest to the wealthier or higher caste members holding the land. Nepal has been struggling hard for attaining sustainable livelihoods since past four decades. The population growth rate is growing at an average of 2.2 percent while food production is fluctuating from a high growth rate of 5 percent in 1981-85 to 2.2 percent in 1991-95 and 2.5 percent in 1996-2000. The per capita food availability, which had been growing strongly at 2.1 per cent in 1981-85 and 3.2 per cent in 1986-90, has shown a negative growth rate in recent decade (Mahbub, 2011). Widespread poverty is the major cause for food insecurity. Food insecurity and hunger remain widespread in Nepal, not only in food deficit districts but also within marginalized communities in districts with surplus food production. Food and financial crisis is gradually increasing. Nationally, 47 percent of the land owning HHs owned only 15 percent of the land with an average size of less than 0.5 ha, whereas the top 5 percent owned nearly 37 percent of land. Most Dalits are landless. A recent rough estimate by WFP stated that the minimum amount of land required for HHs self-sufficiency is approximately 0.54 ha (OCHA, 2008). The growing incidence of poverty and food insecurity in Nepal is an outcome of the economic process of a worsening income distribution pattern among the rural households. Employment opportunities have been further deteriorating the situation of poverty, food

insecurity and livelihoods (Rajbhandari, 2001). Besides these weaknesses and challenges, Nepal has a rich natural resource with high biological value of wetlands that include high biodiversity of plant and animal genetic diversity. Similarly, fresh water originating from the Himalayas created a many wetlands with beautiful natural environment. These facts indicate that Nepal has a good prospect of diversifying and increasing agricultural production by wetland management and conservation for alleviating poverty and attaining sustainable livelihood. Most of the wetlands of Nepal are originated by Himalayas. Rain fed farming is predominant in Nepalese agriculture, and in order to increase production per unit area it is highly recommended to adopt bio-intensive farming system that ultimately would result in food security and higher household income toward ensuring livelihoods of marginalised communities (Rajbhandari, 2010).

Rupa Lake is the third biggest Lake of Pokhara valley. It supports a number of floral and faunal species. The Lake is under pressure from diverse anthropogenic factors. Water birds of Rupa Lake face a number of threats including trapping/hunting, fish farming using nets, habitat destruction by soil erosion, sedimentation and agricultural conversion, human disturbance, water pollution and eutrophication (Kafle et al., 2008). In order to cope with the current stresses to livelihood, Nepalese farmers have adopted several strategies for coping with climate change and food insecurity, many of which are unsustainable over the long term. Many methods exist that offer great potential for improved community based adaptation to occur in Nepal. These include incorporation of agro-ecology and agroforestry into current farming systems, improvement of water management, livelihood diversification, and climate risk management.

This research aims to explore the role wetland plays to food production and food security as well as income generation at micro level in Rupa Lake area in Kaski district. Moreover, this work also looks over the effect of interventions people have made to wetlands condition in a broader framework of climate change.

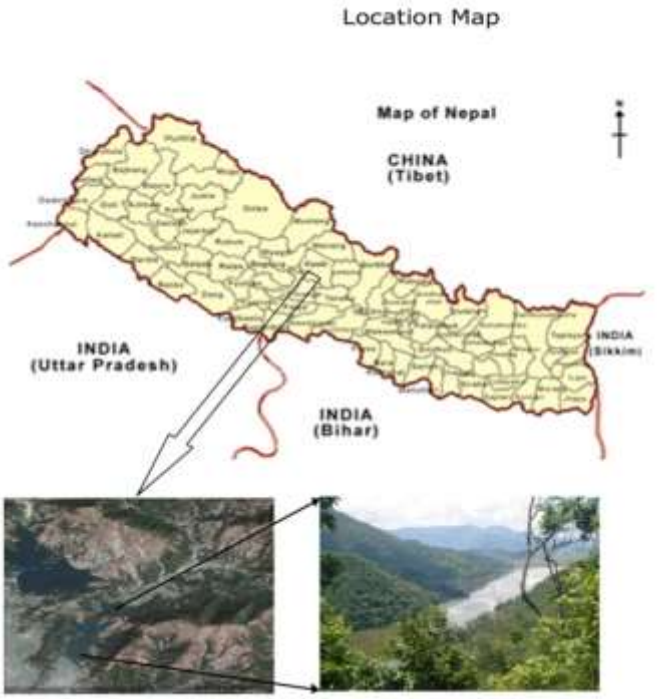
RESEARCH SITE AND METHODOLOGY

Research site

This study was carried out in 2012-13 in Kaski district at Rupa Lake area. Research was conducted by collecting both primary and secondary data. Rupa is a small advancing eutrophic Lake that falls in 4 VDCs and wards 10 & 11 of Lekhnath Municipality in Kaski district of Nepal ($28^0$08'39.72"N and $84^0$06'29.29"E). It covers an area of 115 ha with marshes and paddy field along its shores in its basin of 30 sq. km. Lake area represents humid upper tropical and lower subtropical climate with mean annual temperature 19.3^{0}C and precipitation 3157 mm.

Betani, Libiyani, Syaglung, Tal Bensi, Majhi Gaon, and *Devithan* in the north, *Panchbhaiya* and *Sundare Danda* in east, *Bhangara* and *Jamunkune Gaon* in west and *Talpari* in the south are major settlements. A total of 49749 (CBS, 2001) people resides in the basin areas with its 47 percent comprising to male and 53 percent to female. By ethnicity, 28.8 percent are Janajati, 53.5 percent Brahmin-Cheetri, 14.5 percent

occupational caste and 3.2 percent others. The major occupation is subsistence agriculture. A very low percent of population are engaged in small business and hotel operation. The major occupation is subsistence agriculture (Oli, 1996).



There are 8 main vegetation types with 379 genera and 128 families that comprise 128 tree species and 85 herbs and shrubs that comprises of 25 endangered, 13 threatened, 5

rare and 2 vulnerable species of wetlands plants. Lake is a hotspot of a native of wild rice i.e., *Oryza nivara*. Species of 2 toads and 4 frogs; 14 reptiles, 104 birds including 14 migratory birds and 34 mammals also are known to occur here. Of birds, 90 species are endemic (Oli, 1996). Initially, lake area was bigger than what it is today. Over 60 percent of Lake area has been lost (IUCN, 1996) which is also evident from an elderly response of local people that Lake was 215 ha in 1964 which has been reduced to 115 ha by 2000. There are no measures yet practiced to minimize high sediment inputs fed by *Talbesi, Dovan* and *Khurlung* Kholas and other streams. Further, two temporary roads in east and west are under construction with the use of heavy machines that also has contributed to the process of sedimentation into the Lake.

Deforestation in Rupa watersheds follow a history of construction of Highway that connects Pokhara with Kathmandu during 1960s and subsequent urbanization at Lake basin areas at the cost of denudation of forest. Deforestation became very intense during 1970-1979. The denudation process continued to accelerate until it reached its peak during the referendum in Nepal in 1992. Major urban settlements are found rapidly expanding like *Sundare Danda; Talbesibazar; Dihibazar* and *Bhangara*. There are no interventions adopted to regulate domestic disposals, used water, overflow and seepage from septic tanks and latrines.

Sampling technique and sample size

Stratified random sampling technique (SRST) was used for the questionnaire-based household (HH) survey. Settlements were selected with heterogeneous ethnic groups. In addition to this, gender, caste, educational status and dependency of the people on wetland were the criteria used for selecting sample. Number of sampled HH in each selected location was as given in Table 1.

Samples were taken within impacted areas of wetland (2 km radius of core Rupa Lake area and dependency to the Lake areas). Altogether 20 percent of HHs was surveyed in impacted area. Sisteni, Upper Talbesi, Chaur, Devisthan, Stream Side (Khola Chau), Sundari Dada, Lower Talbesi, Jamankuna Bhangara, Simaldada settlements were sampled as research site. Out of the 532 HH of the research site 70 HHs were selected for direct HH survey.

Data collection

The primary data were collected through field observation, group meeting, focus group discussion, semi-structured interview, stakeholder consultation and laboratory analysis of water quality. Meteorology data were referred from the Department of Hydrology and Metrology, Nepal.

Research team had done preliminary study in September, 2012 following the procedures of rapid reconnaissance in the Rupa Lake area. In this reconnaissance, the research team did transact tour in Lake Side, and conducted meeting with the Chairperson of Rupa Lake Restoration and Fishery Cooperative to share about the purpose, objectives, methodology; and also to make field arrangements to facilitate the research work. With the support of Chairperson, enumerators for survey were selected. Some members of the Cooperative were also consulted during the visit. Draft questionnaire was tested and changes were made accordingly during that visit.

Table 1. Name of settlement and sampled areas

SN	Name of sampled place	No of sampled HH	No of affected HH in settlement
1	Sisteni	10	150
2	Upper Talbesi	6	50
3	Chaur	7	40
4	Devisthan	8	50
5	Stream Side (Khola Chau)	8	50
6	Sundari Dada	10	60
7	Lower Talbesi	8	50
8	Jamankuna	4	26
9	Bhangara	8	50
10	Simaldada	1	6
	Total	70	532

Individual meetings/workshop was conducted in the second time survey with different stakeholders. Interview and discussions were carried out with VDC leaders, villagers/ elders, different stakeholders and community people. Focus Group Discussion (FGD) was done based on key questions. In the mean time, community expectation from the Lake was also collected during the discussion.Collection and review of existing data and information relevant to the area and topic were done from secondary sources.

Food security assessment

Household Food Insecurity Access Scale (HFIAS) tool was used for the measurement of food insecurity as suggested by Coates, J., Swindale, A. and Bilinsky, P. (2006). A set of nine questions was used as a research tool, and the data analysis was done as per the tool. The questions used were as follows:
Q 1. Did you worry that HH would not have enough food?
Q2= Were you or any HH member not able to eat the kinds of food you preferred because of lack of resources?
Q3= Did you or any HH member eat just a few kinds of food day after day due to lack of resources?
Q4= Did you or any HH member eat food that you preferred not to eat because a lack of resources to obtain other types of food?
Q5= Did you or any HH member eat a smaller food than you felt you needed because there was not enough food?
Q6= Was there ever no food at all in your HH because there were not resources to get more?
Q7= Did you or any other HH member eat fewer meals in a day because there was not enough food?
Q8= Did you or any HH member go to sleep at night hungry because there was not enough food?
Q9= Did you or any HH member go a whole day without eating anything because there was not enough food?

The Household Food Insecurity Access Scale (HFIAS) indicator categorizes households into four levels of household food insecurity (access) food secure, and mild, moderately and severely food insecure. Households are categorized as increasingly food insecure as

they respond affirmatively to more severe conditions and / or experience those conditions more frequently. Food security was categories as following condition:

1. Food Secure: Household experiences none of food insecurity (access) conditions, or just experiences worry, but rarely.
2. Food Insecure: This situation was divided into the following 3 conditions:
a. Mild Food Secure: A mildly food insecure (access) household worries about not having enough food sometimes or often, and or is unable to eat preferred foods, and /or eats a more monotonous diet than desired and or some foods considered undesirable, but only rarely. But it does not cut back on quantify nor experience any of three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating).
b. Moderately Food Insecure: Household sacrifices quality more frequently, by eating a monotonous diet or undesirable foods sometimes or often and or has started to cut back on quantity by reducing the size of meals or number of meals, rarely or sometimes. But it does not experience any of the three most severe conditions.
c. Severely Food Insecure: Household has graduated to cutting back on meal size or number of meals, often, and or experience any of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating), even as infrequently as rarely. In order words, any household that experiences one of these three conditions even in the last four weeks (30 days) is considered severely food insecure.

Meteorological data

The monthly meteorological data for the last 30 years were taken from Pokhara Airport station, which is the closest meteorological station to Rupa Lake. The meteorological data included minimum, maximum and average temperature, and rainfall. These data were computed to reveal the climate change in terms of temperature regime and rainfall in the study area. The result was also used to verify local people's experience/perception in this regard.

Data analysis

SPSS and Microsoft Excel were used to process and analyze the data. Both qualitative and quantitative methods were used for the analysis.

RESULTS AND DISCUSSION

Climate change: meteorological data and people's experiences

Meteorological data were taken from Pokhara Airport station, the nearest meteorological station to Rupa Lake. Two major parameters taken were temperature (maximum, minimum and average) and rainfall. It showed the increasing trend of temperature (average, maximum and minimum) by about 2^0 in 30 years (Figure 1, 2, and 3). The average temperature incfeeasedd from 26 to 28, maxiumum temperature increased from 30 to 32^0 C, and minimum temperature increased from 16 to 18 ^{0}C.

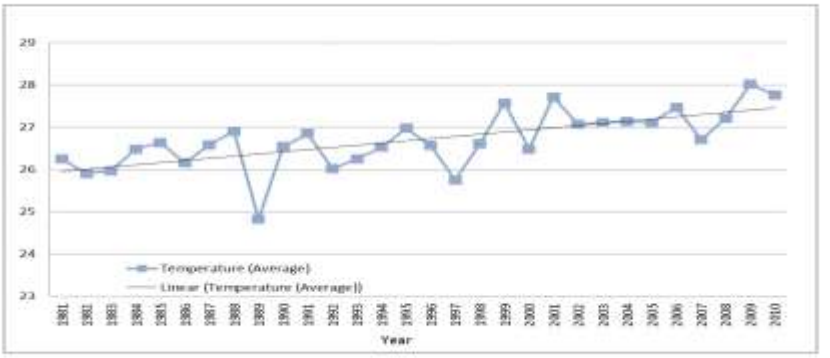


Figure 1. Trend of average temperature change in 30 years

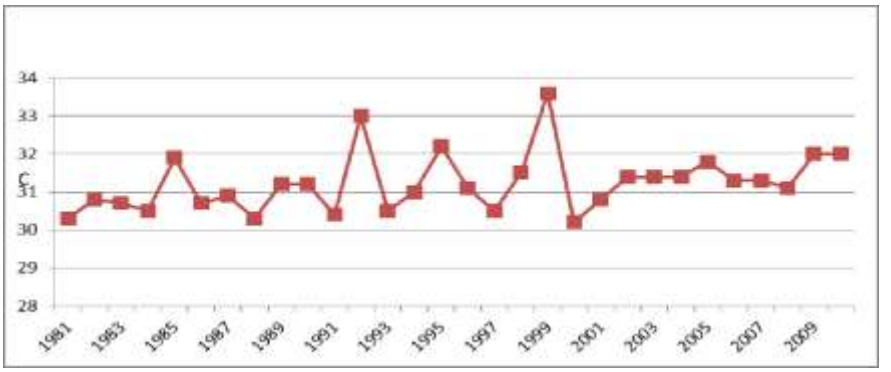


Figure 2. Trend of Maximum Temperature change in 30 years

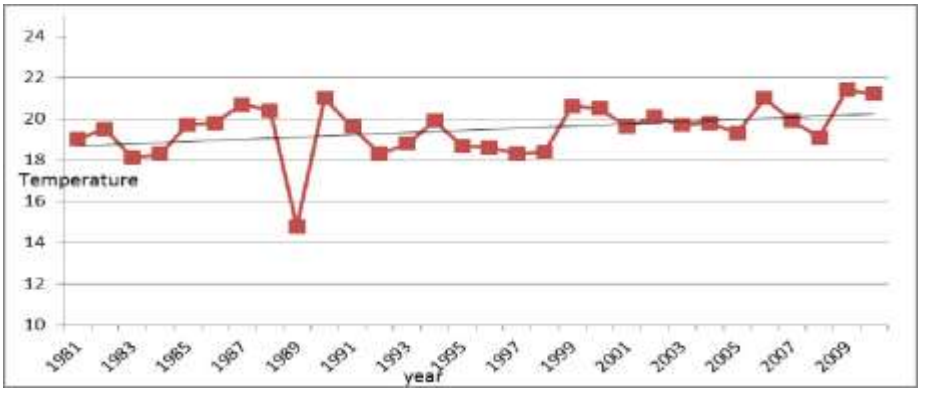


Figure 3. Trend of Minimum Temperature change in 30 years

However, rainfall pattern was observed oscillating (Figure 4). It is evidenced that the meteorological data and people's perception were similar in the context of climate change.

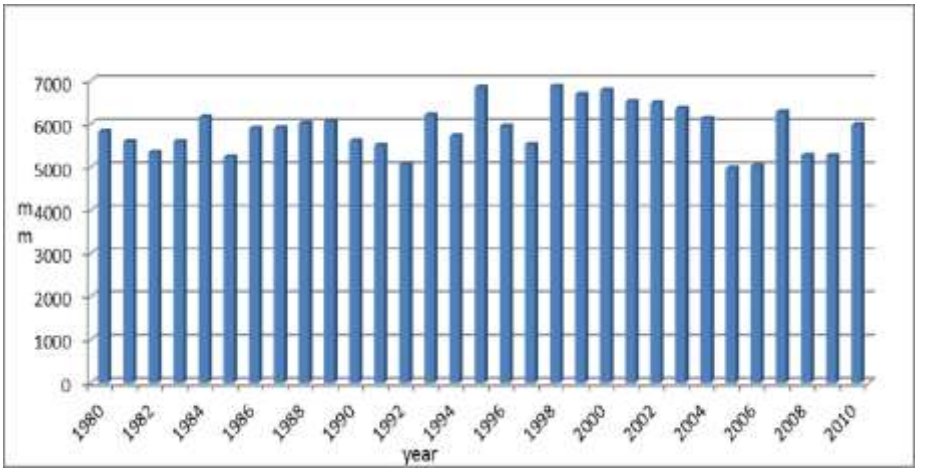


Figure 4. Trend of rainfall pattern change during the last 30 years

Of the total sampled households (50), 92 percent shared their experiences regarding the change and impacts of climatic parameters, wetland ecosystem, agriculture system, food security and livelihoods. Rise in temperature, unpredictable rainfall, shift in rainfall pattern and phenological changes in plants were the indicators of climate change (Figure 7). During the last one decade, long period drought, unpredictable drought, flash floods, loss of biodiversity and phenological changes in plants were the most visible impacts that 50 percent or more local respondents pointed out (Figure 5).

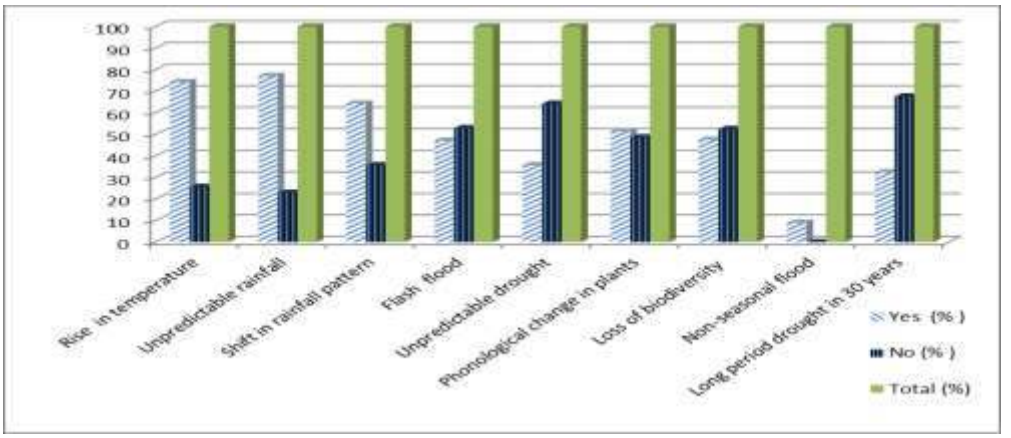


Figure 5. Visible impact of climate change in people's experience (%)

Climate change, agriculture and livelihoods

Majority of the households in the study area depended in agriculture for their livelihoods. Out of the 70 households, 87.1 percent the household were involved in agricultural practices. Average land holding size of HH is 0.34 hectare. More than 57 percent HH have 0.05-0.25 hectare of land holding. Most of the landless people have taken other's land for farming on contract basis. The major field crops grown in the study area are paddy, maize, finger millet, wheat, barley, buckwheat, beans and lentils. Paddy is the major crop grown in this area which stands for 90 percent. But the cereals (energy food crops) produced locally is not sufficient for the food security of all the households in the area.

Impact of climate change in agriculture, particularly crop production, and livelihood is very crucial. In relation to agriculture production more than 54 percent respondents reported that crop production is decreasing while 12 percent respondents reported that production is as it is. It should be interpreted as negative impact of climate change in provision of food to the people. If climate change affects the crop production negatively, it will create the serious consequences on the level of food production and food security in the country. Because of the impact of climate change in the study area, 65.7 percent of the respondents stated that the decrease in food production was due to the effects of climate change, i.e. unpredictable or prolonged drought. Besides this, incidence of diseases and insects are common problems. Lack of improved seeds, technical know-how, manure and fertilizers, irrigation facilities and widely prevalent traditional methods of cultivation were other major problems faced by the local farmers. Rain-fed farming system is yet a common practice on the uplands above Rupa Lake wetland area. It was found that more than 90 percent of the households cultivated paddy and only 10 percent cultivated maize.

Major vegetables cultivated in the study area were potato, tomato, cabbage, cauliflower, leafy vegetables, cucurbits, and beans. Above 85 percent of the respondents have been cultivating vegetables for household consumption only, while 15 percent of the households use to sell vegetables besides household consumption. Banana and Guava were the commonly grown fruits in the study area. Besides contribution in nutritional security, the vegetables and fruits were making around 45 percent contribution in income generation for supporting livelihoods.

Some farmers in the study area reported that the climate change has had visible impacts on agriculture, forestry and wetland, and therefore in their lifestyles and livelihoods. They remarked that the climate has changed, not because they know much about global warming but because of their long experiences with the realities of local environment. Local farmers have adapted different coping strategies.

Subsistence nature of farming system is rampant in the study area. The average landholding size including both self-owned and leasehold was 0.48 hectare (9.52 ropani), out of which the highest percentage of the households (>37%) holding the land was 0.25 hectare (0-5 ropani) (Figure 8). Of the total, the average of 0.13 hectare (2.75 ropani) of land was practiced on leased land mostly by the landless households. More than two-third (70%) of the households had small farms of 0.51 hectare (<10 ropani).

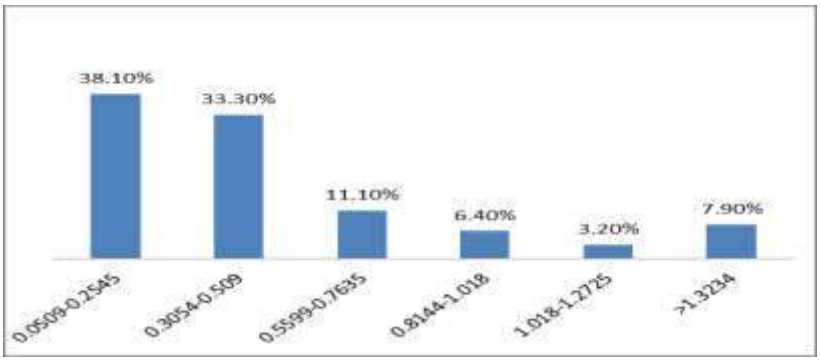


Figure 6. Land holding size of the households

Impact of climate change on food crops production and food security

The following impacts of climate change were realized in the context of food security system during the last 30 years in the study area (Table 2). Above 65 percent of the respondents stated that as an impact of climate change there has been decline in crop production. However the national agricultural statistics of the MoAD (as cited by Rajbhandari and Bhatta, 2008) does not agree with this statement of that locality.

Table 2. Impacts of climate change in food production during the last 30 years

SN	Impact of climate change	Percent	Remarks
1	Decline in food production	65.7	
2	Threats in livestock husbandry	15.7	
3	Increased vulnerability	4.3	People could not respond properly
4	Have no idea	31.4	

It was found that 50 percent of the households produced food to meet their annual requirement, while the rest households did not have enough food production to meet their annual requirements (Figure 9). Twenty six percent of the households produced food from their own land that fulfilled their food requirement for 6 to 9 months only. There were 5 percent households that met their food requirement only for less than 3 months with their own production. The average production of the paddy in the study area was 2451 kg/ ha which is lower than that of the national average production for mid hills of 2706 kg/ha (MoAC, 2009).

Altogether there were 392 family members, out of whom 155 were adult male, 144 adult female and 93 were counted as children in the family members. The average family size in the sampled household in the study area was 5.68, which is higher than the national average (4.88); and majority of the households (42%) had 5-7 members in their family. In the study area, majority of the households had similar kinds of the livestock (cattle,

buffalo, goat, and poultry). Ninety percent of the households reported that livestock has been contributing to their food/nutritional security.

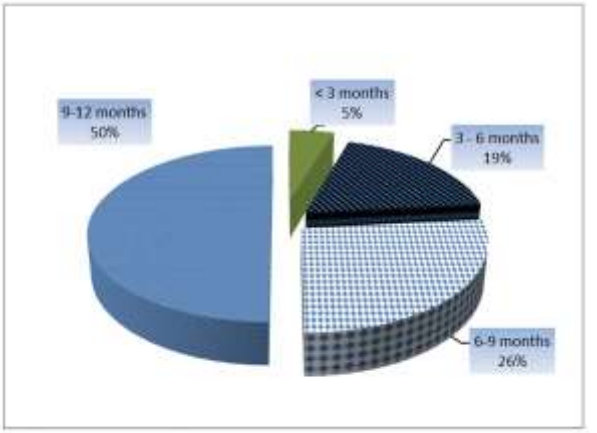


Figure 7. Food secirity status in study area

People were also relying upon the nearby watershed and wetland area to meet the demand of food security. They were also relying upon various wetland and forest resources to escape from the food insecurity. However, people were willing to do bee keeping, coffee production and fish farming, commercial poultry farming and *ayurvedic* (herbal) medicine production as alternative source of income for their livelihoods.

Adaptation strategies to climate change for crop production and food security

Subsistence farmers have adopted different strategies to cope with climate change because of the less food production in the study area. About 74 percent of households were found aware about the effect of climate change and had adopted different strategies to cope with the effect of climate change. Out of the 74 percent of HHs, more than 50 percent of the households use chemical fertilizers and agriculture inputs to cope against the climate change and to increase the crop yields. Only these coping strategies are not effective to resist against the climate change effect. All other strategies adopted against the climate change are very few and insignificant to resist the effect of climate change. Many households are unknown and do not adopt any types of strategies too. All these problems directly affect the production of these major crops.

Most common strategies included use of chemical fertilizer/pesticides, hybrid/improved seeds, use of bio-gas and change in agriculture farming system. About 77 percent, 52 percent and 50 percent of the respondents had adopted chemical fertilizer/ pesticides, bio-gas and increased agriculture input such as compost & bio-fertilizer as coping strategies for climate change, respectively (Figure 8).

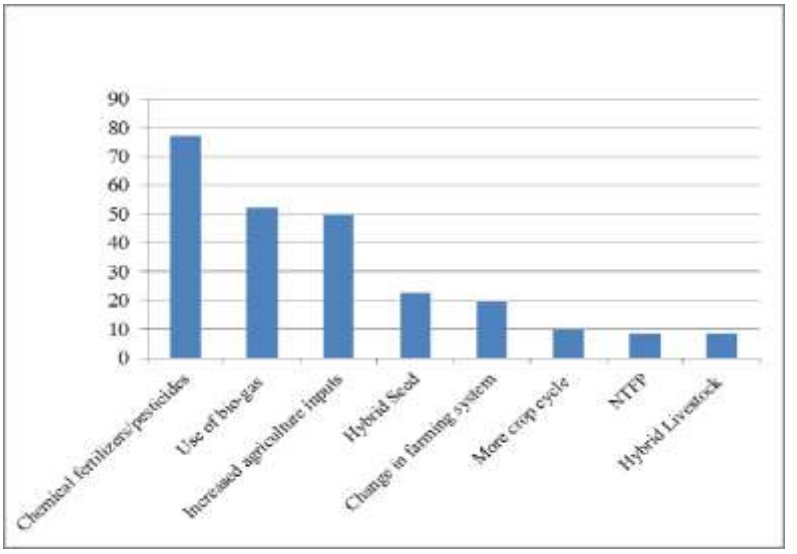


Figure 8. Adaptation strategies to climate change for crop production and food security (%)

As discussed above, climate change had negative impact on crop production that has direct relationship with food security. If climate change negatively affects the crop production, it creates serious consequences on the level of food / nutritional security. Therefore, subsistence farmers have adopted different strategies to cope with climate change because of the decline in food production. About 74 percent of households were aware of the effect of climate change, and therefore had adopted different strategies to adapt to the effects of climate change. Most of them reported that they were adopting mixed cropping; and were using short duration crops. Almost all of the respondents reported that they were using organic manure / compost and bio-pesticides whenever need arises. Out of the 74 percent of HHs, more than 50 percent of the household use bio-fertilizers or composts to cope with the climate change impact and to increase the crop production. Only these coping strategies are not effective to reduce the impact of the climate change. All other strategies adopted against the climate change are very few and insignificant to resist the effect of climate change. Many households are unaware and do not adopt any strategies at all. All these problems directly affect the production of agricultural crops.

Irrigation is also the important factor to increase the agricultural production. Irrigation here is mostly done in the nearby wetland and watershed area. Among the respondents, 36.4 percent of the households stated that they are using water for irrigation from the nearby watershed area. But huge proportions of the farmers are still not using water for the irrigation purpose. However, Pokhara valley is the most frequently precipitated area during the monsoon season and so most of the farmers rely upon the rainfall for their agricultural production. Only during the off season production less rainfall may affect the production in that area, where water is not available for irrigation. So decrease in food

production may not only be the result of less water in that area because of irrigation facilities for off season crop, it may also include other different climatic parameters such as unpredictable rainfall and shifting pattern of rainfall.

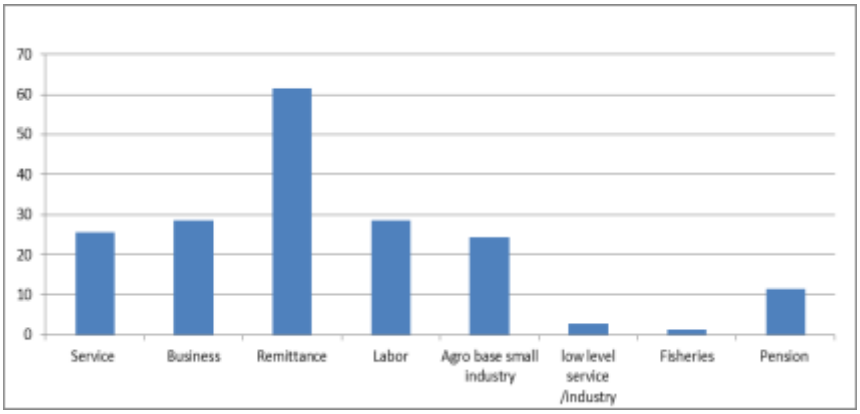


Figure 9. Alternative source of income for food Security

The only coping strategies for climate change effect on agricultural production are insufficient for the food security in the study area. Besides agriculture, people are involved in different alternative source of income generation for livelihoods. Vulnerable households for the food security often responded by skipping meals, reducing food intake, selling assets like livestock, temporary migration for employment, cross boarder migration and daily wage labor are some common strategies adopted to reduce the food insecurity among the family members (Figure 9).

Alternative source of income for food security

Remittance has become the highest priority for alternative source of income in the respondents' household. 61.4 percent of the households informed that at least one household members are abroad to earn money to secure food and livelihood. People are willing to do bee keeping, coffee production and fish farming, poultry, and use non-timber forest products for *ayurvedic* (herbal) medicine production as the alternative source of income for livelihood. Storage of food is also helpful in food security. All cereals storage technique is traditional. It means 10-30 percent losses are caused by rodents and pest. More than 80 percent of the households practice vegetable drying when they have adequate vegetables. About 60 percent make pickles (*achaar*), do value addition to vegetable and pulses (m*aseura / titaura)* and produce fermented vegetable-based products (*gundruk, sinki*).

Food insecurity assessment

The HFIAS indicator categorizes households into four levels of household food in/security (access), viz. food secure, and mild, moderately and severely food insecure.

Table 3 illustrates this categorization. The categorization scheme is designed to ensure that a household's set of responses are placed in single, unique category.

Table 3. Categories of food insecurity (access)

Q. No	Never % (# of sample)	Rarely (once or twice in past 30 days)	Sometimes (three to ten times in the past 30 days)	Often (more than ten times in the past 30 days)	Percentage of sample (in bracket is # of sample HH)
Q1	57.1 (40)	15.7 (11)	17.1 (12)	10 (7)	100 (70)
Q2	14.3 (10)	22.9 (16)	34.3 (24)	28.6 (20)	100 (70)
Q3	15.7 (11)	27.1 (19)	38.6 (27)	18.6 (13)	100 (70)
Q4	20.0 (14)	32.9 (23)	31.4 (22)	15.7 (11)	100 (70)
Q5	87.1 (61)	4.3 (3)	4.3 (3)	4.3 (3)	100 (70)
Q6	92.9 (65)	5.7 (4)	1.4 (1)	-	100 (70)
Q7	94.3 (66)	5.7 (4)	-	-	100 (70)
Q8	95.7 (67)	4.3 (3)	-	-	100 (70)
Q9	97.1 (68)	2.9 (2)	-	-	100 (70)

Note: A. Food *Secured: green; mildly food insured: light red; moderately food insecured: yellow; and severely food insured: Red.*
B. Questions are presented in the methodology section.

Food Security assessment done by HFIAS method revealed the following food security situations in the study area.

1. **Food secured households:**
   It was found that 57 percent of the HHs never worried about food quality and quantity. Those were food secure households (Table 4).
2. **Food insecure households:**

a. **Mildly food insecured**: From the study, it was found that 32 percent of the households were midldly food insecure (Table 4). They worried about not having enough food or unable to eat preferred foods rarely, and /or ate monotonous diets or less preferred foods.

b. **Moderately food insecured:** It was found that 6 percent of the HHs was moderately food insecure (Table 4). These households sacrificed quality more frequently by eating monotonous diet or undesirable foods sometimes. They had started to cut back on quantity by deducting size or number of meals sometimes.

c. **Severely food insecured**: It was found that 4.3 percent was severely food insecure, i.e. they cut on the meal size or number of meals often, or experienced any of the three most severe conditions (running out of food, going to bed hungry, or going a whole day and night without eating) even as infrequently as rarely in last 30 days. It is considered as severely food insecure (Table 4).

Table 4. Assessment of food security by HFIAS score method

SN	Status of food security	%	Remarks
1	Food secured	57	From different sources of income
2	Mildly food insecured	32	
3	Moderately food insecured	6	
4	Severely food insecured	5	

CONCLUSION

It was found that majority of population (87%) of Lake basin was dependent on agriculture for food security and livelihoods. The status of community forest and lake environment has improved in the period of last 10 years because of conservation practices initiated by local communities including the Rupa Lake Restoration and Fishery Cooperative. subsistence farmers have adopted different strategies to cope with climate change because of the decline in food production.

About 74 percent of households were aware of the effect of climate change, and therefore had adopted different strategies to adapt to the effects of climate change. Most of them reported that they were adopting mixed cropping; and were using short duration crops. Almost all of the respondents reported that they were using organic manure / compost and bio-pesticides whenever need arises. Out of the 74 percent of HHs, more than 50 percent of the household were using bio-fertilizers or composts to cope with the climate change impact and to increase the crop production.

There was a year-round food security for 50 percent of sampled HHs, with 22 percent of those HHs having surplus food. Estimation of food security using HFIAS method revealed 57 percent of the households having food security. Based on the questionnaire survey five percent of HHs was found having food security for less than three months while 19 percent of the HHs had food security for more than six months. Estimation of Household Food Insceecurity Scale revealed 32 percent of the households facing mild food insecurity, 6 percent- moderate food insecurity and only 5 percent – severe food insecurity.

In the study area, during the last one decade, long period drought, unpredictable drought, flash floods, loss of biodiversity and phenological changes in plants were the most visible impacts that 50 percent or more local respondents pointed out. Over 90 percent of the HHs responded to climate change variously, i. e. in the form of rise in temperature (by 74% of the respondents); unpredictable rainfall (by 77%); shift in rainfall (by 64%); and phonological changes in plants (by 51%). Meteorological data showed that during the last 30 years average temperature rose by 2^0 C while fluctuation of annual rainfall had abrupt pattern; and it was visible that during the year 2005 to 2010 annual rainfall decreased to 5000 mm (from average of 6000 mm/year) except in the year 2007 (6000 mm/year) and 2010 (5800 mm/year). Of the total sampled households (50), 92 percent shared their experiences regarding the change and impacts of climatic parameters, wetland ecosystem, agriculture system, food security and livelihoods. Rise in temperature, unpredictable rainfall, shift in rainfall pattern and phenological changes in plants were the indicators of climate change.

ACKNOWLEDGEMENT

This paper is a part of the research project supported by the University Grant Commission. Sincere acknowledgement is hereby extended to the University Grant Commission for providing financial assistance to conduct the research project.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Genotypic variation in lettuce in response to soil water and nutrient stress

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ABSTRACT

The experiment aimed to analyze the genetic variation in coping mechanism in two different lettuce cultivars and to assess whether these varieties differ in shoot and root development and resource utilization under water and nutrient stress conditions. Two modern cultivars (B & D) were selected for this experiment. The experiment was conducted in controlled greenhouse conditions in the Wageningen University and Research Centre, the Netherlands in 2011. There were five treatments: 1) control, 2) water stress in top layer, 3) nutrient stress in top layer, 4) water stress in top layer and nutrient stress in bottom layer, and 5) nutrient stress in top layer and water stress in bottom layer. No statistically significant genotypic variation was foound in coping mechanism, shoot and root development or resource utilization in lettuce under water and nutrient stress condition. This might be because the genotypes selected for the experiment were not distinctly different, so they showed similar responses to the stress conditions imposed. And, it may be due to a pot experiment where the soil volume available was entirely exploited by the root system, even under stress; and therefore genetic variation in root development might not be expressed themselves under such conditions. It has been suggested that further investigation should be done under field conditions.

Key Words: lettuce, water stress, nutrient stress, genotypes

INTRODUCTION

Lettuce is an important salad crop in Europe (Eyder, 2002). About 10,000 hectare is cropped for butter head lettuce in the open field in the Netherlands. Organic lettuce is sold in specialized health food stores in limited quantity but no organic lettuce is available in the Dutch supermarkets because of the problem in regular supply of sufficient and adequate lettuce (Struik and Lammerts van Bueren, 2009). This is because organic farming aims at optimizing the production system more than the individual crop yield, thus uses organic manure and often with less frequent irrigation.

Nutrient and water availability affect the root mass distribution. If water is limited on the surface of the field, root growth is restricted to near surface but lettuce (*L. sativa*) plants compensate to some extent by producing more roots in the deeper soil layers. However, *L. sativa* cv. *Salinas* produces more lateral and external links at the top of the tap root, which is the zone of highest water and nutrient availability whereas the *L. serriola* (wild

lettuce) produces more lateral and external links in the lower zones, which may access a deeper supply of moistures and nutrients (Jackson, 1995).

Plants sense the water availability around the roots, and respond by sending chemical signals to the shoot to show several adaptive responses, including decrease in leaf expansion growth and stomata closure; and this can occur without any change in shoot water relations (Davies and Zhang, 1991). One of the drought adaptation strategies for a plant is the development of a deep and extensive root system (Kondo *et al*., 2003). In fact, the size, architecture and distribution with depth of plant root systems affect the acquisition of soil water and consequently, the water status and dry matter production of the shoot. In the greenhouse experiment of Gallardo *et al.* (1996), with cultivated lettuce (*L. sativa*) and wild lettuce (*L. serriola*), final shoot production was reduced only in *L. sativa* when surface of the soil (0-20cm) was dried. This different response was explained by differences in root distribution because allocation of the total biomass to roots in *L. serriola* was double than that of *L. sativa*.

Different genotypes of the same species can have different adaptation mechanism in different water conditions. For example, upland adapted *japonica rice* CT9993 is well adapted to rainfed low land condition, which has deep, thicker root system and strong root penetrating ability (Wade *et al*., 2000; Azhiri-Sigari *et al*., 2000; Samson *et al*., 2002); and low land adapted *indica* rice IR 62266 has contrast adaptation mechanism which has a shallow root system (Azhiri-Sigari *et al*., 2000; Wade *et al*., 2000; Nguyen *et al*., 2004)

There are many modern varieties of lettuce, which are bred for maximum yield under optimum water and nutrient supply. These modern varieties often have shallow root systems (Johnson *et al.*, 2000). Among them, still some varieties have variation in the root system. For example, variety B and D differed in the vertical profile of the root depth distribution. There is not yet any research conducted to answer whether these varieties can adapt to water and nutrient stress in the field.

This experiment was therefore conducted with the aim to analyze the genotypic variation in lettuce in its response to soil water and nutrient stress. Our research objectives were: 1) to analyze the genetic variation in stress coping mechanisms in two contrasting lettuce cultivars and 2) to analyze how varieties differ in shoot and root development and resource utilization under stress.

MATERIALS AND METHODS

The experiment was conducted in a greenhouse of Unifarm, Wageningen University, the Netherlands from 18th of February 2011 to 6th of April 2011. The experiment was carried out in a randomized complete block design with five treatments, four replications, three times sampling and two varieties. A single experimental unit consisted of one pot. One block consisted of 30 pots in two rows. Pots were placed 30 cm apart. Distance between blocks was 75 cm. Day and night lengths were maintained at 12 hours. Ambient CO2 concentration was approximately 33 m mol (c) m^{-3} (air) (400 ppm). During the growing

period, when sunlight levels were too low, 16 SON-T agro lamps with each 400 W were used to provide additional light. The lamps were switch on when the external light intensity dropped below 150 Wm^{-2} and when the light increased beyond 250 Wm^{-2} they were switched off automatically. Day temperature was set to 24 degrees C and night temperature 15 degrees C. Air moisture was maintained at 60%. 20×30 cm^2 plastic pots were taken. Pots were insulated outside to prevent temperature fluctuation. Each layer in the pot was filled separately. Two layers in a pot were separated by Vaseline layer to prevent the water leakage from the top layer and nutrient movement from one layer to the other. To irrigate the bottom layer, special irrigation pipe was inserted through the Vaseline layer. To prevent evapo-transpiration an isolating disc was placed on top of the pot after transplanting. 26 days butter head summer lettuce varieties B and D (Vitalis Biologische Zaden B.V, The Netherlands) were planted in the pots.

Treatments were the combination of various water and nitrogen levels in the top (0-20cm) or bottom (20-40cm) layer of the pot. Low water level was maintained at 6.86% moisture content and high water level was maintained at 14.8% moisture content. 7 g of fertilizer per layer was applied for no nutrient stress condition whereas 2 g of the fertilizer was applied per layer for nutrient stress condition. The fertilizer had the composition in a ratio of 9:3:3 of nitrogen, phosphorus and potassium. Fertilizer was applied only once initially during soil moisture preparation.

Moisture content in the pot was monitored by daily weighing. All levels of stress were maintained constant from the beginning of the trial (transplanting date) until the end of the experiment (final harvest).

The experiment followed a three split sampling strategy to observe shoot and root development over a different time span. The first, second and last sampling was done at 18, 32 and 48 days after transplanting to allow roots to reach the bottom of the pot. All samplings were done between 8:00 to 11:00 am. Each sample consisted of four replications in each treatment per variety in all 40 pots.

Leaf counting and fresh weight of the samples were taken on the same day of harvesting. Leaf area was calculated by leaf area meter. For dry weight measurement, leaf material was put in oven at 70 degree Celsius for 24 hours.

A pot's soil was kept in 4 separate plastic bags according to its layer depth, i.e. 0-10 cm, 10-20 cm, 20-30 cm and 30-40 cm. First the layers were rinsed with water through 2 mm sieve so that soil materials run out. Organic matter from the root samples was removed by hand. Left over roots were kept in a plastic bottle with water for root scanning. Root length was determined with WinRHIZO Pro software and an Epson 1680 modified flatbed scanner (Reagent Instrument, 2007 V 2005 b). After scanning, roots were put in the oven at 70 degree Celsius to dry for the dry weight.

A soil sample of 200 gram per layer was taken for moisture content measurement. It was dried in oven at 70^0C. 10 gram soil from dried one was separated for nitrate analysis. Soil nitrate was analyzed by Thermo Fisher ISE electrode method. 30 g of soil sample was

mixed with 100 ml of water. Three solutions with known concentration of nitrate (0.0001 M, 0.0005 M and 0.001 M) were used to set the calibration curve.

Statistical analysis was done through Genstat 13th edition. Root biomass or length for the different treatments for each layer was compared using Bonferroni test, following the procedure GLM, Genstat 13th edition.

RESULTS AND DISCUSSION

Shoot Development

Shoot growth rate

In the overall analysis, the treatment effect was significant for growth rate based on fresh weight ($p<0.001$), dry weight ($p<0.001$) and leaf expansion rate ($p=0.014$) but not for leaf appearance rate ($p=0.421$). Statistical analysis did not show any varietal effect or interaction between variety and treatment for shoot growth rate. Growth rate based on fresh weight was the same for T1 and T3 whereas it was higher than T2, T4 and T5 (Table 1). Dry matter production rate was greatest for T3; and it was comparable with control. The lowest dry matter production rate was for water stress in top (T2). Leaf expansion rate was significantly lowest for water stress in top (T2) whereas other treatments were comparable with control. Although shoot growth rate was not significantly different for two varieties, it was reduced significantly by water stress in both varieties. This might be because cell growth and expansion might have decreased due to reduced cell turgor during stress condition which causes reduction of CO_2 assimilation in light due to stomata closure that impedes inwards passage of CO_2 (Hsiao, 1973).

Table 1. Multiple comparisons between different treatments for shoot growth rate.

Shoot growth rate	T1	T2	T3	T4	T5
Growth rate based on fresh weight	0.0554^{b}	0.0521^{a}	0.0543^{b}	0.0529^{a}	0.0528^{a}
Growth rate based on dry weight	0.0596^{cd}	0.0562^{a}	0.0600^{d}	0.0572^{ab}	0.0581^{bc}
Leaf expansion rate	0.0485^{b}	0.0469^{a}	0.0486^{b}	0.0477^{ab}	0.0476^{ab}

Shoot characteristics

Multiple comparisons for different treatments over shoot characteristics have been shown in table 2.

Fresh weight: Treatment effect was highly significant ($p<0.001$) for all shoot characteristics at each degree days. Varietal effect was found significant in only fresh weight (g) ($p<0.05$) and leaf area (cm^2) ($p<0.01$) only at final harvest (768 degree days). Variety B had higher fresh weight (315 g) and leaf area (6565 cm^2) than variety D (299 g, 5975 cm^2) which was 5 percent and 9 percent more, respectively. Variety B had significantly more leaves than variety D at all degree days ($p<0.001$).

Dry weight: Significant lowest dry weight was in T2 as 0.77g, 5.41g and 20.76g at 288, 512 and 768 degree days which was 55 percent, 53 percent and 33 percent reduction, respectively as compared to control treatment (Table 2). At the end, T2 and T4 had same effect in dry matter production. But T5 had affected less than those two treatments (T2 and T4). On the other hand, T3 did not affect for the reduction of shoot dry matter.

Leaf area (cm^2): T2 had significantly lower leaf area at all degree days than the control treatment. T4 had results comparable with those of T2. T3 did not affect leaf expansion at any degree days. At the end, T5 had results comparable with those under T3 and T1.

Specific leaf weight (g/cm^2): Treatment effect was significant at first and last harvesting time. Initially, T2 showed the highest specific leaf weight (0.0033 g/cm^2) which was comparable with that under T4. But T5 showed the lowest specific weight (0.0026 g/cm^2) which was comparable to that unde r T3. On the other hand, at the last harvest, specific leaf weight was lower for T2, T4 and T5 than for T1. Varietal effect was highly significant for specific leaf weight at final harvest (768 degree days), where it was higher in variety D (0.0044 g/cm^2) than B (0.0041 g/cm^2).

Shoot: root ratio: There was no varietal effect in the experiment ($p=0.062$). Treatment effect was highly significant ($p<0.001$). Interaction between treatment and variety was not significant ($p=0.062$). Treatments two and four had significantly lower (around 40%) shoot: root ratio than other treatments. Nutrient stress either in the top layer or in the bottom layer (T3 and T5) did not affect the shoot: root ratio of the crop. Shoot: root ratio was decreased by 40 percent due to water stress in both varieties. It means both varieties invested more in root production under water stress condition. Under water deficiency, growth of roots is favored over that of leaves (Hsiao and Xu, 2000). There was no significant difference in this characteristic when water stress was in the bottom layer suggesting that water stress during early growth phase (due to water stress in top layer) is more harmful than that in the bottom layer. The result coincides with the findings of Wu *et al.,* (2008) in which root biomass was increased indicating reduced shoot/root ratio.

Table 2. Multiple comparisons for different treatment over shoot characteristics

Shoot characteristics	Treatment	Degree days		
		288	512	768
Dry shoot weight (g)	T1	1.73^{b}	11.50^{cd}	31.08^{c}
	T2	0.77^{a}	5.41^{a}	20.76^{a}
	T3	1.77^{b}	12.42^{d}	32.14^{c}
	T4	0.88^{a}	7.25^{b}	22.01^{a}
	T5	1.67^{b}	10.83^{c}	26.78^{b}
Fresh shoot weight (g)	T1	24^{b}	159^{cd}	384^{d}
	T2	8^{a}	62^{a}	249^{a}
	T3	27^{b}	172^{d}	343^{c}

	T4	10^{a}	95^{b}	251^{a}
	T5	25^{b}	138^{c}	307^{b}
Leaf area (cm^2)	T1	578^{b}	3506^{bc}	6843^{b}
	T2	234^{a}	1523^{a}	5440^{a}
	T3	660^{b}	4240^{c}	6870^{b}
	T4	289^{a}	2176^{a}	5633^{a}
	T5	640^{b}	3164^{b}	6564^{b}
Specific leaf weight (g/cm^2)	T1	0.0030^{bc}	0.0034^{ab}	0.0046^{b}
	T2	0.0033^{d}	0.0036^{b}	0.0038^{a}
	T3	0.0027^{ab}	0.0030^{a}	0.0047^{b}
	T4	0.0031^{cd}	0.0034^{ab}	0.0039^{a}
	T5	0.0026^{a}	0.0035^{ab}	0.0041^{a}
Root weight (g)	T1	0.192^{a}	0.814^{a}	2.409^{a}
	T2	0.169^{a}	0.666^{a}	2.514^{a}
	T3	0.178^{a}	0.889^{a}	2.502^{a}
	T4	0.14^{a}	0.758^{a}	2.796^{a}
	T5	0.164^{a}	0.985^{a}	2.536^{a}
Shoot: root ratio	T1	9.6^{b}	14.4^{b}	13.8^{b}
	T2	4.7^{a}	8.1^{a}	8.9^{a}
	T3	10.6^{b}	14.1^{b}	13.7^{b}
	T4	6.6^{a}	10.2^{a}	8.1^{a}
	T5	10.6^{b}	11.5^{ab}	10.9^{a}
Leaf number per plant	T1	19^{b}	41^{bc}	70^{c}
	T2	15^{a}	33^{a}	62^{ab}
	T3	20^{b}	44^{c}	70^{c}
	T4	18^{b}	37^{ab}	61^{a}
	T5	19^{b}	40^{bc}	65^{b}

- *Different letters (in superscript) means differed significantly ($P<0.05$) as established by the Bonferroni Test for every characteristic throughout this article.*
- *T1=Control, T2=water stress in top, T3=Nutrient stress in top, T4=water stress in top+Nutrient stress in bottom, T5=Nutrient stress in top+water stress in bottom.*

Leaf number per plant: The treatment and varietal effects were significant (<0.001) for leaf number per plant at all harvest date. Interaction between treatment and variety was significant only at last harvest in this trait. Variety B had significantly more leaves than

variety D (Table 3). Number of leaves for variety B was always higher than that of variety D in all treatments (Table 4). T3 did not significantly affect leaf number in either variety. But in case of T5 variety B showed significantly fewer leaves (8%) whereas there was no significant effect in variety D. Water stress in the top layer together with nutrient stress or without nutrient stress in the bottom layer (T2 and T4) gave 15 percent reduction in variety B whereas in variety D there was no significant difference with control treatment.

Table 3. Leaf number for two varieties

Degree days	VAR	Leaf number (mean)	Lower	Upper
288	B	20	19	20
	D	17	17	18
512	B	43	42	45
	D	35	33	36
768	B	74	73	75
	D	57	56	58

Table 4. Treatment effect over two different varieties on leaf number

Treatments	Variety B	Variety D
Control (T1)	81^{e}	59^{ab}
Water stress in the top layer (T2)	69^{c}	54^{a}
Nutrient stress in the top layer (T3)	79^{de}	60^{b}
Water stress in the top layer + Nutrient stress in the bottom layer (T4)	69^{c}	54^{a}
Nutrient stress in the top layer + water stress in the bottom layer (T5)	74^{cd}	56^{ab}

While looking at shoot development in two varieties, more leaves and larger leaf area were found in variety B than D. It might have contributed to the higher fresh weight in B than D or D might have lost more water than B. Water stress in the top layer had a larger influence on leaf area as compared to the bottom layer which caused to decrease leaf area by 20 percent after 768 degree days. In the findings of Wu *et al.* (2008), significant reduction in leaf area was observed in *Sophora davidii* seedlings due to drought stress.

Root Development

Root growth rate (g/degree day)

In the overall analysis, there was no significant treatment effect ($p=0.146$), varietal effect (0.231) or interaction between treatment and variety ($p=0.806$). But, layers were found to be significantly different ($p<0.001$) and interaction between treatment and layer was also highly significant for rate of root growth ($p<0.001$). For the 0-10 cm layer, treatment did not have a significant effect on root growth rate (g/degree day). For the 10-20 cm layer, root growth rate was lowest for T3. Root growth for all treatments was higher in 20-30 cm and 30-40 cm depth of the soil layer (Table 5). Since varietal effect was not significant, the data are presented in Table 5 after pooling data from both varieties.

Both nutrient stress and water stress conditions had no significant effect in the root growth rate compared to without stress conditions. This result confirms both varieties are able to adapt in the water and nutrient stress conditions. In contrast, treatments have significant influence on the root growth rate in different soil layers. Under nutrient stress situation, the root growth rate was two times higher in the transition root zone (20 – 30 cm soil horizon) than 10 to 20 cm soil horizon (Table 5). These results showed that water stress on the top layer (0 to 20 cm) stimulated plants to grow roots in the transition root zone. However, water stress has no significant influence on the root growth rate in different soil layers. These results confirm that plant reacts to the nutrient stress condition via encouraging root growth in the less stressed environment (Drew *et al.*, 1973).

Table 5. Multiple comparisons for the effect of different treatments on root growth rate in four different layers

Treatment	Soil horizon (cm)			
	0-10	10-20	20-30	30-40
Control (T1)	0.026^{a}	0.035^{abcd}	0.053^{cdefg}	0.068^{g}
Water stress in top layer (T2)	0.034^{abc}	0.034^{abc}	0.041^{abcde}	0.058^{efg}
Nutrient stress in top layer (T3)	0.033^{ab}	0.028^{a}	0.053^{defg}	0.063^{fg}
Water stress in top layer + Nutrient stress in bottom layer (T4)	0.037^{abcd}	0.047^{bcdef}	0.042^{abcdef}	0.058^{efg}
Nutrient stress in top layer + water stress in bottom layer (T5)	0.029^{ab}	0.031^{ab}	0.067^{g}	0.066^{g}

Root length density (cm/cm^3)

Treatment effect was significant for first and second harvesting time ($p<0.05$) but no significant varietal effect or interaction between variety and treatment at all harvesting time. Statistical analysis showed that root length density was not significantly different for the layer in the control (Table 6). However, although T1 and T2 were comparable per layer, higher values for root length density were found at 0-10 cm, but lower values for root length density were observed in the lower layers when water stress was applied in the top layer (T2) of the soil profile (Figure 1). Figure 1 is based on pooled data for both varieties over four replicates. Zhao *et al.* (2010) also found water stress caused the root length density to increase in lower soil layers in cotton. In fact, ability of a plant to absorb water and nutrients is more closely related to root length than to root weight (Cowan, 1965). Moreover, moderate water stress induces the spread of roots in deeper layers of the soil, so that plants would obtain a larger spatial distribution to uptake more nutrients and water (Yan *et al*., 2008). However, at the end of the experiment root length density was indifferent among treatments.

Table 6**.** Multiple comparisons for different treatments over root length density (cm/cm3)

Degree days	Treatment[1]	Soil horizon (cm)			
		0-10	10-20	20-30	30-40
288	1	0.55^{f}	0.23^{bc}	0.04^{a}	0.02^{a}
	2	0.41^{de}	0.23^{bc}	0.06^{a}	0.04^{a}

	3	0.49^{ef}	0.31^{bcd}	0.05^{a}	0.03^{a}
	4	0.40^{de}	0.21^{b}	0.07^{a}	0.04^{a}
	5	0.50^{ef}	0.34^{cd}	0.05^{a}	0.03^{a}
512	1	1.27^{cd}	1.06^{abcd}	0.73^{abc}	0.82^{abc}
	2	1.41^{d}	0.94^{abcd}	0.56^{a}	0.83^{abc}
	3	1.21^{bcd}	1.08^{abcd}	0.94^{abcd}	0.92^{abcd}
	4	1.26^{cd}	0.76^{abc}	0.64^{ab}	0.74^{abc}
	5	1.12^{abcd}	1.04^{abcd}	1.16^{bcd}	1.05^{abcd}
768	1	1.26^{a}	0.90^{a}	2.05^{a}	1.49^{a}
	2	2.27^{a}	0.90^{a}	1.83^{a}	2.08^{a}
	3	1.04^{a}	1.43^{a}	1.88^{a}	1.26^{a}
	4	2.27^{a}	0.88^{a}	1.42^{a}	1.31^{a}
	5	1.06^{a}	1.34^{a}	1.49^{a}	1.50^{a}

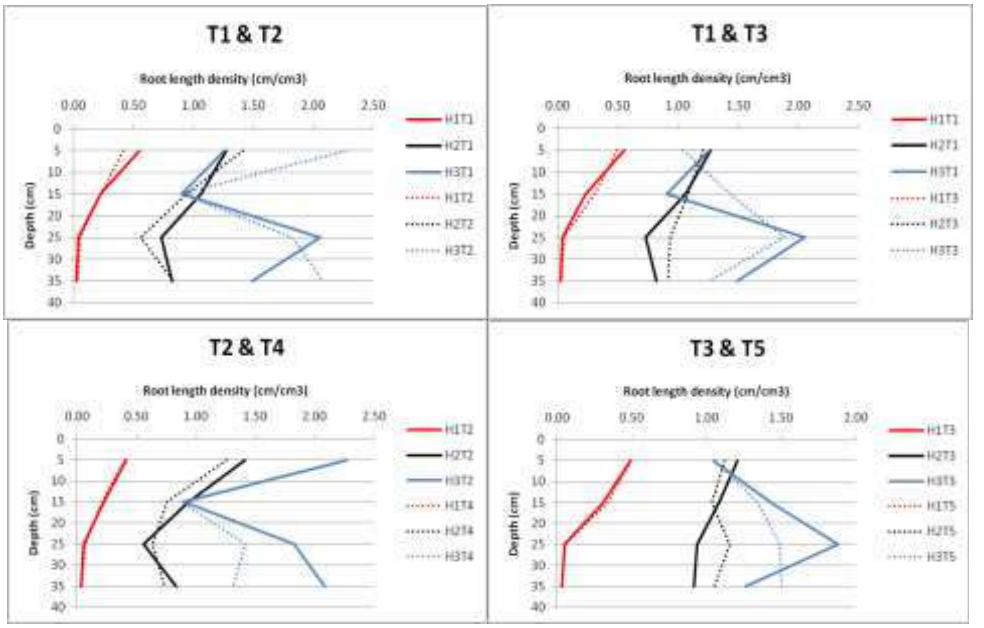

Figure 1. Root length density (cm/cm3) in each layer

Proportion nitrate (NO_3) uptake

With regard to proportion nitrate uptake, T2 reduced the proportion NO_3 taken up by nearly 50 percent in the top layers but did not change it in the bottom layer as compared to control treatment. In case of T4, the proportion of NO_3 taken up was significantly higher as compared to control in each layer except in the 30-40cm layer (Table 7). T3 did

not affect the proportion of NO_3 taken up in the top layer but caused an increase in that proportion in the lower layer. T5 did not affect the NO_3 uptake in the top layer but significantly reduced than T3. NO_3 uptake was slower when there was water stress, since NO_3 ion has to be absorbed through water. NO_3 uptake was decreased by 40 percent in water deficit condition as compared to well watered plants of *Artemisia tridentate* (Bassirirad and Caldwell, 1992). In case of water stress, not all NO_3 was taken up even at the end of the growth, which indicates that there are still nutrients available in the soil. Initially, NO_3 uptake rate was slow but later the rate was increased abruptly, which might have contributed to higher root length density.

Table 7. Multiple comparisons for different treatment over proportion NO_3 uptake

Degree days	Treatments	Layer (cm)			
		0-10	20-30	20-30	30-40
288	1	0.64^{d}	0.66^{d}	0.60^{d}	0.57^{d}
	2	0.33^{abc}	0.13^{a}	0.58^{d}	0.56^{cd}
	3	0.69^{d}	0.57^{d}	0.59^{d}	0.53^{bcd}
	4	0.29^{ab}	0.13^{a}	0.31^{ab}	0.20^{a}
	5	0.66^{d}	0.60^{d}	0.32^{ab}	0.20^{a}
518	1	0.99^{i}	0.95^{hi}	0.75^{fgh}	0.67^{def}
	2	0.46^{bc}	0.18^{a}	0.64^{cdef}	0.54^{cde}
	3	0.99^{i}	0.99^{i}	0.92^{hi}	0.80^{fghi}
	4	0.71^{rfg}	0.31^{ab}	0.87^{ghi}	0.47^{bcd}
	5	0.99^{i}	0.99^{i}	0.49^{bcd}	0.12^{a}
768	1	1.00^{d}	1.00^{d}	1.00^{d}	1.00^{d}
	2	0.90^{bc}	0.78^{a}	0.99^{d}	0.90^{bc}
	3	0.99^{d}	0.99^{d}	1.00^{d}	1.00^{d}
	4	0.95^{cd}	0.89^{bc}	0.99^{d}	0.99^{d}
	5	0.99^{d}	0.99^{d}	0.99^{d}	0.87^{b}

Water uptake per plant

Treatment effect was significant for water uptake per plant. When there was water stress in the top layer, water uptake increased in the lower layer (T2 and T4) (Table 8). Water uptake from lower soil layer (20 to 40 cm) was 68 percent higher ($p<0.001$) than top layer (0-20 cm) in water stress treatment compared to control. This result confirms that if there is limited water on the surface level of the soil, roots develop more towards the bottom layer to explore the water (Gallardo *et al.*, 1996). Thus, such increase in the root development in the bottom layer helped the plant to take up water from the bottom soil.

Water use efficiency (g/l)

Water use efficiency was calculated as total dry biomass (shoot and root) in gram divided by total water taken up by the plant. Treatment effect was significant but neither the varietal effect nor interaction between treatment and variety was significant at any degree day. Water use efficiency was not significantly different for the treatments at the end (Table 9). Initially, water use efficiency was lower for the plant under water stress but at the end water use efficiency was not significantly different among treatments. It means even under the water stress conditions plant could develop the dry shoot and root biomass comparable to that of the control conditions.

Table 8. Water uptake (ml / plant) during the treatment period per soil layer

Treatments/Layers/degree days	288		512		768	
	Top	Bottom	Top	Bottom	Top	Bottom
1	1747^{d}	993^{c}	3314^{d}	1155^{ab}	6454^{f}	1973^{b}
2	1029^{c}	903^{bc}	1382^{b}	1382^{b}	2514^{c}	3324^{e}
3	1623^{d}	949^{bc}	3294^{d}	1039^{ab}	6125^{f}	2734^{cd}
4	1447^{d}	577^{ab}	2058^{c}	968^{ab}	3165^{de}	3134^{de}
5	1773^{d}	442^{a}	3074^{d}	712^{a}	6083^{f}	1192^{a}

Table 9. Multiple comparisons for different treatment over water use efficiency (g/L)

Treatments	Degree days		
	288	512	768
Control (T1)	0.71^{b}	2.77^{bc}	3.98^{a}
Water stress in top layer (T2)	0.50^{a}	2.21^{a}	3.98^{a}
Nutrient stress in top layer (T3)	0.77^{b}	3.02^{bc}	3.91^{a}
Water stress in top layer + Nutrient stress in bottom layer (T4)	0.52^{a}	2.62^{ab}	3.94^{a}
Nutrient stress in top layer + water stress in bottom layer (T5)	0.83^{b}	3.13^{c}	4.04^{a}

CONCLUSION AND RECOMMENDATION

There was no genotypic variation in coping mechanism, shoot and root development and resource utilisation in lettuce under water and nutrient stress. It may be due to the genotypes selected for the experiments were not distinctly different. Also, the pot trial in green house condition might have been optimum for the plant growth. It has therefore been recommended for further investigation in a field condition. Since the roots were lost during root ringing and root cleaning which might have deviated the result in the experiment. It is recommended to adopt the better way of root processing.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Socio-economic and technological transformation in ecovillage Baireni, Udayapur

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ABSTRACT

In order to examine the livelihoods and socio-economic conditions, as well as the environment friendly technologies and farming practices in the eco-village Baireini, Udayapur, a household survey was conducted in the village using defined eco-village indicators. The survey revealed that several groups, clubs, and cooperatives are functional in Baireini with 84 percent of the respondents (households) pro-actively participating in regular eco-village activities that have strengthened their community. According to the respondents, discrimination and violence against women and children have substantially reduced. Ninety four percent of them told they do not experience violence, while 98 percent households don't feel discriminated. All childrenof both sexex are sent to schools. Seventy five percent of the respondents have been using indigenous knowledge and technology (IKT). Almost all (92 %) of all households use the health service of the community health clinic, and 80 percent- the Women Health Resource Counselling Centre. Almost all of the farming households have changed their farming habits and adopted bio-intensive farming (BIF) - vegetables production (93 %), calorie farming (50 %), using own seeds (96 %), organic fertilisers (89 %) and naturally-derived bio-pesticides (78 %), and in case they have a biogas plant (BGP) recycle bio-slurry (90 %). They have benefited from these practises by having higher crop yields, more variety and better soil conditions. 42 percent of the respondents do commercial vegetable farming, but sell only little amounts of their vegetables. Only 10 percent of the respondents are interested in yoga. 71 percent of the households have a toilet: either a BGP attached one (56 %), a simple pit latrine (25 %) or a ventilated two ring pit latrine (19 %). Around 41 percent of the households own a BGP; while 24 percent own an improved cooking stove (ICS). In case of animal sheds, 25 percent of the livestock rearing respondents had an improved one with a provision of cattle urine collection. What came to most people's minds regarding transformation was the implementation of techniques like BGPs, toilets, ICSs, and BIFs that included micro irrigation facilities and animal sheds, the knowledge about vegetable farming, compost and bio-pesticide making, goat farming and the creation of awareness for the environment conservation and human equality. They said that all these things had increased their life quality, their state of food security, the socio-economic condition; and has created feeling of being a healthy community.

Key word: Eco-village, bio-gas, vegetables, bio-intensive farming, sustainability

INTRODUCTION

Sustainability approaches are searched for and implemented on different levels all over the world to warrant life of biological organisms including human beings as well as the existence of the planet Earth itself. WOREC, Nepal in cooperation with Himalayan College of Agricultural Sciences and Technology (HICAST) has been promoting changes on micro-level in Nepal; and for that has been working with different communities under 'Sustainable Livelihood Program'. Poor management and over exploitation of natural resources and misuse of chemical inputs in farming practices lead to environmental degradation thereby increasing food and livelihood challenges for the humanity all over the world. A huge proportion of Nepal's population is already perceivably affected by these deteriorating conditions. Besides, many individuals, groups or communities get discriminated and marginalised based on their religion, gender, caste, sex, etc., often motivated and justified by cultures or interpretations of religions (Rajbhandari, 2013). In order to tackle the named social, environmental and livelihood challenges, the human rights organisation Women's Rehabilitation Centre (WOREC), Nepal in collaboration with HICAST started the 'Sustainable Livelihood Program' in 2010 and in the financial assistance of AEI, Luxembourg, that aims to transform traditional villages into human friendly, non-discriminatory, socially acceptable, ecologically non-degradable and economically profitable human settlements, the so-called 'model ecovillages' (WOREC, 2014). For that infrastructure and technical facilities should provide the hardware to improve sanitation and resource management (e.g. by BGPs, toilets), while trainings and workshops lead to the needed human resource development on various levels (e.g. denial of violence aganst women, discrimination against children).

Up to now WOREC, Nepal has been working with 16 village communities within four districts: Dang, Salyan, Siraha and Udayapur in the context of their 'Ecovillage Program'. In Udayapur WOREC, Nepal started its interventions with animation, collective empowerment, health programs and organic vegetable gardening trainings and support around 20 years ago. Back then the people there were suffering from various sicknesses and malnutrition due to poor portions of vegetables and fruits in their daily meals. Nowadays, the organisation cooperates with five villages in this district to transform them according to their defined ecovillage goals that encompass sustainability criteria on social, ecological, technological and economical level. One of these villages is Baireini. There the program was started in 2010 and specifically addresses the the indigenous Danuwar community.

This study was conducted in that village with an objective of assessing the impact of the participatory intervention towards transforming the traditional village Baireini into a model eco-village. For this, the livelihood, ecological, economical, technological and social progress in the village was investigated as compared to the base line data.

RESEARCH METHODOLOGY

A detailed household survey was conducted in Baireini with the Danuwar people, which

form the eco village community. Quantitative and qualitative data were collected using a structured questionnaire. The installed technical facilities and the applied practices were inspected at the same time. The questionnaire was compiled according to the 14 pre-defined eco-village indicators. Each indicator was measured by some (one to five) variables. In total 51 households were intereviewed. Since many of the socially concerned questions focused especially on women's conditions and opinions, in each case only the female family members were consulted.

Some of the qualitative results were quantified afterwards and analysed together with the other collected quantitative answers using Open Office Calc©. Since not each question addressed all households, the sample size (N) used for each variable varied. The determined percentages refer to the particular sample sizes and were used for the final interpretation of the data.

Baseline data were obtained from the WOREC, Nepal office at Udayapur. That was compiled based on surveyes conducted in that village in 2010 and 1012.

RESULTS AND DISCUSSIONS

Formation of groups, clubs and cooperatives

In Baireni, several social groups, clubs and cooperatives were formed with the facilitation of WOREC. Some new groups (ecovillage management committee and organic vegetable grower's committee) and ecological club were formed after initiation of the "eco-village project". Through these groups, members of the families are engaged in various activities of the eco-village and the respective groups to different extents.

End of violence against women

The survey has revelaed substantial change in the situation of violence against women (VAW) in the eco-village. Some of the responding women told that they never experienced any physical or mental violence in their lives (28 %), while majority of the respondents told that they donot experience any more (66 %). Some women of the eco-village are still suffering from it (6 %). The perpetrators were and are mainly the women's husbands and their families. VAW was documented in 35 percent HHs at the beginning of the project in 2010, but now that figure has gradually increased to 94 percent (Table 1).

According to all respondents, discriminatory attitudes and behaviours because of cast and gender were prevalent in the past but have decreased a lot and are barely existent nowadays. The way of discussing has been changed from physical and mental fights towards non-violent discussions. Most of the respondents told that they presently do not feel discrimination in their village, neither against themselves (98 %) nor against others (92 %). The women who felt discrimination specified it as disatvantages because of their gender. Most of the respondets told that the positive changes could be accounted to the increased awareness about education, community work and trainings. The VAW

campaign of WOREC, Nepal and its related trainings were often named to having had a great importance towards the changes regarding violence, either directly or indirectly. Discrimination and violence are perceived as being wrong and rejected by all respondents.

End of violence and discrimination against children

Among those children who are between five and 18 years old, 100 percent visit or visited school. The respondents told that they felt the need of education for all of their children, their sons and daughters equally. These attitudes changed a lot during the last decade, regarding the view on importance of education in general and especially gender-wise. Thus, while the nowadays children have the chance on education equally, their parent's generation had a different reality: back then there was a limited feeling for the need of sending children-especially girls- to school. And if the the families had the needed financial resources they were spent for their son's education.

Participation in eco village activities

The majority of households (84 %) actively participate in regular eco-village activities like the sanitation program, the adult education program, the health counselling and many more different meetings. Most of them are involved in a few of these activities, some only in one or none (16 %). Seventy six percent of the respondents told that they or their family members attended some orientation meetings or trainings for example about off-season vegetable farming, compost and bio-pesticide making, weaving or VAW.

Almost all farmers, eventhough the ones that do not actively participate in eco-village activities, told that they recognized and appreciated the changes that the transformation had brought. What came to most people's minds was the implementation of techniques like BGPs, toilets, ICSs, BIF, e.g. micro irrigation facilities and animal sheds, the knowledge about off-season vegetable farming, compost and bio-pesticide making, goat farming and the creation of awareness for the environment conservation and human equality. They said that all these things had increased their life quality, their state of food security, the social atmosphere and the created feeling of being a healthy community.

Promotion and protection ethnic culture, arts, knowledge

Ten percent of the respondents could not think of any indigenous knowledge, rite or technology while the majority (90 %) came up with at least one or two. Other things that they perceived as ethnic culture and knowledge / technology included the skills of making alcohol (*Raksi*), baskets (*Doko*), mattresses out of paddy (*Gundri*) or bamboo (*Mandro*), the way how to catch fish with a certain fishnet (e.g. *Jaal*) and the tools and their usage for grinding staple crops like paddy (*Dhilki*, *Jaanto*). The majority (75 %) still practice at least one of the named skills but most of them only occasionally or very limited.

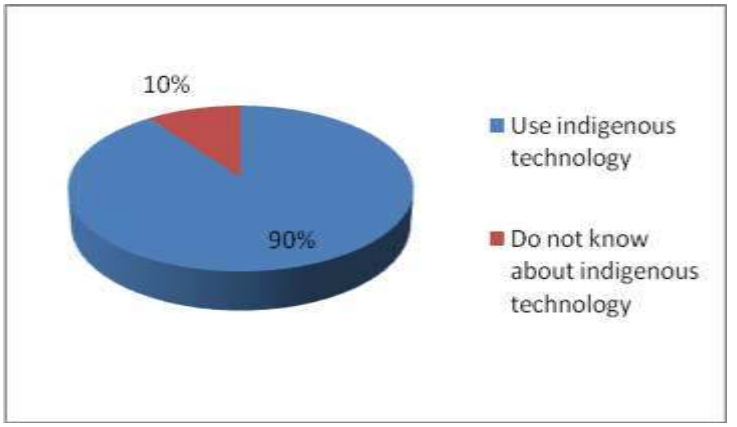

Figure 1. Percentage distribution of HHs using indigenous knowledge and technology

Use of health care services

In most parts of rural Nepal, people use to go to the traditional healers instead of modern health facilities for the remedies of various health problems. In Baireni, the majority of respondents (92 %) told that their family members now visit the community health clinic that had been established by WOREC, Nepal and that is at a five-minutewalking distance from the villsage. There they took different services of primary health care -including preventive, curative and counselling service, identifying health risks, screening problems, providing medication- and were linked to secondary and tertiary level hospitals.

The study revealed that only 16 percent of the respondents visited the women health resource counselling centre (WHRCC) where especially women healthcare and psucho-social counseling is provided. But 80 percent women respondents told that they and their female household members attended the monthly counseling meetings in the village where the assigned women health counsellor and an additional health assistant checked the women's weight and blood pressure.

Use of bio-intensive farming practices

Forty six out of the 51 interviewed households (90 %) are enrolled in agriculture labour, cultivating their own and/or other people's land. They were taught in BIF principles and practices by WOREC, Nepal. It was found that 43 of the farming households (93 %) started cultivating own vegetables according to BIF principles, which increased HH consumption and thereby improved their health conditions due to the higher nutrient supply. All of the farming households (100 %) cultivated compost crops like wheat, millet or maize, while only 23 (50 %) combine them with potatoes as a calorie crop. Most of the yields (in average 90 %) are consumed by the families themselves. Those families, who sell some of their agricultural outputs, sell mainly vegetables (72 %), followed by corn (48 %), legumes (36 %), paddy (32 %), wheat (12 %) and potatoes (12 %) which are beneficial for their income generation. Forty four out of the 46 respondents (96 %)

exclusively or mainly used their own seeds for cropping.

Overwhelming majority (89%) households use exclusively compost and/or farmyard manure (FYM) as a natural fertiliser. Besides, 19 from the 21 BGP owning families (90 %) use the bigas by-product, the so-called bio-slurry, for fertilising purpose. They collect it in a pit, let it either dry as it is, then mix it with other organic materials like harvest residues or animal excreta or add it to their compost before applying to the fields. Most of the respondents, who adopted different kinds of BIF practices, told that they observed an improvement of their field's soil health (fertility and structure) conditions (65 %), while 16 percent did not feel remarkable change, and 19 percent did not noticed any change.

Promotion of a commercial vegetable marketing

Most of the 43 households that crop vegetables, exclusively consume them themselves (58 %) while 18 (42 %) sell some either on the weekly Haat Bazaar (46 %), to WOREC canteen and other neighbours (29 %) or on the local market (25 %). Ninety eight percent of them support the general idea of establishing a vegetable and fruit collection centre for its marketing. But only five households (10 %) told that they were engaged in the process by talking to WOREC and other stakeholders.

Promotion of a community meditation and yoga centre (CEMYC)

None of the respondents told to have ever practiced meditation, particularly owing to their very busy daily work burden and negligence. Ten (20 %) HH attended former yoga classes when it was taught in the close-by WOREC office. But only two of them still practice it regularly at home. Only five respondents (10 %) are engaged in organising new yoga classes by talking to the teacher and spread their passion about yoga among the other villagers. They think about using the community house as location. According to them there is no need of an additional centre like a CEMYC.

Construction and use of modern toilets at household level

It was found that 36 interviewed households (71 %) have a toilet (a few of them are still under construction), while 15 (29 %) do not have it. At the beginniing of the project only one third (31%) of the HHs had toilet (Table 1). The most prevalent toilet type now is the one attached to a BGP digester (56 %), followed by the simple pit latrine (25 %) and the ventilated two ring pit latrine (19 %). Among the respondents who do not own a toilet on household level, eleven (73 %) use the toilets of other HHs and four (27 %) still go to the riverside for defecation. It follows, that in total 92 % had the access to toilet. Seven households (14 %) are planning to construct a toilet. Thus, in total at least 85 % of the households are aware of the need of a toilet; and are pro-actively involved in its construction and use.

Construction and use of biogas plants (BGP) and improved cooking stoves (ICS) at household level

Twenty one of the interviewed households (59 %) own a BGP (Figure 2). The produced

biogas from faeces, cattle and buffalo dung was only found to be sufficient in five cases (24 %). Alternatively the respondents use firewood, liquefied petroleum gas (LPG) or electricity. In average, the biogas lasts for 1.6 hours per day and thus covers 71 % of the average cooking time of 2.2 hours per day.

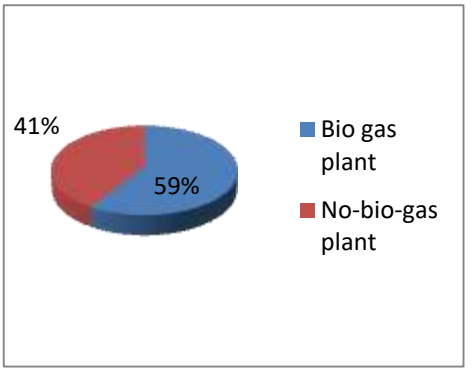

Figure 2

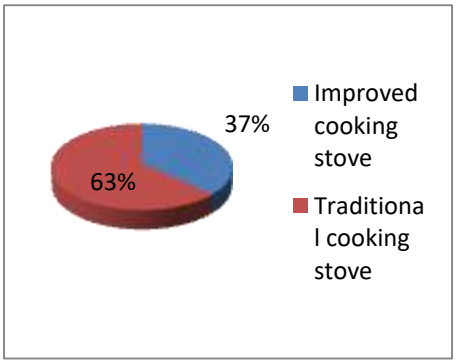

Figure 3

Figure 2. Distribution of HH with/without BGP
Figure 3. Percentage distribution of HHs with improved and traditional cooking stoves

Eighteeen percent of the respondents had planned to construct a BGB at their house. They know about the advantages of BGP; and their digesters are already under construction or some of the families had formally applied for it. Thus, in total 59 percent of the households are pro-actively participating in BGP construction and usage of its produced biogas. It should be noted that only n1 percent of the HHs had BGP at the beginning of the project there (Table 1).

The study revealed that thirty seven percent of the HHs had an ICS in their house, while 63 percent neither had nor had planned to get one (Figure 3). It should be noted that there was no ICS at the beginning of the project (Table 1). Obviously, it should be regarded as a positive sopcio, economic and ecological transformation towards addressing the issue of climate change and health of the family members, particulraly of the women who have the cooking roles at home.

Construction and use of improved animal sheds at household level

Forty nine (96 %) of the responding households own livestock. Twelve of them (25 %) already have improved sheds, while 28 respondents (57 %) own traditional ones and nine (18 %) none (Figure 4). There was no improved shed in the village at the beginning of the project in 2010 (Table 1). All of the households with improved animal sheds use the seperate collected urine for making bio-pesticides and fertiliser. They reported that it has increased health condition of the animals, increased soil health condition as well as crop productivity.

All livestock holding households, no matter if they have a shed or not, use the available animal excreta locally as manure or for making bio-pesticides. Thus, the need and will of

recycling animal excreta is existent but could be further supported by promoting the improved sheds.

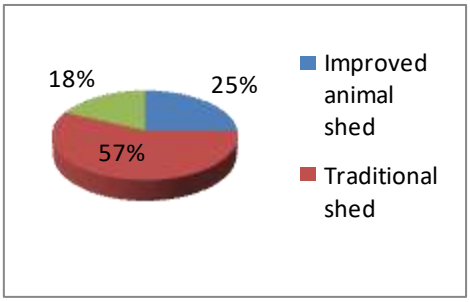

Figure 4. Percentage distribution of HHs with different types of animal shed

Production and use of bio-fertilisers and bio-pesticides

The survey revealed that most of the farming households use exclusively FYM (59 %) or compost (17 %). Others combine these two organic fertilisers (13 %) or use synthetic ones, either combined with FYM (7 %) or exclusively (4 %) as shown in Figure 7. Moreover, some respondents add ashes of harvest residues or decomposed chicken manure as nutrient input to the fields. Thus 89 percent of the respondents use organic fertilisers only, while 11 percent use chemical fertlizers also. Two of the latter (4 %) stated their will to change their habits back to bio-fertilisers because the chemicals have degraded their soil health (structure and fertility). Many respondents told that they used to make their own compost for fertilising purpose after they were trained by WOREC, Nepal. But with the time they changed back to FYM because of missing time and ignorance. Among the 14 households (30 %) that still use compost, 12 (86 %) make it themselves. The others get it from friends or neighbours.

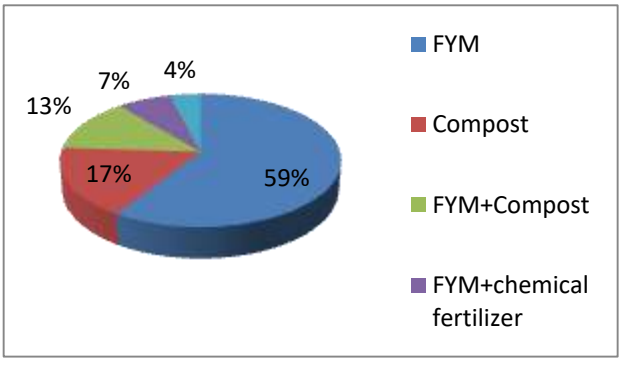

Figure 7. Percentage distribution of HHs using various types of fertilizers/manures

For pest management, most of respondents use ashes and cattle urine (54 %), followed by the new type of bio-pesticide they were taught by WOREC, Nepal (24 %) and chemical pesticides (22 %) as shown in Figure 8. A few respondents additionally use a soap-water-

solution or papaya leaf-chili-water. In total, 78 percentof the respondents use naturally-derived botanical pesticides.

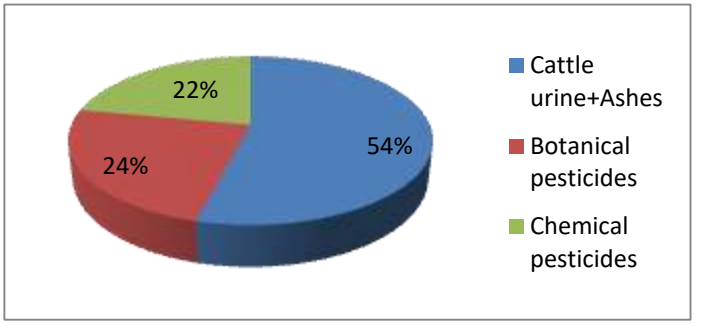

Figure 8. Percentage distribution of HHs using various types of pesticides

All of them make these pesticides themselves, either at home or collectively with other farmers from the village. Also in this case, many respondents told that they used to prepare and use the new kind of bio-pesticide after the training but quit after a while and changed back to traditional practises. Approximately 50 percent of those who do not use the bio-pesticides told that they wanted to try them again. At the beginning of the project, none of the HHs had idea or practice of making and using botanical-pesticides for pest management (Table 1).

Table 1. Indicators of transformation in eco-village Baireni during 2010 to 2014

Indicators	Years		
	2014	2012	2010 (baseline)
Social/ ecological groups/clubs and cooperatives	Women group, farmer's group, youth clubs and eco clubs, tole bikash samiti, 84% participate in regular meeting and activities, strong sense of social cohesion	Women group, farmer's group, youth clubs and eco clubs, tole bikash samiti, 80% participate in regular meeting, sense of social cohesion	Women and farmers groups, no sense of social cohesion
Change in the status of violence against women (VAW), i.e. % HH without VAW	94%	77%	35%
Ending all forms of discrimination and violence against children (DVAC) and establishment / promotion of a Model Early Childhood Development Centre	ECDC present, 75% HH children visited ECDC, no discrimination between son and daughter.Increased children's self confidence, parents	ECDC present, 65% HH children visited ECDC, no discrimination between son and daughter. iIncreased children's self confidence, parents	ECDC present but very few HHs senttheir children to ECDC, gender discrimination prevalent

	involved in IGA	involved in IGA	
Access to education	97%	95%	45%
Participation of members of household/ groups in different activities of eco village.	76%	63%	50%
Promotion and protection of ethnic culture, arts, indigenous knowledge and traditional technologies	Have the feeling that all traditional knowledge, technology and culture should be conserved	Have the feeling that all traditional knowledge, technology and culture should be conserved	Had no sense for the conservation of traditional technology
Visit to community health clinic and women health resource counselling centre (WHRCC)	Community health clinic visited by 92%, WHRCC by 16%, counseling in village by 80% HHs.	Community healtjh clinic visited by 85%, WHRCC by 10%, and counseling service in village by 62% HHs.	Community clinic visited by 80%, WHRCC by 7%, counseling service in village by 45% HHs.
Promotion of Bio-intensive farming system (BIFS)	Calorie farming 50%, veg farming 90%, indigenous seed 95%, bio-slurry 90%, bio-pesticides-70%, sell excess grains and vegetables by 25%.	Calorie farming 50%, veg farming 70%, indigenous seed 75%, bio slurry 70%, bio-pesticides-60%, sell excess grains and veg by 13%.	Less use of compost/ no use of slurry from BGPs, no use of bio-pesticides). Traditional vegetable farming was there in kitchen gardens after WOREC intervention in 1993.
Construction and use of toilet at household level	71%	55%	32%
Construction and use of: a. BGP and b. ICS at household level	59% 37%	35% 10%	a.1% b. o%
Construction and use of improved animal shed at household level.	25%	5%	0
Production and use of compost	78%	53%	0
Preparation and use of bio-pesticide	65%	10%	0
Community house	1	0	0
Cleanliness campaign	Every week	Irregular	0
Access to service and counseling on health, sexual and reproductive rights awareness	almost no SRHR, every month health campaign	Less SRHR problems, occasional health camps	much of SRHR problems

Sources: WOREC, Nepal records (2010 and 2012); Field survey (2014)

Indficators of transformation

Indicators of transformation in eco-village Baireni for the period of 2010 to 2014 is summarized above in Table 1. The data of the year 2010 (baseline) and 2012 were obtained from WOREC, Nepal's record while the data of 2014 were compiled based on the field survey conducted by the authors in 2014. It is evident from the table that the eco-village has achieved quite a remarkable progress in various indicators set for the eco-

village.

CONCLUSION

The key findings show that the 'Sustainable Livelihood Program' has had huge benefit to the community, its structures and the individual lives of the people belonging to this community. The goals, strategies and their implementation were chosen appropriately to become accepted and supported by the targeted people, which is one of the most imortant and difficult steps. It is obvious that in eco-village Baireini the needed social, physical, cultural and ecological structures have been formed to become a model eco village. But a few further steps have to be taken to sufficiently accomplish all targets. The needed structures are existent to implement the named lacks very easily. The path is paved towards a sustainable settlement where social, spiritual, psychological, physical and economic needs of the people can be met without a negative impact on natural ecosystems, resources, climate and health.

ACKNOWLEDGEMENT

We would like to acknowledge WOREC, Nepal for providing the opportunity and needed support includiing relevant data and information for conducting the research. Special thanks are also extended to AEI, Luxembourg for providing financial assistance to WOREC for implementing the project.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Sero-prevalence of Leptospiral infection in canine population of Kathmandu valley

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ABSTRACT

To determine the status of Leptospiral infection in a canine population of Kathmandu valley, a rapid diagnostic test kit was used to detect Ig antibodies in sera samples. Altogether a total of 150 sera samples were collected from the pet and stray dogs brought to the Veterinary Hospitals and Clinics with the history of fever and jaundice. Screening of all sera samples by the rapid diagnostic test kit (SD Bio Line) showed 2.7 % (4/150) sera samples positive for Leptospiral antibodies. The present study suggests that Leptospiral (organism) pathogens continue to circulate in canine population of Kathmandu valley.

Key words: Pathogens, rapid diagnostic kit, leptospiral antibodies, leptospirosis

INTRODUCTION

Leptospirosis is a zoonotic disease with epidemic potential, especially after a heavy rainfall, caused by bacteria of Leptospira genus. *Leptospira interrogans* is pathogenic to humans and animals, with more than 200 serologic variants or serovars (WHO, 2003). The infection is however more common in the tropical and sub-tropical countries, since favorable conditions for its transmission exists there and most of the countries in this region are developing ones (Bharti *et al*., 2003; WHO, 2003). In the developed world, Leptospirosis is considered as an emerging infectious disease (Levett, 2001). Recreational activities like water-sports are also believed to be an important factor for the emergence of this infection (Morgan *et al*., 2002). The earliest recognised accounts of leptospirosis were descriptions of severe illness with jaundice and renal involvement in man published by Landouzy (1883), Weil (1886), and Vasiliev (1888). These were clinically distinct from other icteric and nephritic illnesses, but the cause was not determined (Turner, 1966).

Canine Leptospirosis was first described in 1899. Before 1960, *L. interrogans* serovars *icterohaemorrhagiae* and *canicola* were believed responsible for most clinical cases of canine Leptospirosis. The disease then, mainly described as acute or subacute hepatic and renal failure, was often thought characterized by acute hemorrhagic diathesis (Sykes, *et al*., 2011). Canine leptospirosis has received increased attention as a cause of febrile illness and hepatic renal disease (Bolin, 1996). The canine disease presents as an acute infection of the kidney and liver and sometimes as a septicemia. Chronic kidney disease

is a common sequel of infection and abortions may occur in pregnant dams (McDonough, 2001). More than 200 serovars of Leptospira are found to infect the mammals, and the organism has been isolated from reptiles, amphibians, fish, birds and invertebrates throughout the world (Binder and Mermel, 1998; Mac Allister, 2003).

Leptospirosis occurs worldwide wherever there is a risk of direct or indirect contact with the urine of infected animals. Theoretically, any mammal is capable of being infected by any serovar of *Leptospira interrogans*. However, only a few serovars are enzootic in any particular region. Optimal conditions for survival are a warm and wet environment, with neutral or slightly alkaline water; however, leptospires are known to survive acidity of pH 5 to 6.2 for limited periods. They can survive in cold water, provided that it does not freeze (Thiermann, 1984). Because of the importance of water as a means of spreading infection, new cases are most likely to occur in wet seasons and low lying areas, especially when contamination and susceptibility are high (Nervig *et al*., 1978). Leptospirosis is believed to be endemic as ideal conditions exist for transmission of this infection in Nepal (Brown *et al*., 1981), however, as with other developing countries; the infection is largely under reported. Though Leptospira in dogs has been reported in south-east Asia including India, Bangladesh and Pakistan, there is lack of baseline information about its prevalence in Nepal. Therefore, this study was conducted with the objective to detect the seroprevalence of Leptospira in dogs of Kathmandu.

MATERIALS AND METHODS

Sample Size and Site Selection

This hospital and dog sanctuary based prospective cross-sectional study was conducted from April to August. Altogether 150 blood samples were collected from dogs brought with febrile illness and jaundice at Central Veterinary Hospital (CVH), Advanced Pet Hospital, Mobile Veterinary Hospital, Dog Sanctuary of Animal Nepal and Kathmandu Veterinary Clinic. Domesticated dogs brought with the history of febrile illness were regular vaccinated against Leptospirosis while stray dogs did not receive any such vaccination against Leptospirosis.

Blood collection and serum preparation

Blood samples were collected from the cephalic vein with a 21 G needle and a 3 ml syringe. For one hour, the blood samples were allowed to clot and then centrifuged at 2000 rpm for 15 minutes. The serum sample was then kept separated and stored in a cryovial at -20°C until tested.

Ig detection by rapid test kit method

Each serum sample was tested for *Leptospira* Ig by rapid test kit method (SD Bioline).

Table 1. Demographic status of dog cases tested for Leptospira

Source of Data				
Data Collected Places	Frequency	Percent	Valid Percent	Cumulative Percent
MVH	76	50.7	50.7	50.7
Advanced Pet Hospital	29	19.3	19.3	70
Vet for pet clinic	3	2	2	72
Jenny Vet	2	1.3	1.3	73.3
CVH	10	6.7	6.7	80
HICAST	2	1.3	1.3	81.3
Animal Nepal	16	10.7	10.7	92
Kathmandu Vet Clinic	11	7.3	7.3	99.3
Divine Vet Clinic	1	0.7	0.7	100
Total	150	100	100	

Ig antibodies are produced in acute infection; and IgG are Produced later as disease progresses to chronicity. Serological tests used for the detection of Ig are MAT, HA, Lepto- Dipstick, CF or ELISA, where as MAT or ELISA can be used for the detection of IgG (WHO, 1982). Thus, detection of Ig indicates acute infection; and Detection of IgG gives an indication of chronic infection.

Data were analyzed using SPSS (16.0)

RESULTS AND DISCUSSION

A total of 150 blood samples were collected from Mobile Veterinary Hospital, Advanced Pet Hospital, Central Veterinary Hospital (CVH), Vet for Pet clinic, Jenny Vet, HICAST, Kathmandu Vet Clinic, Divine Vet Clinic and Dog Sanctuary of Animal Nepal. Of the total samples, 91 were from male and 59 were from female of which 119 were vaccinated, 31 were of unvaccinated and 123 were Pet dogs while 31 were stray dogs.

Out of 150 sera sample screened by Rapid Diagnostic Test (RDT) Kit, 4 samples were positive for Ig of *Leptospira interrogans* as shown in Figure 7. Seroprevalence of *Leptospira* Ig was 2.7% (4/150).

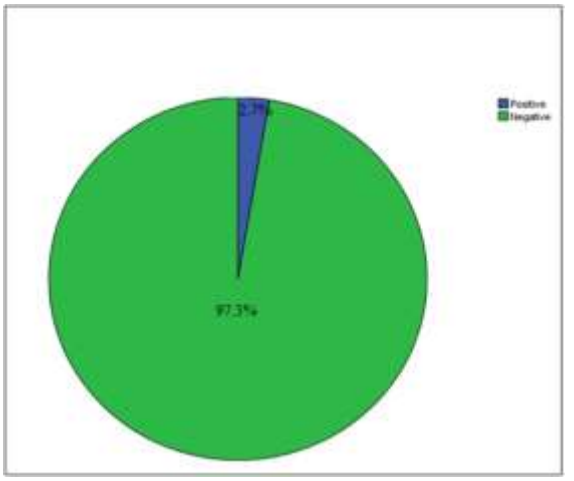

Figure 1. Seroprevalence of *Leptospira* Ig among dogs by rapid diagnostic test kit

Pattern of RDT results

Seroprevalence of the leptospiral antibodies in the present study was 2.7% (4/150). Previous investigators reported canine *leptospira* in stray dogs was 6.67%. (Sharma, 2012).Chuan-Jiang Lai *et al*. (2005) found 45.6% seropositivity of *Leptospira* in dogs in Northern Taiwan. However, Tongkorn Meeyam *et al*. (2004) found 11% in Thailand and Gautam *et al*. (2010) found 8.1% seropositivity of *Leptospira* antibodies in dogs in USA.

In a survey conducted in Japan over a period of three years, 1.2% seroprevalence was observed in dogs (Ryu, 1975). In another study conducted by Abdoel (2011), the seroprevalence was 21.3% in dogs. In a study conducted by Dayou Shi *et al*. (2012), the seroprevalence of Leptospirosis was 7.3%. This may due to higher sample sizes which ranged from 210 to 33,119.

The prevalence of *Leptospira* antibodies in dogs has varied among different countries: 21.3% in India (Venkataraman and Nedunchelliyan, 1992) and 6.36% in Italy (Cerri *et al*., 2003). Climate may be an important factor affecting the prevalence of *Leptospira* in each area. The suitable climate for *Leptospira* is the tropical climate, and the prevalence of *Leptospira* has been found to be the highest in the rainy season (Ward *et al*., 2002). Prescott *et al*. (1991) found 8.2% seropositivity in dogs in Southern Ontario. In a retrospective study conducted by Kikuti M, *et al*. from 2003 to 2010 at the Laboratory of Zoonosis Diagnosis at the Veterinary Hospital of São Paulo State University (UNESP) in Botucatu, São Paulo state, Brazil, the seroprevalence was 20.08%.

Seroprevalence of *Leptospira* among cattle and buffaloes was found to be 5.5% and 11% respectively in Nepal (Joshi, 2000 and 2001). Similar serological survey was done throughout Nepal by Dyson *et al*. (2000). They found the prevalence rate of 17% in different species of livestock, and suggested that chronic infection is very common.

Seropositivity was 57.47% among domesticated animals and 72.72% in wild animals in captivity and 33.03% in rodents in Tamil Nadu (Koteeswaran, 2006). Clinical leptospirosis is much less common in cats despite the apparently greater seroprevalence of Leptospiral antibodies in cats than in dogs (16.9% of 59 cats, 9.8% of 501 dogs) in a recent (1988 to1990) survey conducted by Dickeson *et al*. in Australia.

Age wise distribution of *Leptospira* cases among dogs

Among the Leptospira positive cases, the highest number of cases belonged to the age group 12-48 months (Figure 8).

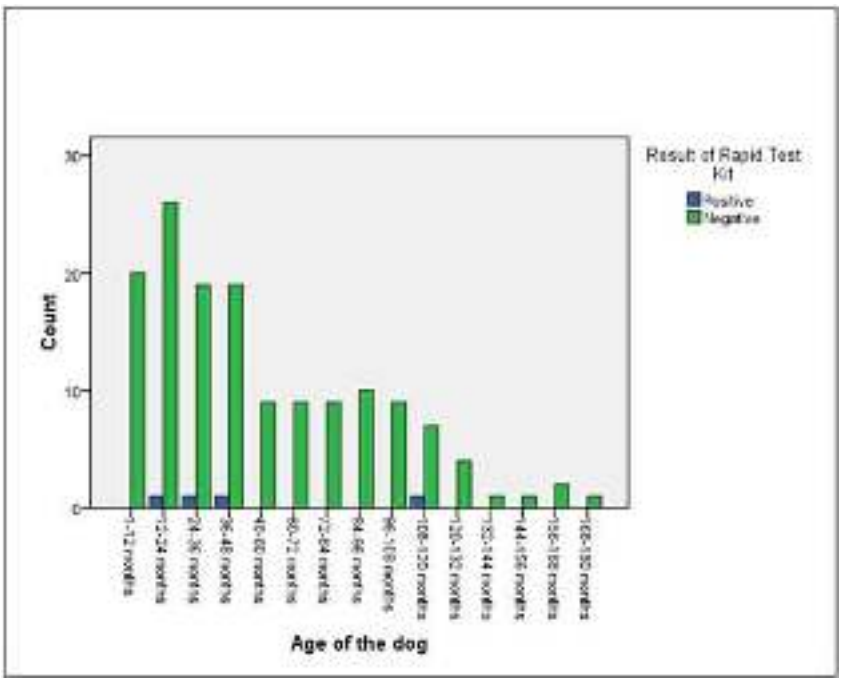

Figure 2. Age wise prevalence of *Leptospira* among dogs

Among the *Leptospira* positive cases, the highest number of cases belonged to the age group 12-48 months (i.e. more than 1 year of age). This might be due to the fact that the samples collected were more in number in this age group. This is similar to the study

done by Ghneim *et al*. (2007). However Ward *et al*. (2004) found dogs between 4 and 9 years of age were more likely to acquire infection than dogs more than 1 year of age.

No significant difference was observed in terms of age in the seroprevalence of leptospirosis by Dayou *et al*. (2012). In contrast, Aslantaş *et al*. (2005) reported that adult dogs were more commonly infected than juvenile dogs.

In a retrospective study conducted by Kikuti *et al*. from 2003 to 2010 at the Laboratory of Zoonosis Diagnosis at the Veterinary Hospital of São Paulo State University (UNESP) in Botucatu, São Paulo state, Brazil age was not statistically related to higher rates of leptospirosis.

Gender wise distribution of Leptospira cases among dogs

Leptospira positivity was found in both Male and Female (Table 4).

Table 2. Gender wise prevalence of *Leptospira* among dogs

Sex of dog	Result of Rapid Test Kit		Total
	Positive	Negative	
Female	2	57	59
Male	2	89	91
Total	4	146	150

Leptospira positive was more in female in the present study,which is similar to Harkin and Gartrell (2002) and Miller *et al*. (2007) identified more infected females than males.However Rentko *et al*. (1992) and Zwijnenberg *et al*. (2008) found more infected males than females.

In a study conducted by Dayou *et al*. (2012), no significant difference was observed with respect to exes. In a retrospective study conducted by Kikuti *et al*. from 2003 to 2010 at the Laboratory of Zoonosis Diagnosis at the Veterinary Hospital of São Paulo State University (UNESP) in Botucatu, São Paulo state, Brazil male dogs were connected with higher rates of leptospirosis antibodies.

Vaccination status with Leptospira Ig positivity in dogs

The Leptospira Ig was found in vaccinated as well as unvaccinated dogs (Table 5). Apparently, *Leptospira* Ig antibodies were detected only in vaccinated dogs but not in non vaccinated dogs. Inability to demonstrate Ig antibodies in Vaccinated ones may be due to recent vaccination response and inclusion of smaller sample size. The vaccinated and non vaccinated dogs were positive to *Leptospira* Ig which showed that they were

chronically infected. The vaccinated dogs might have shown positive due to clinical cases.

Table 3. Vaccination status with *Leptospira* Ig positivity in dogs

Vaccination Status	Result of Rapid Test Kit		Total
	Positive	Negative	
Vaccinated	4	115	119
Not vaccinated	0	31	31
Total	4	146	150

Ig class antibodies usually appear somewhat earlier than IgG class antibodies, and generally remain detectable for months or even years but at low titre. Detection of IgG antibodies is more variable. They may sometimes not be detected at all, or be detectable for only relatively short periods of time, but may sometimes persist for several years.

Immunity to *leptospirosis* is primarily humoral, (i.e. mediated by antibody-producing branch of the immune system), the result of B-cell and Th-2 T-helper (CD4) cell stimulation. Cell-mediated immunity does not appear to be important, but may be responsible for some of the late manifestation of the disease (WHO, 2010)

Leptospira vaccination (combined) is given at 6-8 weeks (1st prick) and at 12-16weeks of age (2nd prick) followed by booster dose annually in Nepal. In India, Leptospira vaccination (combined) is done at 6 weeks of age (1st prick) and at 2-3 weeks later upto 16 weeks (2nd prick) followed by booster dose annually (http://dogsindia.com /vaccination_schedule.htm).

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Economics of production, marketing and export potentiality of large cardamom in eastern hills of Nepal: a case of Ilam district

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ABSTRACT

A survey research was conducted in 2009 in Nayabazar, Panchakanya and Pashupatinagar VDCs to assess the economics of large cardamom production and its export potentiality in Ilam district of Nepal. Sample size of 135 farmers comprising of 45 farmers from each VDC, and was selected using simple random sampling. The required information was obtained through a pre tested questionnaire and PRA. To study the marketing aspects and export performance of cardamom 15 local, 10 medium, 10 large traders and 5 exporters were selected from Fikkal, Nayabazar and Birtamod Market. B/C ratio and gross margin/ropani was observed the highest in Nayabazar (1.86 and Rs.2106 respectively) and the lowest in Panchakanya (1.70 and Rs.1876 respectively). More than 21 percent of household income was attributed through cardamom cultivation. Increase in marketing margin, marketing costs and decrease in marketing efficiency and producers' share were observed with increase in no. of marketing intermediaries and vice-versa. Years of cultivation (p = 0.000), area under cardamom (p = 0.000), irrigation (p = 0.000), labour use (p = 0.000), Plant protection measures use (p = 0.000), and involvement of family members in cardamom farming (p = 0.041) were most contributing factors to total production. More than 29 percent exporters believed that the Indian market was the most responsible factor for price determination. Export growth rate of cardamom in the later years of WTO membership was higher than in just before and initial stage of WTO membership. The study indicated the cardamom farming could be highly profitable and export oriented enterprise in eastern hills of Nepal.

Key words: Cardamom, marketing, economics, export, WTO

INTRODUCTION

Large cardamom (*Ammomum subulatum* Roxb.), a unique substitute for the true cardamom, is said to be one of the oldest spices indigenous to the Eastern Himalayan region, probably in Nepal and hence also known as Nepal Cardamom (AEC/FNCCI, 2006). Large cardamom, an important cash crop of the Eastern Region of Nepal, has been identified as a priority commodity for the region (APP, 1995; ITC, 2007). Large cardamom is one of the most important cash generating crops through export and shares

1.87% of total export and 2.68% of total export to India and 0.3% of total export to overseas (TPC, 2008). Quantitatively, the total export earnings were raised from N.Rs.679963000 in 2004/04 to N.Rs.1082536000 in 2007/08 (TPC, 2008). Large cardamom occupies first place in terms of Nepal's export to India, (Tulachan, 1994). A large number of farmers, rural households, traders and exporters are involved in the large cardamom industry from production, processing, marketing to export. This sector generates employment for minimum of 80-100 days per hectare and more than one million labour days in total per year. Large cardamom has direct impact on the economy of the rural people. Its development contributes significantly in poverty alleviation of the people living in the mid-hill areas as this crop thrives well at altitudes ranging from 700 to 2300 m and it provides cash income to the small and excluded farmers (ITC, 2007).

MATERIALS AND METHODS

Ilam district, which ranks number one in terms of area and production of cardamom, was purposively selected for the study. Three Village Development Committees (VDCs) namely Nayabazar, Pashupatinagar and Panchakanya were for the survey. Altogether 45 producers from each VDC meeting the criteria of sampling unit were selected by applying simple random sampling method. Altogether 135 respondents were randomly selected for this study (Table 1).

Table 1. Sample size distribution by VDC in the study area (2009)

Name of VDC	Sample size (no.)
Nayabazar	45
Pashupatinagar	45
Panchakanya	45
Total	135

Local traders were indentified during the visit of study sites. Altogether 15 local traders, 10 medium traders and 10 large traders and 5 exporters were selected purposively and interviewed from the Ilam district and Jhapa district (main centre of export).In this study, both the primary and secondary data were collected and analyzed. Interview schedule was used to collect the primary data. Socioeconomic and farm characteristics were described using descriptive statistics like mean, standard deviation, percent and frequency. Multiple regression models were used to analyze the factor affecting the cardamom production. Cobb Douglas production function was used to find the factor share to total output of large cardamom. Data entry and analysis was done by using computer software package like Statistical Package for Social Science (SPSS) and Microsoft Excel.

RESULTS AND DISCUSSION

Benefit-cost analysis of large cardamom production in study area

Benefit cost ratio simply gives an idea about recovery of cost incurred during the production by return from products. The benefit cost analysis of large cardamom in the study area is presented in the Table 2.

Table 2. Average cost and return of cardamom in study areas (2009)

Items	Nayabazar (188.6/kg)	Panchakanya (192/kg)	Pashupatinagar (191/kg)	Total
Average return	4326	4299	4255	4293.33
Average cost	2320	2521	2439	2426.67
Average return/40 Kg	7543	7718	7601	7620.67
Average Cost/40 Kg	4045	4526	4357	4309.33
B/C ratio	1.86	1.70	1.74	1.77

The benefit cost analysis showed that the overall B/C ratio was found greater than unity. The benefit-cost analysis was higher in Nayabazar (1.86), followed by Pashupatinagar (1.74) and Panchakanya (1.70). The higher B/C ratio in Nayabazar was mainly due to higher productivity of cardamom and less incidence of diseases and pests as compared to other VDCs, which reduced the cost of production. However the price used in calculation of B/C ratio in all the VDCs was not significantly different because the whole cardamom produced in Ilam district was considered of the same quality.

Factor share to total output of the cardamom

The estimated production function and other related statistics of the function are presented in Table 3. The coefficients of all the quantitative variables have positive signs, which indicate the rational application of resources. The coefficients of plant protection measures, irrigation and labor were found to be 0.066, 0.019 and 0.377, respectively; and were significant at 1% level of significance. Among the various coefficients of input factors, the coefficient of labor was found to be the highest as compared to other factors. It was because the most of expenditure incurred in large cardamom production was governed by labor; and the labor was one of the most important factors governing the yield. Since the crop does not need other factors of production to a great extent, if the better labor management could be done for cultivation the yield may increase to a satisfactory level. Thus, more labor was found to be used as compared to other factors. The sum of input elasticities of production functions was found to be 0.462. Thus all cardamom growing farmers were experiencing decreasing returns to scale.

Table 3. Factors share to total output of cardamom in study area (2009)

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Constant	2.273	0.258		8.823	0.000**
Plant protection measures	0.066	0.026	0.321	2.559	0.014*
Irrigation	0.019	0.009	0.242	2.086	0.043*
Labour	0.377	0.073	0.651	5.146	0.000**

$R = 0.676$ and $R^2 = 0.457$
*Note: * and ** refers to the significant at 0.01 and 0.05 level of significance, respectively.*
The cardamom production function was obtained as follows:
$Y = A\ L^{b}{}_{1} I^{b}{}_{2} P^{b}{}_{3}$ i.e.
$Y = 2.273\ L^{0.377}\ I^{0.019}\ P^{0.066}$

Contribution of large cardamom to household income

The contribution of large cardamom in household economy was observed the highest in Nayabazar (23.40%) followed by Pashupatinagar (22%) and Panchakanya (21.3%). Details of contribution of large cardamom to household income are presented in table 4.

Table 4. Contribution of large cardamom to household income ('000 NRs.) (2009)

Source of cash income	Nayabazar	Share (%)	Pashupati nagar	Share (%)	Panchaka nya	Share (%)	Total	Share (%)
	Mean ± SE		Mean ± SE		Mean ± SE		Mean ± SE	
Cardamom	62.42 ± 7.16	23.40	36.03 ± 2.49	22	36.10± 2.05	22.63	44.8 ± 14.88	21.30
Cereals	10.00 ± 3.52	3.75	49.13± 9.66	3.0	4.88 ± 1.77	3.08	21.33 ± 4.98	10.13
Vegetables	30.00 ± 4.76	14.04	24.25 ± 6.66	14.8	18.88 ± 2.72	11.91	24.37 ± 4.74	11.57
Zinger	17.00 ± 6.78	6.37	8.18 ± 2.42	5.0	14.33 ± 2.22	9.11	13.17 ± 3.80	6.25
Tea	37.45 ±12.34	11.24	18.13 ± 9.23	11.07	26.66 ± 4.65	16.82	27.41 ± 8.74	13.02
Livestock	49.93±29. 17	18.72	29.84±32. 94	18.22	29.33±12. 76	18.50	36.36±2 4.95	17.27
Amriso	5.00 ± 3.19	1.87	4.76 ± 1.32	2.91	7.11 ± 3.76	4.49	5.62 ± 2.75	2.66
Total farm	211.8 ±46.92	79.39	170.32 ±64.72	77.0	137.29 ±29.93	86.54	173.11 ±64.84	82.24
Total off farm	55.00 ± 8.71	20.61	37.66 ± 9.67	23.0	21.33 ± 5.76	13.46	37.39 ± 8.04	17.76
Total income	266.8 ±55.63	100	207.98 ±74.39	100	158.62 ±35.69	100	210.5 ±72.88	100

Gross margin analysis
The Gross Margin of Cardamom cultivation was calculated by deducting the average variable cost from average gross return. The findings showed that the gross margin of the cardamom was highest in Nayabar (Rs. 2106), followed by Pashupatinagar (Rs. 1916) and Panchakanya (Rs. 1876). Difference in gross margin along the study sites was mainly due to difference in productivity of the cardamom. Higher gross margin in Nayabazar was due to the higher productivity of the commodity as compared with other location (Table 5).

Marketing channels and marketing efficiency
Various marketing channels were identified in the study areas. The farmers usually sell their product to the small traders at village or at collection centre nearby road head or to

large traders at Fikkal or exporters at Birtamod. Five marketing channels were identified as follows:

1. Farmers → Local Traders → Medium Traders → Large Traders → Exporters
2. Farmers → Local Traders → Large Traders → Exporters
3. Farmers → Medium Traders → Large Traders → Exporters
4. Farmers → Large Traders → Exporters
5. Farmers → Exporters

Domestic market channel

6. Farmers → District traders → National retailers → Consumers

Table 5. Average gross margin of cardamom across the study sites (2009)

Name of the VDC	Gross Margin (Rs./*Ropani*)	Gross Margin (Rs./40 Kg)
Nayabazar	2106	3498
Panchakanya	1876	3192
Pashupatinagar	1916	3248
Total	1966	3312.67

Marketing efficiency

Cardamom value chain analysis showed that the marketing efficiency and producer's share on consumer rupees was decreasing with the increase in the number of the intermediaries (Table 6).

Table 6. Estimates of marketing costs, margins, and marketing efficiency for Cardamom (2009)

Particulars	Marketing channels**					
	1	2	3	4	5	6
Net price received by producer (FP)	190.53	190.53	199	215	220	190.53
Total marketing costs (MC)	12.42	10.75	12.31	10.0	9.5	5.0
Total marketing margins (MM)	72.05	63.72	63.69	51	45.5	89.47
Retailer's sale price (RP)	275*	275*	275*	275*	275*	385
Value added (VA)	84.47	84.47	80	60	55	194.47
Producer's share (PS) %	69.92	69.92	72.36	78.18	80.00	49.48
Index of marketing efficiency (MME)	2.25	2.55	2.61	3.52	4.00	2.01

**indicates the price at Birtamod which is the world's one of the export port for cardamom. So, this price was taken as final price to reach the other countries and the producers' share was calculated accordingly.*

***Marketing Channels are explained in the section 4.8.2.2.*

Factors affecting export price of large cardamom

The large traders and exporters of Birtamod market were asked about the various factors that affect the price of large cardamom. Majority of the exporters (29.41%) said that it is the demand of commodity in the Indian market that determines the price. Some respondents (23.53%) argued the quality of commodity was the major factor influencing the price of the commodity. Hence price of Nepalese cardamom was totally dependent on the demand. The response of exporters on factors affecting the price of large cardamom is presented on Table 7.

Table 7. Factors responsible for export price of cardamom in Birtamod market (2009)

Factors	Frequency of response
Indian Market	5 (29.41)
Production	3 (17.64)
Quality	4 (23.53)
Competition	2 (11.76)
Time of selling	3 (17.65)
Total	17 (100)

Figures in parenthesis indicate percentages

Value chain analysis of large cardamom in the study area

Input suppliers, cardamom producers, various intermediaries of market, and domestic consumers were the stakeholders of cardamom value chain. The flow of commodity started from the producers and it ended to exporter in case of export market and domestic consumers in case of domestic market. The involvement of middle man was found very intensive in the cardamom value chain. Cardamom farmers, various governmental and non-governmental agencies, local traders, middle traders, large traders, exporters, domestic consumers were major stakeholders of cardamom value chain. Most of transaction of cardamom used to flow through the market intermediaries. Very few of the farmers were selling their produce directly to the exporter. In the cardamom value chain, small traders used to collect large cardamom from villages and sold either to medium traders or other traders. Similarly, medium traders used to buy any quantity from farmers or small traders; some one can act as branch of large traders; act as a collection centre at road head for example Fikkal, Ilam bazaar etc. Large traders used to buy any quantity from the farmers, small traders and medium type traders; sold either to exporter and some time acted as exporter themselves; did grading like tail cutting. Exporter had a capacity to

buy any quantity either from the farmers or any level of traders; and exported to India and other countries. All the exporters of Birtamod performed some of the processing activities like tail cutting, sizing and packaging. Exporters used to add the value to the cardamom by grading them into their own grades like Jamboo jet, Super Delux, Ilami (sano), Kainchi cut, etc. based on various quality criteria such as size, use of dryer, color and aroma, etc.

Export growth rate

The exponential export growth rate was computed and compared with the period i.e. just before and initial stage of WTO membership and later stage of WTO membership. The analysis showed that the exponential export growth rate was higher in later stage than just before and at initial stage of WTO membership (Table 8). This clearly indicated that the WTO membership is favorable in case of export of cardamom from Nepal. The increased exponential export growth rate was due to easy access to international market especially with India and few other foreign countries after Nepal became the member of WTO. Thus, Nepal has potentiality to gain from international trade especially in context of WTO membership.

Table 8. Exponential export growth rate of large cardamom

Periods	Exponential export growth rate
Just before and initial stage of WTO membership(2003/04-2004/05)	0.177 Equation: $Y= 569248e^{0.177X}$
Later stage of WTO membership (2005/05-2007/08)	0.206 Equation: $Y= 603708e^{0.206X}$

Source: TPC, 2008

CONCLUSION

Higher benefit cost ratio along with higher gross margin indicates that the crop appears to be highly profitable and remunerative enterprise in Ilam district of Nepal. The crop contributes significantly to the total household economy; and thus can be the better option for uplifting the socio-economic status of the farmers in study area. Long marketing channels existed during marketing of this commodity so that the producers' share on consumer rupee and net margin was lower. Producers' share increased with the decrease in marketing channel.

Years of cultivation, land under cardamom, use of plant protection measures, labor involvement, irrigation facility affects the total production of the commodity. Increase in inputs like use of chemical pesticides, increase in number of persons in cardamom cultivation will definitely increase the total income from the commodity. Increasing trend of area, production, and productivity and export shares and export growth rate of the commodity over the years implies the commodity to be highly export oriented cash crop in Ilam district and other areas with similar agro-ecological conditions of Nepal.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Analysis of international markets for Nepalese agricultural commodities

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ABSTRACT

Agriculture continues to provide a broad base to the Nepalese economy. Nearly four fifths of all Nepalese households are essentially farm households, who derive nearly half of income from agricultural sources consisting of farm income and agricultural wage income. Engaging two-thirds of labor force, this sector alone contributes one-third to the GDP. As such, the growth originating in agriculture holds high potential to have relatively wider impact on poverty reduction and inclusiveness. International markets where Nepalese agricultural commodities have been exported, marketwise trend analysis of specific commodity, analysis of specific conditions including international demand and market access, norms, priority setting of the international market for the identified commodity and identifying best markets for specific Nepalese agricultural commodities Are lacking. Results derived from comparative advantages, domestic resource cost, competitiveness and export potential index were used to identify the international market destination. Commodity wise export by Nepal, world import, export parties price and export possibility and competitive margin by country specific destination of specified commodities were additionally considered for such identification. This study identified that the possible market countries for export of selected agricultural commodities are: Saudi Arabia, Afghanistan for Cardamom; UK, USA, Iran for Tea; USA, France, Italy, Belgium, Canada for Coffee; USA, Germany, UK, France, Canada for vegetable; USA, Germany, UK, France, Netherland, Russian Federation, Belgium for Fruits; USA, Japan, UK, Germany, France, Netherlands for Ginger; Turkey, UAE, Egypt for Lentil; China, Bangladesh for Pulses; Belgium, Germany, France, Netherlands, China for Mustard and linseed; USA, Hong Kong, Japan for Herbs; USA, Mexico, Malaysia, Spain, Netherlands, UK for Spices; Pakistan, China, India, UK for Jute goods.

Key world: Agriculture, international market, commodities

INTRODUCTION

Agriculture is the most dominant sector of the economy employing more than 70 percent of the workforce and generating about 33 percent of the total GDP whereas industries and services account for 15 percent and 52 percent of the GDP, respectively. The central challenge for rural development in Nepal is to shift from subsistence to a commercial economy. Nepal's agriculture is largely based on low-value cereals and subsistence production, with a mere 13 percent of output traded in markets. Although there is considerable scope for increasing productivity; and value-added sector's current 40 percent share in national GDP is declining (The World Bank Group, 2011).

Despite an increasing reliance on remittances from laborers abroad, the absence of economic opportunities outside subsistence agriculture keeps most Nepalese poor. As World Development Report (2008) suggests improving productivity agriculture and shifting people from agriculture is essential for taking out people from extreme poverty and hunger and achieving Millennium Development Goals. Therefore, creating opportunities in non-farm sector, and improving productivity and value addition in agriculture through commercialization is important.

Two large neighbors in the south and in the north provide Nepal huge export market for various high value quality agricultural products. During monsoon North Indian plain cannot produce temperate vegetable due to high temperature and submerging soil condition but Nepal can produce large quantities of temperate vegetables which can have niche market in India. Similarly, during winter many vegetables cannot be produced in higher altitude of Tibet/China, and Nepal can export there (Panday, 2007).

Export of many agricultural products like tea, coffee, cardamom, pulses, lentil, vegetable, fruits, etc. to both the neighboring and third countries is gaining momentum since last decade. Nepal's agricultural trade is 15.68 percent of its total trade for the year 2007/08 with the agricultural trade deficit of Rs. 12,673 million, percent of export being 33.21 and that of import being 66.69 percent. Higher proportion of both export as well as import in foreign trade composition of Nepal is with India for the last few years. The share of India and other countries in total exports were 58.65 percent and 14.35 percent and that of import was 19.89 percent and 80.11 percent, respectively for FY 2007/08 (MOAC, 2008).

In Nepal, predominance of subsistence nature of production in the agriculture coupled with low diversification and commercialization amidst very slow structural changes in the economy is perpetuating trade and current account deficits. The problems in trade fronts are aggravating due to the absence of diversification in commodity trade. This, among others, is due to inability to tap the potentials of the agricultural sector. Certain policy biases are also circumscribing the scope of diversifying agricultural sector (Khanal et al., 2005 and MoICS, 2004). In the tariff system, still there is certain cascading structure with strong disincentives to high value added and labour intensive products (MoICS, 2004; and Khanal, 2006).

In a situation of Nepal being the member of WTO and a party to the SAFTA and BIMSETC, there is a need to identify products, which have comparative advantages under multilateral and regional trading arrangements. Due to diverse climatic conditions, many Nepalese agricultural products will have big export potentials (MoICS, 2002, 2004; TEPC, 2006; and ITC, 2007). However, export performance of agricultural products has been far from satisfactory (MoF, 2007). This is persisting at a time when Nepal is fully engaged in seeking duty-free and quota-free market access facilities for its agro-based and other manufactured products. LDCs are also attempting to get additional facilities under SAFTA and BIMSETC arrangements. Studies attempting to explore export potentials of agricultural products from comparative advantages or competitiveness point

of view under multilateral and regional trade arrangements, which are crucial from policy as well as trade negotiation point of view, are rarely done. In this context, a study was undertaken to fill such a research gap by comprehensively addressing analysis of international market for Nepalese agricultural commodities.

MATERIALS AND METHODS

This study focused on international markets, where Nepalese agricultural commodities have been exported, marketwise trend analysis of specific commodity, analysis of specific conditions including international demand and market access, norms, priority setting of the international market for the identified commodity, and identifying best markets for specific Nepalese agricultural commodities.

Identification of international markets

Results derived from comparative advantages, domestic resource cost, competitiveness and export potential index were used to identify the international market destination. Commodity-wise export by Nepal, world import, export parity prices and competitive margin by country specific destination of specified commodities were additionally considered for such identification of marketable countries.

RESULTS AND DISCUSSION

Results derived from comparative advantages, domestic resource cost, and export potential index were used to identify the international market destination (Table 1). Commodity-wise domestic border price, export prices and competitive margin by country specific destinations of specified commodities were identified Table 2, 3 and 4). This enabled to make comparative assessment. The data provided basis to suggest potential international markets for various agricultural commodities from Nepal.

Table 1. Selected countries for market purpose on the basis of export from Nepal

Name of Commodities	Countries
Cardamom	Pakistan, Singapore ,UAE, Afghanistan
Tea	Germany, Japan, France, Pakistan, UAE
Coffee	Japan, Germany
Vegetable	Bangladesh, Korea ,Japan Qatar, Hong Kong
Fruit	Bangladesh
Ginger	Bangladesh, Singapore
Lintel	Bangladesh, Sri Lanka, Singapore, Korea, UK
Pulses	Pakistan
Mustard and linseed	India
Herbs	Japan, Germany, Pakistan, France, Italy
Spices	Japan, Germany, Bangladesh, Pakistan
Jute goods	Poland, Egypt, Switzerland, Germany, USA

Source: ITC (2003-2008)
Note: All countries were selected on the basis of export data given by ITC (2001-2008)

Table 2. Selected countries for market purpose on the basis of World import

Name of Commodities	Countries
Cardamom	Saudi Arabia, Singapore, India, UAE,
Tea	Russian Federation, UAE,UK, USA, Iran, Pakistan, Egypt, Germany, Japan, France
Coffee	USA, Germany, France , Italy, Japan, Belgium, Canada
Vegetable	USA, Germany, UK, France, Canada
Fruit	USA, Germany, UK, France, Netherlands, Russian Federation, Belgium
Ginger	USA, Japan, UK, Germany, France, Netherlands
Lintel	Turkey, Sri Lanka, UAE, Egypt
Pulses	India, China, Bangladesh, Belgium
Mustard and linseed	Belgium, Germany, USA, France, Netherlands, China
Herbs	USA, Hong Kong, Germany, Japan, France
Spices	USA, Germany, Mexico, Malaysia, Japan Spain, Netherlands, UK
Jute goods	Pakistan, China, India , UK

Source: ITC (2001-2008)
Note: All countries were selected on the basis demand data given by ITC (2001-2008)

Table 3. Selected countries for market purpose on the basis of price (US dollar per ton)

Name of Commodities	Name of country	Years				
		2003	2004	2005	2006	2007
Tea	Russian Federation	276.49	376.74	420.27	456.12	553.15
	UAE	NA	NA	NA	NA	NA
	UK	NA	NA	NA	NA	NA
	Nepal	922.43	1009.90	1132.00	1185.27	1395.20
Coffee	USA	6393.99	7826.00	10031.00	9480.00	9370.00
	France	NA	NA	NA	NA	NA
	Italy	NA	NA	NA	NA	NA
	Belgium	NA	NA	NA	NA	NA
	Canada	NA	NA	NA	NA	NA
	Nepal	902.13	987.67	1107.16	1159.18	1364.49
Ginger	USA	1323.00	1984.00	1764.00	1543.00	1874.00
	Japan	3186.31	3525.47	3464.52	3202.07	3983.98
	UK	NA	NA	NA	NA	NA
	France	NA	NA	NA	NA	NA
	Germany	NA	NA	NA	NA	NA
	Nepal	372.99	395.61	432.04	452.34	514.53
Vegetable	USA	295.00	326.00	306.00	401.00	450.00
	Germany	2026.16	2164.84	2372.91	2981.54	3809.13
	UK	1650.69	1970.47	2034.66	2143.16	2487.09
	France	662.50	593.55	666.35	579.23	607.60
	Canada	835.80	835.43	970.30	1005.24	1070.86
	Nepal	137.90	146.91	156.00	163.33	187.80
Fruits	USA	743.79	730.70	712.80	892.00	929.90
	Germany	800.75	817.10	642.56	653.82	660.37
	UK	NA	NA	NA	NA	NA
	France	NA	NA	NA	NA	NA
	Netherland	NA	NA	NA	NA	NA

	Russian Federation	NA	NA	NA	NA	NA
	Belgium	NA	NA	NA	NA	NA
	Nepal	170.77	193.41	215.42	225.54	266.14
Lintel	Turkey	627.56	710.90	923.07	702.19	946.59
	UAE	NA	NA	NA	NA	NA
	Egypt	361.14	454.96	511.54	552.75	575.65
	Nepal	357.94	459.30	516.29	540.54	643.60
Pulses	China	1986.43	2111.31	2174.70	2330.34	2679.18
	Bangladesh	1516.46	1561.36	1593.38	1770.71	1540.72
	Belgium	645.46	721.73	702.85	NA	581.83
	Nepal	1453.88	1678.04	1846.26	1974.86	2351.38
Mustard and Linseed	Germany	259.58	312.07	235.45	286.29	345.13
	USA	353.00	353.00	298.00	302.00	437.00
	Nepal	501.79	580.08	646.33	676.70	796.54
Jute goods	Pakistan	290.15	289.25	289.16	311.34	331.06
	China	160.35	167.21	172.37	184.72	210.98
	UK	NA	NA	NA	NA	NA
	Nepal	288.94	298.73	308.33	298.49	357.24
Spices	Mexico	1418.12	1298.10	1748.85	1407.98	1797.06
	Spain	NA	NA	NA	NA	NA
	Nepal	577.86	632.66	709.20	742.52	874.03

Source: FAO.org

Table 4. Selected countries for market purpose on the basis of export possibility

Name of commodities	Countries
Cardamom	Saudi Arabia, Afghanistan
Tea	UK, USA, Iran
Coffee	USA, France , Italy, Belgium, Canada
Vegetable	USA, Germany, UK, France , Canada
Fruit	USA, Germany, UK, France, Netherland, Russia Federation, Belgium
Ginger	USA, Japan, UK, Germany, France, Netherland
Lintel	Turkey, UAE, Egypt
Pulses	China, Bangladesh
Mustard and linseed	Belgium, Germany, France, Netherland, China
Herbs	USA, Hong Kong, Japan
Spices	USA, Mexico, Malaysia, Spain, Netherland, UK
Jute goods	Pakistan, China, India , UK

CONCLUSION

Considering the existing export market, world import and world price the possible market countries for export of selected agricultural commodities are: Saudi Arabia, Afghanistan for cardamom; UK, USA, Iran for Tea; USA, France, Italy, Belgium, Canada for coffee; USA, Germany, UK, France, Canada for vegetables; USA, Germany, UK, France, Netherlands, Russian Federation, Belgium for fruits; USA, Japan, UK, Germany, France, Netherlands for Ginger; Turkey, UAE, Egypt for lenntil; China, Bangladesh for pulses; Belgium, Germany, France, Netherlands, China for mustard and linseed. Likewise

potential countries for the export of herbs are USA, Hong Kong, Japan. USA, Mexico, Malaysia, Spain, Netherlands, and UK are potential destinations for export of spices, while Pakistan, China, India, and UK are potential markets for Jute goods.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Demand projections for poultry products and pellet feed in Nepal

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ABSTRACT

This study was conducted with the objectives to estimate demand projection for commercial feed, particularly pellet feed, across the country and to explore opportunities and challenges for establishing pellet feed industry based on key informants interview and focus group discussion during 2009-2010. Poultry is one of the major and fast growing sub-sectors of the livestock in Nepal. The poultry industry has in recent times made significant contributions to the Nepalese agricultural economy. It has emerged as an income generating enterprise in agriculture sector over the last four decades. Its contribution to the national GDP is 4 percent and to the agriculture GDP is 8 % with an output of 10 billion rupees from this sector. It goes unsaying that the poultry population was increasing from 2007; and it is expected to increase responding changes in population, income, urbanization and food habit. Total feed consumption was 564,445 MTMT in 2009 by poultry sector alone. Overall, total feed consumed by commercial broilers, commercial layers, broiler parent population and layer parent populations were 197140, 325000, 37350.15, 4954.95 MTMT, respectively in 2009.Currently, 310000 MTMT pellet feed which is 53 percent of total feed production are being produced across the country. Poultry alone consumes 73 percent of total pellet feed production out of which 70% has been shared by broiler. Total requirement of pellet feed is expected to increase by 67 per cent in year 2015 and by 104 percent in year 2020. Nepalese people in an average consume 11 kg meat per annum where contribution of poultry meat is only 10 percent of total meat consumption. Total poultry meat production has been estimated 73835 MTMT in 2009. It is expected geometric growth progression in meat consumption in Nepal due to increase in population growth, changes in income and health conscious. The national meat productions are projected to be 103267, 123879, 141716, and 156071 MTMT for 2015, 2020, 2025 and 2030 years respectively. Thus, the total consumption of meat is expected to increase by 67% in year 2020 and by 111% in year 2030. APP (1995) also projected that poultry meat production would be doubled during the period of 2010 to 2030. It has been concluded that demand of pellet feed is projected to increase by 10 percent per annum for next 10 years and more than double in 2020. However, the industry is still not competitive in case of production cost and quality management. The pellet feed Industries of forward and backward linkages will increase commercial feed production and economically feasible for long run.

Key Words: Feed, industry, pellet, population, poultry, production, income

INTRODUCTION

Agriculture is the mainstay of Nepalese economy. It is a major source of livelihoods of the Nepalese people and about 65.6 percent of economically active populations are engaged in this sector (MOAC, 2009). The contribution of this sector to national GDP is 33 percent (MOAC, 2010).

Livestock is an integral part of the Nepalese farming system. This sector alone contributes 32.4 percent to the AGDP (Karki, 2005). Poultry is one of the major and fast growing sub-sectors of the livestock in Nepal. The poultry industry has, in recent times, made significant contributions to the Nepalese agricultural economy. It has emerged as an income generating enterprise in agriculture sector over the last four decades. Its contribution to the national GDP is 4 percent and to the agriculture GDP is 8 percent with an output of 10 billion rupees from this sector (Dhakal, 2005). Among the livestock commodities prioritized, APP has emphasized the poultry sector in third position (APP, 1995).

The poultry sub-sector is crucially important in the context of agricultural growth and improvement of diets of people in Nepal. The sub-sector is particularly important in that it is a significant source for the supply of protein and nutrition in a household's nutritional intake. It is an attractive economic activity as well, especially to women and poor population. One of the major problems of development of the poultry sub-sector in Nepal relates to lack of sufficient and appropriate feeds. Relevant study and observation suggests that a high priority is given on the improvement of feed supply in the subsector, which is expected to help in developing resistance to diseases, on the one hand, and production of quality products, on the other.

Poultry sector development initiative were taken by government some forty years back, to convert poultry keeping from scavenging system for subsistence to commercialization (WFP, 2007). The government operated Central Hatchery was established at Parwanipur of Bara District with the help of USAID in 1960 which was beginning of the industrial poultry farming in Nepal (Shrestha et al.,2005). At present there are 45 hatchery industries and 19 big feed factories in Nepal (Field survey, 2010).Poultry farms in Nepal are growing fast in recent times. With a significant population and income growth, urbanization and response of changes in income on demand, the demand for poultry products is expected to increase appreciably in the future. Hence, poultry farms are also expected to increase over time. Against this background and the fact that there exists a large potential for the poultry sub-sector in Nepal, this report intends to explore possibility of commercial feed production, particularly pellet feed in Nepal. More specifically the study aims to estimate total pellet feed production and demand projections for the next decades to explore potentiality of the said sector.

METHODOLOGY

This study is largely based on information collected through market survey by delivering semi structure interview schedule to key informants of poultry sub sector. In addition

focus group discussion was also carried out to know the farmers perception on poultry products. Agricultural census and quarantine department are the main sources of historical data on poultry population. FAO Yearbook (2009), World Bank statistics were also a source in this respect to validate the collected data. A basic problem with the analysis of poultry population and feed projection is related to the lack of reliable and adequate data on their use by type of feed and category of poultry output. In particular, the data on poultry population are disaggregated by commercial and subsistence level farms in rural and urban part of the country. Particularly data on feed requirement were projected through collecting information from agricultural census and quarantine department on poultry population while required data on population growth, per capita income growth and income elasticity of poultry meat and egg for projecting demand of poultry meat; and feed requirement was based on secondary sources.

A rapid market survey including key-informant interviews was also conducted among feed entrepreneurs, poultry raisers and chick's producers to know feed type, feed production requirements, per unit cost, feed quality, feed response, mortality rates, and average weight of live birds. Key informant techniques of data collection were also adopted to supplement the information collected from secondary sources for making projections of growth of poultry products particularly broiler, layer, parent layer and broiler and also pellet feed requirement.

RESULTS AND DISCUSSION

Poultry Population

Poultry is one of the important subsectors on the way to commercialization. To be more precise, commercial poultry pockets are mostly concentrated in Chitwan, Kathmandu Valley, Rupandehi, Kaski and Morang Districts. The scale of commercialization of poultry has been reached during 1990 to 2000. It is observed that poultry industry was growing steadily until 2001 Bird flu outbreak in India then population began to decline that lasted until 2004.

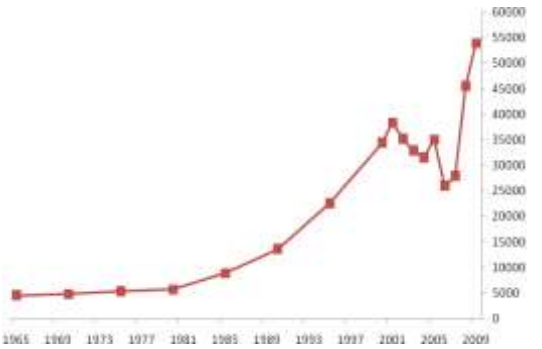

Figure 1. Development stage of poultry sector (No.000)

Repeated outbreaks in the neighboring nations like India, China and Other Asian countries have been affecting consumer's behavior producing erratic demand until 2007. Poultry population was increasing from 2007 and it is expected to increase responding changes in population and income.

Estimated Broiler Parent Stock

It goes unsaying that there is drastic increase in the rearing of broiler parent stocks. In the year 2009, there were imports of 5, 98,336 chicks of different breeds from various country of the world. On the top of this to have an easy transport, the parent breeders were introduced 54,924 of hatching eggs. Similarly in the first 6 months year 2010, the 314118 chicks and 90540 hatching eggs were imported. The year wise data of the same has been presented in the graphs below.

Figure 2. Broiler Parent Stock, 2009

The feed consumed by the broiler parent during their life time is about 60 kg. In year 2009, there were imports of 5, 98,336 chicks which requires 35900160 kg (35900.16 MTMT). Similarly from the 54,924 of hatching eggs if hatched at 80%, there should be 43939.2 chicks out of which 21969.6 chicks will be female that consume 1318176 kg (1318.176 MTMT) of feed. To maintain the mating efficiency there is need to keep 1:10 male to female chicks, so there is need to rear 2196.96 male chicks require 131817.6 kg (131.8176 MTMT)**.** Total feed consumed by broiler parent would be approximately 37350.1536 MTMT. Similarly in the first 6 months year 2010, the 314118 chicks must consume 18847080 kg (18847.08 MTMT) and 90540 hatching eggs if hatched at 80% produce 72432 chicks. It has been supposed that half population is female and male each. So, female chicks are 36216 that consume 2172960 kg (2172.96 MTMT). To maintain mating efficiency there is need to keep male and female ratio at 1:10 i.e. 3622 male chicks are needed which consume 217296 kg (217.296 MTMT) of feed. The total feed consumed will be 21237336 kg i.e. 21237.3362 MTMT of feed.

Estimated Layer Parent Stock

There is a great need to keep on the rearing of layer parent stocks to fulfill the demand of chicks of commercial layers. In the year 2009, there were imports of 77,187 chicks of different breeds from various country of the world. On the top of this to have an easy

transport, the parent breeders had introduced 49,800 of hatching eggs. Similarly in the first 6 months of the year 2010, 23,569 chicks were imported. The year wise data of the same have been presented in the figures below.

Figure 3. Broiler Parent Stock, 2010

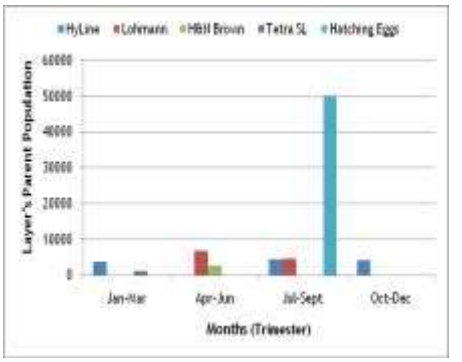

Figure 4. Layer Parent Stock, 2009

To raise a single layer parent there is need to feed 50 kg ration throughout their life. To provide the feed for 77,187 chicks imported chicks on 2009, it requires 3859350 kg (i.e.3859.35 MTMT) of feed. Similarly, if the imported 49,800 eggs hatch at 80% produce 39840 chicks. In general, there is equal half of each sex. So, there will be 19920 female chicks that must consume 996000 kg of feed. Similarly to mate these female parent chicks there is need of 1992 male chicks that consume 99600 Kg (i.e. 99.6 MTMT) kg of feed. So total feed consumed by the layers parent is 4954950 kg (4954.95 MTMT).

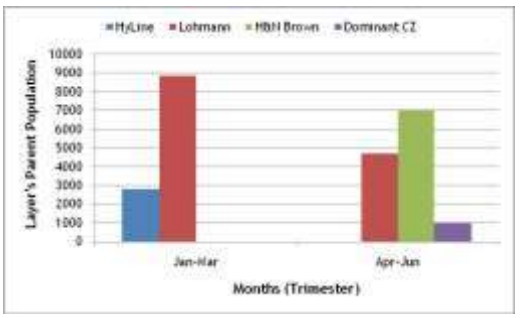

Figure 5. Layer Parent Stock, 2010

Similarly in the first 6 months of the year 2010, the imported 23,569 chicks must consume 1178450 kg (1178.45 MTMT) of feed throughout their life.

Estimation of Weekly Chicks Production

Semi-structured interview was made to obtain primary data in terms of numbers of poultry hatcheries and their weekly chicks' hatches. Due to technical difficulties, diverse broiler hatcheries and trade secrecy of the hatcheries, we were not able to find the accurate data. We used the secondary data from the hatcheries association of Nepal to obtain the proximate numbers of both broiler and layer chicks. For the purpose, we applied thumb principles.

Table 1. Estimation of per week broiler chick production

Broiler for 2009 at 1:10		Broiler for 2010 at 1:10	
Primary Chicks	538502	Primary Chicks	282706
Eggs at 80%	39545	Eggs at 80%	65189
Total Chicks	578048	Total Chicks	347895
MR at 15%	86707	MR at 15%	52184
Productive Population	491340	Productive Population	295711
Production Period (Wks)	50	Production Period (Wks)	50
Av. Egg Production	50%	Av. Egg Production	50%
Hatch %	60%	Hatch %	60%
Total Egg Lay	350	Total Egg Lay	350
Av. Egg Production	175	Av. Egg Production	175
Chicks Production at 60%	105	Chicks Production at 60%	105
Total Chicks Production	51590755	Total Chicks Production	31049629
Per week Chicks Production	992130		

There were import of 598336 broiler parent chicks and imported eggs 54924 (if hatched at 80%) produced 43939 chicks. So, overall broiler parent chicks numbered 578048 in 2009. It has been supposed that mortality rate remains 10-20 percent for both sexes. Here we considered the mortality rate at its intermediate value i.e. 15 percent. The productive populations of broiler parent were 491340. It has been reported that the productive period of broiler parent is approximately 50 weeks i.e.350 days and average egg production is 50 percent. If hatched that 60 percent, there will be 105 chicks per broiler parent. So, total saleable broiler chicks were revealed 51590755 in 2009. If same thumb rule was applied for initial half period of 2010, there were 31049629 saleable chicks.

There were import of 69468 layer parent chicks and imported eggs 35856 (if hatched at 80%) produced 35856 chicks. So, overall layer parent chicks numbered 105324 in 2009. It has been supposed that mortality rate remains 10-20 percent for both sexes. Here we considered the mortality rate at its intermediate value i.e. 15 percent. The productive populations of layer parent were 89526. It has been reported that the productive period of layer parent is approximately 50 weeks i.e. 350 days and average egg production is 65 percent. If hatched at 65 percent there will be 1148 chicks per layer parent. According to thumb rules, total hatched population consists of equal proportion of male and female

chicks. Hence, total saleable layer chicks were 6619303 in 2009. If principle was applied for initial half period of 2010, there were 1333114 saleable chicks.

Projection of Poultry Products Requirement

Nepalese people on an average consume 11 kg meat per annum per person where contribution of poultry meat is only 10 percent of total meat consumption. Majority of the portion is contributed by bovine meat and mutton, 60 percent and 20 percent, respectively (FAO, 2007). Last year Nepal import meat except poultry from India and China valued at 150 billion Rupees. Here if meat was an important consideration, buffalo for example would be selected during the course of breeding program to provide a higher proportion of carcass. But the income provided from the sale of an animal for meat is a relatively small proportion of the animal's value to the farmer throughout its life as a source of draught power or milk. Accordingly, the expense involved in genetic selection would not be justified, when the price of meat is already low. The same applied to the production of goats but not for poultry. So there is huge potentiality of poultry production in Nepal considering import substitution, investment return, health, population and economic growth.

Table 2. Estimation of per week layer chick production

Layer for 2009 at 1:10		Layer for 2010 at 1:10	
Primary Chicks	69468	Primary Chicks	21212
Eggs at 80%	35856	MR at 15%	31812
Total Chicks	105324	Productive Population	18030
MR at 15%	15799	Production Period (Wks)	50
Productive Population	89526	Avg. Egg Production	65%
Production Period (Wks)	50	Hatch %	65%
Avg Egg Production	65%	Total Egg Lay	350
Hatch %	65%	Avg. Egg Production	227
Total Egg Lay	350	Chicks Production at 60%	147
Avg. Egg Production	227	Saleable Layer Chicks	73
Chicks Production at 60%	148	Total Saleable Chicks	1333114
Saleable Layer Chicks	74		
Total Saleable Chicks	6619303		
Per week chicks production	127294		

Projection of requirement of poultry products requires data on population growth, per capita income growth and income elasticity. Alam (1995) estimated income elasticity as 0.83 for poultry meat for 2010 in least developed country while Rosengrant (1995) estimated income elasticity for meat ranges from 0.2 to 0.9 indicating higher elasticity than cereal and food crops while for egg ranges from 1.10 to 1.30. Average annual income growth per Capita, estimated on the basis of past trends, is 3.5 percent for 2009 to

2015 while 3 percent for remaining projected period. Population projection is carried out and presented in appendix 2 (Worldbank, 2009). Starting from the base year (2009) data, requirement of poultry products over the years are projected incorporating growth in population, income, and income elasticity for poultry products while base year meat production is collected through market survey particularly from quarantine department and this data is validated through Hatchery and Feed Association.

Total poultry net meat production is estimated at 73835 MTMT in 2009, however government estimated data are far below. According to MOAC (2010), National poultry meat production had reached at 16662 MTMT in 2009.

Table 3. Projected poultry meat requirement in Nepal (Demand approach)

Poultry products	Base year	Projections for poultry for next 20 Yrs			
	2009	2015	2020	2025	2030
Net Meat production (MTMT)	73835	103267	123879	141716	156071
Per capita meat consumption (kg/yr)	2.7	3.2	3.52	3.74	3.86
Feed requirement (MTMT)	197140	275728	330758	378382	417811

(Note: Feed conversion ratio, 1:2.5-2)

It can be seen from table that requirements of meat are projected to be 103267, 123879, 141716, and 156071 MTMTs for the four selected years, respectively. Thus, the total consumption of meat is expected to increase by 67 per cent in year 2020 and by 111 percent in year 2030. APP (1995) also had projected that poultry meat production would be doubled during the period of 2009 to 2030.

Feed Demand

The demand for commercially manufactured concentrated poultry feed is being affected by the fast growth of the livestock population, particularly in dairy animals and poultry birds. A significant growth in commercial poultry firms can be seen in the country, particularly in urban areas of Tarai and accessible areas of the hills. Increasing numbers of poultry birds of improved breeds are replacing local birds. This has necessitated the use of blended and manufactured feeds under the intensive livestock raising systems. Many farmers in Chitwan, Pokhara and Bhairahawa reported that they would sacrifice the personal expenses on unnecessary items and would prefer to spend the limited income on good feeds and healthcare for their poultry.

Supply of Feeds and Demand Projection

The number of feed processing industries in 2000 was 154, producing about 410,000 MTMT of feed (Maharjan, 2003). Currently 115 small and large scale feed mills are running throughout the country, which produced 581132 MTMT of feeds in 2009 (Feed Association, 2010). Pellet feed and mash feed contributed 310000 and 271132 MTMT, respectively. Nimbus, a leading private company, alone produces 80000 metric ton pellet

feed per annum. However, it has been estimated that 564445 MTMT commercial feed is consumed by poultry sector alone.

Table 4. Commercial feed consumed by poultry sector in 2009

Particulars	Feed Consumption (MTMT)	Pellet feed consumption	Mash feed
Broilers	197140	157712 (80%)	39428
Layers	325000	65000 (20%)	260000
Broiler parents	37350.15	1867.50 (5%)	35482.64
Layer Parents	4954.95	247.74 (5%)	4707.2
Total	564445.1	224827.2	339617.8

It can be assumed that there is production of homemade mash feed by poultry and livestock raisers, which have not been documented in the data of Feed Association of Nepal. It is found that currently 310000 MTMT pellet feed, which is 53 percent of total feed production, is produced across the country of which poultry alone consisists of 73 percent (224827 MTMT) of total pellet feed production out of which 70 percent has been shared by broiler. It can be derived from the table that 85173 MTMT pellet feed has been consumed by the livestock sector.

Starting from the base year (2009) data, requirement of pellet feed over the years are projected incorporating growth in population, changes in per capita income, and income elasticity for egg while data on parent layers; and broiler is projected through average production of parent broiler and layers to their respective commercial population.

Table 5. Projected pellet feed requirement of poultry for the next 10 years

Poultry products	Projection of pellet feed demand (MTMT)		
	Base 2009	2015	2020
Broilers	157712 (80%)	275728	330758
Layers	65000 (20%)	95256	121343
Broiler parents	1867.50 (5%)	2850	3439
Layer Parents	247.74 (5%)	477	607
Total	224827	376326	458167

Projected pellet feed requirement of poultry for next decade is presented in table 6. Total pellet feed consumed by poultry sector was estimated at 224827 MTMT in 2009. It can be seen from table demand for pellet feed are projected to be 376326, 458167 MTMTs for the two selected years, respectively. Thus, total requirement of pellet feed is expected to increase by 67 per cent in year 2015 and by 104 percent in year 2020. It could be strongly suggested that, total demand of pellet feed is expected to increase by 10 percent per annum for next 11 years. The total demand of pellet feed would be more than double in 2020 in poultry sector alone.

The demand of the pellet feed will be dramatically increased if pellet entrepreneur produce feed considering quality and feed requirement of commercial layer and parent broiler and layer and also implement compliance marketing strategy.

Currently, it is estimated that consumption of pellet feed to the total feed consumption to be 80, 20, 5, 5 percent for broilers, layers, parent layers and broiler, respectively.

Figure 6. Projected demand of pellet feed requirement

It is expected to be 100 percent in broilers very shortly while demand for other product would be depend upon quality, feed requirement and marketing strategy of the entrepreneur. Here it is noteworthy to mention that entrepreneur can also add to the demand of pellet feed through considering livestock subsector.

CONCLUSIONS AND RECOMMENDATIONS

- Demand is being driven by population growth, urbanization and increasing incomes in developing countries
- Religious barrier and tradition are not favorable for other type of meat
- High quality protein in lowest price-helps to reduce malnutrition and is healthier compared to other meat
- Return is high in poultry compared to goat and cattle, pro-poor friendly enterprise
- Total consumption of poultry meat is expected to increase by 67 percent in the year 2020 and by 111 percent in the year 2030.
- Sterilized feed and induced fast growth in broiler so demand of pellet is high for at least next one decade
- Total demand of pellet feed is expected to increase by 10 percent per annum for the next 11 years
- Pellet industry is still not competitive in case of production cost and quality management.
- Quality standard not fully adopted in all step of production and distribution.
- It is expected to be competitive afterwards one decade.

- Dependency in imported raw materials is in increasing trend.
- Not fully supported by national policy.
- Industries of forward and backward linkages will increase pellet feed production and will be economically feasible for long run.
- Training and exposure is needed to entrepreneurs for quality production and marketing.

ACKNOWLEDGEMENT

This study was supported by Sadgudhn High Tech. Pvt. Ltd, Narayangadh, Chitwan, Nepal. We would like to thank Hatchery Association of Nepal, Feed Association of Nepal, Feed Industries of Nepal, and Livestock Service Department for providing some primary data. We would also like to acknowledge the cooperation of Pellet Feed Industries, broiler and layers raisers of Nepal for their valuable contribution, remarks and suggestion.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Impact of economic development activities for livelihood security and social inclusion of dalits: a lesson from ILISSCON project

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ABSTRACT

A study was carried out to measure the impact of the socio-economic development activities for livelihood security and social inclusion of Dalits in Improving Livelihood Security of Socially-excluded Communities (ILISSCON) project of Local Initiative for Biodiversity, Research and Development (LI-BIRD). Sample survey was used in the study for collecting the qualitative and quantitative data. Project results shows that average annual household income of the Dalit has been increased by Rs. 56,861.27 (increment 48.19%) from baseline and similar result was also observed in Janjati (Rs.57581.54) and Brahmin (Rs.66243.75) groups. Such increment on income of beneficiaries was the result of positive growth on production and diversifying the livelihood sources. Majority of Dalits households (46.57%) have food sufficiency for more than 6 months as compared to baseline data (10.47%). Participation of the Dalits and disadvantaged groups has been remarkably increased in development activities, which shows important indication of the empowerment and inclusion of excluded groups. As a result, they are able to make meaningful exercise of their right with different service providers. Therefore, economic development activities have made significant impact on social and economic empowerment, livelihood security and social inclusion.

Keywords: Food sufficiency, household income, livelihood diversification, empowerment

INTRODUCTION

A livelihood is concerned primarily with poverty, development, vulnerability and people's coping strategies. This particular understanding of livelihoods has been informed and shaped by multiple studies on community forestry (Gautam *et al.,* 2008); access to land and livelihoods of rural people (Upreti *et al.,* 2008); and internal and international migration (Kaspar, 2005; Thieme, 2006). The second one, which can be termed a 'group-centered' understanding, privileges an analysis of identity (caste and ethnicity) and social inclusion/exclusion (Lietchy, 2008; Fischer, 2001; Geiser, 2005). This second understanding pays greater attention to social relations, focusing on the problems and issues of specific caste and ethnic groups.

Dalits and other ethnic minority groups are deprived of socio-cultural, political and economic rights because of the prevalence of discriminatory traditional practices, poverty and deprivation. Dalits are highly dependent on their traditional so-called caste based occupation for their livelihoods. Their living standard is also very low, i.e. per capita income of Dalit is 39 US dollar as compared to national per capita income of 240 US dollar (BK, 2005). Their livelihood may be sustainable,as they can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation (Chambers and Conway,1991).

Dalit groups are skillful in their professional occupation but due to lack of resources and access to finance, it is becoming increasingly difficult for them to make a living on the sole income out of their artisan (NNDSWO, 2005). Dalits have limited access to farm land, the ownership of which in Nepal has social prestige. Sharma (2004) has pointed out that land is a matter of prestige, pride and productive asset of Nepalese people. Though various tenure systems of feudalistic nature do not exist, legacies that Nepalese people have inherited from the past still persist. The so-called upper castes therefore tend to own as much land as possible. Dalits own only 1 percent of Nepal total cultivated land; about 15 percent of hill dalits and 44 percent of Terai Dalits are landless. Unlike other groups, Dalits have limited opportunities to employment. Over 54 percent of Dalits have derived their livelihoods from agriculture, though they are marginalized farmers; another 20 percent from wage-earning and rest 16 percent from services (NHRC, 2004). Even if they rear livestock they cannot sell the dairy products, because of untouchability. Seasonal unemployment, minimum wage, subsistence farming, etc. are the basic problems of the Dalits.

Social exclusion is yet a major challenge faced by the people in Nepal. Dalits and minority ethnic groups are the most vulnerable communities in Nepal, not having access to even the minimum basic services. Dalits are routinely denied access to education, public resources, and other mainstream socio-economic resources. Other discriminated groups, created and recreated along the process are Sukumbasi (landless squatters), Haliya (bonded laborers), and ethnic minorities, who form substantially a part of historically poverty stricken groups in Nepal (Lumsali, 2005). Similarly, the World Bank (2005) has also identified four elements: excluded people who are in exclusion; the institutions from which they are excluded; agents whose results are in exclusion; and process or mechanisms through which exclusion occur.

Employment opportunities are less for the Dalits and minority ethnic groups (indigenous people). Due to exploitation and oppression of these groups of people, and lack of their rights to lands, forests and other natural resources, many male members use to migrate in search of jobs to secure their families' livelihoods. This has increased the burden and responsibilities of women since they have had to lead the households. Furthermore, the poor remuneration of manual scavenging, agricultural labour, and other forms of low-caste employment often force families of these groups into bondage. Lack of access to

cultivable land, low productivity, lack of knowledge, lack of extension services, lack of appropriate tools and technologies are other factors contributing to this situation.

To address the above issues a four years' project "Improving Livelihood Security of Socially-excluded Communities of Nepal (ILISSCON) Project" was implemented from March 2006 to February 2010 in the partnership among Dalit Welfare Organization (DWO), LI-BIRD and Practical Action Nepal in six conflict affected districts, viz. Doti, Kailali, Banke, Surkhet, Rupandehi and Nawalparasi of Nepal. The major socio-economic development activities implemented by the project includes; farm (lease based and semi-commercial vegetable farming, fish farming, goat keeping, mushroom production) and off-farm (house wiring, bamboo carving, leather shoe making, blacksmithing, etc.) based activities for income and employment generation; micro-enterprise and business development; group capacity building for economic and institutional development and infrastructure support (collection center, equipment and materials) for promotion of market and basic services. The main objective of this impact study was to assess the socio-economic status of low-caste and excluded minority groups; and also assesses the capabilities of the project beneficiaries for exploring the resources from different service providers.

MATERIALS AND METHOD

Study design

In this study stratified random sampling was used to get the required information from targeted beneficiaries. Due to the heterogeneous nature of targeted beneficiaries and different levels of support to the targeted beneficiaries, it was divided into three categories viz. high, medium and low support level and considered each category as the sampling population. Sampling population for each district was made separately. As the financial and technical support was higher in leasehold vegetable farming, it was kept in high support level, on the other hand comparatively low investment was in semi-commercial vegetable farming, community leasehold fish farming and black smith training, so it was placed under medium support and remaining activities were put on low support category. Altogether 1,422 households were surveyed in six districts. Sample size was calculated by using formula as per given below (Parel*et al*., 1973).

$$n = \frac{NZ^2P(1-P)}{Nd^2+Z^2P(1-P)}$$

Where;
n= sample size;
N= total number of households or members in the study district;
d= maximum error deemed acceptable (in this case 0.10);
Z= the normal variable (in this case value used is 1.64 to correspond 90% reliability);
P= probability of the success (50%) due to the implement of the project.

Project results in terms of outcome and goal were assessed from qualitative and quantitative data, which was collected by different participatory methods (focus group discussion, field visit, interaction and group meeting) and sampling survey (semi-structured open ended questionnaire). All the information collected from the field were coded, tabulated and entered into the computer using the Statistical Packages for Social Sciences (SPSS) program. Simple descriptive statistics were used to analyze the data; and necessary tables and graphs were prepared and inserted under suitable headings.

RESULTS AND DISCUSSION

Sources of livelihood

Major livelihood sources of the people in the project areawere agriculture farming, wage laborer and off-farm based enterprises. Before project, majority of the Dalits (20.72%) were doing daily wages and caste-based occupation like tailoring and blacksmiths for the normal living. Due to low productivity from the occupation, livelihood source of Dalit was not increased and diversified. Upreti et al., (2008) also revealed that crisis associated with stagnant production has led to a deepening struggle for the fulfillment of basic needs, causing people to diversify their livelihoods options.

Table 1. Contribution of the different sources of livelihoods on average annual household income according to different ethnicities

Ethnic groups	(Baseline Status) Sources of livelihoods			
	Agriculture (%)	Wage Laborer (%)	Foreign Income (%)	Others (%)
Brahamin	6.78	30.82	43.39	18.02
Janjati	9.24	53.17	14.80	22.79
Dalit	6.23	20.72	29.46	43.59
Other	3.21	27.71	18.78	50.29

Sources of livelihood of Dalits have been increased and diversified in a larger scale as compared to the baseline data as they received support on commercial vegetable farming, goat keeping and off-farm enterprises (leather shoe making and weilding). Level of contribution of lease-based and semi-commercial vegetable farming (29.64%) to household income was found to be increased remarkably (6.23%) in Dalit group and increment was similar to Janjati (23.99%) and Brahamin (18.96%) as shown in Table 1 and 2. This helped to diversify farming and created employment opportunity to Dalits.Timilsina (2003) has shown that the changing livelihood patterns of different caste/ethnic groups are due to changes in social traditions, market systems and other

economic systems.The most important contribution of the wage laborer (10.66%) to household income has significantly decreased from the baseline data (20.72%) in Dalit group (Table 1 and 2); and this was due to support of commercial vegetable farming and improved off-farm enterprises.

Table 2. Contribution of the different sources of livelihoods on average annual household income according different ethnicities

Ethnic groups	(End line status) Sources of livelihoods			
	Agriculture (%)	Wage Labourer (%)	Foreign Income (%)	Others (%)
Brahamin	18.96	13.22	1.38	66.44
Janjati	23.99	7.96	3.84	64.21
Dalit	29.64	10.66	2.72	56.98
Other	32.68	17.29	1.16	48.87

Access to resources

One factor that causes vulnerability among the people is the limited access to assets. A report by UNDP (1997) suggests that asset ownership reduces people's vulnerability and builds their resilience. Land is perhaps the most important economic asset that provides the basis for generating income, economic production and safe livelihoods. Average landholding of the Dalit (5.68 Katha) was found least at the baseline than other ethnic group and this was increased by 6.24 Katha at the end of the project and gap of the landholding against Janjati (6.77 Katha) and Brahamin (9.96 Katha) was found to be decreased after the end of the project (Fig. 1). Average rented/share cropped land (6.77 Katha) by Dalit was found to be increased from the baseline (Fig. 2).This shows project was successful to ensure the access of land to Dalits and excluded groups.

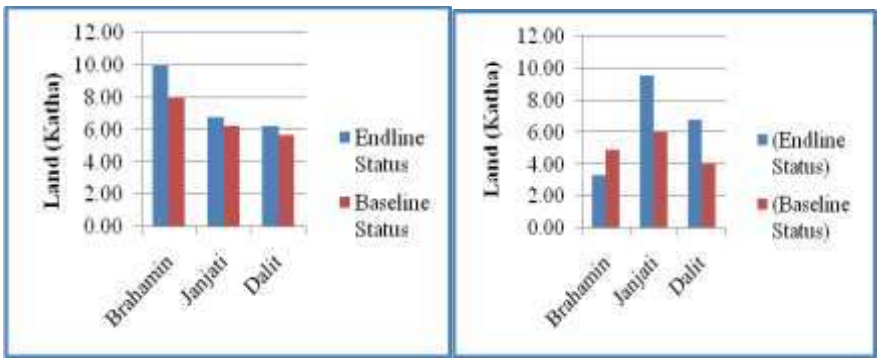
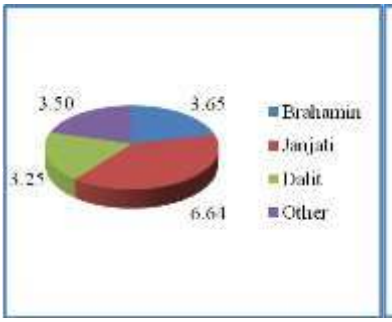


Figure 1. Status of the average landholding of beneficiaries

Figure 2. Status of average rented and share cropped land by beneficiaries

Project members from Dalit groups were also able to purchase about 3.25 Katha (avg.) land (Figure 3); this was due to creditable earning from the lease based and semi-commercial vegetable farming and improved off-farm skill based enterprise. This increase on access to land provides opportunity to Dalti group for making meaningful income and self-employment. Nepali (2008) also suggests that land is critical for the livelihoods of a large number of poor farmers and minorities; and those with poor land entitlement are systematically marginalized and excluded from productive opportunities. Majority of the project beneficiaries have accumulated assets portfolio like she-buffaloes, goats, bicycle, TV, bullocks, water pump/boring, houses, mobiles, leasing and purchasing of lands. Survey results show Dalits were able to generate total average assets value of Rs. 16,054.41 as compared to baseline (Rs. 7,981.14); and this is not the big gap than Janjati (Rs.20427.98) and Brahmin (Rs. 23,213.06) (Figure 4).



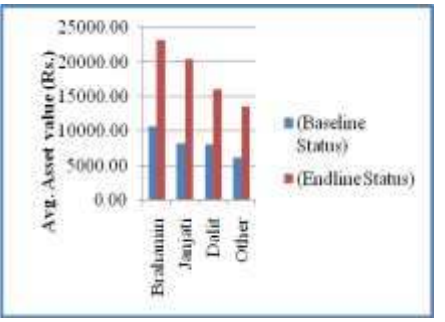


Figure 3. Average purchased land (katha) by different ethnic groups at the end of the project

Figure 4. Average total assets worth generated by different ethnic groups

Household income

Household income is the most important source for meeting basic needs and running the productive activities of the beneficiaries. Before project, daily wage was the major occupation contributing to income of the Dalit and ethnic minority groups. People used to go to the field of land owner for work. It was very difficult to Dalits and other ethnic minority groups for sustaining the livelihood from the small amount of income. After the project support, average annual household income of the Dalit (Rs. 56,861.27 and 48.19% increase from baseline) has significantly increased from the baseline (Rs. 29462.59). This change in the income was minimum difference with Janjati (Rs. 57581.54 and 49.63% increase from baseline) and Brahamin (66243.75 and 49.50% increase from baseline) (Table 3).

Similar result was also observed in household income (43% increased from baseline) of Dalits group through support of micro-enterprise interventions of MEDEP project (MEDEP, 2001). Such increment in income is the result of commercialization of leasehold vegetable farming and improved off-farm enterprises. They have utilized the income on household works, education and health of children and agriculture. Survey data shows, expenditure of farm and off-farm activities (Rs. 3,575.98 and Rs. 54,826.14) have been found to be increased remarkably higher in Daltis group from the baseline (Rs. 1943.19 and 30619.59), respectively (Table 4). As a result of this they are growing business in larger scale and generating good profit.

Table 3. Average annual household income of the beneficiaries according to different ethnic groups

Ethnic Groups	Average Annual Household Income (Rs.)		Increment (%)
	(Baseline Status)	(End line Status)	
Brahamin	33451.82	66243.75	49.50
Janjati	29003.03	57581.54	49.63
Dalit	29462.59	56861.27	48.19
Other	31085.37	57104.55	45.56

Table 4. Average annual household expenditure of the beneficiaries according to different ethnic groups

Ethnic Groups	Farm Expense (Rs.)		Off-farm Expense (Rs.)	
	(Baseline Status)	(Endline Status)	(Baseline Status)	(Endline Status)
Brahamin	1950.00	2228.32	33146.03	49398.94
Janjati	2488.33	5592.95	27728.57	46246.48
Dalit	1943.19	3575.98	30619.59	54826.14
Other	3179.67	8399.69	35294.17	42110.07

Food sufficiency

Food security is a complex, multidimensional issue that needs to be addressed with a more holistic approach for moving towards attaining sustainable livelihoods. Most of the excluded and disadvantaged groups from the rural areas are the vulnerable to food security throughout the year. Household survey shows project activities have contributed to increase the food sufficiency months of the beneficiaries from their own production and income. Before the project, food security situation of Dalits was very worse than other ethnic groups. Majority of the Dalits (63.53%) had food sufficiency for less than three month (Table 5).

Table 5. Percentage response of different ethnic groups on household level food sufficiency

Ethnic Groups	Baseline Status			
	< 3 months (%)	3-6 months (%)	6-9 months (%)	9-12 months (%)
Brahamin	60.00	29.70	6.67	3.64
Janjati	35.22	37.25	21.46	6.07
Dalit	63.53	26.00	8.59	1.88
Other	68.82	19.35	8.60	3.23

After the project support, only 8.8 percent Dalits households had food deficit for less than three month (Table 6). More remarkably, project was successful to improve the food sufficiency of Dalits for 3 to 6 month (44.60% HHs), 6 to 9 month (31.6% HHs) and 9-12 month (15.21% HHs) as compare to baseline (26.0 and 8.59 and 1.88% HHs), respectively (Table 5 and 6) and similar trend was also found in Janjati and Ethnic groups. Similar result was also found with Dalits and excluded groups on household food sufficiency (more than 5 month) in Food Facility Project of Practical Action Nepal (Practical Action, 2012). Such improvement in food sufficiency month of target beneficiaries is the result of income and production of logically designed farm and off-farm based economic development activities of the project.

Table 6. Percentage response of different ethnic groups on household level food sufficiency

Ethnic Groups	Endline status			
	< 3 months (%)	3-6 months (%)	6-9 months (%)	9-12 months (%)

Brahamin	4.68	43.27	35.09	16.96
Janjati	2.88	23.05	42.80	31.28
Dalit	8.83	44.60	31.36	15.21
Other	2.13	52.13	29.79	15.96

Participation and capacity building

Majority of the disadvantaged groups were excluded from the development activities around project site due to their low income and awareness before project. Project had benefitedto 2792 Dalits; 1269 Janjaties and 1183 Brahamins through participating them in different farm and off-farm programs. This shows project was successful to ensure participation of Dalits and other ethnic minorities groups in the programs. Similarly participation of the disadvantaged group was also found prominent inLivelihood and ForestyProgram (LFP) of DFID (DFID, 2005) and it indicates targeted programs are more rationale strategy for social inclusion of excluded groups.

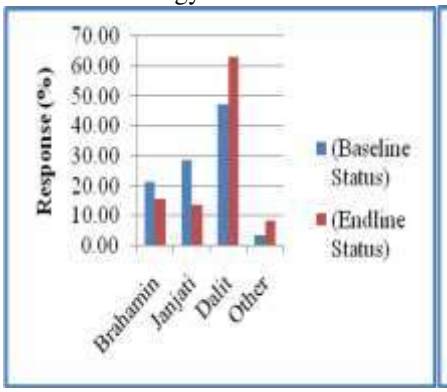


Figure 5. Participation of different ethnic groups in community organization

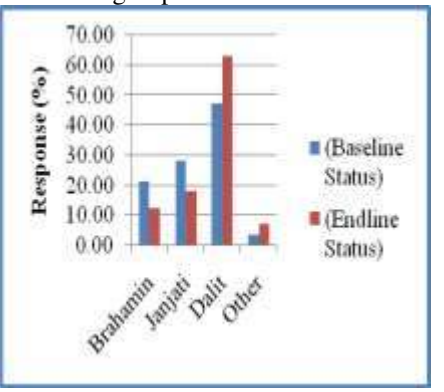


Figure 6. Participation of different ethnic groups in saving credit groups

Household survey shows participation of Dalit's households have been increased notably in community group (63.01%) and saving credit groups (62.94%) as compared to baseline(Fig. 5 and 6), and trend of participation was similar to Janjati and Brahmin groups. Project supported different capacity building programs like group management and leadership development, enterprise development, group level planning and monitoring. Because of this, Dalits and excluded groups'capacity has been enhanced markedly and they are able to receive different resources (sprayers, irrigation pump, and technical services) from DADO, VDC and local level NGOs and private service providers. Another positive aspect of the capacity building program was adoption of participatory decision making system in family. Survey result shows majority of the Dalit households (69.9%) have made participatory decision by both male and female on daily

household affairs compare to baseline (47.80% HHs) (Fig. 7 and 8), and similar trend was also observed in Janjati and Brahmin groups.This will surely help them to increase and diversify their enterprises in larger scale and contribute for sustainable livelihood security.

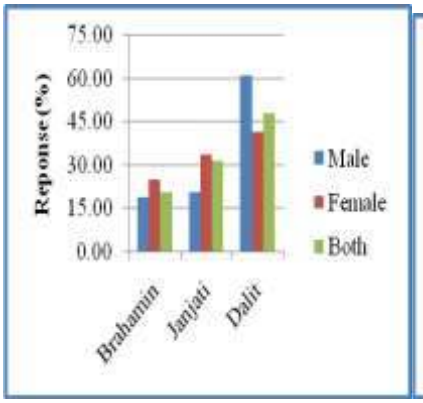


Figure 7. Trend of decision making on daily household affairs (Baseline)

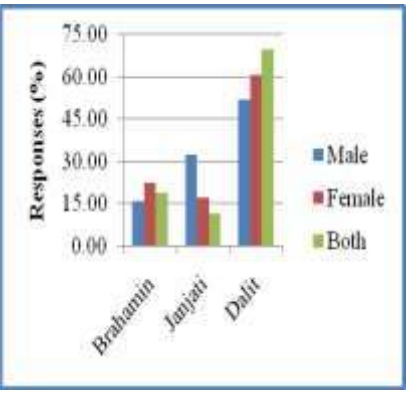


Figure 8. Trend of decision making on daily household affairs (End line)

CONCLUSION

Increased income of Dalit and ethnic minorities groups within the short period through farm and improved off-farm based activities is most important outcome of the economic development programs. As a result, gap on access of resources (physical, financial andservices) of Dalits and socially excluded groups have been narrow downed against Janjati and Brahamin groups. Impacts of project can be observed in various areas of beneficiaries. Most importantly wage laborers have been changed into self-employed mainly because of leasehold and semi commercial vegetable farming and off-farm based enterprises. Because of regular income from the enterprises, this has helped to secure livelihood in household level.

Because of encouraging income and production from the farm (commercial lease based vegetable farming, mushroom production, fish farming and goat keeping) and improved off-farm based (improved blacksmithing, leather shoe making, house wiring, bamboo carving and motor winding etc.) economic development activities, food deficit of Dalits and excluded groups have been addressed to large extent. Possession of livelihood assets such as bullocks, water pump/boring, houses, mobiles, leasing and purchasing of lands has been increased significantly. School education and health services have been affordable among beneficiaries' groups. A kind of social dignity, especially in landless and Dalit, was found fostering.

Capabilities of Dalits and excluded groups have been remarkably increased through involving in different trainingsespecially technical and management aspects. Because of

this, they have been participating in group strengthening activities such as monthly meeting of groups, training, workshop and other social development program at community level. As a result, they are able to advocate for the resource with different service providers at village and district level. Thus, beneficiaries groups have been empowered socially, technically and economically through support of project interventions, and which resulted to improve livelihood security and social inclusion of Dalits and excluded groups.

ACKNOWLEDGENT

The authors express sincere gratitude to European Union for financial support toimplement the project "Improving Livelihood Security of Socially-excluded Communities of Nepal. He is grateful to Practical Action Nepal for providing this opportunity and managing financial resources for the study. Special thanks go to Dalit Welfare Organization (DWO) and Local Initiative for Biodiversity, Research and Development (LIBIRD) for providing immense support and cooperation to carry out study at field level. He also indebted to the entire project beneficiaries and enumerators those involved in this study for their amicable cooperation. At last, he would like to give sincere thanks to all authors/organizations whose article were used for citation during preparation of this paper.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Effect of different seeding ratios in rice-maize mixed cropping system under rain-fed condition

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ABSTRACT

This study was conducted in order to investigate the effect of mixed cropped maize with rice at different seeding ratios on yield, total rice grain yield equivalent (TRGYE), net benefit, and land equivalent ratio (LER) under rain-fed condition of Agriculture Research Station, Doti. The mixed cropping systems comprised sole rice (100% rice), sole maize (100% maize), 90% rice + 10% maize, 80% rice + 20% maize and 70% rice + 30% maize seeding ratios. The total rice grain yield equivalent was found significantly higher with 70% rice + 30% maize seed mixture (4.55 ton ha^{-1}) than sole rice (3.8 ton ha^{-1}) but at par to 80% rice + 20% maize (4.12 ton ha^{-1}) and 90% rice + 10% maize (4.07 ton ha^{-1}) seed mixture. On the other hand, 70% rice+30% maize and 80% rice + 20% maize seeding ratio have produced remarkably higher net benefit of Rs. 46769.03 and 43402.81/ha, respectively than sole rice (Rs. 43300.32/ha) and sole maize (Rs.21749.90 ha^{-1}). Likewise, 70% rice + 30% maize seed mixture gave the highest LER (1.19) as compared to 90% rice + 10% maize (1.07) and 80% rice + 20% maize (1.08) seeding ratios.Land equivalent ratio for straw (1.36) was also found higher in the same treatment as in land equivalent ratio for grain than 90% rice + 10% maize (1.28) and 80% rice + 20% maize (1.33) seeding ratio. Thus, seeding ratio of 70% rice + 30% maize has been found to be more efficient in terms of higher yield, maximum utilization of land and economic return.

Key words: Mixed cropping, TRGYE, LER, yield

INTRODUCTION

Rice is the most preferred staple food in Nepal and mainstay for the food security of rural population. Similarly maize is second crop after rice and it is the major food crop of small land holding farmers in mid-hill district of Nepal. Rice and maize are grown in about 14.96 and 9.06 million hectares with total production of 44.6 and 20.67 million tones and productivity was 2.98 and 2.28 t/ha, respectively (Statistical Year Book, 2011). The major staple food crops in mid-hill areas of country are rice (*Oryza sativa* L.), maize (*Zea mays* L.), wheat (*Triticumasetivaum* L.), and millet (*Pennisetumamericanum* L.). Due to low productivity of crops farmers have challenge to feed their family and

sustaining normal living. The major constraints for crop productivity are erratic rainfall, poor irrigation facility, and practicing of unscientific cropping system. Mixed cropping, the practice of growing two or more crop species on the same piece of land in a cropping season continues to be popular and persistent among small landholding farmers in the developing world (Andrews &Kassam, 1976; Willey, 1979). It provides precautions against uncertainty, income stability (Abalu, 1977), improved yield (Saleem*et al*., 2000; Nazir*et al*., 2002; Bhatti *et al*., 2006), and increase in total productivity (Rahat& Singh, 1979). It also helps making efficient use of nutrients (Aggarwal *et al*., 1992; Nazir*et al*., 1997; Ahmad and Saeed, 1998; Maingi*et al*., 2001) and ensuring economic utilization of land, labor and capital (Moris and Garrity, 1993; Singh *et al*., 1996; Jeyabel and Kuppuswamy, 2001). Mixed cropping of maize with upland rice is a unique and prevailing system practiced by rural farmers across the rain-fed upland condition of Doti District. The advantages derived from mixed cropping might have compelled small land holding farmers to intensify the practice in order to meet the yield of major food crops (rice and maize), food diversity, and maximum utilization of land and resources. This necessitates going for appropriate alternative and more efficient production system such as multi-cropping (mixed/inter/relay cropping) which can ensure proper utilization of resources to obtain increased production per unit area and time on a sustainable basis (Trenbath, 1986).

Under the present situation farmers are doing mixed cropping of upland rice and maize in rain-fed condition by using their own past knowledge. They are adjusting seeding ratio of rice and maize by rule of thumb. Farmers do not properly follow the principles of mixed cropping, so they are unable to get stable yield and profit. This calls for further studies into the system to improve the productivity of component crops. Research study in the area of upland rice and maize mixed cropping in rain-fed condition of mid-hill areas is very little, so viewing the situation of cropping system there is need to identify and recommend the appropriate seeding ratio of rice and maize in mixed cropping which result higher yield with minimum distribution of the present cropping system. Therefore, the objective of this study was to investigate the suitable seeding ratio of rice and maize mixed cropping for high yield and economic gain.

MATERIALS AND METHOD

A field experiment was carried out at the Research Station, Doti in rain-fed condition during summer season in 2011. The research station is located at 29° 15' North latitude and 80° 55' East longitude at 600m above sea level. The climate is semi-arid with temperatures ranging from 20C to 450C with average rainfall 1100-1200mm. Regarding chemical properties of the soil, 0.17% N, 4.65% organic matter, 231.55kg/ha P and 140.04 kg/ha K are available in the soil of research station. The soil pH is 5.22 and soil textural class is sandy loam with 54.7% sand, 30.8% silt and 14.5% clay.

Five treatments were included in the study as follows, T1 = Sole rice with recommended seed rate (R100%), T2 = Sole maize with recommended seed rate (M100%), T3= 90% rice seed rate and 10% maize seed rate (90%R+10%M), T4 = 80% rice seed rate and 20% maize seed rate (80%R+20%M), T5 =70% rice seed rate and 30% maize

(70%R+30%M). Detail information about treatment is given in Table 1. The experiment was laid out in a randomized complete block design (RCBD) with four replications. Five treatments were randomly assigned in each replication. There were 20 units (plots) in the experiment and the size of each plot was 5.0 m x 3.0 m. One half (1/2) amount of nitrogen, whole amount of phosphorus and potash were applied at the time of final land preparation. Rest amount of urea (1/2) was applied as top dressing at 45 days after sowing of crop.

Rice variety, Ghaiya-2 and Arun-2 of maize cultivar were used in the experiment. The seed rate of upland rice and maize were 80 and 20 kg ha^{-1}, respectively. Seed rate and fertilizer dose was calculated for each treatment separately as per percentage mentioned in each treatment for seeding ratio. Observations on desired parameters of the components crops were recorded using standard procedure and the data obtained were analyzed statistically by using "MSTAT-C" statistical package. The difference among treatments mean were compared by Duncan's Multiple Range Test (DMRT) at P=0.05. The rice grain yield equivalent of mixed crop was computed by converting the yield of mixed crop into grain yield of rice on the existing market price of mixed crop (Anjeneyulu*et al.,* 1982). The Land equivalent ratio (LER) index was used to evaluate mixed crop's efficiencies with respect to sole crops. The LER defines yield as a function of area:

$LER = Ia/Sa + I_b/S_b$

Where, I and S refer to mixed crop and sole-crop yield, respectively and the subscript a and b indicate component crops in the mixture.

Table 1. Detail of the treatments in mixed cropping of rice and maize at different seeding ratios in rain-fed condition of agriculture research station, Doti

Treatment	Treatment Combination	Description of Treatment
T1	100% rice	Recommended seed rate (80 $kgha^{-1}$)
T2	100% maize	Recommended seed rate (20 $kgha^{-1}$)
T3	90% rice + 10% maize	90 percent seed rate of rice + 10 percent seed rate of maize from recommended rate
T4	80% rice + 20% maize	80 percent seed rate of rice + 20 percent seed rate of maize from recommended rate
T5	70% rice + 30% maize	70 percent seed rate of rice + 30 percent seed rate of maize from recommended rate

RESULTS AND DISCUSSION

Rice grain and straw yield

The rice grain yield was decreased to a significant level by mixed cropping of maize with rice in various seeding ratios (90% rice + 10% maize, 80% rice + 20% maize, and 70% rice + 30% maize). However, percentage decrease in rice grain yield varied from 11.32 to 32.89%, with the maximum in 70% rice + 30% maize (32.89%) seed mixture (Table 2). By contrast, the minimum decrease in rice grain yield was recorded in 90% rice + 10% maize (11.32%) seed mixture. The rice grain yield was recorded significantly higher in

90% rice + 10% maize (3.37 ton ha^{-1}) as compared to 70% rice + 30% maize (2.55 ton ha^{-1}) and non-significant to 80% rice + 20% maize (3.06 ton ha^{-1}) (Table 2). This higher grain yield was due to higher seed rate (90% of the recommended rate) of rice in the mixed cropping. Similar result was also observed by Malek*et al*., 2011 in grain yield of wheat (3.14 ton ha^{-1}) with 90% wheat + 10% lentil than 80% wheat + 20% lentil (2.88 ton ha^{-1}) and 70% wheat + 30% lentil (2.84 ton ha^{-1}) seeding ratio. On the other hand, rice grain yield was obtained significantly higher with sole rice (3.8 ton ha^{-1}) than 80% rice + 20% maize and 70% rice + 30% maize but at par to 90% rice + 10% maize seeding ratio.

The rice straw yield was also observed decreasing trend in different seeding ratios of rice and maize and difference was significant. The straw yield was recorded significantly higher with 90% rice + 10% maize (3.16 ton ha^{-1}) than 70% rice + 30% maize (2.43 ton ha^{-1}) and non-significant to 80% rice + 20% maize (2.73 ton ha^{-1}) seeding ratio (Table 3). However, the highest rice straw yield was obtained with sole rice (3.96 ton ha^{-1}) which was significant to all seeding ratios of rice and maize treatments. Similar result was also observed by Ciftci and Ulker, 2005 with sole wheat (3.7 ton ha^{-1}).

Grain and straw yield of mixed crop (Maize)

The mixed crop yield was increased to a significant level in mixed cropping of maize with rice in seeding ratios of 90% rice + 10% maize, 80% rice + 20% maize, and 70% rice + 30% maize. The grain yield of maize was recorded significantly higher with 70% rice + 30% maize (1.45 ton ha^{-1}) than 80% rice + 20% maize (0.77 ton ha^{-1}) and 90% rice + 10% maize (0.51 ton ha^{-1}) seed mixture (Table 2). This increase in yield was due to higher seeding ratio of maize (30% of the recommended rate) than in other seeding ratios which resulted more plant population than other mixed cropping systems. Malek*et al.,* 2011 also found remarkably higher yield of lentil (0.37 ton ha^{-1}) in 70% wheat + 30% lentil seeding ratio than 90% wheat + 10% lentil (0.09 ton ha^{-1}) and 80% wheat + 20% lentil (0.16 ton ha^{-1}) seeding ratio. However, grain yield of maize was recorded significantly higher with sole maize (2.81 ton ha^{-1}) than other mixed cropping systems.

Similarly, maize straw yield was increased to a significant level in different seeding ratios of rice and maize. The maize straw yield was recorded significantly higher in 70% rice + 30% maize (2.85 ton ha^{-1}) than 90% rice + 10% maize (1.83 ton ha^{-1}) and at par to 80% rice + 20% maize (2.43 ton ha^{-1}) seed mixture. By contrast, the highest straw yield was obtained with sole maize (3.83 ton ha^{-1}) which was significant to all seeding ratios of rice and maize treatments.

Rice grain yield equivalent to mixed crop

The grain yield of mixed crop converted into the rice grain yield equivalent on the basis of existing market price of mixed crop. The rice grain yield equivalent of mixed crop was ranged between 0.77 to 1.99 ton ha^{-1} and the difference was significant. The maximum rice grain yield equivalent was recorded in 70% rice + 30% maize seed mixture (1.99 ton ha^{-1}) and followed by 80% rice + 20% maize (1.06 ton ha^{-1}) and least with 90% rice + 10% maize (0.77 ton ha^{-1}) (Table 2). The highest rice grain yield equivalent with this seeding ratio (70% rice + 30% maize) was due to higher LER value and seed rate of maize (30% of recommended rate) in the treatment. Jabbar*et al.,* 2010 also found the

higher rice grain yield equivalent (2.87 ton ha^{-1}) in rice+maize intercropping system than other systems.

Total rice grain yield equivalent of the systems

All the mixed cropping treatments had higher total rice grain yield equivalent than sole crop of rice and difference was significant. The total rice grain yield equivalent was found significantly higher in 70% rice + 30% maize seed mixture (4.55 ton ha^{-1}) than sole rice (3.8 ton ha^{-1}) but at par to 80% rice+20% maize (4.12 ton ha^{-1}) and 90% rice + 10% maize (4.07 ton ha^{-1}) seeding ratio (Table 2). The reason behind higher total rice grain yield equivalent was due to higher LER value associated with the 70% rice + 30% maize seeding ratio. Jabbar*et al*., 2010 also revealed that all intercropping treatments had higher total rice grain yield equivalent (average 5.1 ton ha^{-1}) in the system over sole rice (4.02 ton ha^{-1}).

Table 2. Comparative bio-economic performance of rice and maize mixed cropping in different seeding ratios at Agriculture Research Station, Doti

Rice-Maize seeding ratio	Rice grain yield (ton ha^{-1})	% decrease over mono-cropping	Grain yield of mixed crop maize (ton ha^{-1})	Rice grain yield equivalent of mixed crop (ton ha^{-1})	Total rice grain yield equivalent of the system	%increase over alone	Net benefit (NRs/ha)	%net benefit increase over sole rice	Net benefit excluding income of rice straw(Rs./ha)	% net benefit increase over sole maize excluding income of rice straw
100% rice	3.80 ^{a}				3.80^{b}		43300.32		23466.98	
90% rice + 10% maize	3.37 ^{ab}	11.32	0.51 ^{d}	0.70^{c}	4.07^{ab}	7.11	41671.33	-3.76	21749.90	26.76
80% rice + 20% maize	3.06 ^{b}	19.47	0.77 ^{c}	1.06^{b}	4.12^{ab}	8.42	43402.81	0.24	27569.48	28.76
70% rice + 30% maize	2.55 ^{c}	32.89	1.45 ^{b}	1.99^{a}	4.55^{a}	19.74	46769.03	8.01	28004.67	59.09
100% maize			2.81 ^{a}				21749.90		34602.37	
LSD	0.45		0.16	0.24	0.52					
P=0.05	**		**	**	*					

CV	7.26		5.4	12.49	6.82					

Land equivalent ratio

The highest land equivalent ratio (LER) for grain was obtained in 70% rice + 30% maize (1.19) as compared to 90% rice + 10% maize (1.07) and 80% rice + 20% maize (1.08) seeding ratios (Table 3). Similarly, land equivalent ratio for straw (1.36) was also found higher in the same treatment as in land equivalent ratio for grain than 90% rice + 10% maize (1.28) and 80% rice + 20% maize (1.33) seeding ratios. As the LER value was recorded higher with 70% rice + 30% maize seed mixture, it shows mixed crop was more efficient in term of land utilization over sole cropping. Ciftci and Ulker, 2005 also found higher LER for grain and straw yield (1.04 and 1.10) in 70% lentil + 30% wheat seeding ratio than 80% lentil + 20% wheat (0.85 and 0.89) and 90% lentil + 10% wheat (0.83 and 0.86), respectively.

Economic analysis

The economic analysis showed that 70% rice + 30% maize and 80% rice + 20% maize seeding ratio gave higher net benefit of NRs. 46769.03 and NRs. 43402.81/ha, respectively than sole rice (Rs. 43300.32/ha) and sole maize (Rs.21749.90 ha^{-1}) and percentage increase of net benefit with these treatments was 0.24 and 8.01% over sole rice and 28.76 and 59.09% over sole maize (Table 2). This higher net benefit in 70% rice + 30% maize and 80% rice + 20% maize seeding ratio was the result of higher total rice grain yield equivalent and LER value associated with this treatments. Akter*et al*., 2004 also observed remarkably higher gross profit (Rs. 27,759.00/ha) in 100% lentil + 40% wheat seeding ratio than sole lentil (18519.00) and other mixed cropping treatments.

In conclusion, mixed cropping of maize with rice in 70% rice + 30% maize seeding ratio have produced remarkably higher total rice grain yield equivalent, net benefit and LER as compare to 80% rice + 20% maize and 90% rice + 10% maize seeding ratio, therefore 70% rice + 30% maize seeding ratio would be more profitable mixed cropping practice to small landholding farmers for higher yield and economic gain in rain-fed condition of Doti district, Nepal.

Table 3. Relative yields and land equivalent ratio (LER) under different cropping systems at Agriculture Research Station, Doti

Rice-Maize seeding ratio	Relative grain yield (ton ha^{-1})			Relative straw yield (ton ha^{-1})		
	Rice	Maize	LER	Rice	Maize	LER
100% rice	3.80^{a}			3.96^{a}		
90% rice + 10% maize	3.37^{ab}	0.51^{d}	1.07	3.16^{b}	1.83^{d}	1.28
80% rice + 20% maize	3.06^{b}	0.77^{c}	1.08	2.73^{bc}	2.43^{cd}	1.33

70% rice + 30% maize	2.55[c]	1.45[b]	1.19	2.43[c]	2.85[bc]	1.36
100% maize		2.81[a]			3.83[a]	
LSD	0.45	0.16		0.44	0.71	
P=0.05	**	**		**	**	
CV	7.26	5.4		7.36	13.26	

ACKNOWLEDGEMENT

We are grateful to Nepal Agricultural Research Council (NARC) for providing the research fund for doing this research work at Agriculture Research Station Doti. I am thankful to Mr. Hari Kumar Prasai, Station Chief for valuable support and cooperation for managing research trial at research station. Thanks go to all technical staff, finance and admin personnel and office helpers for their trustworthy support and contribution for the success of research work.

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Survey and monitoring of insect pest and disease of ginger in Nepal

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ABSTRACT

A random field survey was conducted from August to September during two consecutive ginger growing seasons in 2011 and 2012 in the major ginger growing districts (Illam, Salyan Palpa, Nawalparasi, Dhankuta, Syanja, Makawanpur, Tanahu and Surkhet) of Nepal. White Grub (Phyllophaga spp.), Ginger shoot borer (Dichocrosis punctiferalis Guen.), Red ant (Dorylus sp), termites (Odontotermes sp) and Leaf roller (Udaspes folus) pest infestation was found in most of the surveyed districts. Among them white grub and rhizome fly were found economically important insect pests in ginger. Rhizome rot (Pythium sp) infestation was found associated with rhizome fly (Calobata sp) in patches in almost all the surveyed districts. However, no any association of rhizome fly was found in fusarium infestation. Monitoring of insect species using Siga energy saving lamp of 18 watt was conducted at National Ginger Research Program (1480 masl) during 2011/12. A total of 27 species of insects were collected through light trap were identified. However, only 6 different insects namely Phyllophaga serricolis Hope, Dorylus orientalis, Xylotrupes gideon L., Anomala xanthroptera Blanchard, Areas galactina orientalis and Nezara viridula L were observed for the population build up trend. Phyllophaga serricolis Hope (38) and Xylotrupes gideon L. (98) showed the highest occurrence in July where as other insect species during June. During winter season no any occurrence of insect species were recorded in Kapurkot condition.

Key words: Ginger, insect pests, diseases, occurrence, yield

INTRODUCTION

Ginger (Zingiber officinale Rosc.) is one of the principle spice crop commercially grown in the mid hills of the Nepal and established as a cash/commercial crop. It is valued for its spicy properties. Illam, Salyan, Palpa, Nawalparasi, and Doti are the major ginger

growing districts of the country. Ginger is being grown in about 41.61% (20,256 ha) of total major spices cultivated area (48,680 ha) and the production of ginger was recorded 255,208 MTMT with the productivity of 12.60 MTMT/ha (ABPSD, 2011). Despite the favorable environment available in the mid-hills for production, national productivity is stagnant and could not exceed 12.60 MTMT/ha which was mainly due to the many biotic factors mainly rhizome rot, rhizome fly, white grub and other minor diseases and insect pests which are randomly noticed in farmer's field at various ginger growing places and soil fertility degradation (GRP, 2010). A total of 32 kinds of insect pests of ginger have been identified in the world but very few of them have been reported in Nepal (CAB, 2007). Dake (1995) has reported that ginger suffers from 24 diseases of fungal, bacterial, viral and mycoplasmal origin. Sharma *et al* (1998) reported the occurrence of six diseases and five insect pests in ginger field in Nepal. Shoot borer *Dichocrocis punitiferalis* was found most destructive insect pests of ginger crop in Nepal (NARC, 1997). Rhizome fly, shoot borer, mites, and white grub were also found associated with the rhizome rot complex of ginger (Sah *et al*, 2001). From last decades status of insect pest and diseases is not clearly known in our agro climatic conditions. This paper gives the present status and occurrences of insect pests and disease on ginger in Nepal.

MATERIALS AND METHODS

Insect pests and disease survey

A survey was carried out by the team of NGRP, Kapurkot, Salyan, from August-September in two consecutive year 2011 and 2012 in important ginger growing pockets of Illam, Salyan, Nawalparasi, Palpa, Syanja, Tanahu, Dhankuta, Makawanpur and Surkhet district of Nepal. The total number of farmers visited from Salyan, Nawalparasi, Palpa, Syanja and Tanahu districts was 42 in 2011 where as it was 22 in 2012 from Illam, Dhankuta, Makawanpur and Surkhet districts. These districts together constitute about 51.45 % of the area under ginger cultivation in Nepal. The objective of the study was to identify the status of insect pests and major disease (Rhizome rot) of ginger in Nepal. All together 64 ginger growing farmers' field were visited to observe and study the insect pest incidence in standing crop. Insect pests and diseases were identified based on the symptoms, morphology, nature of damage and other distinguishing characters. A sets of questions related to the ginger cultivation, insect pests and diseases problems etc were prepared and farmers were surveyed. Field incidence was also calculated from crop cut data by using the formula number of clumps infected by total number of clumps per unit area expressed as percentage. However, of them insect pests and disease problems faced by the farmers and also observed by the scientists are discussed in the present context.

Monitoring of insects species through light trap

The experiment was conducted at National Ginger Research Program (NGRP), Salyan during 2011/12. The light trap was brought from Entomology Division, Khumaltar in which aluminum sheet is folded in to a funnel. It was hanged in fields at the height of 1 m with the help of 3 bamboo stem and jute rope where the illuminated light can be seen by the insect species. The siga energy saving lamp of 18 watt was fitted in the center for

insect trapping purpose. The light was operated every day from 7 pm to 7 am. Every day insect species were collected from the trap and total numbers were recorded. Insects were sent to Entomology Division for the identification.

RESULTS AND DISCUSSION

Survey of the insect pest and disease of ginger

The survey showed that ginger is attacked by various insect pests and disease rhizome rot problems in the field condition**.** Almost all the ginger field was found infested with rhizome rot and rhizome fly. Rhizome rot reported by most of farmers was the major problem in the field condition. The rhizome rot and rhizome fly was found to be associated with each other with the maximum field infestation of 31.12% and 25 %, in Jaubari, Nawalparasi and D. N. P., Dhankuta, respectively. The polyphagous white grub was also found to be emerging problems in almost all the surveyed district with the highest percentage field infestation of 46.28% in Panchakanya, Ilam.

Table 1. Prevalence of insect pests and disease in different ginger growing areas of Nepal (Sept. – Aug., 2011 and 2012)

VDC and District	# of field surveyed	Insect pests												Disease	
		White grub		Rhizome fly		Red ant		Shoot borer		Termites		Leaf folder		Rhizome rot	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B
Phalabang, Salyan	7	6	22.71	4	7.14	-	-	4	1.28	-	-	3	0.28	4	13.85
Karangithi, Salyan	5	5	8.8	5	17.8	4	1.6	5	3.0	-	-	3	0.7	5	21.0
Deuchali, Nawalparasi	6	5	1.66	5	13.16	5	2.16	1	0.03	-	-	-	-	6	29.5
Jaubari, Nawalparasi	8	6	5.62	6	14.62	6	3.6	8	2.75	-	-	5	0.56	8	31.12
Khausali, Palpa	6	4	3.16	4	5.75	3	1.37	-	-	1	0.16	1	0.16	6	21.83
Narayanna MTMTales, Palpa	4	-	-	-	0.6	3	1.25	-	-	3	2.0	-	-	4	8.25
Chhanchhandi, Syanja	3	3	-	3	3.66	-	-	3	1.66	2	1.66	-	-	3	21.66
Ghasikuwa, Tanahu	3	1	0.5	2	1.33	1	0.33	-	-	-	-	-	-	3	23.33
D. N. P., Dhankuta	6	3	20.83	5	25.00	2	1.5	4	0.66	-	-	-	-	6	28.5
Panchakanya, Illam	7	5	46.28	2	2.14	1	1.14	1	1.02	-	-	-	-	3	15.0
Bhimphedi, Makawanpur	5	3	4.17	3	7.04	-	-	-	-	-	-	-	-	4	22.6
Lekparsa,	4	-	-	3	15.0	4	2.83	-	-	3	1	-	-	4	11.66

Surkhet														

A=Infected field number, B = % infestation

RESULTS AND DISCUSSION

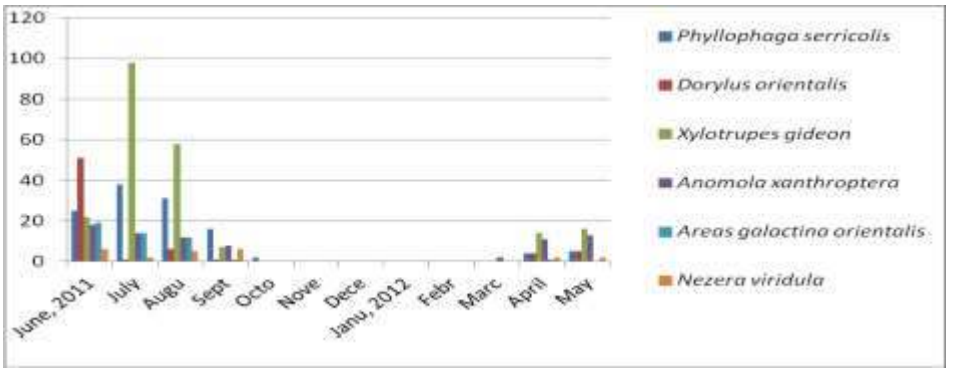
Monitoring of insects species through light trap

Several species of insects were collected from light trap but only 6 different insect species namely *Phyllophaga serricolis* Hope, *Dorylus orientalis, Xylotrupes gideon* L., *Anomala xanthroptera* Blanchard*, Areas galactina orientalis* and *Nezara viridula* L were recorded to observe the trend of population build up. A total of 27 species of insects were identified (Table 2).

Table 2. Different insect species trapped in light trap at GRP, Salyan during 2011/12

S.N.	Scientific name	Common name	Family	Order
1.	*Phyllophaga serricolis* Hope	White grub small	Scarabaeidae	Coleoptera
2	*Dorylus orientalis*	Red ant	Formicidae	Hymenoptera
3	*Xylotrupes gideon* L.	Stag beetle	Lucanidae	Coleoptera
4	*Anomala xanthroptera* Blanchard	White grub	Rutellidae	Coleoptera
5	*Areas galactina orientalis* Walker	Tiger moth	Arctiidae	Lepidoptera
6	*Nezara viridula* L.	Green stink bug	Pentatomidae	Hetroptera
7	*Eupterote* sp.	Moth	Eupterotisae	Lepidoptera
8	*Rosalia ttenua*	Long horned beetle	Cerambicidae	Coleoptera
9	*Cretonotus transiens transiens*.	Tiger moth	Arctiidae	Lepidoptera
10	*Vamuna ramelana* Moore	Tiger moth	Arctiidae	Lepidoptera
11	*Eupterote* sp.	Moth	Eupterotisae	Lepidoptera
12	*Spiractia casignata* Kollar	Hairy caterpillar	Arctiidae	Lepidoptera
13	*Lucanus attractus* Hope	Stag beetle	Lucanidae	Coleoptera
14	*Callidula ttenuate* Moore	Moth	Callidulidae	Lepidoptera
15	*Agrotis segetum* Hampson	Cutworm	Noctuidae	Lepidoptera
16	*Ctenicera noxia* Hyslop	Click beetle	Elateridae	Coleoptera
17	*Polycoris baccarum*	Stink bug	Pentatomidae	Heteroptera
18	*Cerura himalayana* Moore	Prominents	Notodontidae	Lepidoptera
19	*Pacna repanda* (small)	Cicada	Cicadellidae	Homoptera
20	*Platylomia* sp (big)	Cicada	Cicadellidae	Homoptera
21	*Dorcus* sp.	Stag beetle	Lucanidae	Coleoptera
22	*Catharsius melosus* L.	Leaf chaffer	Scarabaidae	Coleoptera
23	*Autocrates aeneus* Parry	Beetle	Eupterotidae	Coleoptera
24	*Theretra alecto alecto*	Hawk moth	Sphingidae	Lepidoptera
25	*Phyllophaga rugosa*	Root grubs	Melolonthidae	Coleoptera
26	*Crocotcems surnlia*	Dragonfly	Libellulidae	Odonata
27	*Mantispa sp*	Mantid	Mantidae	Neuroptera

The average occurrence of different insect species in the different month of the year is mentioned in figure 1. *Phyllophaga serricolis* Hope (38) and *Xylotrupes gideon* L. (98) showed the highest number in July where as other insect species namely *Dorylus orientalis (51), Anomala xanthroptera* Blanchard (18), *Areas galactina orientalis* Walker (19) and *Nezara viridula* L (6) showed their highest occurrence during June. During winter season no occurrence of any insect species were recorded. Generally, insect's occurrence was recorded during April to September.



Figurer 1. Average number of insect species collected through light trap at GRP, Salyan during 2011/12

CONCLUSION

Ginger is a high value exportable spice crop cultivated as cash/commercial crop particularly in the mid-hills of Nepal. The national productivity is only 12.60 MTMT/ha which was mainly due to the many biotic and abiotic factors randomly noticed in farmer's field at various ginger growing places and soil fertility degradation. This survey showed that ginger is attacked by various insect pests and diseases in the field condition**.** Rhizome rot reported by most of farmers was the major problem in the field condition. The rhizome rot and rhizome fly was found to be associated with each other with the maximum field infestation of 31.12% and 25 %, in Jaubari, Nawalparasi and D. N. P., Dhankuta, respectively. The polyphagous white grub was also found to be emerging problems in almost all the surveyed district with the highest percentage field infestation of 46.28% in Panchakanya, Illam.

Similarly, monitoring of insect species through light trap in the different month of the year showed that *Phyllophaga serricolis* Hope (38) and *Xylotrupes gideon* L. (98) showed the highest number in July where as other insect species namely *Dorylus orientalis (51), Anomala xanthroptera* Blanchard (18), *Areas galactina orientalis* Walker (19) and *Nezara viridula* L (6) showed their highest occurrence during June. During winter season no occurrence of any insect species were recorded. Generally, insect's occurrence was recorded during April to September.

ACKNOWLEDGEMENT

We would like to thank Mr Govind K.C., Co-ordinator of National Ginger Research Program, Salyan for providing all necessary facilities for conducting the experiments and also for his valuable suggestions and comments. The authors also express their sincere thanks to Entomology Division for the identification of insect pests. Thanks are also due to the staff of NGRP for facilitating survey and monitoring.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Development of eco-friendly technology for the management of white grub (*phyllophaga* sp.) pest in ginger

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ABSTRACT

A field experiment was under taken during the year 2011 and 2012 to study the effect of different botanicals, bio-pesticides and chemical pesticide for the sustainable management of white grub (Phyllophaga sp.) of ginger at Dhangbang - 7, Salyan (1520 masl). Experiment was arranged in RCB design with three replications. Among the tested management practices statistically significantly lowest number of live white grubs (6.8/m^2) at one month after germination of ginger and highly significantly lowest amount of white grub infected rhizome yield (0.28 MTMT/ha) was obtained with the use of Chloropyrifos @ 1.5 kg/ropani followed by the use of Metarhiziumanisopliae 1.15% WP (PACER) along with @ 10g/kg compost (8.03 white grub/m^2 and 0.35 MTMT/ha). From this study it was revealed that the use of Metarhiziumanisopliae 1.15% WP (PACER) @ 10g/kg compost was found equally effective and eco-friendly as with check pesticide Chloropyrifos @ 1.5 kg/ropani for white grub management in ginger.

INTRODUCTION

Ginger (*Zingiber officinale* Rosc.) is one of the major spices grown in Nepal. It has been popularized as a commercial crop in hilly region. Its cultivation is spreading from east to west and inner terai, foot hills to mid hills up to an altitude of 1600 masl. In Nepal, ginger is grown in an estimated area of 19376 hectares with an annual production of 235033 MTMT in 2012/13 (ABPSD 2013). Insufficient number of high yielding varietal option to growers, high cost of production, rhizome rot, white grub, rhizome fly, unstable market price, etc. are the major bottle necks for ginger production in Nepal.

A total of 32 kinds of insect pests of ginger have been identified in the world but very few of them have been reported in Nepal (CAB, 2007). Sharma *et al.* (1998) reported the occurrence of six diseases and five insect pests in ginger field in Nepal. Rhizome fly, shoot borer, mites, and white grub were found associated with the rhizome rot complex of ginger (Sah *et al.*, 2001). Sharma *et al. (*1998) reported that the white grubs species associated with the damage of ginger rhizome are *Phyllophaga* spp. The grubs are creamy white with brown head, 'C' shaped and found in the upper 50-100 mm layer of the

soil. The grubs eat away roots and feed on rhizomes and make holes inside them. Probably it paves the way for theinfection of fungi to develop rhizomes rot. The damage become evident only when entire plant dries up due to feeding by grubs on roots and rhizomes. White grub is a serious threat to the different agronomical and horticultural crops in the in the mid and high hills of Nepal. The extent of damage by the grubs varies with the crops. In ginger the damage ranges from 80 to 10 percent, 25- 50 percent in maize, vegetables and the late harvested potato, 20 percent in tea planted in up land (Timsina, 2003). White grub and rhizome fly are becoming emerging threats in many ginger growing area of country with the maximum field incidence of 22.71 percent and 17.8 percent, respectively (GRP, 2012).

White grub is a soil pest and some chemicals have been recommended for its management. Chemical is the quick and effective means of pest control. Often excess or uncontrolled uses of chemical pesticides have spoiled the balance of insect population. Besides causing serious threat to the environment, resistance, resurgence and persistency problems can also not be denied. Majority of chemical pesticides contain harmful chemicals and toxins that not only kill the unwanted pests, but also many beneficial insects and non target animals of the ecosystem. These chemicals are also posing serious threat to human health. Under such scenario, insect pest control strategies have necessitated the attention towards alternative method of insect management that offer adequate levels of pest control with fewer hazards. Such alternative are the use of botanicals and microbial insecticides or their byproducts.

METHODOLOGY

A field experiment was conducted at the white grub infected farmers field of Dhanbang - 7, Salyan during the ginger growing season of 2011 and 2012 to study the effect of different botanicals and bio-pesticides including chloropyrifos as check chemical pesticides to minimize the white grub infestation. Same plot was used for planting ginger in both years. Eight different management practices: 1.Neem cake @ 3 kg/ropani; 2. *Metarhiziumanisopliae* containing 1 x 10^8 spore/gram (Brought from plant protection laboratory, Khumaltar) @ 10 g/kg compost; 3. *Metarhiziumanisopliae*1.5 WP (PACER WP) produced by AgriLife India @ 10g/kg compost; 4. Bakaino seed powder @3kg/ropani; 5. Timur dust @ 3 kg/ropani; 6. Ketuki chopped leaves @ 1/2 kg/m^2; 7. Chloropyrifos @ 1.5 kg/ropani; and 8. Control, were evaluated in both years. *Metarhizium* was well mixed with rotten compost at the rate of 10 gram *Metarhizium* with 1 kg compost for application. All the treatments were applied at the time of ginger planting in row. Trial was arranged in RCBD design and each treatment replicated thrice. Planting was done during the second week of April. Rhizome bits of 50-60 gram size were planted in 30 cm x 30 cm spacing in a plot of 4.5 m^2 during the third week of April. FYM and fertilizers were applied @ 30 t/ha and NPK @ 75: 50: 50 kg/ha respectively. Mulching with dry leaves was done immediately after planting. Two times weeding was done during crop season. The trial was harvested at a time when leaves and pseudo stems became dry and fallen down during the first week of December, 2013. The data on germination %, grub number/m^2, fresh rhizome yield (FRY), white grub infected rhizome yield (WGIRY) and diseased rhizome yield (DRY) were recorded. White grub

incidence was calculated by dividing the number of infected rhizome by total number of rhizome and expressed as percentage. Data analysis was done using statistical tool MSTATC.

RESULTS AND DISCUSSION

Effect on ginger growth performance and white grub (*Phyllophaga*spp.) population

The result of the efficacy of different botanicals and bio-pesticides including chloropyrifos for ginger rhizome germination, weed population, tiller, plant height and white grub population has been presented in table 1. Germination percentage and weed population/m^2 was found statistically non-significant. Though CV was high for both the observation on weed population/m^2, plant height, tiller and white grub population/m^2 at one month after the germination of ginger was found statistically significant.The use of timur dust @ 3 kg/ropaniwas found effective for suppressing the early weed population (6.83 weeds at 1MAG and 19.50 weeds at 2MAG). The lowest number of live white grub (6.80 white grub/m^2) was found with the use of chloropyrifos followed by *Metarhiziumanisopliae* 1.15% WP (Pacer WP) @ 10 g /kg compost (8.03 white grub/m^2) at one month after germination of ginger. However, highest live white grub population was observed in control plot (53.33 white grub/m^2) followed by the use of chloropyrifos (39.0 white grub/m^2) and bakaino seed powder (38.0 white grub/m^2) at two month after ginger germination. This indicates that the effectiveness of chloropyrifos have decreated after certain duration. Hence, for sustainable and effective white grub management *Metarhiziumanisopliae* 1.15% WP (Pacer WP) was more effective than chemicals.

Table 1. Effect of botanicals, bio-pesticides and chemicals for ginger growth performance and white grub (*Phyllophaga* spp.) population in ginger growing farmer's field of Salyan district, during 2011 and 2012

		Germination %	Weed population/m^2		Tiller /clump	Plant height, cm	White grub population/m^2	
			1MAG	2MAG			1MAG	2MAG
Year	2011	93.50	13.91	33.45	10.72	89.95	17.39	33.45
	2012	90.50	15.45	36.54	6.5	58.53	14.66	NA
Management practices	Neem cake @ 3 kg/ropani	91.00	16.00	40.00	7.06	68.73	17.75	28.33
	Metarhiziumianisopliae @ 10 g/kg compost	92.00	12.16	35.00	10.30	81.76	13.11	27.66
	Metarhiziumanisopliae 1.15% WP (PACER WP) @ 10g/kg compost	92.33	13.66	31.83	8.70	80.20	8.03	31.66
	Bakaino seed powder@3kg/ropani	94.33	15.16	35.66	8.50	74.96	27.77	38.00
	Timur dust @ 3 kg/ropani	94.00	6.83	19.50	7.40	74.73	12.96	21.00
	Ketuki chopped leaves @ 1/2 kg/m^2	89.66	16.33	39.00	7.66	66.71	15.58	28.66

	Chloropyrifos @ 1.5 kg/ropani	91.66	13.50	36.33	9.00	74.33	6.80	39.00
	Control	91.00	23.83	42.66	8.46	72.53	26.23	53.33
	CV %	5.09	61.40	51.17	18.85	10.23	48.57	37.41
	F-test A	NS	NS	NS	*	*	*	
	F-test LA		NS	NS	NS	NS	NS	NS
	LSD (p=0.05)				3.05	14.66	15.03	

*NS – Not significant * – Significant ** – Highly significant NA– Not available*
1MAG – One month after ginger germination; 2 MAG – Two months after ginger germination

Effect on ginger rhizome yield and white grub (*Phyllophaga* spp.) incidence

Statistically highly significant result was reported in white grub infected and fresh ginger rhizome yield at the time of ginger harvesting. White grub incidence was found significant. All other traits were found non-significant. The lowest amount of white grub infected rhizome yield (0.28 MTMT/ha) was recorded with the use of Chloropyrifos @ 1.5 kg/ropani followed by*Metarhiziumanisopliae* 1.15% WP (Pacer WP) @ 10 g /kg compost (0.35 MTMT/ha) with the harvested fresh rhizome yield of 37.59 and 34.40 MTMT/ha, respectively.Similarly, same dose of chloropyrifos was found effective for minimum white grub incidence (3.70 %) followed by the same microbial pesticide *Metarhiziumanisopliae* 1.15% WP (Pacer WP) @ 10 g /kg compost (4.44%). However, timur dust 3 kg/ropani was found effective for rhizome rot management (0.85 MTMT/ha rhizome rot infected rhizome yield).

Table 2. Effect of botanicals, bio-pesticides and chemicals for ginger rhizome yield and white grub (*Phyllophaga*spp.) incidence in ginger growing farmer's field of Salyan district, during 2011 and 2012

Particulars		Plant stand/m^2	Rhizome yield, MTMT/ha				White grub incidence (%)
			Mother	White grub infected	Rhizome rot infected	Fresh	
Year	2011	10.07	5.78	2.13	1.89	38.03	NA
	2012	8.50	3.11	3.93	1.80	14.16	11.66
Management practices	Neem cake @ 3 kg/ropani	8.85	3.62	2.81	1.70	23.92	8.88
	Metarhiziumianisopliae @ 10 g/kg compost	8.88	3.75	0.87	2.22	30.55	6.66
	Metarhiziumanisopliae 1.15% WP (PACER WP) @ 10g/kg compost	9.40	4.32	0.35	1.03	34.40	4.44
	Bakaino seed powder@3kg/ropani	9.77	3.33	3.53	1.88	24.44	22.96
	Timur dust @ 3 kg/ropani	9.33	3.85	3.77	0.85	27.38	17.03
	Ketuki chopped leaves @ 1/2 kg/m^2	9.25	5.78	2.61	3.18	19.27	5.92
	Chloropyrifos @ 1.5 kg/ropani	9.48	7.97	0.28	1.44	37.59	3.70
	Control	9.33	2.92	7.87	2.48	11.20	23.70

	CV %	9.27	96.42	66.99	109.58	30.67	72.28
	F-test A	NS	NS	**	NS	**	*
	F-test LA	NS	NS	NS	NS	NS	
	LSD (p=0.05)			3.57		15.45	

*NS – Not significant * – Significant ** – Highly significant NA– Not available*

CONCLUSION

White grub is a emerging threat in many ginger growing field of the country with the maximum field incidence of 22.71. In past some effort have been made for this management and some chemical have been recommended. Excess or uncontrolled uses of chemical pesticides have harmful to living creature, spoiled the balance of insect population, environment and soil health. It also creates pest resistance, resurgence and persistency problems. With the aims of reducing this harmful effect of chemicals pesticides this research was conducted. From this study the use of *Metarhiziumanisopliae*1.15% WP (Pacer WP) @ 10 g /kg compost was found alternative of chemicals pesticide Chloropyrifos for white grub management.

ACKNOWLEDGEMENT

The author sincerely acknowledges Mr. Govind K. C., the Co-ordinator of Ginger Research Program, Kapurkot, Salyan for his valuable support in conducting the experiment. The author is also grateful to the staffs of GRP, Salyan for the smooth running of the experiment. Mr. Sunil Aryal, Entomology Division, Khumaltar is also thanked for his valuable comments and suggestions.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Plant diseases and their management practices in commercial organic and conventional vegetable farms in Kathmandu valley

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ABSTRACT

Plant diseases are one of the major factors of crop yield loss during production process. Different disease management methods have been innovated including chemical to biological methods. Additionally, role of farm management methods in the disease occurrence and crop yield loss has been realized. In this study, we compared plant diseases and their management practices in organically managed and conventionally managed commercial vegetable farms in Kathmandu valley. We documented major diseases, disease related management methods, and crop yield loss by diseases using questionnaire survey. Diseased plant samples were collected and identified using standard methods. Disease occurrence was lesser in the organic farm (maximum 46.7% respondents reporting a disease occurrence) in comparison to the conventional farm (maximum 83.3% respondents reporting a disease occurrence). Results showed that lack of cleanliness, mono-cropping, lack of mixed cropping, not selecting resistant variety and improper crop residue management seems to have increased disease occurrence in the conventional farm. Crop yield loss was reported higher in the organic fields as once disease occurred in the field, there were no curative methods available in organic disease management.

Keywords: Sustainable agriculture, yield, biological pesticides

INTRODUCTION

Diseases are one of the main causal factors to the crop loss (Raaijmakers et al., 2008). From 2001 - 2003, an average of 7 to 15 percent of crop loss was occurred in the world major food crops (wheat, rice, potato, maize and soybean) due to fungi and bacteria. In 2003, an estimate showed that nematodes caused 10 to 20 percent crop losses worldwide (Raaijmakers et al., 2008). Human has tried to prevent or cure plant diseases by different

means and methods for ages. Innovation of chemical pesticides was thought to be the ultimate solution to the plant disease management. However, development of chemical pesticide resistance in pathogens, environmental pollution and loss of biodiversity created by pesticides leached from the fields to the other places, chemical pesticide residue in the food items leading to different diseases in human, health concern of the person applying chemical pesticides (Atreya et al., 2012) all has forced human to rethink the sustainability of chemical pesticides use in agriculture (MoAC, 2008, Hall and Moffitt, 2002, Eyhorn et al., 2002). Vegetables are one of the main produces consumed fresh or raw. However, these crops receive high amount of pesticides (PPD, 2014) more than optimal economic dose due to lack of knowledge among farmers (Jha and Regi, 2009). According to Pokhrel and Pant (2009) after rice farmers, vegetable farmers use the second highest amount of the pesticide in the country. The recent increase in the use of pesticides in the vegetables (Atreya et al., 2012) is due to increase in the vegetable production area and off-season vegetable cultivation in semi-rural and peri-urban areas. Timila and Manandhar (2011) describe major vegetable crop diseases of economic importance in Nepal. They mention clubroot, alternaria leaf spot, downy mildew; sclerotia stalk rot, black rot and damping off as the major crucifer diseases. Late blight, septoria blight, bacterial stem rot, bacterial wilt, rootknot and blossom end rot are the major diseases of tomato. The major diseases of cucurbits are downy mildew, powdery mildew and gummy stem blight. Additionally, viral diseases are the important disease factor causing complete crop failure in many crop production systems (Hanssen et al., 2010). PPD (2012) has reported that tomato mosaic virus (ToMV), tomato yellow leaf curl virus (TYLCV) and cucumber mosaic virus (CMV) in tomato are causing considerable yield losses. The environment for pathogen is either created or destroyed by human practices of field management. In conventional farming, practices like monocropping (van Elsas et al., 2002), use of only one type of manure year after year (Bending et al., 2002) select few microbes which are able to survive in such monotonous environment and remove others from there (van Elsas et al., 2002, Garbeva et al., 2006). This will favor less competition and appearance of a specific microbe as a pathogen in the field. In contrast, organic farming tries to create soil environment which can help to co-exist many micro-organisms in the soil and avoid pathogenic micro-organism to become a dominant one (Postma et al., 2008). Hence, this study aims to compare the differences in the disease occurrence, management practices and crop yield loss by disease between commercial organic and conventional vegetable farmers in Kathmandu valley.

MATERIALS AND METHODS

Study area

Kathmandu valley consists of three districts namely Kathmandu, Lalitpur and Bhaktapur. These districts are densely populated areas (MEGA., 2010, Zurick and Rose, 2009). Vegetable production is an age old traditional farming practice near the water resources in Kathmandu valley. Kathmandu valley is one of the areas with the highest vegetable productivity per unit area in Nepal (ABPSD, 2012). Moreover, increasing population and demand for fresh vegetables have increased the area of commercial vegetable farming in the periurban areas of the valley. Furthermore, health conscious consumers dwelling in the city area are demanding for the organic vegetables; to supply the demand organic

vegetable production area is also expanding (Bhandari, 2006). The periurban commercial vegetable growing farmers in Kathmandu valley were selected for the study.

Questionnaire survey

Thirty farmers each growing vegetables by organic management methods and conventional management methods were selected for the study. Questionnaire was prepared in Nepali language and pre-tested and amended before the survey. Farmers from Bhaktapur (15), Kathmandu (25) and Lalitpur (20) districts were interviewed with semi-structured questionnaire to gather the information about plant diseases and their management practices. Questionnaire survey and diseased plant samples collection were done from May 15 to June 15, 2013. Diseased plant samples were identified using visual symptoms and pathogen isolation and identification from the diseased parts as per requirement.

RESULTS AND DISCUSSION

Major vegetable diseases

Conventional farms had more problem of vegetable diseases compared to organic farms (Table 1). In tomato, late blight, viral diseases and bacterial wilt were more problematic in conventional farm than in organic farm. Downy mildew disease of cucurbits was more prevalent in conventional farm compared to organic farm. Damping off disease of seedlings was more widespread in tomato, cauliflower and cabbage growing conventional farms than in organic farm. In contrast, club root and black rot diseases in cabbage were reported by more organic farmers than conventional farmers (Table 1). Similarly, cucumber mosaic disease was noticed by more organic vegetable farmers compared to conventional vegetable farmers. Viral diseases in tomato and pumpkin (Table 1) were relatively more in the conventional vegetable farm than in the organic farm.

As conventional farm soil contains significantly higher amount of available soil nitrogen than organic farm soil (Shrestha, 2014), higher amount of available nitrogen also satisfies the fungi along with plant. Higher availability of nitrogen makes fungi to get carbon from plants evolving as a plant pathogen (Veresoglou et al., 2013) to maintain their carbon to nitrogen ratio (C:N). Higher available nitrogen also leads to tender and soft plant parts especially leaves (Marschner, 2012), which helps pathogens to easily penetrate the tissue (Letourneau and van Bruggen, 2006). All these cause and effect relations might have resulted into severe crop yield loss by bacterial soft blight in cabbage, downy mildew (Huber and Watson, 1974) in cucumber, late blight in tomato and viral diseases in many vegetables in conventional farm (Table 1). Hence, host plant resistance (Tamis and Van den Brink, 1999) is maintained in the organic farm by avoiding excess nitrogen supply.
Commercial farmers planting same commercial crop such as tomato every year continuously in the plastic house can result into more problem of rootknot nematode (Letourneau and van Bruggen, 2006) in the future though it was noticed by only few farmers during the survey (Table 1). More problem of seed borne disease black rot (Manandhar et al., 1989) in the organic cabbage production (Table 1) was due to no use of seed treatment methods (Table 4). Against black rot, seed disinfection by hot water

treatment at 50°C for 30 minutes has been recommended, however that was not practiced by farmers (Manandhar et al., 1989).

Having seed borne diseases like alternaria leaf spot, stalk rot (Table 1) in the commercial vegetable fields was due to lack of proper seed treatment practice. More clubroot disease in the organic farms (Table 1) may be due to higher amount of organic matter present in the organic farm (Shrestha, 2014), which is the source of pathogen survival (Singh, 1998). Moreover, higher organic matter content in the soil retains higher amount of water giving higher chance for pathogen zoospore movement (Singh, 1998).

Table 1. Major vegetable diseases in commercial organic and conventional vegetable farm (percentage respondents out of 30 each) in Kathmandu valley

Crop	Diseases	Causal pathogens	Disease occurrence in	
			Organic farm	Conventional farm
Tomato	Late blight	*Phytophthora infestans*	73.3	86.7
	Viral diseases	Viruses	23.3	43.3
	Septoria leaf spot	*Septoria lycopersici*	6.7	13.3
	Bacterial wilt	*Pseudomonas solanacearum*	6.7	26.7
	Damping off	*Rhizoctonia* spp.	3.3	10.0
	Root knot nematode	*Meloidogyne* spp.	-	3.3
Cauliflower	Club root	*Plasmodiophora brassicae*	3.3	3.3
	Black rot	*Xanthomonas campestris*	3.3	3.3
	Sclerotia stalk rot	*Sclerotinia sclerotiorum*	3.3	6.7
	Boron deficiency	Nutrient deficiency	3.3	3.3
	Alternaria leaf spot	*Alternaria brassicae*	3.3	3.3
	Damping off	*Rhizoctonia* spp.	-	3.3
Cabbage	Club root	*Plasmodiophora brassicae*	10.0	3.3
	Black rot	*Xanthomonas campestris*	16.7	10.0
	Bacterial soft rot	*Erwinia carotovora*	-	10.0
	Damping off	*Rhizoctonia* spp.	-	3.3
	Boron deficiency	nutrient deficiency	-	3.3
Cucumber	Anthracnose	*Colletotrichum orbiculare*	6.7	3.3
	Cucumber mosaic	Viruses	16.7	13.3
	Powdery mildew	*Erysiphe* spp.	6.7	6.7
	Downy mildew	*Pseudoperonospora cubensis*	3.3	23.3
Pumpkin	Phytophthora blight	*Phytophthora capsici*	3.3	-
	Powdery mildew	*Erysiphe* spp.	-	6.7
	Downy mildew	*Pseudoperonospora cubensis*	-	3.3
	Viral diseases	Viruses	-	3.3

Disease occurrence calendar

Disease occurrence calendar (Table 2) showed that many diseases occurred in the conventional farm more frequently compared to the organic farm. Jestha, Asar, Shrawan and Kartik were the months of higher incidence of late blight in tomato. In other months, late blight was reported to be negligible in conventional farms. Organic farmers noticed

late blight in tomato during the months of Baisakh to Shrawan with higher prevalence in the month of Asar. Viral diseases in cucumber were observed from the month of Chaitra to Asoj by organic farmers. In contrast, conventional farmers had problem in the month of Baisakh and Jestha only. Tomato diseases were observed all the year round by

Table 2. Disease occurrence calendar of major vegetable diseases in conventional (top) and organic (bottom) farms (percentage respondents out of 30 each) in Kathmandu valley

Crop	Baisakh	Jestha	Asar	Shrawan	Bhadra	Asoj	Kartik	Mansir	Poush	Magh	Phagun	Chaitra
Tomato												
Late blight	-	33.3	63.3	53.3	16.7	3.3	83.3	-	6.7	6.7	6.7	3.3
Septoria leaf spot	3.3	6.7	3.3	3.3	-	-	10.0	-	-	-	-	-
Bacterial wilt	3.3	10.0	13.3	6.7	-	-	23.3	-	-	-	-	-
Viral diseases	13.3	20.0	16.7	6.7	6.7	3.3	40.0	-	-	-	-	-
Damping off	-	-	-	-	-	-	6.7	-	-	-	-	6.7
Nematode	-	3.3	-	-	-	-	3.3	-	-	-	-	-
Cauliflower												
Club root	-	-	-	-	-	-	-	-	-	-	-	3.3
Black rot	-	-	3.3	3.3	-	-	-	-	-	-	-	-
Sclerotia stalk rot	-	-	-	-	-	3.3	3.3	-	-	-	-	-
Damping off	-	3.3	-	-	-	-	-	-	-	-	-	-
Cabbage												
Club root	3.3	-	-	-	-	-	-	-	-	-	-	-
Black rot	-	-	3.3	3.3	-	-	-	-	-	-	-	3.3
Bacterial soft rot	-	6.7	6.7	-	-	-	-	-	-	-	-	-
Cucumber												
Anthracnose	-	-	-	-	-	-	-	-	-	-	-	3.3
Cucumber mosaic	10.0	10.0	-	-	-	-	-	-	-	-	-	-
Downy mildew	3.3	3.3	3.3	-	-	-	-	-	-	-	-	-
Pumpkin												
Powdery mildew	6.7	6.7	6.7	-	-	-	-	-	-	-	-	-
Viral diseases	-	3.3	-	-	-	-	-	-	-	-	-	-

Crop	Baisakh	Jestha	Asar	Shrawan	Bhadra	Asoj	Kartik	Mansir	Poush	Magh	Phagun	Chaitra
Tomato												
Late blight	16.7	16.7	46.7	40.0	-	-	-	-	-	-	-	-
Septoria leaf spot	-	-	3.3	3.3	-	-	-	-	-	-	-	-
Bacterial wilt	-	-	6.7	3.3	-	-	-	-	-	-	-	-
Viral diseases	10.0	10.0	-	-	-	-	-	-	-	-	-	3.3
Damping off	-	-	-	-	-	-	-	-	-	-	-	3.3
Cauliflower												
Club root	-	-	-	-	-	3.3	3.3	-	-	-	-	-
Sclerotia stalk	-	-	-	-	-	3.3	3.3	-	-	-	-	-

rot												
Cabbage												
Black rot	-	-	10.0	-	3.3	3.3	3.3	-	-	-	-	-
Cucumber												
Anthracnose	-	6.7	6.7	-	6.7	6.7	-	-	-	-	-	-
Cucumber mosaic	10.0	6.7	3.3	3.3	16.7	16.7	-	-	-	-	-	3.3
Powdery mildew	3.3	6.7	3.3	-	6.7	6.7	-	-	-	-	-	-
Downy mildew	3.3	-	-	-	3.3	3.3	-	-	-	-	-	-
Pumpkin												
Phytophthora blight	3.3	3.3	-	-	-	-	-	-	-	-	-	-

conventional farmers. Organic farmers observed cucumber diseases more frequently during the year (Table 2).

More disease in the conventional farm were resulted also due to less crop diversity (Shrestha, 2014), monocropping (Shrestha et al., 2014), high density planting in cucumber and pumpkin. Having disease occurrence calendar (Table 2), commercial farmers can use temporal asynchrony method to avoid diseases causing yield loss (Letourneau and van Bruggen, 2006). For example – in winter half of the year, vegetable diseases are less occurring compared to summer half. Viral diseases in tomato occurred at the highest rate in the month of Kartik in commercial conventional farms, so harvesting tomato before this month will safeguard the yield and decrease disease management costs as well.

Non-chemical disease management methods

Among different methods of crop residue management, more organic farmers (26.7%) used crop residues as animal feed than conventional farmers (6.7%) as shown in Table 3. Uprooting and manuring practice was the most common method of weed management among organic farmers (76.7%) than conventional farmers (50.0%). Cleanliness (80.0%), mixed cropping (63.3%), disease resistant varieties (56.7%), collect and destroy (60.0%) were the cultural methods used to avoid diseases by organic farmers (Table 3).

Table 3. Non-chemical disease management methods followed in commercial organic and conventional vegetable farms (% respondents out of 30 each) in Kathmandu valley

Particulars	Organic farm	Conventional farm
Crop residue management		
Use to prepare manure	50.0	66.7
Use as animal feed	26.7	6.7
Throw away	-	23.3
Burning	26.7	10.0
Weed management		
Uproot and burn	13.3	23.3
Uproot and manuring	76.7	50.0
Soiling	10.0	10.0
Diseased plant management		

Leave it	-	10.0
Uproot and throw	66.7	60.0
Cut the diseased part and throw	6.7	16.7
Uproot and burn	16.7	6.7
Soiling	13.3	13.3
Cultural methods		
Cleanliness	80.0	50.0
Ploughing	-	-
Time of sowing	13.3	13.3
Fertiliser amount and application time	26.7	0.0
Mixed cropping	63.3	16.7
Irrigation	30.0	50.0
Resistant varieties	56.7	23.3
Mechanical methods		
Collect and destroy	60.0	33.3
Cropping practice around the farm		
Rice – wheat	46.7	56.7
Vegetables	10.0	-
Rice – vegetables	33.3	43.3

Chemical based disease management methods

Organic farmers applied botanical pesticides from the start of crop establishments irrespective of disease appearance (70.0%) as shown in table Table 4. Many conventional farmers applied chemical pesticides as one percentage of plants in the field showed disease symptoms. Pesticide application time was mainly evening among the organic farmers (46.7%) whereas day time was preferred by the conventional farmers (33.3%). Nursery bed treatment mainly with formalin solution was more popular among conventional farmers (53.3%). Additionally, farmers raised nursery seedling in the sunny and airy place to avoid damping off disease. Very few organic farmers were known to be doing solarization as nursery bed treatment (13.8%) (Table 4).

Botanical pesticide application

Botanical pesticide application was the only available method of disease management among organic farmers. On an average, 100 ml of extract prepared was applied per plant per week. The mixture contained two or more ingredients (Table 5). Cattle urine was used as both fertiliser and pesticide. Liquid pesticide extract was prepared after fermenting mixture for a month or so. The extract was filtered through sieve and was diluted (1:4 or more). The solution was sprayed as preventive and or curative mean against disease causing pathogens. The ingredient of the extract differed for different pests and diseases. Cow milk was mixed for controlling viral diseases. Marigold extract is known to have anti-nematodal activity. Moreover, farmers added strong smelling plants, weeds which can deter pests from the plants.

Organic farmers were extremely preventive to plant diseases compared to conventional farmers (Table 4). It was because as soon as plants got diseased, there was a little possibility to get them recovered by organic methods. The similar results were found by Thapa and Rattanasuteerakul (2011) in Thailand which have deterred farmer's interest in

organic farming as well. In contrast, conventional farmers applied pesticides as soon as few plants got diseased. It was mainly because pesticides were cheaply available in the market. Additionally, recommendation of multiple pesticides rather than disease specific pesticide by agricultural shop owner (Figure 1) increases pesticide input in the conventional farm. Lack of cultural disease management practices (Table 4) like proper disposal of diseased plants (10.0%), maintain cleanliness (50.0%), use of disease resistant varieties (23.3%) and follow mixed cropping (16.7%) might have resulted into higher disease incidence in the conventional farm (Table 1).

Table 4. Economic threshold and time of pesticide (botanical or chemical) application, seed treatment, and nursery bed treatment practices among commercial organic and conventional vegetable farms (% respondents out of 30 each) in Kathmandu valley

Particulars	Organic farmers	Conventional farmers
Pesticide application (economic threshold)		
Before disease occurrence	70.0	26.7
1% plant infected	16.7	43.3
10% plant infected	13.3	30.0
Pesticide application time		
Morning	20.0	13.3
Day	13.3	33.3
Evening	46.7	30.0
Morning/evening	10.0	16.7
Morning/day	10.0	6.7
Seed treatment		
Yes	16.7	30.0
Treated seed from market	33.3	46.7
Nursery bed treatment	13.8	53.3

Not following seed treatment practice among conventional farmers (Table 4) was also one of the reasons for loss of purchased expensive seeds of tomato, cauliflower and cabbage (Mehrotra and Aggarwal, 2003, ABPSD, 2012). Use of pesticide treated seeds by organic farmers (Table 4) save crops from seed borne diseases (van Bueren, 2002). However, use of pesticide treated seeds is not permitted under certified organic production system (MoAC, 2008).

Unavailability of biological (and/or microbial) disease management methods in the market, ineffectiveness of biological methods in the field situation (Ravel, 1999) and lack of farmers' knowledge on use of biological disease management tools (Table 7) all have prevented use of these methods by both organic and conventional farmers in Kathmandu valley (Table 4).

In contrast to Letourneau and van Bruggen (2006) use of botanical pesticides was common in organic farms in Kathmandu valley (Table 5). Different botanical and locally available materials are recommended to prepare botanical pesticide (PPD, 2009). Neem has been known to control damping-off; ginger has effects on nematodes, viruses, powdery mildew of squash. Milk has promising effect in the viral disease control. Artemisia has bactericidal and fungicidal properties. Melia has biocidal effects on soil

micro-organisms. Bojo is known to have biocidal effect on storage pathogens (PPD, 2009).

Organic farmers use locally available materials to prepare botanical pesticides (Table 5) and rely on cultural management methods (Table 4) to manage plant diseases (Klonsky, 2012). In contrast conventional farmers apply different chemical pesticides in more than required dose (Jha and Regi, 2009) without identifying cause of disease (Table 4) yielding into significant difference in the plant protection cost between organic and conventional farms (Shrestha et al., 2014). However, this difference may change as per the availability of biological or microbial pesticides permitted in organic farming. Foliar spray of nutrients solution is also recommended for disease management (Reuveni et al., 1996, Reuveni et al., 1997, Reuveni and Reuveni, 1998). Foliar spray of the potassium and phosphorus salt decreased the powdery mildew and downy mildew in cucumber (Reuveni et al., 1996). Foliar spraying micro-nutrient solution induces systemic induced resistance against pathogens (Reuveni and Reuveni, 1998). This alternative can help to reduce the pesticide application in the vegetable crops as well as manage the vegetable diseases. However, this method was not in practice among commercial farmers (Table 3, 4).

Table 5. Ingredients of botanical pesticide prepared by organic vegetable farmers (% respondents out of 30 each) in Kathmandu valley

English name	Local name	Scientific name	Users (percentage)
Cattle urine	Gahut		100.0
Mugwort	Titepati	*Artemisia vulgaris*	86.7
Neem extract/oil	Neem	*Azadiracta indica*	73.3
Persian lilac	Bakaino	*Melia azedarach*	43.3
Crofton weed	Banmara	*Eupatorium adenophorum*	23.3
Cow milk	Dudh		20.0
Chili powder	Khursani	*Capsicum annum*	20.0
Malabar	Asuro	*Adhatoda vasica*	16.7
Stinging nettle	Sisno	*Urtica dioica*	13.3
Garlic powder	Lasun	*Allium sativum*	10.0
Century plant	Ketuki	*Agave americana*	10.0
Marigold flower	Sayapatri phool	*Tagetes* spp.	10.0
Cloth washing soap	Sabun		6.7
Sweet flag	Bojo	*Acorus calamus*	6.7
Turmeric	Haledo	*Curcuma domestica*	3.3
Effective microorganisms (EM), Trichoderma, Microfood			3.3

Crop yield loss from major vegetable diseases

Data on yield loss caused by diseases were given by more organic farmers compared to conventional farmers (Table 6). Late blight of tomato and viral diseases of cucumber were the diseases considered as causing complete crop failure in organic fields. Bacterial soft rot of cabbage was the disease causing more than 75% crop loss in conventional farm. Downy mildew was causing 50 to 75% crop loss in the conventional commercial farm where cucurbits were grown. Whereas phytophthora blight disease (*Phytophthora capsici*) of cucurbits was causing 50 to 75% crop loss in its severity in the organic pumpkin fields (Table 6).

In contrast to van Bruggen (1995), damping off disease caused higher losses in the conventional farm compared to organic farm (Table 6). It was maybe due to use of undecomposed organic manures (especially chicken manure) used in the conventional farms compared to organic farms.

Table 6. Crop yield loss due major vegetable diseases in commercial organic (Org) and conventional (Conv) farms (% respondents out of 30 each) in Kathmandu valley

Crops	Diseases	Crop yield loss (%)							
		<25%		25 to 50%		50 to 75%		>75%	
		Org	Conv	Org	Conv	Org	Conv	Org	Conv
Tomato	Late blight	13.3	-	16.7	-	23.3	-	10.0	-
	Viral diseases	13.3	-	3.3	-	-	-	-	-
	Septoria leaf spot	3.3	-	-	-	-	-	-	-
	Bacterial wilt	3.3	-	3.3	-	-	-	-	-
	Damping off	3.3	-	-	-	-	-	-	-
Cauliflower	Club root	6.7	16.7	3.3	3.3	-	-	-	-
	Black rot	-	3.3	-	-	-	-	-	-
	Sclerotia stalk rot	-	-	3.3	3.3	-	-	-	-
	Alternaria leaf spot	3.3	-	-	-	-	-	-	-
	Damping off	-	3.3	-	3.3	-	-	-	-
Cabbage	Club root	3.3	-	3.3	3.3	-	-	-	-
	Black rot	16.7	10.0	-	-	-	-	-	-
	Bacterial soft rot	-	-	-	-	-	3.3	-	3.3
	Damping off	-	-	-	3.3	-	-	-	-
Cucumber	Anthracnose	3.3	3.3	3.3	-	-	-	-	-
	Cucumber mosaic	3.3	3.3	10	-	-	3.3	3.3	-
	Powdery mildew	6.7	-	-	-	-	-	-	-
	Downy mildew	3.3	-	-	-	-	3.3	-	-
Pumpkin	Phytophthora blight	-	-	-	-	3.3	-	-	-
	Powdery mildew	3.3	-	3.3	-	-	-	-	-
	Viral diseases	3.3	-	-	_	-	_	_	_

Seriousness of problems

Disease related problems in organic and conventional vegetable farm were ranked using index developed by Miẏa (1993). Plant diseases were the moderate problem in both organic and conventional farm (Table 7). Farmers did not feel scarcity of disease specific management options in the market. On par with de Ponti et al. (2012) crop yield loss was higher in the organic farm (Table 6) compared to the conventional farm. This leads to higher yield gap between organic and conventional farms. However, organic farmers do not feel disease as a serious problem (Table 7).

Resort for advice

Advice seeking habit was more common among conventional farmers than organic farmers (Figure 1). Conventional farmers were seeking help from the private consultants (56.7%) more often than from government support office staffs and agricultural shop owner. Disease and pest management related advices were sought from government

offices by organic farmers (56.7%). Agricultural shop owner were also contributing to solve the disease related problems in commercial farms (Figure 1).

Table 7. Disease related problems of commercial organic and conventional vegetable farmers in Kathmandu valley

Disease related problems	Organic farm		Conventional farm	
	Index value*	Rank	Index value	Rank
Availability of disease specific biological and chemical pesticides	2.037	2	1.233	2
Disease and pest problem	3.259	1	3.366	1

** Index value range from 5 to 1, where 5= most serious, 4 = serious, 3 = moderate, 2 = little bit and 1 = no problem at all*

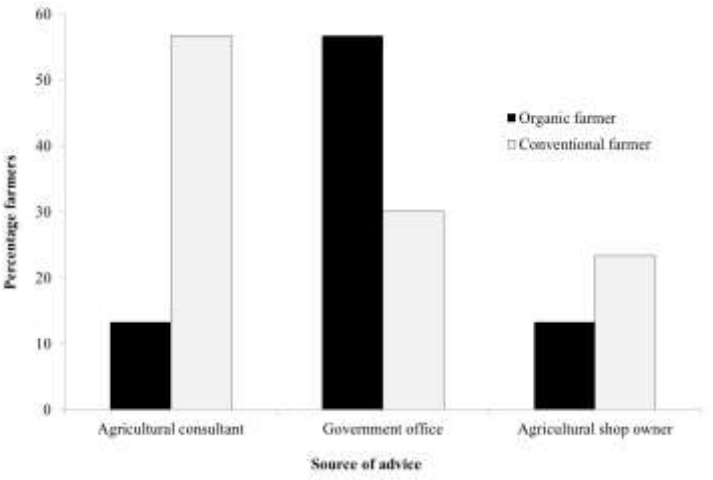

Figure 1. Resort for advice on disease management by commercial organic and conventional farmers in Kathmandu valley

CONCLUSION

Plant diseases and their management are important activities for commercial vegetable farming. Preventive methods such as botanical pesticide and cultural methods in the organic farming resulted into less disease problem than in conventional farms. However, in Nepal, lack of organic disease curative methods has led to more crop yield loss in organic farming. Furthermore, it has forced farmers to be less dependent on the organic farming and / or infringe the organic farming standards. Having cheaply available chemical pesticides in the market, conventional farmers are reluctant to follow preventive

cultural methods in the conventional farms. Availability and promotion of biological pesticides as curative methods of diseases will certainly encourage organic farmers.

ACKNOWLEDGEMENT

Authors are highly indebted to the University Grants Commission (UGC), Nepal for providing faculty research grant to conduct this research at Himalayan College of Agricultural Sciences and Technology (HICAST).

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Trout farming enterprise and marketing potential in Nepal

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ABSTRACT

This research was conducted in April 2011. Primary data about trout production, trout entrepreneurs, and marketing were collected from household survey; and relevant secondary data were also collected from related institutions. The objective of the study was to assess improvement in livelihoods through trout farming enterprise at community level; and also to estimate the marketing potential of the enterprise. In 2011, rainbow trout entrepreneurs were found in eleven districts and sixty five farming households were engaged in private trout farming. Farm gate price of trout was found to be NRs.825 per Kg (fresh fish) and NRs 1200 per Kg (cooked fish). There was high demand for the traout fish as compared to the production. Benefit cost ratio was found to be 2.18 which indicated about the economic viability and marketing potential of the enterprise that enhanced the livelihood of the trout farming households/communities.

Key words: Trout enterprises, marketing potential, income generation, value chain

INTRODUCTION

Rainbow trout (*Onchorynchus mykiss*) was first introduced to Nepal from England in 1960s. Rainbow trout was reintroduced from Japan in 1988 (Gurung et al., 2000/01). They grow well at lower temperature of 10- 13ºC in cold water and have optimum growth at 15 – 18 ºC (Yamazaki, 1991). In 1998, the first private rainbow trout farming in Nepal was started from Ranipauwa-4, Kakni, Nuwakot (Nepal et al., 2008). Fisheries Research Division, Godawari and Fisheries Research Station, Trishuli had also conducted breeding programmes with active participation of private rainbow trout enterprises from different districts (Joshi et al., 2009). Trout farming substitutes imported fish to meet the market demands and improve living condition of trout entrepreneurs in the society (Joshi et al., 2007). Trout raceway area has increased up to 3966.4 sq. m.; and the fish harvest has reached to 160.0 MTMT. (Basnet et al., 2011). People living in hilly areas have good opportunities to increase their income and improve livelihood through trout farming enterprises (Joshi et al., 2011). This research was conducted with the objectives to assess the improvement in livelihood through trout farming enterprise at community level; and explore the marketing potential of the enterprise.

METHODOLOGY

Household survey and focus group discussions were conducted with private trout farming entrepreneurs and agricultural development officers to collect information regarding cost of production, demand, supply, market mechanism, growth performance of rainbow trout, value addition, and problems related to trout farming. Random sampling was done and 60 farmers were selected for the survey from 11 districts of Nepal. Tabular analysis was conducted to arrive at meaningful conclusions.

RESULTS AND DISCUSSION

Trout farming enterprises have been established in eleven districts namely Mustang, Manang, Rasuwa, Nuwakot, Sindhupalchok, Lalitpur, Kathmandu, Makwanpur, Dhading, Kavre, and Kaski. Among them thirty six farmers were involved in private rainbow trout farming in Nuwakot district because rainbow trout farming technologies were adopted by the entrepreneurs, and access to market was relatively better. Besides that, Fisheries Research Division, Godawari and Fisheries Research Station, Trishuli had conducted training on breeding, hatching, nutrient management and marketing for the private trout entrepreneurs.

Private rainbow trout farming

Presently, private rainbow trout farming has covered eleven districts where 65 farmers were economically involved. About 9510 sq m was covered by eleven districts and produced 160 MTMT of trout and NRs. 88,600,000 revenue was received by trout farmers. In Nuwakot district alone, 32 farmers were engaged in rainbow trout farming and covered the area of 4544 sq m (49.3% of total area). Production of trout was found to be 55 MTMT. and NRs 43,600,000 revenue was received by the farmers. Sindhupalchok district covered an area of 2171 sq m and NRs 20,880,000 revenue was received by the farmers. One of the smallest private rainbow trout farming was found in Mustang district which covered the area of 100 sq m and NRs 600,000 revenue was received by the farmers (Table 1).

Table 1. Scenario of private rainbow trout farming in different districts of Nepal, 2011

S.N	Districts	No. of farmers involvement	Private Rainbow Farming	Area, sq m	Total production, MTMT	Average revenue in NRs '.000
1	Nuwakot	36	30	4544 (49.3%) (Av. 152)	54.5	43600
2	Rasuwa	8	8	387	4.6	3680
3	Sindhupalchok	7	7	2171	26.1	20880
4	Lalitpur	3	3	470	5.6	4480
5	Kathmandu	5	1	150	1.8	1440

6	Makwanpur	1	1	500	6.0	4800
7	Dhading	1	1	350	4.2	3360
8	Mustang	1	1	100	1.2	600
9	Kavre	1	1	250	3.0	2400
10	Kaski	1	1	200	2.4	1920
11	Dolkha	1	1	150	1.8	1440
Total		65	55	9210	111.2	88600

Note: 1 sq m = 12 kg production, Farm gate price = NRs. 825/kg, Av. Cost of Production = NRs. 525/kg, (Source: Interview with private enterprises)

Economic scale of rainbow trout farming

Fisheries researchers and technicians provided training on trout farming management to trout producers. After receiving training on trout hatching management, incubation process, fry and fingerlings rearing management and feeding management, farmers applied cost effective trout production technologies for promotion and production of rainbow trout which helped them to improve their livelihoods as well as generate income for their business.

Estimated cost of the production of rainbow trout

Feed management was one of the major important activities of trout production that needed two to three times supply a day. Eleven to twelve month of fish had the best growth performance of 100 – 150 g, which was ready for table fish. Male (73) and female (53) farmers were involved in different activities like brood management, packaging for marketing and transportation. Total cost for labour was found to be NRs. 769,650. Gross product of rainbow trout was 3.0 MTMT. Gross and net profit were NRs. 2400,000 and NRs. 692,135, respectively from an area of 250 sq m. Pond construction cost for that area was found to be NRs. 1,000,000. Construction of depression cost was found to be NRs. 938,215 (33.3%) for one year. Cost of rainbow trout was worth of NRs.525/kg and farm gate price was NRs. 825/kg. Benefit cost ratio was found to be 2.18 (Table 2). Economic analysis of rainbow trout production revealed that trout enterprise was an economically profitable business. Therefore, trout farming should be expanded in other districts where resources are available.

Rainbow Trout farming at Nuwakot

Women involvement in Rainbow Trout entrepreneurship

Value addition to rainbow trout at entrepreneur level

Market transition generally occurs after November until June. Current transportation system and production sites are reasonably good for a quick distribution of trout. As a result it requires good care and handling in post harvest technique to reach up to market. Presently, there is high demand of rainbow trout product at local market and Kathmandu. Values added rainbow trout dishes were available at local hotels. Different types of dishes included Fish gravy, Fish curry, Fish roast, Fish snack, Fish fry, Fish soup, Fish pickle, and Fish dry with different rate of price. Value added dishes of rainbow trout with average prices in the market wrere as presented in Table 3.

Table 2. Estimated cost of production of rainbow trout for an area of 250 sq m, 2011

Labor activities	Gender involvement*				Area:250 sq m Construction Cost (NRs. 1000,000)**
	Male	Cost NRs.	Female	Cost NRs.	
Brood management	4	20000	3	15500	Gross product, MTMT. 3.0
Hatchery management	4	20000	3	15500	Cost of production Nrs. 525/kg
Fry rearing	7	36575	6	31350	Farm gate price Nrs. 800kg
Watering	6	31350	4	20900	Gross profit Nrs. 2400000
Feed management	7	36575	6	31350	Labour cost Nrs. 769650 (Mc + Fc)
Harvesting	6	31350	4	20900	Construction of depression cost Nrs. 330000 (33.3%) for 1 yrs.
Fish grading	7	36575	6	31350	Lc+Dc= Total cost Nrs.1099650
Disease and parasite	7	36575	6	31350	Net profit=Tc + Dc - Gp = 1099650 – 2400000 = Nrs. 1300350

Dressing for marketing	5	26135	4	22100	Benefit Cost ratio = 2.18
Cleaning	6	31350	5	26125	-
Weighting and handling	5	26125	3	16575	-
Packing for market	5	26125	3	16575	-
Transportation	6	31350	-	-	-
Fingerlings	-	10000	-	-	-
Sub Total	75	(A) 490075	53	(B) 279575	769650 = (A + B)

Source: Interview with farmers and rainbow trout production management technique**.*

Table 3. Value added dishes of rainbow trout with average prices in the market, 2011

S.N	Value added dishes of trout fish	Average price NRs. /kg
1	Fish gravy	1200
2	Fish curry	1200
3	Fish roast	1200
4	Fish snack	1200
5	Fish fry	1200
6	Fish soap	1200
7	Fish pickle	1200
8	Fish dry	2000

Source: Private trout restaurant, Nuwakot, 2011

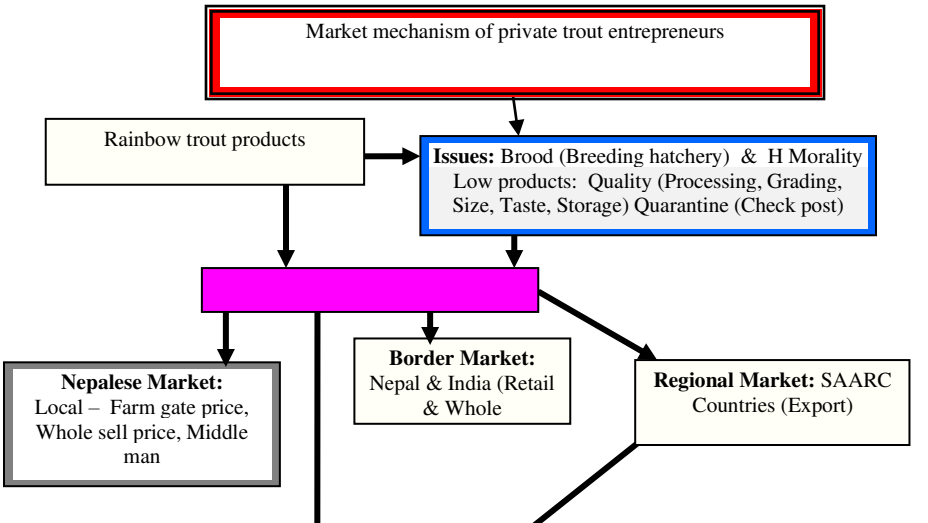

Figure 3. Market mechanism of private trout entrepreneurs

Market mechanism of private trout farming

Market mechanism of private trout enterprise should be from local level to main market. Rainbow trout market in Nepal has still no problem because product is not sufficient as compared to consumer's demand. Nepal has potential for rainbow trout farming due to its ecological characteristics. Rainbow trout has worldwide demand for human consumption. Rainbow trout products have a good potential of export to the countries of South Asian Association of Regional Cooperation (Figure. 3).

Lessons learned from private rainbow trout farming

Rainbow Trout being a cold water fish has potential of farming particularly in hilly regions where people have high opportunities to increase their income through rainbow trout production. Rainbow trout producers are self motivated because trout farming is more profitable as compared to other agricultural crops production.

CONCLUSION

Rainbow trout private enterprises are more profitable as compared to other agricultural production like livestock production or crop production. Rainbow trout entrepreneurs have generated high income and have improved livelihoods of the concerned household's livelihoods. Owing to consumer demand and high price of rainbow trout in the market it can be sold easily at any time. Therefore, it has been suggested that rainbow trout enterprise should be intensively promoted in other districts with suitable ecological conditions.

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Effect of non-genetic factors on productive traits of murrah buffaloes

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ABSTRACT

A study was carried out to characterize, evaluate and estimate the effect of non- genetic factors on productive performance of murrah buffaloes of Livestock Development Farm, Pokhara, Nepal, during February 2014 to June 2014. Altogether 350 buffaloes that calved over 10 years' period (2002-2012) A.D. were included in the study. The overall least square means for annual milk yield was 1540.34±17.86 liters, lactation length was 362.77±4.49 days and dry period was 276.10±12.5 days respectively. Among the non-genetic factors, year of calving had significant effect on annual milk yield (P<0.05) and dry period (P<0.001). However, year of calving had non-significant effect on lactation length (P>0.05). Similarly, season of calving had significant effect on annual milk yield (P<0.01) and lactation length (P<0.05) but non- significant effect on dry period (P>0.05). Parity had significant effect on annual milk yield and lactation length (P<0.01) but non-significant effect on dry period (P>0.05). Thus, the results of this study suggested that the overall productive performance of murrah buffaloes could be improved through selective breeding practices especially by considering various non genetic factors and through optimization and standardization of environmental factors.

Key words: Murrah buffaloes, least square means, parity, non-genetic factors

INTRODUCTION

Agriculture sector in Nepal contributes about 34.8% to National GDP and share of livestock subsector to AGDP is 25.68% (MOAD, 2009). Thus, livestock sub-sector is an

important output of agriculture that contributes to national economy. Domestic buffaloes are well adapted to different geo climatic conditions and thrive well on poor quality roughages. This has made buffalo as the major livestock commodity in the country. MOAD (2012) has indicated that the population of milking buffaloes in Nepal had increased from 9.8 million (2002 A.D) to13.3 million (2012 A.D.). Moreover, buffaloes contribute about 70% of total milk and 59% of total meat produced in the country and ranks at first among all species (MOAD, 2012). Among the total population of buffaloes in Nepal, 35 percent of buffaloes are murrah and their crosses and rest of them are indigenous. The profitability in buffalo farming primarily depends up on overall productive performance of buffaloes comprising lactation yield, lactation length and dry period. These traits directly affect economic value of animal. However, the expression of the economic trait is a function of genotype under the environment. Thus for the improvement of the trait, it is necessary to partition these economic traits into genetic and non genetic factors (Singh et al., 1989). Unfortunately, such investigation in murrah buffaloes in Nepal is very scanty. Therefore, this study was designed to characterize, evaluate and estimate the effect of non genetic factors on productive performance of murrah buffaloes. It is envisaged that the information so generated would be helpful in formulating future breeding plan for improving the genetic potentiality and overall productivity of the murrah buffaloes in future to come.

MATERIALS AND METHODS

This study was carried out between February 2014 to June 2014 at Livestock Development Farm, Lampatan, Pokhara. Altogether 350 buffaloes that calved over 10 years' period (2002-2012) A.D. were included in the study. The productive performances evaluated were in terms of annual milk yield (standard 305- day milk yield), lactation length and dry period. The non-genetic factors (fixed effects) related to productive performance were year of calving, season of calving and dam's parity. For evaluating the effect of non-genetic factors on productive traits as well as for overcoming the difficulty of disproportionate subclass number, data were analyzed by least square procedures using Harvey (1990) software package. The statistically significant means were compared using DMRT. A following fixed effect model was used to analyze the effect of non genetic factors on productive performance of murrah buffalo herd.

$Y_{ijkl} = \mu + a_i + b_j + c_k + e_{ijkl}$

Y_{ijkl} = adjusted means for productive traits under consideration in i^{th} year of calving, j^{th} season of calving and k^{th} parity.

μ= overall mean of the trait

a_i = The effect of i^{th} year of calving (1= 2003-04, 2=2005-06, 3=2007-08, 4=2009-10,5-2010-12)

b_j = the effect of j^{th} season of calving (1=summer, 2=Rainy, 3=winter)

c_k=effect of k^{th} parity (1=first to second, 2=third to fourth, 3=five and above parity)

e_{ijkl} = the random element (residual effect) assumed to be normally and independently distributed

RESULTS AND DISCUSSION

The overall least square means and standard errors for annual milk yield (305-day milk yield), lactation length and dry period are presented in Table 1. The overall least square means of 305-day annual milk yield in the present study was found to be 1540.34±17.86 liters. This value is lower than the value reported by Sethi (2003) who reported a higher value of 1800 liters for 305-day standard milk yield of murrah buffaloes in India. Similarly, the overall least square means for lactation length in the present study was found to be 362.77±4.49 days which compares favorably with the findings of Hussain et al. (2006) who reported the overall mean of 369.53±8.44 days in Nilli-ravi buffaloes in Pakistan.

The overall mean dry period of murrah buffaloes observed in the present study was 276.10±12.53 days. However, Gupta et al. (1994) reported a lower dry period of 184 days in murrah buffaloes in India. The exceptionally higher dry period observed in the present study could be the majority number of the buffaloes in the present study did not produce an annual calf , instead produce calf at two or three year interval, thus resulting an obviously longer dry period.

Year of Calving (YOC)

Year of calving (YOC) had significant effect on annual milk yield ($P<0.05$). DMRT also revealed that maximum annual milk yield was observed in year 2011-2012A.D. (1601.15±33.60 liters) and minimum in 2003-2004 A.D. (1493.94±37.10 liters) .The increment in annual milk yield over the years might be the incorporation of better genes to this trait during the process of selection. Also, the farm management condition might have improved over the years resulting in higher annual milk yield.

Similarly, YOC had highly significant effect on dry period in murrah buffaloes ($P<0.001$). DMRT, in the present study, further revealed that the longest dry period was found in 2009-2010 A.D. (350.77±19.69 days) and shortest in 2011-2012A.D. (190.35±38.85days). The wide variation in values for dry period in the present study indicated that there is a scope for reducing this parameter to an optimum level through effective breeding management, balanced feeding and proper housing to prevent exposure to adverse climatic conditions.

Season of calving (SOC)

Season of calving had significant effect on annual milk yield ($P<0.01$). DMRT, in the present study, confirmed that animal calved in winter season produce maximum milk yield (1552.31±19.73 liters) than calved in rainy season (1451.94±33.28 liters). Higher lactation yield in winter season calvers might be the favorable effect of monsoon season when they were in their late pregnancy. Another reason could be the availability of good quality fodder such as berseem and oat during winter season when the buffaloes were in their peak lactation period resulting persistence of milk yield at peak level for several days. Similarly, SOC is also as source of variation for lactation length ($P<0.05$). DMRT also revealed that winter season calvers had longest lactation length (374.09±4.96 days)

whereas summer season calvers had shortest lactation length (348.22±9.24 days). Longer lactation length for winter season calvers could be the better availability of good quality fodder at the time of calving. Moreover, cool environment during winter season might have enhanced the milk yield of buffaloes even at the later stage of lactation, therefore, milkers, might have been interested in milking, resulting, longer lactation period.

Dam's parity

The result of the present study showed that dam's parity had highly significant (P<0.001) effect on annual milk yield. DMRT also confirmed that annual milk yield was maximum in mid parity (1601.92±28.83liters) and minimum in early parity (1562.43±31.65liters). Higher milk yield in mid parity could be attributed to fully functional lactation glands and physiological stability of the animals in mid-age.

Similarly, Parity also had significant effect on lactation length (P<0.001). DMRT also confirmed the highest lactation length in mid parity (373.71 ±7.95 days) and lowest in early parity (339.76±6.07 days) .Highest lactation length in mid parity might be due to full maturity and efficient function of lactation glands, yielding more milk, and hence increasing lactation length.

Table1. Effect of Year of Calving, Season of Calving and Dam's parity on productive traits of murrah buffaloes

	LS mean±SE		
Factors	Annual milk yield (Liters)	Lactation length (days)	Dry period (days)
Overall	1540.34±17.86 (332)	362.77 ±4.49 (332)	276.10±12.53 (224)
Year of calving			
2003-2004	1493.94±37.10^{b} (59)	367.31±9.32 (59)	246.20±18.61^{bc} (58)
2005-2006	1595.07±32.70^{ab} (79)	367.36±8.22 (79)	291.57±18.72^{ab} (58)
2007-2008	1497.85±34.22^{b} (64)	366.34±8.60 (64)	301.59±20.85^{ab} (43)
2009-2010	1513.69±37.16^{ab} (60)	356.65±9.34 (60)	350.77±19.69^{a}(53)
2011-2012	1601.15±33.60^{a}(70)	356.17±8.44 (70)	190.35±38.85^{c} (12)
Level of significance	*	NS	***
Season of calving			
Summer (Feb-May)	1616.78±36.79^{a} (56)	348.22±9.24^{b} (56)	274.54±24.69
Rainy (June-Sep.)	1451.94±33.28^{b}(70)	365.99±8.36^{ab} (70)	264.62±19.94
Winter(Oct-Jan)	1552.31±19.73^{a}(206)	374.09±4.96^{a}(206)	289.13±13.11
Level of significance	**	*	NS
Parity			
Early (1-2)	1456.67±24.15^{b} (154)	339.76±6.07^{b}(154)	292.46±14.55
Mid (3-4)	1601.92±28.83^{a} (101)	374.83±7.24^{a}(101)	245.98±19.43
Advanced (≥5)	1562.43±31.65^{a} (77)	373.71±7.95^{a}(77)	289.86±21.10
Level of significance	***	***	NS
CV%	17.62	18.65	23.59
R^2	0.140	0.075	0.123

Note: significant at 5% (P<0.05), ** significant at 1 % (P<0.01), *** significant at 0.1% (P<0.001), NS=*

Non significant, CV= Coefficient of variation, R^2= level of precision
Figures in parenthesis refer to the number of observations.

CONCLUSION

Based on the findings of the study, it can be concluded that there is a wider scope of enhancing the overall productivity of murrah buffalo herd by considering various non-genetic factors. The significant effects of non genetic factors on productive traits (as reflected by the present study) suggest us that non genetic factors should be used as an important criterion for selection to improve the overall productive performance of murrah buffaloes. Therefore, the breeding policy of the farm should consider various non-genetic factors for improving the life- time productivity of the animal and overall productivity of the herd. Moreover, the findings of this study should be incorporated in future projects comprising heritability estimates and correlation among different productive traits to increase the genetic gain.

ACKNOWLEDGEMENT

We would like to acknowledge Institute of Agriculture and Animal Science for providing technical support to conduct this research. We would also like to thank Dr. Narayan Sharma, Farm Manager of Livestock Development farm Lampatan, Pokhara for timely availability of data. Thanks also extend to other staffs of the farm.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Economic and marketing dynamics of chiuri (*Diploknema butyracea*): a case of Jajarkot district of Nepal

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ABSTRACT

Chiuri (D. butyracea) is multipurpose species not only in its economic and marketing values but also in socio-cultural aspects to local people of hilly areas of Nepal. Harvesting, collection and production of Chiuri have become a tradition in hilly areas not only for home consumption but also for income generation. Therefore, a study was carried out in Khalanga VDC of Jajarkot district of Nepal to analyse the economic and marketing dynamics of Chiuri and its products. The study revealed that Chiuri business was the tradition of most of the people in the study sites and mostly farmers used to harvest Chiuri (fruits, seeds, honey production) primarily from the community forest (400 ropani),and from own land (1.82 ropani). Chiuri fruit, seed, ghee, honey, juice, soap and wine were found as major economic commodities. Economic analysis showed that Chiuri business had significantly higher return per unit of investment. On an average benefit cost ratio was found to be 4.77. The higher B:C ratio may be due to lower cost of cultivation. The gross margin of fruit and seed was found NRs. 10.86 and Rs. 13.76 per Kg, respectively. Likewise, marketing margin of fruit and seed was found to be Rs. 10.85 and Rs. 8.82 per Kg, respectively. Producers, collector/middle men, processors, traders, retailers and consumers were found as the major actors engaged in marketing channel. It has been concluded that the Chiuri enterprise has comparative advantages to local people to generate income from diversified products. Thus, it has been suggested that government and stakeholders should harmonize their policy and programs for the promotion of Chiuri enterprise by providing processing, technical and marketing facilities to the local farmers.

Key words: *Chiuri, benefit cost ratio, marketing margin, nutritional security, income generation, livelihoods,*

INTRODUCTION

Chiuri *(Diploknema butyracea* Roxb syn. *Bassia butyracea*, syn. *Madhuca butyracea*, syn. *Aesandra butyracea)* also known as *Nepali Butter Tree* found on steep and difficult slopes of hilly areas of Nepal is a multipurpose, large tree of the family Sapotaceae. It flowers during cold season; and fruits ripen in June-July. It commonly occurs in the sub Himalayan tract between 300-1500 masl (Wikipedia Dictionary, 2013). *D. butyracea* is a latex yielding plant useful for block planting to different edapho-climatic conditions in the hilly areas. Obviously, it does not compete with the traditional agricultural crops. The main edible products of the tree are fruits, juice, honey and ghee. Ghee is extracted from the seeds and commonly known as "Chiuri ghee" or "Phulwara butter". Chiuri ghee is the main source of edible oil for more than one hundred thousand people of Nepal (Practical Action, 2013). The potential use of Chiuri products is found in different fields such as confectionery, pharmaceutical, vegetable ghee production, candle manufacturing and soap making. The cake produced after processing of Chiuri is used as manure, which has pesticide properties; and is commonly used on paddy fields and banana plantations. Cost of cake in local market is Rs 25/pathi. It is also used as a wormicide, nematicide, molluscicide, rodenticide and insecticide. The cake can be used as crude fish poison substituting the dangerous chemical pesticides. It can be used as feed for poultry after detoxification. It can serve as a source of saponin for industry (Practical Action, 2012). Chiuri serves as an important source of nectar for bees to produce honey commonly known as Chiuri honey. It has been found that about 70 percent of total honey produced in Nepal comes from wild flora, which is by default organic. Some plant specific honeys available in Nepal are: multi-floral honey such as buckwheat honey, mustard honey, rudilo honey, chiuri honey, and litchi honey (Joshi, 2008). The physico-chemical property of this honey is well preserved when produced, harvested and stored in a good way (BOKU, 2012). Moreover, the plant species has social, cultural and environmental values as well. Chepangs (indigenous people) have special relationship with Chiuri trees as they have custom of giving Chiuri trees to their daughters as gift during marriage. Hence, it is regarded as private asset (Practical Action, 2013).

A study conducted by Thapa Magar (2008) showed that Chiuri was most preferred among traded NTFP species and wild yam among the food items consumed and traded by the Chepang community of Chitwan district. It is considered that Chiuri is one of the important non-timber forest species and components of bio-trade of Nepal. Non-timber forest products (NTFPs) play a crucial role in the livelihood of the rural communities as a source for their primary health care, nutritional security and income generation (Thapa Magar, 2008). The export of high-value MAPs offers great potential for reducing poverty and providing livelihoods in these remote areas, whilst contributing to biodiversity conservation and growth of exports (UNEP, 2012). It is equally important to link rural producers with markets and sustain and grow these links so that they form a perpetual growth cycle of production and consumption (BOKU, 2012). About 24 percent of the total population is living below poverty line in Nepal (UNEP, 2012). It is particularly even more pronounced in the remote areas of the hills and mountains and in the ethnic communities and occupational castes of Nepal. A well-managed trade in MAPs in Nepal

can overcome the lack of employment opportunities in the rural and remote areas, contribute to the development of the country's export sector, and create incentives for biodiversity conservation in the country (UNEP, 2012). This study was therefore conducted to garner the authentic information on economics and marketing of Chiuri in remote rural hilly areas; and to assess the economic products, value and marketing system of Chiuri in Jajarkot district of Nepal.

METHODOLOGY

The study was conducted in May-June 2013. Based on the cultivation, collection, production, processing and marketing of Chiuri and Chiuri products, Khalanga Village Development Committee (VDC) of Jajarkot District was selected purposively for this study. After preparing a non-formal list of chiuri entrepreneurs in coordination with District Agriculture Development Office (DADO), Jajarkot, altogether 100 respondents were selected randomly for household survey. A set of pretested semi-structured questionnaire and a separate checklist related to economic and marketing aspects of chiuri was administered to collect primary data. A Focus Group Discussion (FGD) was also carried out by assembling 9 key informants recognized by DADO, including 3 of each producers, processors and traders at local level. The collected data were processed using Microsoft Excel and descriptive statistics analysis was done. Cost of production, processing and marketing; return from the products and benefit-cost (B:C) ratio was taken as economic variables (Gitinger, 1982). These economic parameters were calculated by using following formulae.

B/C = Gross return / Total cost
Total cost = Total variable cost + Total fixed cost
Here, Total variable cost = Summation of monetary value at local market of all variable items
Gross margin = Gross return - Total variable cost
Where, Gross return= Price at local market Total quantity marketed*

RESULTS AND DISCUSSION

History and Land under Chiuri cultivation

The survey result revealed that almost all tradition of harvesting chiuri fruits from forest areas for direct consumption and to extract Ghee (plant butter). This indicates that there is a tradition of Chiuri harvesting from Chiuri forest. Majority of the farmers (65%) have more than 50 years of history of cultivating Chiuri in their own land. However, only 8 percent respondents have history of cultivating Chiuri in their own land.

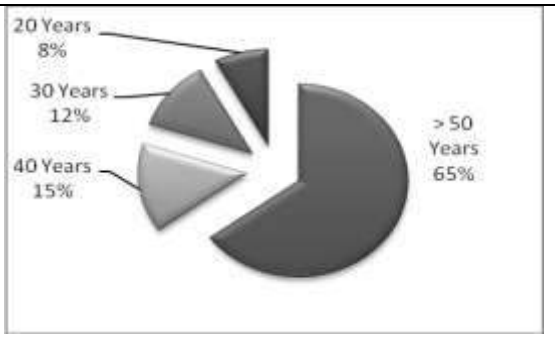

Figure 1. Percentage of farmers with history (in years) of Chiuri cultivation in own land

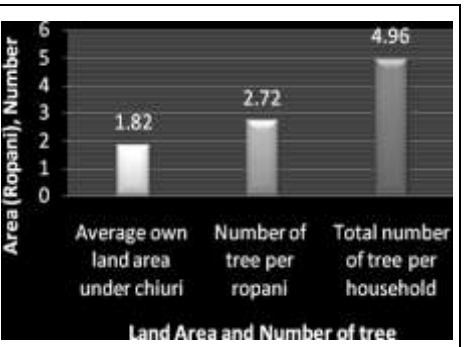

Figure 2. Own land area (ropani) under Chiuri cultivation and number of trees

Own land under Chiuri cultivation was found lower than that of forest land (Figure 1 and 2). This may be due to low land holding and more availability of forest land for Chiuri cultivation.

Land under Chiuri cultivation in community forest

On an average, area of community forest under Chiuri was found 400 ropani with 1200 numbers of Chiuri trees. Altogether, 300 households were found directly benefited from the community forest through Chiuri harvesting. On an average 1.34 households were benefited from per ropani of community forest regarding Chiuri harvesting. This indicates that the Chiuri forest has great role for income generation to the local people through Chiuri harvesting.

Table 1. Area (Ropani) of community forestry under chiuri and beneficiaries (HH)

Average Area (ropani)	Number of Trees		No of beneficiaries (HH)	
	Per ropani	Total	Per ropani	Total
400	3	1200	1.34	300

Major economic products

Fruits, seeds, ghee, honey, juice, soap and wine of Chiuri were recognized as major economic commodities by farmers across the study sites. The study showed that almost all sampled farmers were grown and harvest Chiuri for fruit, seed and ghee purpose. Majority of the Chiuri growers and harvesters have been involved in this business for ghee purpose. Likewise, 62 % farmers were produced Chiury honey by cultivating and conserving Chiuri plants across the study areas.

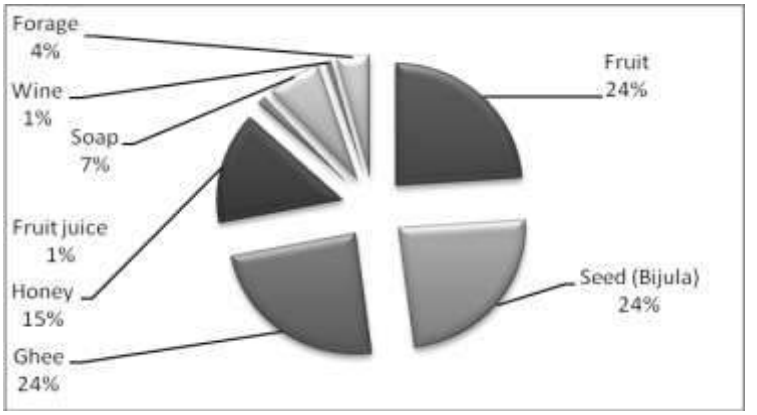

Figure 3. Major economic products produced from Chiuri (percentage of farmers)

Above figure indicates that there was higher potentiality of producing soap and wine from Chiuri but all farmers were still unable to utilize Chiuri for soap and wine production. This may be due to lack of appropriate technology, marketing, trainings and support facilities for processing.

Economic value of major Chiuri products

Market price of the respective commodities at local market during the study period was taken as an indicator of economic value of respective Chiuri products. Chiuri honey and Chiuri ghee has found higher economic value across the study sites. Value of different Chiuri commodities at local market was given in the Table 2.

Table 2. Economic value of different Chiuri products

Products	Unit	Price per unit (NRs) at local market
Fruit	Dharni	48.87
Seed	Dharni	78.75
Ghee	Dharni	402.672
Honey	Kg	422
Fruit juice	Bottle (750 ml)	29
Soap	Piece	40
Wine	Bottle (750 ml)	45

Table 2 indicates that soap and wine of Chiuri has huge scope to increase income of local people and diversified economic value of Chiuri could be an important tool for income generation of the rural people across the study areas.

Knowledge on economic value of Chiuri products

Varieties of products can be prepared from Chiuri. Broadly primary products are categorized into five groups namely; fruit, seed, flower (nectar), forages (leaves) and wood (stem) directly harvest from Chiuri. The study showed that all most all respondents were took fruit for nutritional purpose, extract seed for oil purpose and wine preparation from fruit for cash generation purpose. Whereas about 67 % and 65 % of the respondents were known that juice and jam can be prepared from the Chiuri fruit. However, no any farmers were found to prepare jam from Chiuri fruit. This may be due to lack of processing facilities at local level. Only about 23 % were known that oil cake of Chiuri can be used as fertilizer and pesticide purpose and 11 % of farmers were known that it can be used to produce candle.

Cost of cultivation and production

Both the variable and fixed cost incurred to produce different products of Chiuri was considered as the cost of cultivation. The study revealed that on an average total cost of cultivation (considered as fixed cost) of Chiuri was found NRs. 955.57, and total variable cost was found Rs. 1150.27 per ropani. The total cost of production including cost of cultivation was found NRs. 2105.84 per ropani. On an average the total cost for harvesting and processing (variable cost) to produce seeds was found to be Rs. 1150.27 per ropani. This indicates that the farmers of the study areas had used very limited resources and materials for cultivation of Chiuri.

Table 3. Farmers knowledge on different products in percentage

Primary Products	Knowledge on processed products				
Fruit	Direct consumption of fruit for nutrition and test	Seed extraction	Juice preparation	Wine preparation	Jam Preparation
Farmers (%)	100	100	67	100	65
Seed	Oil extraction	Cosmetic products	Medicine	Oil cake for fertilizer and pesticides	Candle preparation
Farmers (%)	100	100	62	23	11
Flower (Nectar)	Sweet Juice Production	Bee cultivation	Wine preparation	Jam preparation	
Farmers (%)	100	100	52	3	
Leaves	Forages for cattle	*Tapari* preparation		Disposable plate	
Farmers (%)	100	100		100	

Stem/wood	Fuel wood	Furniture preparation	Wood for construction
Farmers (%)	100	87	80

Production of fruit and seed

Production of major two products: fruits and seeds, which can be directly obtained from Chiuri tree was analyzed. However, it was found that most of the farmers collected seeds from the Chiuri field as seed is naturally spilled out from the decayed fruit on the ground. On an average production of fruits and seeds was found 593.92 Kg per ropani and 148.47 Kg per ropani. On an average, cost of production of fruit was found NRs 3.54 per Kg and that of seed was found NRs. 14.18 per Kg. This variation in cost of production between fruits and seeds may be due to processing cost. The cost of production of seed includes cost of collection, extraction of seed from fruit, drying, cleaning, weaning and storage also.

Table 4. Cost of cultivation and cost of production (NRs/ropani) of Chiuri

Fixed Cost	Amount	Unit	Price per unit (NRs)	Cost per ropani per season (NRs.)
Cost of Materials Used				
Depreciation on *Kuto*	1.80	Number	216.93	43.49
Depreciation on *Kodalo*	1.08	Number	226.84	45.36
Depreciation on Plough	1	Number	500.00	50.00
Land Tax	No*	NRs.	No*	No*
Total (A)				138.85
Labor Cost				
Labor for seedling production	2	Man days	180	360.00
Labor for field preparation	1.5	"	180	270.00
Labor for transplantation	1	"	180	180.00
Total (B)				810.00
Seed and Fertilizer cost				
Seed	0.11	Kg	50	5.50
FYM	2.061	Doko	20	41.22
Total (C)				46.72
Sub Total (D) = A+B+C				955.57
Variable cost				
Labor for harvesting	1.5	Man days	180.00	270
Sticks for harvesting	2	Number	43.22	86.44
Collecting materials (Doko)	1	"	154.45	51.48
Cost for weaning, drying, cleaning of seed (= total production * Price per unit)	1	Kg	5	742.35
Sub Total (E)				1150.27
Total Cost of production per ropani per season = D+E				2105.84

Retur

ns from Chiuri business

The gross return is the monetary value of total product. Gross return from fruit was found Rs. 6859.77 per ropani and that of seed was NRs. 3192.10 per ropani. The higher gross return from fruit as compared to that from seeds may be due to higher production of fruits as compared to seeds.

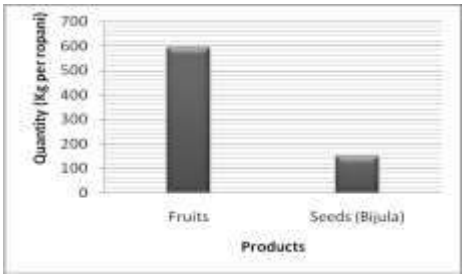

Figure 4.Production of fruit and seeds (Kg/ropani)

Figure 5. Cost of production (NRs./Kg)

Table 5. Gross return from fruits and seeds (NRs./ropani)

Fruits	Amount (kg)	Price per unit (Rs.)	Gross Return (NRs.)
	593.92	11.55	6859.77
Seed	148.47	21.5	3192.10
Total			10051.88

Returns from Chiuri products other than fruit and seed

Other than fruit and seeds ghee, honey, soap and wine are major economic products of chiuri business produced by farmers across the study areas. The study shows that on an average in one season the farmers of the study areas were earned Rs. 7007.46 per season from different products other than fruit and seeds.

Table 6. Return from other Chiuri products (NRs.)

Products	Unit	Amount	Price per Unit	Total return per season (NRs.)
Ghee	Dharni	3.42	402.672	1377.13
Honey	Kg	7.224	422	3048.52
Soap	Piece	56.67	40	2266.80
Wine	Bottle (750 ml)	7	45	315.00
Total				7007.46

Benefit cost ratio

On an average B/C ratio of Chiuri cultivation (per ropani) was found 4.77. This indicates that Chiuri business is highly worthy and profitable business across the study site.

Table 7. B:C ratio of Chiuri business

Economic factors	Value
Total cost of production (NRs. Per ropani)	2105.84
Gross return from fruit and seeds (NRs. Per ropani)	10051.88
B:C	4.77

Gross margin analysis

The gross margin analysis of any particular enterprises is defined as the difference between enterprises gross income and variable expenses attributed to that enterprise (Dillon and Hardaker, 1993). In this study, gross margin fruit and seed of Chiuri was analyzed. The study revealed that the gross margin of fruit was NRs. 10.86 per Kg and that of seed was found NRs. 13.76 per Kg. This indicates that the variable cost for the production of both fruit and seed was very low. On an average, variable cost of fruit was Rs. 0.69 and that of seed was Rs. 7.74 per Kg.

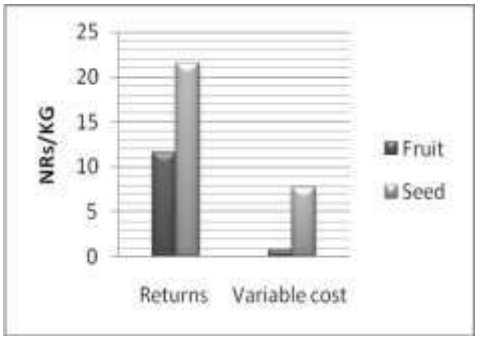

Figure 6. Returns and Variable cost (NRs./Kg)

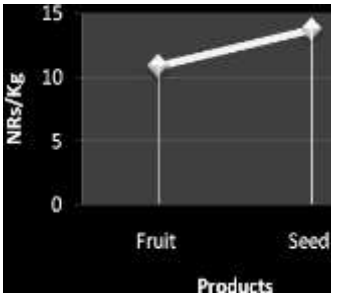

Figure 7. Gross Margin (NRs./Kg)

Marketing margin and producers share

Marketing Margin (MM) is the difference between the price paid by the consumers and the price received by the farmers. This was calculated by subtracting farm-gate price from retailer price. Similarly, producers' share is the proportion of the price received by the farmers that of paid by the consumer. Marketing margin of fruit and seed was found NRs. 10.85 and NRs. 8.82 per Kg respectively. Likewise, on an average the producers' share in seed was found 70.91 percent and that in fruit was 51.56 percent.

Table 9. Marketing margin and producers share

Products	Farm gate price (Rs./Kg)	Retail price (Rs./Kg)	Marketing margin (Rs./Kg)	Producers Share (%)
Fruit	11.55	22.40	10.85	51.56
Seed	21.50	30.32	8.82	70.91

Marketing system and marketing channels

The major actors involved in Chiuri marketing in Jajarkot districts were producers, collector/middle man, processors, traders, retailers and consumers. Marketing channel of Chiuri was classified into two groups in this study namely; vibrant and non-vibrant. Vibrant route indicates the major marketing channels. However, flow of Chiuri products were also found along the non-vibrant route but in negligible quantity. The detail of marketing channel of Chiuri in Jajarkot districts is presented in the figure below.

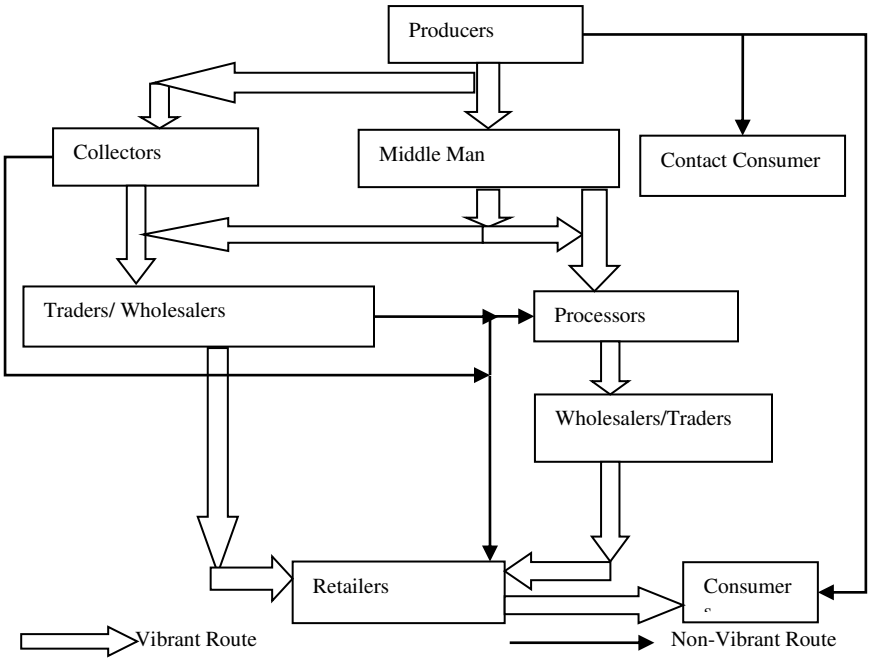

Figure 8. Marketing Channel of different Chiuri Products in Khalanga VDC Jajarkot District

CONCLUSION

It is concluded that Chiuri (*D. butyracea*) is multidimensional species not only in its economic and marketing values but also in socio-cultural aspects to local people of remote area of Nepal. Chiuri forest has significant role to harvest and collect fruits and seeds for income generation and has a comparative advantages to local people. Fruits, seeds, butter (Chiuri ghee) and honey of Chiuri were the major economic commodities produced by farmers while juice, soap and wine are most potential commodities to be produced from Chiuri at local level. Chiuri honey and Chiuri ghee has higher economic value as compared to other products. Fixed cost was found lower than that of variable cost (NRs. 955.57 and 1150.27 per ropani, respectively). Chiuri business is highly worthy and profitable to the farmers across the study site as the benefit cost (B: C) ratio of Chiuri

business was obtained higher (4.77). Gross margin of fruit was NRs. 10.86 per Kg and that of seed was found NRs. 13.76 per Kg. Marketing margin of fruit and seed was found NRs. 10.85 and NRs. 8.82 per Kg, respectively. Likewise, on an average the producers' share in seed was found 70.91 percent and that in fruit was 51.56 percent. Thus, Thus the Chiuri enterprise was the most economic and potential business in for income generation in the study areas. Therefore, the government and stackholders should provide technical supports and facilitates local people to attain potential value of all Chiuri products in remote areas of Nepal.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Comparative study on market access of smallholder farmers in hills and plains of Nepal

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ABSTRACT

Market access is the only medium which can take the final product from farmer to consumer. The small farmers produce low volume. They don't have proper market access facility as majority of them reside at rural area. They are quiet unknown where and at what price to sell their commodity. In such scenario, the study has discovered the existing conditions of such farmers. This study can be a better source of information for the persons/ organizations and policy makers those are working or want to work with market access of the farmers. It is mainly a baseline study conducted pre launching of a UK Aid funded project, Market Access of Smallholder Farmers (MASF) thorugh iDE Nepal in Gulmi and Palpa (from hills) and Rupandehi and Nawalparasi (from terai). It has tried to find out the actual condition of the farmers rather than solving any problem. Stratified random sampling method was followed for selecting sample households from the study areas of the districts. Altogether, 25 VDCs were studied with 5 from Gulmi, 6 from Nawalparasi, 7 from Rupandehi and 7 from Palpa purposively. The obtained information was analyzed using Excel Package. The main markets of the vegetables were the respective district headquarters of all the studied districts. The study revealed that the market access of smallholder farmers in WDR was not so good but comparatively better in terai districts than in hilly districts. About 6% respondents who do vegetables farming sell 25% of their vegetables from the farm gate and another 6% sell the all of the product from the farm gate. Only 0.6% of the respondents sell their 25% of the produce to the collection center and only 0.3% of the respondents sell their all of the product to the collection center. Altogether, 1.6% of the respondents sell their produce to the collection center where as 9.8% of the respondents sell their vegetables to haat/bazaar.

Key Words: Market, smallholder farmers, vegetable, farming

INTRODUCTION

The economy of Nepal is characterized by the excessive dependence on agriculture with involvement of 65.7 percent of population (MoAC, 2009). Despite the decline of contribution of agriculture to GDP from 47.4 percent in 1990/91 to 39.2 percent in 2003/04, it is still the largest sector of the economy and the main livelihood option for around 80 percent of the population (SWATEE, 2006). Enterprises tend to concentrate on production and selling rather than marketing. Poverty is pervasive throughout the country and the people under the poverty line are 30.8 percent of the total population (MoAC 2009). Among those under the poverty line, 67.0 percent are engaged in agro-based

employment and 11 percent are agricultural labors. This indicates that 78 percent of the total poor have made agriculture sector their prime means of employment (MOF, 2009).

Agricultural commercialization is increasing complex and dynamic system of production and consumption based on market (Goletti, 2005). It includes both input and output marketing based on profit maximization principles (Pingali and Rosegrant, 1995). The core problem for agribusiness development in Nepal is the lack of effective value chain linkages among input providers, farmers, traders, processors, and service providers in which they all are aware of their mutual linkages and organize themselves in such a way that they can benefit from such linkages in the network.

This is study generally focused on access on vegetable market. Vegetables are major high value crops. The diverse agro-climatic conditions of Nepal have provided nearly unlimited scope for growing all types of vegetables known in the world. Thus, liking farmers to market and developing value chains at different levels: local, regional, national and international/niches are in high need (GAFSP, 2010). Some of the examples would be appropriate site selection, commercial size pockets, appropriate vehicles, all season transportation network, year round irrigation facilities, extension (both production and technology and market networking) post harvest activities, collection/ market centers, credit facility, information and communication. Different channels are found in vegetable market with different ranges of profit margin. Shrestha (2008) found that profit margin of middlemen was 50 percent farm gate price.

MATERIALS AND METHODS

The study area were purposively selected at four districts of Western Development Region (WDR): Palpa (Rampur, Hungi, Gejha, Wakamalang, Gadakot, Khaliban and Darcha VDCs), Gulmi (Baletkasar, Birbaas, Digam, Hardinet and Pallikot VDCs) Rupandehi (Sukrauli, Ramgram, Palhi, Ramnagar, Devgaun and Manari VDCs) and Nawalparasi (Bogadi, Ekala, Asuraina, Rayapur, Khudabagar, Lumbini Adarsha and Padariya VDCs) as per my job station as an intern in Butwal Regional Office in iDE, Nepal on the basis of Market Access for Smallholders Farmer (MASF) Project. Survey was done from 1st of January to 19th of January. Stratified random sampling method was followed for selecting samples from the study areas of the districts. Primary Data were collected using several methods such as household survey, observation method and interviews. *Household survey* was conducted by using semi structured questionnaire. The questionnaire was prepared, drafted and pretested jointly by me and members of iDE Nepal. 306 respondents were personally interviewed to trace out the true fact in details. *Personal observation* was done in farmer's home, field, market places and haat bazaar to analyze the socioeconomic and market access condition of farmers. Secondary data were collected from several literatures such as books, journals, articles, annual reports available at different academic (HICAST and IAAS) and non academic institutes (ICIMOD, NARC, iDE Nepal, AICC, CBS and NARDF).The collected data were grouped and entered in computer for data processing and were analyzed using MS Excel. Descriptive interpretations of the results were done by using tables and charts. Analysis of primary interpretations was done on the basis of per household.

RESULTS AND DISCUSSIONS

Access on social services

Access on services

Small towns/cities paly vital role in converting rural areas by providing them enhanced access to services. (Nepal and Thapa, 2008) Access to credit is major limitation in value chain. (WB, 2009) Access on services are expressed as time in minutes in the table 1. Accessibility to services and facilities are more easier in Terai than Hills. Among all the above services, smallholder farmers have physical access to cooperative in shorter time than all others. The farmers have very least access on bank in all studied districts. The case is very severe in Palpa, without access on Collection Centre (CC). The farmers in Gulmi don't have access in Micro irrigation technology and services providers.

Table 1. Time of Respondents towards physical Access on services

Districts	Bank	Cooperative	Seeds and Fertilizer Seller	Market	Agriculture Services	Veterinary Services	Haat Bazaar	CC	Micro irrigation Tool selling centre
Gulmi	57.79	15	54.744	53.48	56.39	47.65	59.36	58.67	
Nawalparasi	27.56	15	29.75	24.59	27.97	25.94	25.12	30	23.88
Palpa	140.77	15	110.26	124.6	69.23	74.1	90		135
Rupandehi	54.77	22.37	23.25	35.41	27.72	24.86	20.05	23.78	21.74
Grand Total	81.93	17.62	44.49	67.65	41.78	41.55	29.82	35.94	25.59

Mode of transportation to access on collection centre

Majority of farmers move to collection centre by means of bus (Table 2). Cycle using farmers are less than the bus users but lesser than those moving on foot. In Palpa, none of the studied farmers have access to collection centre.

Mode of access to market

Most of the respondents in the studied area have access to market by foot. Here, the market denotes the local site where most of the daily-use goods are bought. The case is more in the hilly districts as compared to terai districts. "In the Terai, farmers have easy access to many local markets and the terrain allows for easy transport by foot or bicycle." (USAID, 2008 p.3) The hill has undulating terrain which leads to difficulty in construction of roadways. Cycle and rikshwa are very common in terai districts and are easier too.

Table 2. Mode of transportation to access on collection centre

District	Foot	Cycle	Bus	Grand Total	Remarks
Gulmi	19	8	15	42	
Nawalparasi		3		3	
Palpa					no access to CC at all
Rupandehi	9	20	47	76	
Grand Total	28	31	62	121	

Table 3. Frequency of respondents with different modes of access to market

Districts	Foot	Cycle/ Rikshwa	Bus	Grand Total
Gulmi	30	13		43
Nawalparasi	3	35		38
Palpa	66	35		101
Rupandehi	71	38	1	110
Grand Total	170	121	1	292

Access to improved seed

Table 4 shows that around 55% of the respondents have access on improved seeds. Maximum number of the respondents having access on the improved seeds was found in Rupandehi District and least in Palpa. It showed that the respondents of terai have more access on improved seeds as compared to those of hills.

Table 4. Frequency and percentage of the respondents having access to improved seed

Districts	Yes	No	Grand Total
Gulmi	7 (16.3)	36 (83.7)	43 (100)
Nawalparasi	37 (86)	6 (14)	43 (100)
Palpa	20 (18.2)	90 (81.8)	110 (100)
Rupandehi	104 (94.5)	6 (5.5)	110 (100)
Grand Total	168 (54.9)	138 (45.1)	306 (100)

(Note: CC = Collection Centre)

Access to irrigation

Major bottle neck of Nepalese agriculture is irrigation. Most of the farmers depend on rainfed agriculture tradition. From above table 5, it is seen that 71.2 percent of the respondent do not have access to irrigation system. Only 28.8 percent do artificial watering to their vegetable crops. Most of the farmers from Rupandehi have facilities of irrigation.

Table 5. Frequency of respondents having access on irrigation

Districts	Yes	No	Grand Total
Gulmi	11 (25.6)	32 (74.4)	43 (100)
Nawalparasi	5 (11.6)	38 (88.4)	36 (100)
Palpa	3 (1.0)	107 (36)	110 (36.8)
Rupandehi	67 (22.4)	43 (14)	110 (36.8)
Grand Total	86 (28.8)	220 (71.2)	306 (100)

Least number of respondents having irrigation facilities was seen in Palpa districts. The problem of irrigation is more dreadful in Hilly Districts rather than those in terai.

Access to improved technology

Access to improved technology leads to commercialization of vegetable farming. But, very few numbers of respondents have the access on improved technology. The case is more severe in the districts of hills. Only 23.5% of respondents have the access, remaining 76.5% don't have. Thus, access on improved technologies of the studied small farmers is very poor. But, the respondents of terai have better access on improved technology than that of hills.

Table 6. Frequency and percentage of respondents having access on improved technology

Districts	Yes	No	Grand Total
Gulmi	1 (0.9)	42 (99.1)	42 (14.1)
Nawalparasi	7 (16.3)	36 (83.7)	43 (14.1)
Palpa	1 (0.9)	109 (99.1)	110 (36.9)
Rupandehi	63 (57.2)	47 (42.8)	110 (36.6)
Grand Total	72 (23.5)	234 (76.5)	306 (100)

Access to market and market price

More than 50% of the respondent who responded about the market and market prices has access on the market price. From to the table 7, maximum number (58) of the respondent having access on market and market prices was found in Rupandehi district followed by Gulmi (39), then Nawalparasi (37) and the least in Palpa (23).

Table 7. Frequency and percentage of access to market and market price

Districts	Yes	No	Grand Total
Gulmi	39 (90.7)	4 (9.3)	43 (100)
Nawalparasi	37 (86)	6 (14)	43 (100)
Palpa	23 (20.9)	87 (79.1)	110 (100)
Rupandehi	58 (52.7)	52 (47.8)	110 (100)
Grand Total	157 (51.3)	149 (48.7)	306 (100)

Economic Situation

Farmers selling their vegetables at farm gate/ home

This study shows that only 14.7% of the total farmers sell their products from the farm gate. Around 6% of those farmers sell their 25% of their produce from farm gate and next 6% sell the 100% of their produce at farm gate. 2.6% of the respondents sell their produce at the farm gate. The least (0.3%) of the respondents sell 50% of their produce at farm gate. The case is more prevalent in hills than terai. In hills also, the practice of selling from the farm gate is more common in Gulmi where total 92.9% of the respondents sell their vegetable products from farm gate.

Table 8. Counts of farmers selling their vegetables at farm gate/ home

Districts	25%	50%	75%	100%	Grand Total
Gulmi	17(39.5)	8(18.6)	1(2.3)	14(32.5)	40(92.9)
Nawalparasi					
Palpa				4(3.6)	4(3.6)
Rupandehi	1(0.9)				1(0.9)
Grand Total	18(5.9)	8(2.6)	4(0.3)	18(5.9)	45(14.7)

Number of farmers selling their vegetables at collection centre

Only 1.6% of the total respondents sell their vegetables total the collection center. It is seen before implementation of market access project by iDE Nepal. Among the studied districts, Rupandehi has the maximum percentage of the respondents selling the vegetables to the collection center whereas in Palpa none of the farmers sell their produce to the collection center. In rest of the districts, only one respondent in each was found to sell their produce to the collection center.

Table 9. Number of farmers selling their vegetables at collection centre

Districts	25%	50%	75%	100%	Grand Total
Gulmi	1 (0.3)				1 (0.3)
Nawalparasi				1 (0.3)	1 (0.3)
Palpa					
Rupandehi	1 (0.3)	2 (0.7)			3 (1.0)
Grand Total	2 (0.6)	2 (0.7)		1 (0.3)	5 (1.6)

Farmers selling their vegetables at haat/ bazaar

In terai there is tradition of Haat. It is not in practice in hills. So the farmers of hills have sell their vegetables in nearby market or to the collection center. 5.9 percent of the total respondents sell 75 percent of their produce bazaar. It is seen only in Gulmi. Similarly,

only around 3 percent of the farmers sell 50 percent of their produce to bazaar. In Rupandehi, only 2.7 percent of the respondents sell their 50 percent produce to Haat. All together, about only 10 percent of the respondents have access on haat /bazaar. None of the respondents in Nawalparasi and Palpa sell their produce. It may be that they have subsistence farming or they do not have access to haat/bazaar.

Table 10. Farmers selling their vegetables at haat/ bazaar

Districts	25%	50%	75%	100%	Grand Total
Gulmi		9 (21)	18 (42)		27 (63)
Nawalparasi					
Palpa					
Rupandehi		3 (27)			3 (27)
Grand Total		12 (48)	18 (42)		30 (90)

(Note: The figures in parenthesis of tables represent the percentage)

CONCLUSION

Assessing on the access of the smallholder farmers to services, among the studied services, the farmers have better access on cooperative and least access on bank comparatively. The study found that majority of farmers move to collection center by bus and to market by cycle. More than 50 percent of the farmers have access on improved seed whereas only 28.8 percent of them have access on irrigation facilities. Only 24.2mpercent of the farmers have access on improved technologies. Majority of the access having farmers were in Rupandehi district. About 52 percent of the respondents have access on market and market prices of their produces. About 6 percent respondents who do vegetables farming sell only 25 percent of their product from the farm gate while another 6% sell the entire product from the farm gate. Only 0.6 percent of the respondents sell their 25 percent of the product to the collection center and only 0.3 percent of the respondents sell their all of the product to the collection center. Altogether, 1.6 percent of the respondents sell their product to the collection center where as 9.8 percent of the respondents sell their vegetables to haat/bazaar.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Evaluation of promising wheat genotypes against leaf and yellow rust in mid-hill of mid-western Nepal

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ABSTRACT

Yellow rust and leaf rust are the major problems of the wheat production in mid-hill of Nepal. Ultimate solution for the mitigating the negative impact of rust is to find the resistant genotypes of wheat for different agro-climatic domains. The experiment was conducted at farmers' field to find the resistant source of leaf and yellow rust in Salyan, Surkhet and Rolpa districts of mid- western Nepal. Eight promising wheat genotypes received from Agri- botany division of NARC were planted in RCB design with seven replications where farmers were taken as a replication. The disease scoring was done by Modified Cobbs' scale method and scoring was done at flowering stage. The results reveal that the genotype NL-1042 and Kiskade is completely resistant (0) to both leaf rust and yellow or stripe rust in all of experimental sites. Similarly, Chewing is also resistant to both rusts by showing the score of 10R for yellow rust. Genotype WK-1481 has been seen from moderately susceptible to highly susceptible in most of the experimental sites. It showed 90S scoring at Gumi of Surkhet district and its yield also was lowest as compared to other seven genotypes. Danphe-1 is resistant to leaf rust but moderate susceptible to yellow rust. Remaining genotypes; Dhaulagiri showed moderately resistant to moderately susceptible to both rusts, Danphe-2 showed resistant to leaf rust and moderate susceptible to yellow rust where as WK-1204 showed moderate susceptible to leaf rust and resistant to yellow rust in farmers field conditions of Salyan, Rolpa and Surkhet.

Key words: Genotype, resistant, disease, leaf rust, yellow rust

INTRODUCTION

Wheat *(Triticum aestivum L.)* is the first in the world and third most important staple cereal crop in Nepal. It is widely cultivated in terai and mid-hill regions and even up to 5000masl of the high hills. It has covered 754,243 ha of land and production is 1727346 MTMT with average productivity of 2.5MT/ha (MoAC, 2013/14) in context of Nepal. It is cultivated in both of khet (irrigated rice terraces) and upland (unirrigated, unbunded rainfed terraces) in mid-hills. Wheat farming was introduced in Nepal in the 1960s and production has expanded in the mid and far-western regions to be worth US$ 575 million in 2012(Sci Dev Net, 2011). Farmers are eager to grow wheat crop, especially in mid-hills because of the low irrigation need as compared to other crops, but they lack the promising genotypes which are high yielding, disease resistant/tolerant, drought tolerant etc. Wheat rust diseases, being among the major transboundary plant pests and diseases,

cause significant losses to farmers, and pose a major threat to food security (FAO, 2012). One significant constraint to increased wheat production is the variety of rust diseases attacking this crop — leaf rust, stem rust and stripe rust (McIntosh *et al.,* 1995). Besides stem rust (*Puccinia graminis*), leaf or brown rust *(Puccinia recondita)* and yellow rust *(Puccinia striiformis)* are mainly prevalence in plains and hills of Nepal. The farmers of hills had faced several round of epidemics in the past and had to bear around 20-30 percent yield losses (Sharma, 2011). The yellow rust causes 15-20 percent yield loss while leaf rust is relatively less damaging (Mathur *et al.,* 1992). Losses due to leaf rust are usually small (< 10%), but can be severe (30% or more). Stem rust is the most devastating of the rust diseases and can cause losses of 50 percent in 1 month when conditions for its development are favorable. Losses of 100 percent can occur with susceptible cultivars. Losses due to yellow rust or stripe rust can be severe (50%) due to shriveled grain and damaged tillers. In extreme situations, stripe rust can cause 100 percent losses (Roelfs *et al*., 1992).

In the 2009–10 seasons, an epidemic of stripe rust swept across West and Central Asia (ICARDA, 2012) Climate change is expected to increase the spread and severity of rust diseases, further threatening food security. To combat stripe rust, greater investments in research and regional coordination are essential (Solh, 2014). Rust diseases are sparsely distributed in many places of Salyan, Surkhet and Rolpa districts. Despite the present yield loss has been considered as negligible, it is imperative to say that the future is bleak if any further steps will not go ahead, because many resistant released varieties are under the disease vulnerable condition. Similarly, disease is somewhere in mild condition and somewhere in moderately severe condition. It means the severity of the diseases is depending on the locations. Till now, the farmers are not using any type of fungicides for controlling the rust diseases but facing the problems every year (personal communication with selected farmers for trials of Salyan, Surkhet and Rolpa districts, 2014). Keeping this point in mind, finding the new resistant genotypes of wheat based on the topography and climatic conditions is a *sine qua non* condition to overcome the food insecurity; and this was the major perspective of this research.

MATERIALS AND METHODS

Screening of promising wheat genotypes against rusts was carried out in three districts with eight varieties namely Danphe-1, Danphe-2, NL-1042, Kiskade, WK-1481, Chewing, WK-1204 and Dhaulagiri. Experimental sites were selected at Gumi (altitude: 467masl) in Surkhet district, Nuwaganhu (altitude: 1270 masl) of Rolpa and Bartibang (altitude: 1185masl) of Rolpa and Bhotechaur (altitude: 930masl) in Salyan. There were seven replications in overall. Fertilizers dose was 150:50:25 kg NPK/ha and applied as basal dose. The seed treated with Vitavex -200@ 2g/kg of seed was received from Agri-botany division of NARC, Khumaltar, Kathmandu. The experiment was laid out at randomized complete blocks design (RCBD) with the plot size 21 sq.m. (3m ×7m) for each variety. Seed rate was 150 Kg/ha. Wheat planting was completed by first week of December in all experimental sites. Most of the disease scoring and other agronomic data were taken at flowering stage depending upon the maturity period of the genotypes. The data was analyzed by the use of Genstat. Severity was recorded as a percentage,

according to the modified Cobb scale. This recording process relies upon visual observations, and it is common to use the following intervals: trace, 5, 10, 20, 40, 60, and 100 percent infection.

Field response was recorded using the following letters:

Symbol	Detail
O	No visible infection on plants.
R	Resistant; visible chlorosis or necrosis, no uredia are present.
MR	Moderately Resistant; small uredia are present and surrounded by either chlorotic or necrotic areas.
M	Intermediate; variable sized uredia are present, some with chlorosis, .necrosis, or both.
MS	Moderately Susceptible; medium sized uredia are present and possibly surrounded by chlorotic areas.
S	Susceptible; large uredia are present, generally with little or no chlorosis and no necrosis.

Severity and field response readings were usually combined.
For example:
tR = Trace severity with a resistant field response.
5MR= 5% severity with a moderately resistant field response.
60S= 60% severity with a susceptible field response.
Source: CIMMYT rust scoring guide

RESULTS AND DISCUSSION

Agronomic attributes

The results (Table 1) revealed WK- 1481 showed the mean highest plant height and number of spikes per hill with lower yield and WK-1204 as lowest plant height as compared to others. Likewise, Kiskade showed the highest spikes mean length and mean number of spikes per square meter but yield is quite lower. Danphe-1 has given the highest yield over the other genotypes.

Disease severity condition

The results (Figure 1) showed that the genotype NL-1042 and Kiskade is completely resistant to both leaf rust and yellow or stripe rust by scoring the 'zero' and giving the severity condition 'R' in all the locations of experimental sites. Similarly Chewing is also resistant to both rusts by showing the scored of 10R for yellow rust. WK-1481 has been seen from moderate susceptible to highly susceptible in almost all part of the experimental sites. It showed 90S scoring at Gumi of Surkhet district. Danphe-1 is resistant to leaf rust but moderate susceptible to yellow rust. Dhaulagiri showed moderate resistant to moderate susceptible to both rusts, Danphe-2 showed resistant to leaf rust and moderate susceptible to yellow rust, WK-1204 showed moderate susceptible to leaf rust

and resistant to yellow rust. The results showed that the severity condition of rusts is different in different climatic condition for rust vulnerable genotypes but for resistant genotypes have showed constant score for all three agro-ecology.

Table 1. Agronomic characteristics of promising genotypes of wheat tested in different agro-ecological locations of mid western hills of Nepal 2013/014

Genotypes	Plant height (cm)	Length of spikes (cm)	Number of spikes per hill	Number of spikes/sq.m	Yield (MTMT/ha.)
Danphe-1	81.43^{ab}	9^{c}	3.257	361.4	5.19381^{b}
Kiskade	81.40^{ab}	10.729^{a}	3.429	408.7	4.414762^{b}
Chebing	78.94^{bc}	10.202^{ab}	3.029	305.6	4.251905^{b}
Dhaulagiri	82.86^{ab}	10.2^{ab}	3.429	405.3	4.952381^{ab}
WK-1204	73.8^{c}	9.271^{bc}	3.057	363.9	4.517143^{ab}
Danphe-2	87.46^{a}	9.1^{c}	3.371	342.4	4.612381^{ab}
WK-1481	108.06^{a}	9.586^{bc}	3.657	297.4	4.251905^{ab}
NL-1042	88.20^{a}	10.143^{ab}	3.629	389.9	4.537619^{a}
Mean	85.26	9.778875	3.35	359.325	4.591488
F-test	**	**	ns	ns	**
SE	6.31	0.818	0.5013	78.7	1.276
CV	7.4	8.4	14.9	21.9	13.2
LSD	6.81	0.882	0.5408	84.9	1.377

*NS= Non significant at p=0.05, **= Highly significant, SE= Standard error, CV= Coefficient of variation, LSD= Least standard deviation.*

Disease severity in relation to yield

The yield of genotypes with relation to leaf and yellow rust has been shown in figure 2. Among the eight genotypes, Danphe-1(5.2 MTMT/ha) has given the highest yield followed by Dhaulagiri (4.95 MTMT/ha) but the rust severity condition is from resistant to moderate susceptible in both genotypes. Likewise, the resistant genotypes NL-1042 and Kiskade have given the yield 4.5MTMT/ha and 4.4MTMT/ha respectively. The susceptible genotype WK-1481 for both leaf and yellow rust has given the yield 4.2MTMT/ha, the lowest yield among the eight genotypes.

Gradual climate changes and disease outbreak in resistant genotypes by new races of rusts is threatening the overall food security of the country. During mid eighties the occurrence of 7E150 race resulted in breakdown of variety RR 21 to yellow rust. Similarly the varieties Annapurna 1 and Annapurna 4 with effective Yr 9 gene became susceptible when the new virulent race 46S119 appeared during 1999. Heavy infection of the rust was noted in variety Nepal 297 during 2004 in the northern parts of Kathmandu

valley. It had been felt necessary to have effective screening techniques for sound breeding program (Sharma 2004). Most of the released varieties by NARC are yellow rust resistant such as Pasang Lhamu, WK-1204, likewise, Gautam (BL 1887) is resistant to both yellow and leaf rust. But these varieties may be susceptible in future so we have to aware about the proverb "Prevention is better than cure".

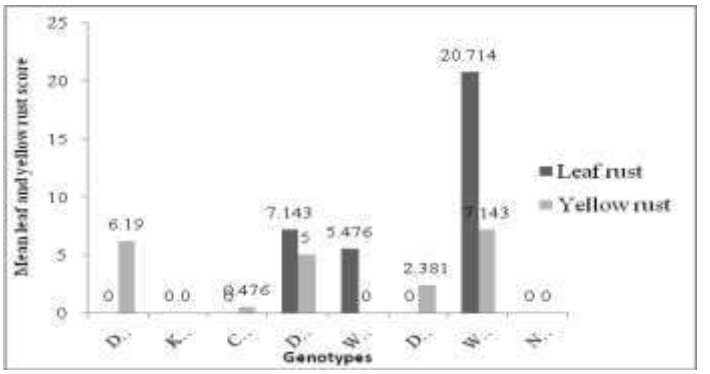

Figure 1. Mean leaf rust and yellow rust score of promising wheat genotypes

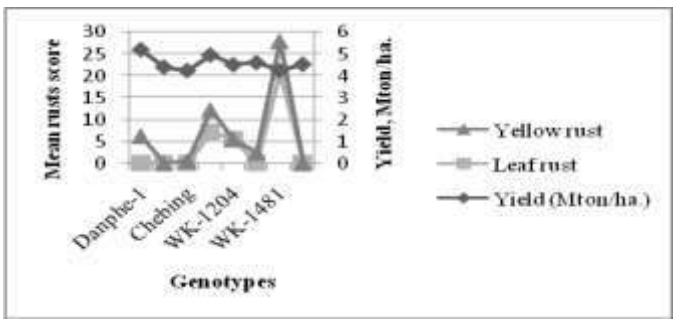

Figure 2. Mean leaf and yellow rust score in relation to yield (MTMT/ha) of promising wheat genotypes

The results revealed that the genotypes like NL-1042, Kiskade and Chewing are resistant for leaf and yellow rust. These varieties can be promoted and recommended in disease prone areas in future. From 2008-11 a Nepal Agricultural Research and Development Fund (NARDF)-funded project was conducted to try to minimize wheat losses caused by yellow rust in ten highly affected districts of Nepal, in partnership with the Department of Agriculture, CIMMYT (Nepal) and the Seed Quality Control Centre, Nepal (CIMMYT 2011). ICARDA has also suggested the five point concerted strategies for long term solution to rusts epidemics; (1) surveillance and rapid response; (2) crop breeding based on durable resistance and gene diversity; (3) scaling-up of resistant varieties and dynamic seed production program; (4) sharing of information and (5) capacity building.

CONCLUSION

Wheat genotypes like NL-1042, Kiskade and Chewing have showed the resistance to both leaf and yellow rust with average yield in all experimental sites of mid-hill of mid-western region of Nepal. If the severity condition of diseases will increase nearby future, these varieties can be promoted. It is imperative to say that there is need of rusts resistant with high yielding varieties for the combating the farmers problems. Farmers are eager to grow new varieties but they have no option to choose, so they are unwillingly growing their own old seed since long decades. Promotion of these genotypes may be become good option for replacing the obsolete varieties which are disease susceptible, low yielding and long duration.

ACKNOWLEDGEMENT

Authors are highly acknowledged to Agriculture and Food Security Project (AFSP) under the Nepal Agriculture Research Council (NARC) for the financial support to accomplished this research. The authors wish to thank helping hand from RARS, Khajura and participated farmers from the experimental sites of Salyan, Surkhet and Rolpa districts.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Performance of promising brinjal (*Solanum melongena* L.) varieties in Mid Western Terai of Nepal

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ABSTRACT

A field evaluation trial was conducted in RCBD with three replications to identify the most appropriate brinjal genotypes at western terai of Nepal. . The individual plot size was 2.7 m^2, gross plot area consisting 3m length and 0.9m breadth. Each plot contain two rows and each rows had five plants so, total ten plants per plot. The highest plant height (80.9 cm) and plant vigour (4) was recorded in genotype Pokharalurki. Purple colour genotype PPL (HRDBRI 003) and lalgulab 001started flowering earlier than yellow and green colour genotypes. Fruit weight percent varied significantly and the highest fruit weight of 10 fully mature fruit was recorded in genotype SBN 07 (912.5 g). In case of disease and insect pest infestation, the highest incidence of disease was recorded in genotype SBN 07 while the highest insect infestation was recorded in genotype PS1 (HRDBRI 011), Devgiri (HRDBRI 002), SBN 02 and SBN 06. Wide variations were observed in yield potential of the genotypes. The highest number of fruit per plot (169) and total marketable fruit yield per plot (11.65 kg) was recorded in genotype Pokharalurki. The effect of genotype on total yield (MTMT/ha) was found to be significant. Highest yield was recorded in genotype Pokharalurki (43.15 MTMT/ha) whereas the lowest yield was recorded in genotype SBN 04 (12.5 MTMT/ha). Besides these, genotypes Bari 8 (HRDBRI 009) and PPL (HRDBRI 003) also had higher marketable yield and total yield than other genotypes. It has been concluded that yield of brinjal can be increased by using these genotypes in mid western terai condition of Nepal.

Key words: Genotypes, brinjal, fruit weight, pests, yield

INTRODUCTION

Brinjal or eggplant (*Solanum melongena* L.) also known as Aubergineor Guinea squash is one of the non-tuberous species of the night shade family Solanaceae (Kantharajah *et al*., 2004). The family contains 75 genera and over 2000 species. There are 3 main botanical varieties under the species *melongena* (Choudhury, 1976). The common brinjal, to which large, round or eggshaped fruited forms belong are grouped under var. *esculentum*. The long, slender types are included under var. *serpentinum* and the dwarf brinjal plants are put under var. *depressum.* It is a cheap vegetable commonly growing in India, Pakistan, China, Philippines, Bangladesh, Egypt, France, Italy, Middle East, Far East and U.S.A. (Anonymous, 2010) including Nepal (Hada et al., 2008). It is

an important solanaceous vegetable crop in sub-tropics and tropics. It is a widely grown vegetable from hill to terai in Nepal. Across the globe, it is grown annually on 1.50 million ha area contributing 25.07 million tones with 16.67 tonnes per ha as productivity (Anonymous, 2004). Asia is the main producer, in particular China (53%), India (28%) and Turkey (4%) of the world production (Daunayet al., 2001). It is highly productive and usually finds a place as "poor man's crop". Single planting of brinjal can harvest many times as compare to other vegetables like cabbage and cauliflowers.Eggplant fruits are known for being low in calories and having a mineral composition beneficial for human health.It is a good source of nutrients, minerals, antioxidants, vitamins, dietary fiber and body building factors and proteins (Matsubara *et al.*, 2005; Obho*et al.*, 2005). One hundred grams of fruit contains 0.7mg iron, 13.0mg sodium, 213.0mg potassium (Nonnecke, 1989), 12.0mg calcium, 26.0mg phosphorus, 5.0mg ascorbic acid and 0.5 International Units of vitamin A and provides 25.0 calories (Tindall, 1978). The varieties of *Solanum melongena* L. show a widerange of fruit shapes and colors, ranging from oval or egg-shaped to long club-shaped and from white, yellow, green through degrees of purple pigentation to almost black. Most of the commercially important varieties have been selected from the long established types of the tropical India and China. Fourteen genotypeswere collected at Horticulture Research Division for varietal evaluation. There is an ample possibility to increase the productivity by introducing these genotypes. However all the genotypes do not perform equally in all ecological conditions. Hence, the present study was conducted with an aim to identify the most appropriate brinjal genotypes suitable for western terai condition of Nepal.

MATERIALS AND METHODS

The experiment was conducted in Regional Agricultural Research Station, Banke, Nepal.Geographically it is located at $81^0 37'$ East longitudes and $28^0\ 26'$ North latitude with altitude of 181 masl. The experiment was carried out from September2013 to May 2014.

The experiment design was laid out in a Randomized Complete Block Design with 12 treatments and 3replications. In total 14 genotypes: PPL (HRDBRI 003), PS-1 (HRDBRI 011), Lalgulab (HRDBRI 001), Devgiri (HRDBRI 002), Bari 8 (HRDBRI 009), PokharaLurki, SBN 01, SBN 02, SBN 03, SBN 04, SBN 05, SBN 06, SBN 07, and SBN 08 were assessed in the trial. These genotypes were obtained from Horticulture Research Division, Khumaltar. Two genotypes, viz. SBN 01, and SBN 03 did not germinate; so only 12 genotypes were kept in experimental trial. The individual plot size was $2.7m^2$, gross plot area consisting 3 m length and 0.9 m breadth. Each plot contain two rows and each rows had five plants so, total ten plants per plot. The spacing between two blocks and main plot was 1m and space between subplots was 0.5m.Seeds of all the varieties were sown on September 23, 2013 in the nursery bed. Seedlings were transplanted in the field on October 21, 2013. After field preparation, fertilizer was applied @ 3 kg FYM, 105.6 gram DAP, 78 g Urea and 36 g Potash per plot. The agronomic practices were same for all the treatments (varieties).

Phenological characters like plant height, plant vigour, number of days to 50 perecnt plant flowering and days to first harvest were recorded from the ten observable plants of each plot.Fruits harvested from ten tagged plants of each treatment at each picking were categorized into marketable and unmarketable fruits and summed up separately over all pickings.Then, weight of 10 fully mature fruit, fruit numbers per plot and fruit yield (MTMT/ha) were computed. Analysis of variance for all parameters was carried out as per the procedures given in MSTATC. Duncan's Multiple Range Test for mean separations was used at 5% probability level as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Phenological characters

Plant height and plant vigour

The experimental results revealed that there was significant effect of genotypes of brinjal on plant height and plant vigour. The highest plant height was recorded in genotype Pokharalurki (80.9 cm) which was at par with genotype SBN 07 (80.4 cm) and the lowest plant height was recorded in genotype PS1 (HRDRI 011) (50.1 cm).The plant vigourness was assed in 1-5 scale where the highest vigourness was provided 5 while lowest vigourness was provided with the 1. The highest plant vigour was found in genotype Pokharalurki (4) which was at par with genotype SBN 07 (4) while the lowest plant vigour was recorded in genotype PS 1(HRDRI 011) (2).

Days to flowering

Days to 50 % flowering after transplanting indicate the earliness of the crop which differs significantly. The genotype SBN 02, SBN 05 required more number of days to 50 percent plant flowering as compared to the grand mean (159.23 days). It seems that growth habit is also one of the important characters, which determines the earliness of the crop. Purple colour genotype PPL (HRDBRI 003) and lalgulab 001 flower earlier than yellow and green colour genotype SBN 02, SBN 04, SBN 05, SBN 06, SBN 07. The highest fruit weight of 10 fully mature fruit was recorded in genotype SBN 07 (912.5 g) which was at par with PS 1 (HRDBRI 011) (885 g) and SBN 06 (812.5 g) while the lowest fruit weight was recorded in genotype SBN 05 (565 g) and lalgulab 001 (605 g).

Table 1. Effect of brinjal genotype on plant height, plant vigour, days to 50 % flowering and fruit weight of 10 fully mature fruit tested at RARS (2013/14)

Treatment (genotypes)	Plant height (cm)	Plant vigour (1-5)	Days to 50 % flowering (DAT)	Fruit wt of 10 fully mature fruit (g)
SNB 02	58.3^{cd}	2.5^{bc}	168^{a}	732.5^{b}
SBN 04	68.6^{abc}	3.5^{ab}	163^{b}	670^{c}
SBN 05	57.6^{cd}	2.5^{bc}	168^{a}	565^{f}
SBN 06	58.5^{cd}	2.5^{bc}	158^{b}	812.5^{a}

SBN 07	80.4[a]	4[a]	158[b]	912.5[a]
SBN 08	66.5[abc]	3.5[ab]	158[b]	655[cd]
Devgiri(HRDBRI 002)	64.4[abc]	3[abc]	157[b]	617.5[de]
PS1 (HRDBRI 011)	50.1[d]	2[c]	160.5[b]	885[a]
Pokharalurki	80.9[a]	4[a]	157[b]	735[b]
Bari 8 (HRDBRI 009)	77.7[ab]	4[a]	158[b]	760[b]
PPL (HRDBRI 003)	64.6[bcd]	3[abc]	153[c]	657.5[cd]
Lalgulab 001	74.2[ab]	4[a]	153[c]	605[ef]
Grand mean	66.8	3.21	159.29	717.3
SEM±	4.37	0.33	0.69	13.25
$LSD_{0.05}$	13.62[*]	1.04[*]	2.15[*]	41.24[*]
CV%	9.3	14.7	0.6	2.6

Means within the same column followed by same letter are not significant at 5%level by DMRT, DAT= Days after Transplanting, SEM= standard error of mean, LSD= least significant difference and CV= coefficient of variance.

Disease and insect pest infestation

Among the disease fungal and bacterial wilt and little leaf of birjnal was recorded while in case of insect brinjal fruit and shoot borer and whilte fly was most damaging insect pest. There was significant effect of genotype on disease and insect infestation. The highest incidence of disease was recorded in genotype SBN 07 which was statistically at par with SBN 08, SBN 06 and PokharaLurki while the lowest disease incidence was seen in genotype PPL (HRDBRI 003), PS1 (HRDBRI 011) and Devgiri (HRDBRI 002). The little leaf disease was recorded only in genotype SBN 06 and Pokharalurki. In case of insect infestation, the highest insect infestation was recorded in genotype PS1 (HRDBRI 011), Devgiri (HRDBRI 002), SBN 02 and SBN 06 while the lowest insect infestation was recorded in genotype Bari 8 (HRDBRI 009). Some frequently encountering insect pest in Nepalese brinjal fields are fruit and shoot borer, white fly, red spider mites, spotted beetle (Gyawali, 1999). Among them, the Shoot and Fruit Borer (*Leucinodesorbonalis* Guenee) was found to be a prominent insect pest (Entomology Division 1999; Neupan e 1993; AVRDC 1994; Joshi 2003) particularly in Terai, Low and Middle mountains of Nepal.

Yield attributing characters and yield

There was significant effect of brinjal genotype on total number of fruit per plot. The highest number of fruit per plot was recorded in genotype pokharalurki (169) which was statistically at par with genotype Bari 08 (HRDBRI 009) (131.5) and PPL (HRDBRI oo3) (125.5). The genotype having highest plant height and plant vigour produce higher number fruit per plot. The mean values of total marketable fruit yield per plot of tested genotypes ranged from (3.38 kg) in SBN 04 to (11.65 kg) in Pokharalurki. It revealed that

genotype SBN 04, DBN 06, SBN 07 and PS1 (HRDBRI 011) produced more number of unmarketable fruit because there genotype were more infested with insect than other genotypes.

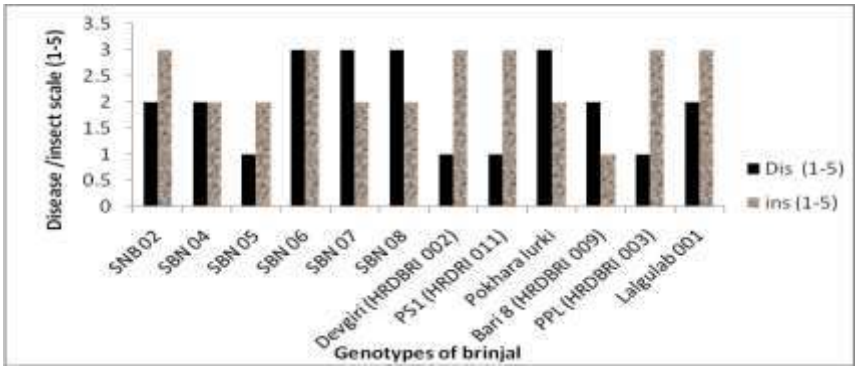

Figure 1. Incidence of disease and insect in different genotypes of brinjal at RARS, Khajura, Banke, Nepal, 2013/14

The effect of genotype on total yield (MTMT/ha) was found to be significant. Highest yield was recorded in genotype Pokharalurki (43.15 MTMT/ha) which was followed by genotype Bari 8 9HRDBRI 009) (33.07 MTMT/ha) whereas the lowest yield was recorded in genotype SBN 04 (12.5 MTMT/ha).

Table 2. Effect of brinjal genotype on total number of fruit per plot, total marketable yield per plot and total yield (MTMT/ha) tested at RARS, Khajura , Banke (2013/14)

Treatment (varieties)	Total number of fruit per plot	Total marketable yield per plot (kg)	Total yield (MTMT/ha)
SNB 02	57^{cd}	4.05^{de}	15^{de}
SBN 04	52.5^{cd}	3.38^{e}	12.5^{e}
SBN 05	100^{bc}	5.55^{cde}	20.56^{cde}
SBN 06	63^{cd}	4.6^{de}	17.04^{de}
SBN 07	52^{cd}	4.5^{de}	16.67^{de}
SBN 08	58^{cd}	3.66^{de}	13.56^{de}
Devgiri(HRDBRI 002)	112.5^{b}	6.33^{bcd}	23.44^{dcd}
PS1 (HRDRI 011)	45.5^{d}	3.57^{de}	13.22^{de}
Pokharalurki	169^{a}	11.65^{a}	43.15^{a}
Bari 8 (HRDBRI 009)	131.5^{ab}	8.93^{b}	33.07^{b}
PPL (HRDBRI 003)	125.5^{ab}	8.22^{bc}	30.44^{bc}
Lalgulab 001	56^{cd}	3.395^{de}	12.57^{de}
Grand mean	85.2	5.65	20.94

SEM±	14.55	0.84	3.13
$LSD_{0.05}$	45.27*	2.63*	9.73*
CV%	24.1	21.1	21.1

Means within the same column followed by same letter are not significant at 5%level by DMRT, DAT= Days after Transplanting, SEM= standard error of mean, LSD= least significant difference and CV= coefficient of variance.

Table 3. Shape/ size and colour of different genotypes of brinjal tested at RARS (2013/14)

Genotypes	Shape/ size	Colour
SNB 02	Medium long	Yellow with purple tinge
SBN 04	round	Green
SBN 05	Medium long	Yellow with purple tinge
SBN 06	round	Purple
SBN 07	long	Green
SBN 08	long	purplish green
Devgiri(HRDBRI 002)	Medium long	Light purple
PS1 (HRDBRI 011)	long	Purple
Pokharalurki	long	Purple
Bari 8 (HRDBRI 009)	Medium long	Purple
PPL (HRDBRI 003)	long	Dark purple
Lalgulab 001	ovale	Light purple

Fruit shape and colur

High variation was observed in fruit shape and colour. Among the tested genotype SNB02, SNB 05 and Devgiri (HRDBRI 002) have medium long fruit shape while SBN04, SBN 06 have round shape while SBN 07, SBN08, PS1 (HRDBRD 011), Pokharalurki and PPL (HRDBRI 003) have long fruit shape and size. The colour of genotype SBN 02 and SBN 05 was yellow with purple tinge and genotype SBN 04 and SBN 07 was green in colour while other genotypes were purple in colour.

CONCLUSION

The brinjal genotype varied greatly in major phonological characters, fruit set efficiency, yield and its quality in terai condition of mid-western region of Nepal. Pokharalurki showed outstanding performance in terms of total yield, marketable yield and fruit weight under climatic condition of mid-westernterai. Besides these, genotypes Bari 8 (HRDBRI 009) and PPL (HRDBRI 003) also had higher marketable yield and total yield than other genotypes. So, it can be concluded than yield of brinjal can be promoted by using these genotypes in mid-westernterai condition of Nepal.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Food security of subsistence farmers in the context of climate change in Nepal

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ABSTRACT

This article is based on a study carried out in a farming community in Nepal and explores the food security situation of the area in the context of climate change. The results of the study indicate that the local climate has changed over the past few decades and as a direct consequence farming communities have been negatively impacted. Use of chemical fertilizers has increased and outbreak of insects, pests, weeds and crop diseases are also on the rise. The food security situation has worsened; and local people feel that the changing climate has been a significant factor. It has required them to embrace alternative cultivation practices and change their traditional cropping pattern. However, the adaptation measures have done little to increase productivity in the area with locals experiencing chronic food deficiency. In addition to the on- farm adaptation measures, farmers increasingly have to rely on nonagricultural coping strategies to lessen the impact of economic hardships. The country will continue to face food security challenges due to climate change; and there is an urgent need to address the issue at local and national level.

Keywords: Climate change, agriculture, food security, farming practices, adaptation

INTRODUCTION

The impact of climate change magnifies in agricultural systems where adaptive capacitiesof farmers are low and vulnerability ishigh.The agricultural sector is the most important contributor to the national economy. It makes up 33 percent of Nepal's GDP and engages 65 percent of the population (MoAC, 2010). More than three quarters of the countries households directly rely on agriculture for their livelihood (WFP and NDRI, 2010). Most famers in Nepal rely on rain-fed agriculture for their livelihoods since only 40 percent of agricultural land is irrigated (MoAC/WFP/ FAO, 2009) and hence effects of climate change tend to be more severe (Gentle & Maraseni, 2012). The high dependence on agriculture for economy, livelihood and general welfare makes the country particularly vulnerable to climate change. An increasing prevalence of natural disasters within Nepal, including: droughts, flooding, landslides and large hail storms, correlates with the increasing concern of global climate change(MoAC; WFP; FAO, 2009).The adverse impact on agriculture from changes in climate has been reported in the past. According to Regi et al. (2008), changes in climate have resulted in crop failures in Nepal further enhancing food insecurity for majority of the people. Increased frequency of rainfall and the resulting floods and landslides have negatively impacted agricultural

production in the country (Regmi and Adhikari, 2007). Evidence indicates that more frequent and more intense extreme weather events and increasing irregularities in seasonal rainfall patterns are already having an impact on not only food production, but also food distribution infrastructure, incidences of food emergencies, livelihood assets and human health (FAO, 2008). Agricultural production is increasingly uncertain and increasingly risky in the country due to erratic rain/snowfall and frequent drought (Gentle & Maraseni, 2012). Since the 1990's Nepal has regularly experienced an annual food deficit, and is reliant on imports from neighboring countries. According to recent estimates nearly 41 percent of the population is undernourished (MoAC; WFP; FAO, 2009). The underlying causes of food insecurity in Nepal are complex and require a thorough assessment of interventions (WFP and NDRI, 2010). Farming communities are at the forefront while facing the challenges of climate change and adapting to it. Improved understanding of the influence of climate on agricultural production is needed to cope with expected changes in temperature and precipitation, and this is especially urgent for the increasing number of undernourished people in food insecure regions (Rowhani, et al., 2011).There is a need to understand what changes in farming systems might be required to better deal with climate change and maintain or enhance productivityand also a need to understand farmer's perceptions and adaptation to climate change (Li, et al., 2010). It is in this context that this study was carried out in Makwanpur district to explore the food security situation of the farmers, and analyze the impact of climate change on agriculture based rural households.

MATERIALS AND METHODS

Study area

Makwanpur district of Nepal was selected as the study area for the research due to high dependence of the local population on agriculture and frequent evidences of floods and landslides along with prolonged winter drought in the district. Makwanpur district lies in central Nepal (27°10' to 27°40' North latitude and 84°41' to85°31' East longitude). It has an area of 2,426 sq. km and the elevation ranges from 166m to 2,584m above sea level. More than half of the terrain of the district has a slope inclination greater than 30° making the district vulnerable to landslides and soil erosion. There are numerous rivers running through the district, the main ones being the Rapti and Bagmati river. The climate in the district ranges from tropical towards the south to temperate towards the north. The highest temperatures are experienced from April to May, the month of July generally being the hottest. The average annual rainfall recorded varies from 1838mm to 3315mm.

Agriculture in the area is characterized by manual labor, small land holdings and a reliance on natural rainfall. Major cultivated food crops in the area include winter rice, autumn rice, wheat, summer maize and winter maize. Potato, cauliflower, cabbage, radish, carrot and cucumber are the main vegetables produced in the area. Majority of the population of the study area rely on agriculture for their livelihood and subsistence. For most vegetable farmers it is also the main source of income. Household and farm characteristics of the four VDCs representing the two distinct farming systems under study are provided in table 1.

Table1. Household and farm characteristics in study area

Household/Farm characteristics	Vegetable based farming	Cereal based farming
Average HH size	4.66	4.04
Education (%)		
Illiterate male	20	24
Illiterate female	34	40
Literate male (up to secondary education)	65	65
Literate female (up to secondary education)	58	55
Literate male (higher education)	15	11
Literate female (higher education)	8	5
Income from farming		
No income	0	54
Less than 100 US $/yr*	23	46
100 -1500 US $/yr*	16	0
More than 1500 US $/yr*	61	0
Off farm employment		
HHs with off farm income	39	7
Agricultural labour	43	64
Others	18	29
Land holdings (%)		
Less than 0.5 hectare	51	47
0.5 to 1 hectare	31	30
More than 1 hectare	18	23
Means of irrigation (%)		
Natural rain	28	47
River/Streams	37	31
Irrigation canal	35	22
Farm mechanization (%)		
Hired tractors	0	47
Motor pumps	11	35
Workinganimals	89	18

**1 US $= 78 NRs*

A total of four VDCs from the district were selected for the field study. Among themtwoVDCs: Makawanpurgadhi and Namtmtar represent hilly region particularly affected by landslide and dominated by vegetable based cropping systems. The other two

VDCs viz., Manahari and Bhimfedi represent the plain areas affected particularly by floods and dominated by cereal based farming systems.

Data collection

A field survey was carried out from the month of August to October in 2010 in the four study VDCs to collect the primary data.This included household questionnaire survey, focus group discussions (FGD), key informant interviews and field observations. A total of 300 households were interviewed using semi structured questionnaire designed to collect both qualitative and quantitative information. Eight FGDs, two in each VDC, were carried out with farmer groups formed by District Agriculture Development Office (DADO). Interviews with ten key informants were also conducted to collect information on the food security situation. Key informants included officials from government and non-government organizations, local leaders and elders.Collection of the secondary data was accomplished through published books, reports, thesis, research papers, journals, websites as well as relevant organizations. Temperature and rainfall data were collected from the Department of Hydrology and Meteorology (DHM) for 30 years (1980 to 2009) period.

Data analysis

Collected primary and secondary data were analysed using software programs, such as RCLIMDEX ver. 2.1, Ms-Excel and SPSS. Both descriptive statistics and quantitative statistics were used to describe the household characteristics, farmer's perception and comparing the findings using statistical tests like t-test, chi square test and Likert scale.

The study examined the food security of the households primarily depending on agriculture for their livelihood. For this only households with farming as the main occupation were included in the study.The food security situation was analyzed on the basis of data collected by interviewing the farmers, focus group and key informants as well as secondary data obtained from DADO by employing the method developed by Coates et al.(2006). The method measures household food security based on the assumption that information on the varied "conditions, behavior and experience" are the indicators that help to measure the food insecurity.

RESULTS AND DISCUSSION

Climate Variability

Trends in temperature and precipitation

The average annual variation of the maximum, minimum and diurnal temperature (DTR) showed an increasing trend for the period of 30 years from 1980 to 2009 (Figure 2).The

average annual value of maximum and minimum temperature refers to the mean of monthly maximum value of daily maximum temperature and monthly minimum value of daily minimum temperature, respectively.

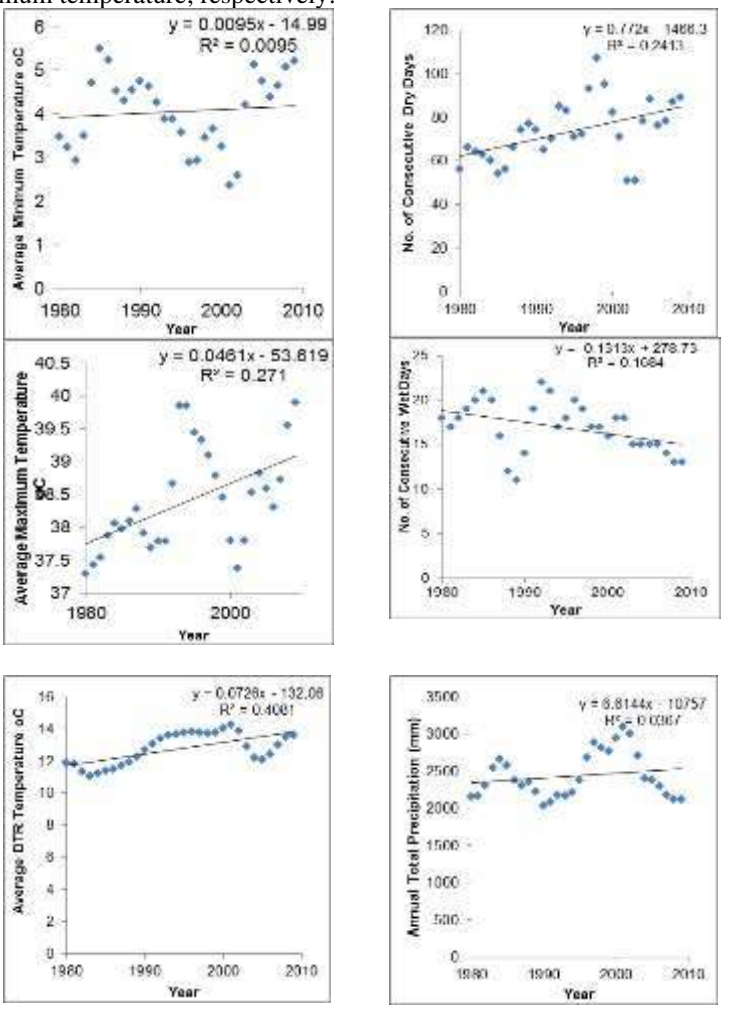

Figure 2. Temperature and precipitation trends for meteorological data

Average annual diurnal temperature refers to the mean of variation in the daily maximum and minimum temperature. The mean average maximum temperature for the period of 30 years was 38.41^0 C. 2008 was the hottest year with maximum temperature of 39.55^0 C for the period of 2000-2010. The temperature has been increasing by 0.0461 degree per year since last 30 years. The regular minimum temperature was found to be increasing by 0.009^0 C per year. DTR has been increasing with the maximum value of 14.6 ^{0} C in the year 2003. Compared to the previous two decade the DTR was found to be higher during 2000-2010 with an average value of 14.67^0 C. This value was only12.41^0 C during the 1990's. To examine the trend of rainfall, three indices for the period of 1980-2009 were

considered viz., consecutive dry days (CDD), consecutive wet days (CWD) and annual precipitation (Figure 2). The CDD was found to be increasing significantly for the first 20 years and since then increasing insignificantly. The CWD was found to be decreasing significantly. The average number of CWD was found to be 17 for 30 years' time period. The annual average rainfall for the period of 30 years was 2436 mm. From 1996 to 2004, the annual rainfall exceeded the average amount of rainfall.

The results indicated that the local climate had changed over the past few decades; and as a direct consequence farming communities across the region were negatively impacted by it. This is in line with the results of studies carried out in other parts of the country (Gentle and Mareseni, 2012; Jones and Boyd, 2011; Regi et al., 2008; Regi and Adhikari, 2007). Vulnerability of the farming system in Nepal is very high to climate fluctuations and there are evidences to support this claim. Droughts in 2006 resulted in an estimated reduction of 21npercent in rice area planted due to low and uneven rainfall distribution during rice planting and early crop growth (Gumma, et al., 2011). The 2008/09 winter drought in Nepal was one of the worst on record when rain monitoring stations across the country received less than 50 percent of average precipitation during the period November 2008 to February 2009 (MoAC; WFP; FAO, 2009). The drought resulted in a significant decrease in wheat and barley production, the two major winter crops, in the country with a decrease of 14.5 and 17.3 percent, respectively compared to the previous year (MoAC; WFP; FAO, 2009). The interactions with local farmers in Makwanpur district revealed the same with productivity in the area declining corresponding to extreme and unreliable weather conditions.

Local perceptions on changes in temperature and precipitation

Majority of the farmers in all the VDCs reported changes in temperature and the frequency of hot and cold waves. According to the farmers, the summer days are hotter and the number of winter days has been decreasing year after year for last ten years. 91 percent farmers reported that they had perceived increase in the number of hot days. Participants of the FGD and key informants also reported increase in the number of hot days. According to them hot days are much more pronounced in the month of April, May and June. Farmers and key informants also reported that cold waves were more prominent in the month of December and January. About 84 percent of the respondents reported decrease in number of cold days. The opinions and responses of farmers, local experts interviewed and participants of the FGD matches with the result obtained from the trend analysis of temperature data. About 91 percent of the farmers perceived increasing rainfall pattern over a period of 10 years. The FGD and key informant interviews revealed that the intensity of rainfall was high during the monsoon, which leads to frequent flooding and landslides in the study site. Although rainfall was lower in earlier years, they lasted for longer periods and were less intense. It was also reported that though there was high rainfall during the monsoon period, winter drought was a major concern. Flooding and landslides were found to be a prominent problem in the study site. About 85 percent of respondents reported a decreasing trend of rainfall while 15 percent respondents reported an increase. According to a local farmer, "*the monsoon does not arrive on time and there is erratic rainfall. In winter, the rain should usually arrive after*

the wheat harvest but it is arriving before the wheat harvest in these years due to which our harvest is down".

Food Security and Climate Change
Food production

According to DADO, the food requirement of each individual for 2009 was 201 kg per year while the availability from local production was only 135.47 kg per year. The production of food grains from the preceding eight years shows an annual decline. Food availability in the district is inadequate to satisfy local demand. According to the local farmers the landslides, floods and drought during different period of the year cause difficulty in crop cultivation. Farmers, FGD participants and key informants reported that uneven rainfall pattern resulted in dropping of seed, matured crop development, delay in crop desiccation along with rotten crops that deprived farmers' livelihood. The farmers reported difficulties in sustaining their livelihood due to floods in the year 1985, 1994, 2002, 2003 and 2005. Similarly drought during the year 2006, 2007 and 2009 had a negative impact on livelihood. Almost all the respondents reported that there has been a serious impact on people's livelihood due to change in climatic pattern. The impacts have been more serious in cereal based farming system as it experiences frequent floods than in vegetable based farming system, primarily carried out in landslide prone areas. Majority of the households have land holdings of less than a hectare with nearly 50 percent of the households owing less than 0.5 hectares of land.

Food availability

Three indicators viz. changes in cropping area, crop productivity, and instances of drought and water scarcity were used to analyze the situation of food availability in the study area (Table 2). Weighted average index (WAI) was calculated for farmer's responses to identify the magnitude of climate change impact on food availability. About 55 percent of the farmers in vegetable cultivating area and 92 percent of the farmers in cereal cultivating area reported significant decline in crop productivity. Majority of the households in vegetable cultivated area experienced severe droughts which decreased the productivity of the crops. In the cereal cultivating area, majority of the farmers had experienced mild droughts and water scarcity. Cereal cultivating farmer experienced more flood than drought in their farms. In the cereal cultivating area, 35 percent of the farmers reported that they changed the cropping area from cereals to vegetables but only 8 percent of the farmers in the vegetable cultivating region stated that they changed the cropping areas to cope with the adverse effect of climate change. Due to decrease in crop productivity there was unequal distribution of the major cereals and vegetable crops in the district. This can be observed from the calculation of WAI as well, where the value for changes in cropping area and decrease in crop productivity was found to be high in cereal cultivating area than vegetable cultivating area (Table 2). The drought and water scarcity problem was more severe in the vegetable cultivating area compared to the cereal cultivating area. According to DADO, staple crops like paddy, pulses and vegetables have to be imported to the district in order to meet their demand. Poor irrigation facilities in the area also negatively affect food availability. Nearly half of the farmers depending

on cereal based farming system depend on river water to irrigate their field followed by their dependency on irrigation canal and natural rainfall. But in area dominated by vegetable based farming majority of the farmers depend on natural rainfall. A considerable number of households (35%) were found practicing rainwater harvesting for irrigation purpose. This was done through community owned rainwater harvesting ponds. This figure was only 19 percent for the cereal cultivating farmers. 93 percent of the farmers in cereal based farming system have medium storage facility against 16 percent of the households in vegetable based farming system. The value of food diversity is high in the vegetable cultivating area; and value of storage facility and spread of diseases is high in the cereal cultivated area. This is because the area dominated by vegetable cultivation produces both cereals and vegetables to improve their livelihood. The vegetables are sold on a daily basis in local markets; and the income generated is used to fulfill other basic necessities. In cereal cultivating area, only few households cultivate vegetables which are insufficient even for their home consumption. Since the households store cereal for a long time, cereal cultivating farmers have good storage facilities compared to the vegetable cultivating farmer.

Table 2. Farmer's response on climate change impact on food availability

Indicators	Farmer's response on climate change impact on food availability (WAI)	
	Vegetable based farming	Cereal based farming
Changes in cropping area	1.95	3.14
Decreased crop productivity	3.46	3.58
Increased drought and water scarcity	3.45	3.23
Storage facility	2.21	3.04
Source: Household survey (2010)	WAI: 4-3 (high impact); 3-2 (medium impact); 2-1 (low impact)	

Household food access and self sufficiency

Two indicators i.e. level of income and food prices were looked at to analyze the situation of food access in the study area (Table 3). Farmers cultivate only limited types of crops in the area which is inadequate to make them food secure. They sell part of their agricultural products and purchase other types of food resources that they do not produce themselves. Around 88 percent of the farmers from vegetable based farming system and 91 percent of the farmers from cereal based farming system reported a decline in the level of income; and increase in food prices year after year. According to the local farmers the impact of climate change on food access has been high. Farmers reported reduced crop yields that have lowered their income as well as increased the prices of food due to increased competition for it in the market. Decreased crop yield, declining income of the farmers and high food prices have worsened the food security situation in the study area. The landslide affected areas included in the study are mainly the hilly regions of the district. Due to the difficult terrain most of these places lack proper transportation facilities. This situation is aggravated by successive landslides year by year.

Table 3. Farmer's response on climate change impact on food access

Indicators	Farmer's response on climate change impact on food access (WAI)	
	Vegetable based farming	Cereal based farming
Decreased Income	3.83	3.88
Increased food prices	3.83	3.88
Source: Household survey (2010) WAI: 4-3 (high impact); 3-2 (medium impact); 2-1 (low impact)		

Income from agricultural production is limited to offset the rise in the food prices. Almost all the farmers adopting vegetable cultivation in the landslide affected area sell vegetables to fulfill the basic needs of the family e.g. education, clothes, food, etc. but very few farmers adopting cereal cultivation in the flood affected area sold vegetables. The limited quantity of vegetables they produce is used for their own consumption. 62 percent of the households depending on vegetable based farming system make approximately 1500 US $ per year from the sales of vegetables. In case of cereal based farming system, the agricultural produce is mainly used for sustenance with more than 50 percent of the farmers do not sell any of their products.

Household food insecurity access scale (HFIAS) was used in this study to divide the population into two broader categories of food security, viz. food secure and food insecure. This tool was used to measure the food security situation of both vegetable and cereal cultivating farmers. Food secure households were defined as households that worried about food. About 37 percent of the households adopting vegetable cultivation and 27 percent of the households adopting cereal cultivation were found to be food secure. Mildly food insecure households were defined as households that worried on the condition of not having sufficient food, and/ or were incapable of eating preferred foods and/ or had to eat same food time and again i.e. relied on monotonous diet and/or had to eat foods not preferred by them. However, the households did not cut down the size of meal in terms of quantity. The study showed that about 34 percent of the households depending on vegetable cultivation were mildly food insecure against 21 percent of the households depending on cereal cultivation. Households sometimes or often depending on monotonous foodstuffs, and/or eating few preferred foods, and/or seldom or occasionally reducing the amount of meal in a day but not facing severe situations were categorized as moderately food insecure households. The study revealed that 16 percent of the vegetable cultivating households and 23 percent of the cereal cultivating households fell under this category. The households that frequently cut the size of meal and amount of meal each day and/or experienced several severe circumstances were categorized as severely food insecure households. The study showed that 13 percent of the households cultivating vegetables and 29 percent of the households cultivating cereals were severely food insecure. The relative difference in the food security situation of the two farming communities is mainly because of the difference in income from the selling of agricultural products.

Small land holdings, cultivation in marginal land, high reliance on natural rainfall for agriculture, poor transport infrastructure, difficult terrain, low levels of education all

interact with each other and magnify the vulnerability of farmers to climate change in the area. The actual impacts of climate change and variability are largely dependent on farm characteristics, which influence management and adaptation (Reidsma, et al., 2010). The hardest hit are the poor consumers and small farmers who increasingly spend a large share (60-70%) of their income to meet their daily consumption needs as a result of increased prices (Gumma, et al., 2011).

Food diversity

Three indicators namely food diversity, spread of diseases and storage facility were looked at to analyze the situation of food use and food vulnerability in the study area (table 4). 51 percent of the farmers in the vegetable cultivating area reported that they have high food diversity. This figure was only 19 percent for the cereal cultivating farmers. The spread of diseases was low in vegetable cultivating area compared to the cereal cultivating area. This is because cereal cultivating area is hotter and receives more rainfall compared to the vegetable cultivating area.

Table 4. Farmer's response on climate change impact on food use and vulnerability

Indicators	Farmer's response on climate change impact on food access (WAI)	
	Vegetable based farming	Cereal based farming
Food diversity	3.41	1.62
Spread of diseases	2.63	2.71
Source: Household survey (2010)	WAI: 4-3 (high impact); 3-2 (medium impact); 2-1 (low impact)	

Contribution of farm production to food security

In order to analyze the food security situation of the farmers, the respondents were categorized into four groups based on the period of the food sufficiency from their own production (table 5). Out of the total household surveyed it was found that 37 percent of the vegetable cultivating farmers were food secure in terms of the food availability, food access and food utilization and food vulnerability while only 27 percent of the cereal cultivating farmers were found to be food secure from their own production in terms of food availability, food access and food utilization. All the households adopting cereal and vegetable farming system were found to be managing the insufficient food grains and vegetables by purchasing it from the market. Farmers with bigger land holdings and smaller household size in general were found to be more food secure than farmers with smaller land holdings size. Farmers depending on vegetable based farming system were found to be more food secure compared to cereal based farming system as they sold vegetables for income.

Local Adaptation Measures

Several strategies have been adopted by local farmers to reduce the impact of climate change on agriculture. Table 6 outlines some of the strategies adopted in the vegetable and cereal based farming systems in the study areas.

Table 5. Food security situation

Food security from own production	Household (%)	
	Vegetable based farming	Cereal based farming
Less than 4 months	34	21
4 to less than 8 months	16	23
8 to less than 12 months	13	29
More than 12 months	37	27
Source: Household survey (2010)		

Table 6. Climate change adaptation strategies in vegetable and cereal based farming systems

Climate change adaptation strategies	Adoption (%)	
	Vegetable based farming	Cereal based farming
Changes in crop varieties	90	95
Off farm employment	61	93
Rainwater harvesting	80	37
Chemical fertilizer	93	90
Organic manure	67	60
Agroforestry	86	21

Majority of the farmers reported changes in varieties of the crops they planted to better cope with the changing climate. The local landraces have been displaced by the new hybrids better suited to withstand flood and drought conditions. Altogether 92 percent of farmers in both the targeted group and study area reported to have changed the varieties of crops. Respondents during the FGD and key informant surveys mentioned that climate change solely was not accountable for the change in varieties of the crops. Change in climatic patterns along with other factors like increased productivity and early maturing of the crops have made farmers to make changes in the varieties of crops. The farmers have made modifications in the traditional cropping calendar owing to the variations of temperature, rainfall, relative humidity as well as changes in the varieties of crops. The changes in the cropping calendar varied from 15 days to one month (Figure 3). Almost all the respondents mentioned changes in the planting time of major cereal crops like paddy, maize, wheat and finger millet. This in turn has led to the shifting pattern of other major crops like potatoes and mustard.

In both the targeted groups in the study area, the farmers cultivated cereal crops like rice, maize, wheat and finger millet. The farmers reported that increased temperature and erratic rainfall resulted in low productivity of the crops; so most of the farmers shifted their cropping pattern from cereal to vegetable crops. According to the farmers it is easier to produce vegetables despite the changing climate as they are able to implement various technologies like use of plastic tunnels and raised bed cultivation, which was almost impossible in cereal crop production.

Majority of the respondents reported that under growing climatic uncertainty, off farm employment has helped them to improve their food security situation. According to them agricultural production has been declining rapidly and they have no choice than to seek alternative sources of income. About 40 percent of the respondents work as agricultural labor, followed by employment in the service sector and small businesses. Only 3 percent of the respondents reported that they still depended solely on agriculture for their livelihood. Only 15 percent of the male population and 7.65 percent of female population had pursued or were pursuing higher education. A low level of education has been a barrier for employment outside the agricultural sector.

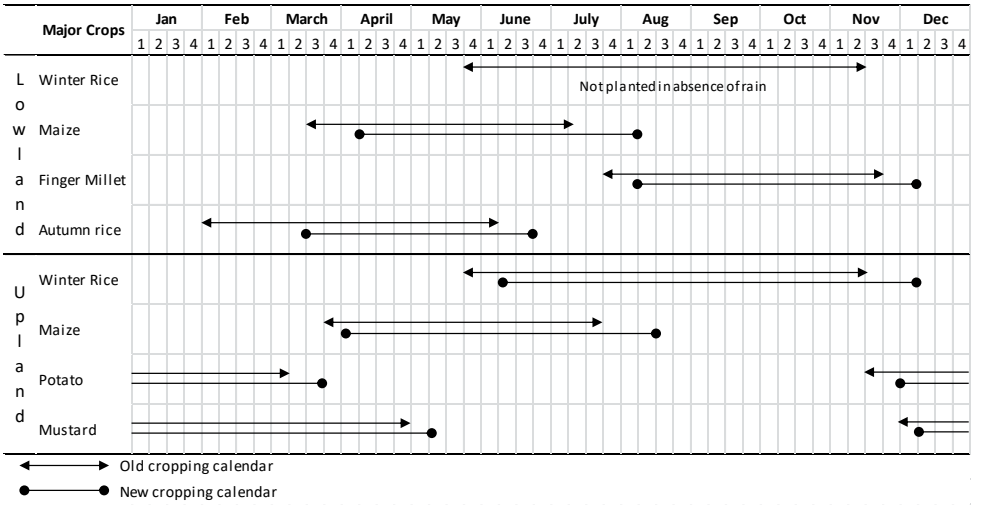

Figure 3**.** Old and new cropping calendar in the study area

Most farmers in the targeted area reported to be using organic and chemical fertilizers in higher proportions than in earlier years to maintain soil fertility. The reason given for the increased application rate was the loss of soil fertility due to drier soil, higher rate of soil erosion and leaching of nutrients from increased temperature and rainfall. According to a farmer 15 years ago the crop yield was good and enough to feed the entire family and the application of fertilizers was less than it is now.

Farmers are mostly on their own while trying to adapt to climate change. Although collaborations with external agencies like local NGOs and international development organizations as well as government agencies are present, the scale of the problem

outweighs the scale of the interventions. According to Gentle and Maraseni (2012), the poor in the country are not adapting to but just coping with climate change, with increasing debts pushing the most vulnerable communities towards a vicious cycle of poverty with additional vulnerabilities and risk.

CONCLUSION

The trend analysis of climate data suggests significant changes in several indicators of temperature and precipitation. Local farmers'perception of changes in the climate strongly matches with the climatic data obtained from DHM. Farmers reported negative impacts of the changing climate on crop productivity, which has made them to adapt different cultivation practices and change their traditional cropping pattern. Use of chemical fertilizers and pesticides has also increased the outbreak of insects, pests and diseases. Although some measures like use of high yielding seed varieties, changes in cropping pattern and cropping calendar, increased use of fertilizers and pesticides is being practiced, it has done little to increase productivity in the area with chronic food deficiency. Migration, off farm employment and putting up land as collateral is prevalent in the area as measures of adapting to economic hardships. Most of the vegetable cultivating farmers are mildly or moderately food insecure, while majority of the cereal cultivating farmers is severely food insecure.

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Nepalese Journal of Agricultural Sciences
1 Sept. 2014, volume 12, ISSN 2091-042X

Effect of non-genetic factors on productive performance of hill goat in Nawalparasi, Nepal

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ABSTRACT

A study was conducted to analyze the effect of non-genetic traits- such as location, season of conception, kidding, sex, birth type, and parity on productive performance of hill goats comparing lower and higher altitude in Nawalparasi district during January, 2011 to May, 2012. The data were collected from field record of 100 households (n=895). Least square procedure -Harvey (1990) was used for data analysis. The average birth weight of upper altitude born kids was 2.83 kg which was 8% heavier than lower altitude born kids (2.62 kg) where as the kids born during summer season were comparatively heavier than winter seasons. Likewise, birth weight of second and third parity were relatively higher than first, fourth and fifth parity. It was thus revealed that the more important non genetic traits such as sex, birth type, and location had significantly affected to the weight and reproductive traits of hill goats. Moreover, location had significant ($p<0.001$) effects on post weaning weight of six (13.5 kg) and nine (14.6 kg.) months for lower and upper altitude with its similar reflection for 9 months. Location had also significant ($p<0.01$) effect to the pre weaning weight. Similarly, sex and birth type also had significant ($p<0.001$) effect on birth weight to post weaning weight. Accordingly, the mean weight was higher for male and lower for female. Similarly, the mean weight was higher for single and lower for multiple birth type kids. The mean weight on birth, pre weaning, weaning and post weaning of six and nine months weight were 2.81 kg, 6.84 kg, 9.71 kg, 13.92 kg and 20.38 kg, respectively. It is thus concluded that the selection of superior genetic flock of goat would be effective, if they were based on post weaning age by considering genetic as sire effect, and non genetic parameters such as location, season, sex, birth type and parity of dam- for selection.

Key words: Non-genetic, Harvey, productive traits, weaning

INTRODUCTION

Goat contributes 20.05% to the total meat production of the nation and ranks in second position followed by buffalo (64.80%) (MoAC, 2008/09). MoAC (2009/10) revealed that the population of goat in Nepal increased with an average annual growth rate of 3.22 from 1996 (5.92 million) to 2010 (8.84 million). Nepal consists of four indigenous breeds of goat- Chyangra, Sinhal, Khari and Terai that inhabit in mountain, high hills, mid hills and terai region of the country, respectively. Nepalese hill goat (*Khari*) is a well

recognized goat breed across the mid hill region of Nepal from east to west. Goat farming fits for landless, marginal and small farmers because it provides continuous income and employment to the rural farming families. Governmental and Non-governmental organizations are focusing on small animal promotion program especially in goat production. It shows that the goat keeping program is the milestone for poverty reduction even for landless. Although goat has greater source for generating additional household income among resource poor, it has been kept on a non-commercial basis, or only in subsistence level (Kolachhapati, 2006). Inbreeding depression and negative selection practices are the factors affecting to the productive and reproductive performance of goat (Kolachhapati, 2006; Neopane, 2003).

The genetic characteristics influence by non genetic factors affect the productivity (Neopane, 2003). Therefore, a study was done to assess productivity of Khari goat and it crosses (Khari x Jamunapari) focusing with non-genetic parameters and also to estimate genetic characteristics, so that a broader guidelines to help farmers to develop community based elite nucleus goat flock would be possible to maintain.

MATERIALS AND METHODS

The study was done during January, 2011 to May, 2012 in Deaurali VDC (ward number6 and 7) of Nawalparasi district. A total of 100 households consisting of more than 895 goats were selected. Different productive traits- such as birth weight, pre weaning weight, weaning weight and post weaning weight were recorded. Data collected during the CLDP project period of DLS were used to study the effect of non-genetic factors on productive performance of hill goat in the study site. Collected data were coded and entered into MS-EXCEL & converted into text documents (Text MS-DOS). The data were analyzed using least square procedure developed by Harvey (1990) and Mean comparison was done by using DMRT. The following fixed effect model was used to estimate the effect of non genetic factors on productive performance of hill goat.

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

Where, μ = Overall mean
$Y_{ijklmno}$ = Total effect on growth performance
a_i = effect of i^{th} location
b_j= effect of j^{th} season of conception
c_k = effect of k^{th} season of birth
d_l= effect of l^{th} sex of kids
f_m= effect of m^{th} birth type
g_n= effect of n^{th} parity of dam
$e_{ijklmno}$= effect of random (residual) element assumed to be normally & independently distributed.

RESULTS AND DISCUSSION

Effect of non genetic factors on growth performance of kids

Effect of Location

Location had non- significant effect on birth and weaning weight, but significant ($p<0.001$) effect on post weaning and pre weaning weight in two months- six and nine months weights (Table 1). Bhattarai (2007) and Pandey (2007) also reported the similar non significant effect on weaning weight of kids. However, Kolachhapati (2006) and Sapkota (2007) reported that the goat kids born in different locations were significantly different ($p<0.001$) on birth weight and weaning weight. It was also found that the upper location born kids, the pre weaning kids, were 8 percent and 22 percent heavier, respectively, compared to those kids born in lower location.

Effect of season of conception

Season of conception had non- significant effect on birth weight, but significantly ($p<0.01$) effected on pre and post weaning weight and weaning weight ($p<0.05$) of hill goat kids (Table 1). The kids born from the dams conceived during summer season were heavier compared to those kids born from dams conceived during winter season. Such positive seasonal effect on weight- of summer season conceived born kids, might be due to more availability of better nutrition to the doe during summer season which could have contributed to the proper fetus growth and development in prenatal stage, which may lead to attain higher weight from birth up to post weaning age (Das et al., 1989).

Effect of season of kidding

In this study, season of kidding was not important source of variation with respect to birth weight, weaning, and post weaning weight of khari goat kids, but had significant effect ($p<0.05$) on pre weaning weight (Table 1). This finding was in line with the findings of Neopane (1997); Shrestha (2002); Kolachhapati (2006); Bhattarai (2007), Pandey (2007) and Sapkota (2007). Higher body weight of kids born in summer season varied from 2 to 11.5 percent compared to those kids born in winter season. Higher weight of summer season born kids might be due to the more availability of green fodder and pasture during early summer season for dam thus the dam could have sufficiently provided better nutritious milk to the kids, which could have ultimately resulted heavier growth in summer season born kids compared to winter season born kids.

Effect of sex

Sex had significant ($p<0.001$) effect on birth, pre weaning, weaning and post weaning weight of hill goat kids (Table 1). Neopane (1997); Kolachhapati (2006); Sapkota (2007) and Pandey (2007) had also reported the significant effect of sex on weight traits. However, Bhattarai (2007) reported the non significant effect on birth, pre weaning and weaning. In this study the body weight of male kids varied 9.6 to 32 percent heavier

compared to female. Findings also showed that males were heavier in most of the cases than females. Male kids weighed heavier confirming that the male fetus grows faster during prenatal development (Soundararajan and Shivakumar, 2011). It could also be due to the male sex hormone secreted from gonads which could have some anabolic effect and the aggressive and dominance nature of male during Suckling and feeding (Hafez, 1989).

Table 1. Least square means and standard errors of the important weight traits (kg)

Factors	No. of observations	LS Mean±SE of Birth weight	LS Mean±SE of Pre weaning weight	LS Mean±SE of Weaning weight	LS Mean±SE of Six months weight	LS Mean±SE of Nine months weight
Overall mean	895	2.81±0.17	6.84±0.46	9.71±0.53	13.92±0.64	20.38±0.68
Location		NS	** (0.01)	NS	*** (0.001)	*** (0.001)
Lower altitude	280	2.62±0.16	5.70±0.47^{b}	9.59±0.53	13.57±0.64^{b}	19.75±0.68^{b}
Upper altitude	615	2.83±0.16	6.97±0.46^{a}	9.83±0.54	14.66±0.65^{a}	21.01±0.69^{a}
Season of concept.		NS	** (0.01)	* (0.05)	** (0.01)	** (0.01)
Summer	552	2.85±0.32	6.55±0.14^{a}	10.87±0.17^{a}	14.84±0.20^{a}	19.62±0.21^{a}
Winter	343	2.68±0.48	5.12±0.15^{b}	9.46±0.17^{b}	13.20±0.21^{b}	18.09±0.22^{b}
Season of kidding		NS	* (0.05)	NS	NS	NS
Winter	310	2.57±0.18	5.99±0.46^{b}	9.08±0.54	13.09±0.65	20.23±0.69
Summer	585	2.84±0.21	6.68±0.47^{a}	9.54±0.54	13.72±0.65	20.78±0.69
Sex		*** (0.001)	*** (0.001)	*** (0.001)	*** (0.001)	*** (0.001)
Male	450	3.30±0.12^{a}	6.53±0.46^{a}	10.42±0.53^{a}	14.48±0.64^{a}	21.32±0.68^{a}
Female	445	2.50±0.17^{b}	5.64±0.46^{b}	9.17±0.54^{b}	13.34±0.65^{b}	19.44±0.69^{b}
Birth type		*** (0.001)	*** (0.001)	** (0.01)	*** (0.001)	*** (0.001)
Single	450	3.78±0.16^{a}	6.36±0.44^{a}	10.91±0.51^{a}	15.78±0.62^{a}	21.45±0.66^{a}
Twin	365	2.77±0.45^{ab}	5.51±0.45^{ab}	9.48±0.51^{ab}	14.09±0.63^{ab}	20.54±0.66^{ab}
More than twin	80	2.45±0.15^{b}	5.17±0.47^{b}	8.49±0.54^{b}	12.78±0.66^{b}	19.98±0.69^{b}
Parity		NS	NS	NS	NS	NS
First	130	2.75±0.12	5.49±0.46	9.38±0.55	13.08±0.67	20.23±0.71
Second	201	2.80±0.15	5.81±0.47	9.73±0.54	13.84±0.65	20.55±0.69
Third	199	2.89±0.17	5.86±0.47	9.80±0.54	14.08±0.65	21.09±0.69
Fourth	190	2.83±0.15	5.78±0.47	9.72±0.54	13.94±0.65	20.83±0.69
Fifth-Sixth	114	2.74±0.16	5.79±0.47	9.60±0.55	13.47±0.66	20.26±0.70
Above Seven	61	2.80±0.16	5.35±0.46	9.41±0.57	13.11±0.69	20.14±0.73
CV		12.14	20.22	17.81	15.53	12.06

*Note: LS= Least Square; SE= Standard error of the mean; *** = Significant at 0.1% (P<0.001) level; ** = Significant at 1% (P<0.01) level; *= Significant at 5% (P<0.05) level; NS= Non Significant; CV= Coefficient of Variation.*

Effect of birth type

Birth type had significant ($p<0.001$) effect on the birth, pre weaning, weaning and post weaning weight of hill goat (Table 1). Findings of this study revealed that the weight of single born kids were about 4.6 to 36 percent heavier compared to those kids born as multiple birth. This finding also matched well with the findings of Neopane (1997), Shrestha (2002), Kolachhapati (2006), Bhattarai (2007), Pandey (2007) and Sapkota (2007)- with the goats of Eastern, Mid-western, Central and Eastern Terai, and hill regions of Nepal. However, Pandey (2007); Sapkota (2007) reported the non-significant effect of birth type on six months weight of goat and Kolachhapati (2006) and Bhattarai (2007) reported non-significant effect of birth type- on weight at 9 months age of hill goat, and 8 months age of Terai goat, respectively. Soundararajan and Shivakumar, (2011) reported that the higher birth weight of single birth than those of multiple births could probably due to the sharing of uterine space and uterine nutrient by the fetus of multiple births leading to lowered birth weight as compared with single birth. Similarly, Neopane (1997) reported that the heavier body weight of single born kids up to weaning age might be due to the mothering ability of dams to their kids, as dams with single kid can more efficiently care her progeny compared to the dams with multiple kids.

Effect of parity of dam

The birth, and pre and post weaning weight of kids in this study did not differ with respect to the parity of dams (Table 1). However, kids born from the dams of third and fourth parity had higher birth weight compared to those born from first and later parity. (Table1). Husain et al (1996), Neopane (1997), Sapkota (2007) and Pandey (2007) also reported the parity of dams as an important source of variation for birth weight of Black Bengal goat and Nepalese hill-goats. However, Abdelsalam and Abdelaziz (1994), Kolachhapati (2006) and Bhattarai (2007) reported the non-significant effect of dams' parity on birth weight, but significance difference on post weaning age at 8 and 9 months age of goats. Similarly, Neupane (1997) reported the significant difference on pre weaning and six months age, and Pandey (2007) reported the significant difference on six months age of goat.

CONCLUSION

Based on the results of this study, it can be concluded that location, sex, birth type, parity, season of conception and season of kidding are the important non-genetic factors that are worthy to consider while improving the productivity of goat flock. Goat of upper altitude was superior with relation to productive and reproductive performance that provided the scope of developing indigenous breed nucleus flock suitable to the mid hills region of Nepal.

ACKNOWLEDGEMENTS

Farmers at the study sites including Rumsi, Ramkot and and Jhyalbas of Deurali VDC, Nawalparasi, and District Livestock Service Office (DLSO), Nawalparasi are

acknowledged for their incredible support and constant encouragement in record keeping, data management, arrangement during entire my research study period are highly acknowledge for their full support..

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