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Contents

CLIMATE SMART FEEDING PACKAGE TO IMPROVE ON MILK PRODUCTION WITH LOWERING METHANE PRODUCTION THROUGH UREA MOLASSES MINERAL BLOCK UMMB SUPPLEMENTATION TO DAIRY DIETS

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ABSTRACT

A study was carried out with the objectives to find out on the effect of UMMB to lower the methane level in the rumen, and effect on milk production of lactating cattle in stall-fed management system. The study was conducted during winter from February to April, 2011.for 90 days. Twelve lactating dairy cows of similar age and lactation stage were divided into two groups, each containing 6 lactating crossbred Jersey and Holstein Friesian cows. The animal were fed with green grass, rice straw, and compounded concentrate feed to fulfill the nutrient requirement as recommended by NRC 2001. The ration included UMMB as supplementary feeding at the rate of 450 gram per day per animal. Daily feed intake and milk yield were recorded. Milk sample was analyzed to determine the milk constituents, such as fat, SNF, protein at 15 days interval. Ruminal gas was collected from the experimental animal and was analyzed to detect the level of methane by using Gas Chromatography. UMMB supplemented group of cows recorded higher level of milk production of 5.11 ± 0.63 (Range 4.10-7.2) vs 6.29 ± 0.63 litters per day. Average total daily milk production per animal of treated group was 1.18 litters (43.30 %) per day. A higher level of milk production at treated groups, although the production level was not significantly higher could be due to the effect of UMMB supplementation in the diet with higher digestibility. Average total daily milk production per animal of treated group was 1.18 litters (43.30 %) per day. Average fat % was increased by 0.43 percent (4.69±0.25 vs 5.12± 0.15), Solid Not Fat was almost similar in the both groups of animal (8.66 and 8.41 % control vs treatment group). Animal's udderwas healthy in terms of mastitis infection as the average conductivity was recorded of 3.5 indicating to help to maintain the milk production and milk letdown. The UMMB supplementation was able to reduce methane level by more than threefold (6.097 vs 18.121%) in the rumen of dairy animal. The use of UMMB is environmentally friendly as the energy, protein and mineral supplementation was able to reduce methane level in the rumen. It has been concluded that the energy, protein and mineral supplementation increase on the digestibility of feedstuff and hence helps to increase milk production, milk composition and to mitigate the methane production in dairy cattle under the stall feeding management system.

Keywords: Gas chromatography, green house gas, methane mitigation, milk production and composition UMMB

INTRODUCTION

Cattle and buffalo farming is one of the important occupations of the farmers in Nepal. The cost of milk production is high due to the higher level of concentrate feeding. Winter is feed deficient in the country where crop residue, mainly the rice straw, is the main feedstuff. But the rice straw is low in nutrient content with higher level of lignin. This type of feed stuff can be improved with mineral supplement that helps to improved in feed digestibility and reduce the cost of milk production. But the use of crop residues is responsible to increase methane level in the rumen which has the Green House Gas (GHG) effect to the environment. Therefore, it has become necessary to develop a low cost feeding package which produces lower level of methane to protect the environment.

Green House Gases are gaseous compounds of the atmosphere that absorbs solar energy reflected from the earth's surface as infrared radiation. This energy is transferred to the major non-GHGs (nitrogen and oxygen) resulting in an overall temperature increase in the lower atmosphere. The main anthropogenic or human-induced GHGs are (a) Carbon dioxide (CO_2), (b) Methane (CH_4), and Nitrous Oxide ((N_2O). These GHGs each have a different "Global Warming Potentials (GWP) based on the gases' ability to absorb solar energy and on their atmospheric lifetime. The GWP for CO_2, CH_4, and N_2O is calculated to be 1, 25, and 298 respectively (Solomon *et al.,* 2007) indicating that 1 kg of CH_4 is 25 times and 1 kg of N_2O be 298 times as potent as 1 kg of CO_2. Weighted by their GWP, CO_2, CH_4, and N_2O currently contribute 75%, 15%, and 10% of the global GHG emission (IPCC, 2001). The main source of CO_2 emission is fossil fuel use, while agricultural practices contribute 40% and 90% of the global CH_4 and N_2O emission respectively. Methane (CH_4) and NO_2 are the two main GHGs from agriculture, contributing over 90% of the emission. Of the total agricultural emission, pastoral grazing systems have been estimated to contribute 20% of the CH_4 emission and between 16% to 33% of the N_2O emissions (Clark *et al*., 2005). Among the source, ruminal digestion is one of the main sources of the methane. Methane (CH_4) is produced by the decomposition of organic matter in the absence of oxygen and is a very potent green house gas which is 21 times more effective to trap the heat in the atmosphere than carbon dioxide on a per kilogram basis. It also produces green house effects by radioactive forcing. Thus continuous release of methane from the animal is a matter of great concern as it is a major contributor to the changes in climate and consequently on desertification, and rising sea levels. Ruminant animal generates green house gas (GHGs) by methanogenic bacteria and fungi that utilize carbon and hydrogen substrate. The methane is eructed from the rumen through mouth (85 percent of total methane production) and remaining from the anus.

Methane is produced in the rumen, strictly under anaerobic conditions, by methanogenic bacteria and fungi that utilize carbon and hydrogen substrate (Chaturvedi *et al.,* 2006). The improved feeding can lower these types of bacteria in the rumen that helps to reduce the methane level. Natural sources make up about 30% and anthropogenic sources account for about 70% of the total global methane emission. Reducing methane emission from anthropogenic source can therefore be a very effective means of lowering the methane concentration in the atmosphere (Moss *et al.,* 2000). About 18 to 22 % of anthropogenic methane is emitted from domesticated livestock systems globally (Chaturbedi *et al.,* 2006). About 75% of the total GHGs from animal agriculture are expelled directly from digestive tract of the animal with the reminder is produced through stored manures (IPCC, 2001; Moss *et al.,* 2000).

The above facts suggest the need to develop the palatable and detestable feed to the ruminant to reduce the methane production. Study done by ICAR India has indicated the beneficial effect of UMMB to reduce the methane level in the rumen of buffalo. Therefore this study was conducted at Bovine Research Programme (BRP) Khumaltar with the aim to find out the effect of UMMB in dairy diet to increase milk production during the winter, and to reduce the methane production level in the rumen of dairy cattle.

MATERIALS AND METHODS

2.1 Housing of experiment animal

Experiment was conducted at Bovine Research Programme, Khumaltar during winter months (Jan to April 2011). Animals were stall fed and camped inside the shed during night. Feeding system was cut and carries to fulfill the nutrient requirements of the lactating animal.

2.2 UMMB preparation and block composition

2.2.1 UMMB Preparation: The preparation of block was done during November 2011 as suggested by Aarts *et al.*, 1990. The manufacturing was divided in to four stages: (1) **Preparation of feed ingredients:** as per the formula (2) **Mixing the feed ingredients:** steps followed as suggested (3) **Molding:** steps followed as per suggested (4) **Drying:** blocks were dried under shed.

2.2.2 Block composition: Ingredients (in %) used to prepare the UMMB were (1) Urea = 10 (2) Molasses = 32 (3) Rice bran = 36 (4) Mineral = 6 (5) Salt = 5 (6)Cement = 6 (7) Dicalcium phosphate = 5 percent. The molasses was of good quality of (1) **Brix:** more than 80^0 (2) **Water:** cement ratio of 2:5 as recommended by Beeches (2010).

2.3 Animal and experimental design

Twelve lactating crossbred dairy cattle (Jersey and Holstein Friesian) were selected for experiment. Feeding was done 3 times per day in 24 hours. Six lactating dairy cattle were supplemented with UMMB and remaining six were without UMMB feeding. The experiment was conducted for 120 days. Two kg UMMB were fed in UMMB feeder (wooden box) to control the intake. During milking, blocks were offered to lick two times a day i.e. in the morning and evening. Fresh drinking water was made available to the experimental animal thought out the experimental period.

2.4 Dietary treatments

Experimental animals were fed with rice straw, green grass, compounded feed to meet the requirement as recommended by NRC 1999.

Animal were fed with rice straw and green grass to fulfill the dietary requirement of the dairy cattle. All experimental animals received the same level of nutrient, and only the UMMB feeding level was different to the animal as shown in Table 2.

Table 2: Dietary treatments to the experimental animal

Groups of dairy cattle	Treatments
Group A	Without UMMB in 6 animal for 120 days
Group B	With UMMB in 6 animals for 120 day

2.5. Analytical Procedure

2.5.1 Feedstuff

Sample of feed, forage and UMMB were oven dried at 65^0C for 48 hours. Samples were ground to pass through 1mm sieve. Dry matter (DM) was determined by drying samples at 100^0C for 2 hour, ash by heating at 600^0C for 2 hours, protein by the micro kjeldal procedure (N×6.25) following the procedure of AOAC, 1999. Proximate analysis of feed ingredients and fecal samples were done in Animal Nutrition Division.

2.6.2 Analysis for methane determination

2.6.2.1 Rumen sample collection

Gas was collected from rumen (upper part of the rumen) of experimental dairy cattle with the help of special syringe. Ten ml gas was collected from each animal and transferred to the

air tight container with capped stopper. Sample was stored at 4 degree centigrade at freeze before the analysis. Samples were analyzed within 24 hours of collection to determine the methane.

2.6.2.2 Methane Gas Analysis

Gas chromatography (GC) fitted with Microcomputer and Software Packages available at Entomology Division of NARC was used to estimate the methane level of the ruminal gas of dairy cattle. Gas chromatography technique was used to separate the gases mixture by which thermally stable compounds is separated into its constituents by a mobile gas phase passing over a stationary phase. The gas sample mixture was introduced quickly into the moving carrier (such as CH_4). Chromotograms (series of peaks obtain related to gases) were recorded and processed by the attached computers.

2.7 Milk yield

Milk yield was recorded daily in morning and evening for 120 days of experimental period. There was seven days pre-adjustment period in the experiment

2.8 Milk Composition

Milk samples were analyzed using lacto scanner at 15 days interval to find out the effect on milk composition of UMMB supplementation.

2.9 Data analysis

The data were subjected to summarize using Statistix and Excel software. ANOVA was used to see the difference in production.

RESULT AND DISCUSSION

3.1 Feeding management of experimental animal

The nutrient was adequately provided to the animal from the feed (Table 3). The nutrient requirement such as (a) Dry matter requirement of average 7.7 kg, (b) energy requirement of 12.21 Mcal, (c) protein requirement of 515 gram, (d) calcium requirement of 12 gram, and 12 gram phosphorus was fulfilled. Experimental diet was formulated considering the nutrient content available in feeds ingredients (Table3).

Table 3: Chemical composition of feed ingredients fed to the experimental animal

Feed ingredients	DM (%)	Chemical composition (%)					Minerals (%)	
		Protein	Crude Fiber	Ether extract	NDF	ADF	Calcium	Phosphorus
1.Rice straw	86.64	4.17	-	-	69.05	49.06		
2.Rice bran	87.83	12.52	9.90	8.33		0.71		
3.Green oats								
4.Concentrate	90.9	18.0	9.0	3.1	-	-	0.48	0.82
5.UMMB	85.63	32.38	-	5.42	-	2.0		

3.2 UMMB Intake

Use of UMMB feeder improved on the UMMB intake by improving on the licking vs biting. Without feeder, cattle consumed all block within half an hour. Therefore, use of feeder is important to control the daily uniform intake of the UMMB by the animal. The intake was 450 g/day with the control of feeding by using wooden feeder. If open feeding, the intake would have even all block (2 kg (Upreti et al , 2010; Upreti, 2011).

3.3 Digestibility

The feeds used in this experiment recorded better digestibility (Table 4). The digestibility of the diet was significantly improved ($P< 0.01$) with the UMMB supplementation. The digestibility of feedstuff was 61.26% and 73.74% for control and UMMB supplemented groups respectively. This has indicated that the use of UMMB could able to increase on the feed digestibility. This result has been supported by the work of Upreti *et al.*, 2010.

Table 4: Digestibility of the feeds in the experiment

Treatments	Digestibility (%)
1. Without UMMB (Control group)	61.3 ± 3.35
2. With UMMB (Treatment Group)	73.7 ± 1.35

3.4 Milk production

UMMB supplemented group of cows recorded higher level of milk production of 5.11 ± 0.63 (Range 4.10-7.2) vs 6.29 ± 0.63 (Range 4.06-7.78) litters per day (Table 5). Average total daily milk production per animal of treated group was 1.18 litters (43.30 %) per day. A higher level of milk production at treated groups,

although the production level was not significantly higher, could be due to the effect of UMMB supplementation in the diet with higher digestibility. Average total daily milk production per animal of treated group was 1.18 litters (43.30 %) per day (Table 5, Figure 2). Khan and Chaudhari, 2000 ; Avilla, 2006 reported increased milk production due to the effect of UMMB feeding in dairy cattle during the winter month. Study at Animal Nutrition Division reported increased milk production with UMMB supplementation (Anonymous, 2010; Upreti *et al.,* 2010).

3.5 Milk composition

None of the milk constituents (fat, SNF and protein) were significantly improved by supplementation of UMMB (Table 5, Figure 2)) in this study. Neither, conductivity of milk reduced significantly. Makkar (2001) reported that SNF increment was by 3 % and fat % increased by 11% when UMMB was supplemented to lactating animals. The milk yield and the fat content was higher in the treated group. Study at Animal Nutrition Division reported increased milk production with UMMB supplementation (Anonymous, 2010; Upreti *et al.,* 2010; Makkar, 2001). These results indicated that the use of UMMB has positive impact on the milk production and on the milk composition.

Table 5: Milk production and composition

Treatment	Milk yield (Av. lit/d)	Milk composition			
		Fat %	SNF %	Protein%	Conductivity %
1. Control (A)	5.11 ± 0.63	4.69± 0.25	8.66± 0.16	3.23± 0.06	5.76± 0.167
2.Treated (B)	6.29 ± 0.63	5.12± 0.15	8.41± 0.12	3.05±0.048	5.41± 0.148
Significance	NS	NS	NS	NS	NS

3.6 Effect of UMMB supplementation on methane mitigation

The potential effect on the methane mitigation was recorded in experiment. The ability of UMMB supplementation was 3 times higher than control group (Table 6, Figure 2) which is higher than as reported by Singh 1997 where in his study 11% methane was reduced with the Molasses Urea Block (MUB). The lower methane level (i.e. 11%) reported by Singh 1997 might be due to the only use of MUB i.e. without minerals. This has indicated the use of mineral is beneficial in lowering the methane level in the rumen. The positive effect of UMMB on methane mitigation has been reported by Upreti, 2011) The lowering on the methane production is due to the improvement in digestibility of feed in the rumen.

Table 6: Methane mitigation by UMMB supplementation

Treatments	Proportion of CH_4 in the rumen (%)
1. Control group (A)	18.1 ± 1.32
2. Treated group (B)	6.1 ± 1.14
Significance	P<0.001

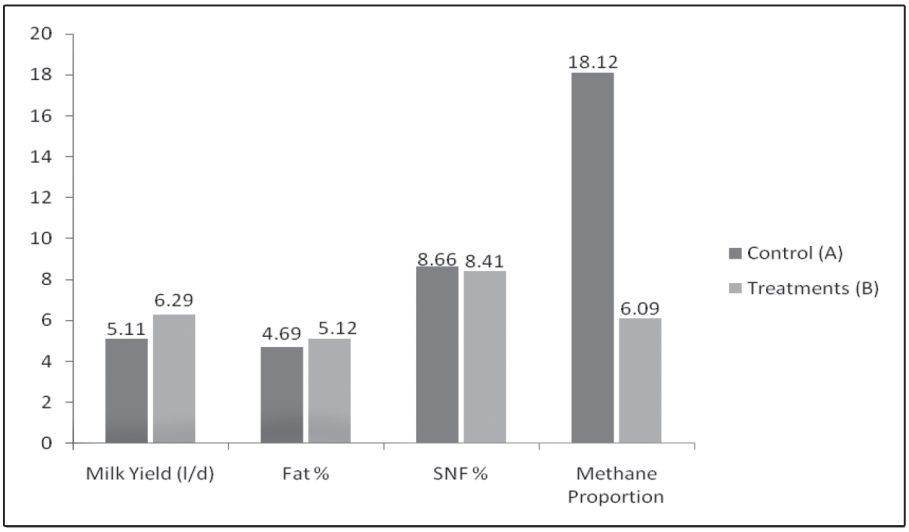

Figure 2. Effect of UMMB on milk yield, composition and methae production

Ruminants produce about 20 gram of methane for each of dry matter intake. Methane production in cattle is affected by variety of nutritional factors including level of intake, type of carbohydrate, forage processing, and changes in the rumen micro-flora. Diet favoring propionate production in rumen causes decrease in methane. Diet like roughages favors acetate production which increases methane production. Therefore, narrowing of the acetate: propionate ratio would increase performance in ruminants by reducing methane production (Chaturvedi *et al*., 2006). The use of minerals as UMMB can help in narrowing the ratio of these two compounds also help to improve the digestibility of fodder, and hence helps to reduce on the methane production in the rumen. As per the principal of methane production, as discussed earlier, the reduced level of methane in this experiment could be due to the use of UMMB in the dairy diets. Improvement on digestibility percent in UMMB fed group (73.745 ± 1.35 vs 61.26 ± 3.35) due to the effect of UMMB (Table 4) could be the main cause to reduce methane production in this experiment. In the experimental shed, the smell of methane was low as experienced by the cow boy.

CONCLUSION

In conclusion the use of UMMB is beneficial in dairy cattle feeding as it helps to improve in feed digestibility, improved on milk production and milk composition, and reduce the level of methane production in the rumen.

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EVALUATION OF GROWTH PERFORMANCE OF LOCAL POULTRY "SAKINI" RAISED UNDER INTENSIVE MANAGEMENT SYSTEM

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ABSTRACT

Sakini chicken represents the common local poultry of Nepal. It is much diversified and heterogeneous population which remains largely unknown and under-studied in spite of high economic value that is seemed to represent mainly in rural areas. Present study was carried out on farm at NARC, Khumaltar for 16 weeks with three lines of Sakini found in three districts, namely Rautahat, Kabhre and Rasuwa, representing three different ecological regions namely lowland, mid hills and high hills respectively of Nepal and envisaged the objectives of conservation, valorization and development of the rustic and well-adapted genetic substrate. In this present study, growth parameters were measured. Result showed that average body weight was observed as 171gm at week 4, 517 gm at week 8 (BW8), 834 gm at week 12 (BW12), 896 gm at week 15 (BW15), and 941 gm at week 16 (BW16). Males showed significantly higher performance ($p<0.005$) in comparison to females in average body weight. Comparing the different lines of Sakini chicken, Rasuwa line revealed significantly better ($p<0.005$) performance than Rautahat and Kavre lines in average body weight. The results concluded that there was a great genetic variation in the growth performance among the different ecotype strains of Sakini chicken, which signifies high potentiality of genetic improvement of these chickens through selective breeding.

Keywords: indigenous chicken, Sakini, growth performance, selective breeding

INTRODUCTION

Sakini chickens of Nepal are distributed throughout the country and contribute almost 50% of the country's total poultry population. They have a wide range of adaptability from tropical to temperate region. They are dual purpose chicken mainly used for meat and eggs. Despite their low growth rates and egg production, these chickens are generally better in disease resistance and could maintain higher level of performance under scavenging conditions which is predominant in Nepalese farming system. They have been characterized at phenotypic level (Neupane and Gorkhali, 2008). They are found in different colors ranging from white to dark black, brown with mixed color as well. In some cases, tufts of feathers are found in the front portion of the neck. The plumage colour tends to vary according to climatic differences. In plains of Nepal, more gray, cream and brownish red coloured Sakini chickens are found, whereas brownish red and black are found in temperate region (Bhurtel, 1996), but overall brownish red is the most common. Majority of them have single comb with white ear lobe and yellow shank, but few of them have pea or rose comb with red or pink ear lobe. Sakini are full-feathered in all parts of the body from head to the hock (Bhurtel, 1996). The population of this breed is still normal and is not at risk from conservation point of view (Neupane and Gorkhali, 2008). Even though this local chicken has morphologic and genetic diversity, they are commonly known as Sakini. Neshida *et al.* (1988) studied the external characteristics of local chicken found in jungles of India and Nepal and reported that the local chicken in Nepal are closer to those found in South Asia. Knowledge of genetic parameters such as growth performance is essential for any genetic improvement program. In the present study, the performance on growth, therefore, was compared in Sakini chickens in different ecological region of the country.

METHODOLOGY

Experimental population and traits measured

Present study was conducted on farm at Nepal Agricultural Research Council (NARC), Khumaltar for 16 weeks from November, 17 2011 to March 31, 2012. The experimental population has been established from eggs collected from different VDCs of Rasuwa (150 eggs), Kavre (147 eggs) and Rauthat (157 eggs) districts (Table 1). These were reared as three lines of Sakini breed with respect to three locations namely Line1 from Rasuwa, Line2 from Kavre and Line3 from Rauthat districts.

While collecting eggs, it was considered that eggs were collected from true to type Sakini breed and were unrelated up to two generations. In order to include more diversity in each line, one to four eggs were selected randomly from each household and transported to Animal Breeding Division, NARC, Khumaltar for storage. Eggs were hatched at Suwal Hatchery, Bhaktapur. All day-old chicks were wing-tagged for individual identification. These birds were reared from day-old to 16 weeks of age and growth rate parameters such as average body weight in week interval to meet the objectives of the study were recorded. All experimental birds were subjected to the same managerial, hygienic and climatic conditions. They were vaccinated against important diseases namely New Castle Disease and Mareks Disease in Day 1, Gumboro at 1 week and Fowl pox at 10 weeks. Standard starter (20% CP and about 3000 kcal/kg) and grower diets (18% CP and about 2900 kcal/kg) were provided *ad libitum* and the birds had free access to water. They were reared together under deep litter system in an open house with natural lighting after 8 weeks of age. Live weight was measured from day one up to sixteen weeks of ages at weekly interval using electronic balance and records of different lines of Sakini chicken from different ecological regions.

Table 1. Locations for eggs collection for different lines of Sakini chicken

Location (Line)	Altitude	Number of eggs
Rasuwa (Line 1)	High hills	150
Kavre (Line 2)	Mid hills	147
Rauthat (Line 3)	Low lands	157

Statistical analyses

Data recorded were statistically analyzed by using Harvey Statistical Software (1990), Duncan multiple ranges and multiple F-tests.

RESULTS AND DISCUSSION

Body weight variation on the basis of ecological region

Average body weights of chickens under the experiment through different agro-ecological zone are presented in Table 2. Live weight and egg production ratio is highly heritable (Dana et al., 2011) which means this characteristic is transferred from generation to generation. Therefore, the body weight in week interval was considered in this

present study. On day-one, the average body weight of chicks of all lines showed similar weight with respect to different locations ($p<0.05$) (Table 1). Nepalese Sakini chicken showed similar day-one weight with local chicken of different countries. The day-one weight of Sakini chicken (31.0 g) is the same as reported by the Dandarawy chicken in Egypt (Abdellatif, 1989) and close to Aardennaise breed in Belgium (30g) (Moula *et al.*, 2009a). However, weight of day old chicks from Cameroun are reported to be lower ranging from 23 to 28g (Fotsa *et al.*, 2007) and chicken from Tunisia (37.84g) (Raach-moujahed *et al.,* 2011), Gouloise breed (33-39g) (N'dri, 2006) and Fayoumi and Sinai breeds (36g and 38g respectively) from Egypt (Saadey *et al.*, 2008) are heavier than Sakini chicken.

Table 2. Mean body weight of Sakini chickens by sex and for both sexes combined

Weeks	Both sex combined			Male (44)	Female (61)	SE	Mean values
	Line1 (40)	Line2 (26)	Line3 (39)				
BW0	31.49[a]	31.24[a]	30.41[a]	31.24[a]	30.86[a]	3.89	31.00
BW1	58.17[b]	47.27[a]	47.35[a]	52.47[a]	49.40[b]	9.62	51.20
BW4	136.26[b]	133.42[a]	168.10[a]	178.52[a]	157.69[b]	60.08	171.00
BW8	657.16[b]	439.39[a]	451.83[a]	573.74[a]	458.52[b]	171.85	517.65
BW9	750.18[b]	531.36[a]	532.48[a]	676.45[a]	532.87[b]	198.55	603.51
BW10	839.48[b]	653.66[a]	634.28[a]	803.26[a]	615.02[b]	224.53	702.02
BW11	891.86[b]	731.14[a]	735.92[a]	895.12[a]	677.48[b]	254.80	776.52
BW12	924.37[a]	827.42[a]	804.77[a]	987.65[a]	716.72[b]	272.17	834.00
BW13	993.90[b]	875.08[a]	864.29[a]	1047.60[a]	774.58[b]	273.49	894.24
BW14	1002.25[b]	874.85[a]	821.47[a]	1036.10[a]	762.95[b]	331.85	881.45
BW15	1023.86[b]	889.37[a]	836.64[a]	1067.98[a]	765.26[b]	361.12	896.51
BW16	1046.214[b]	950.11[a]	898.09[a]	1122.70[a]	806.90[b]	358.60	941.84

a,b: Values with different letters in the same line are statistically different at $p<0.05$. SE: Standard Error of the Mean. Number in the paranthesis are the number of birds.

Significant differences in average body weights of Sakini chicken were observed as the age advanced. However, there was no significant

difference in body weight between Line 2 and Line 3 while there was significant difference of these two lines with Line 1.

Since different lines belong to different altitude level of the central development region of the country, it would be worthwhile to compare the result with past studies that were undertaken in the same range. The average body weight of Line3 (451.83g) which represent lowland of the country showed higher at 8 weeks in comparison to on farm records reported in Morang and Sarlahi districts which was around 370.1g (Sah *et al.,* 2000) but on farm record (865.0g) showed higher value than on station record (821.47g) at 14 weeks of age. Similarly body weight of Line 2 which represents mid hills showed higher in 8th week (439.39g) in comparison with the survey report undertaken in Lalitpur district (400g) (Bhurtel, 1996; Annual report, ABD, 1997; Bhurtel, 1998; Neupane, 2004; Neupane, 2006) and the average body weight at 8th week of age (500g) reported in backyard local chicken (Khanal, 2002).

Comparing the records of the studies undertaken in intensive system, the body weight of 1st week in the present result showed higher performance than reported (46.1g) by Sharma (2008) for local chicken whilst at the 16th weeks, present result (941.84g) was lower than the result reported (1248.0g) by Sharma (2008).

The weight at hatching day might have affected the 8th week weight, Sakini chicken body weight showed lower than that of Tunisian local chicken. Sakini chicken showed significantly lower body weight at the age of the 8th week in comparison with Tunisian local chicken (690.91g and 604.61g for male and female, respectively) (Raach-moujahed *et al.*, 2011).

In the present study, the performance of Sakini chicken was encouraging upto 11 weeks of age while after 12 weeks slight decline in body weight was observed which might be attributed to multiple disease infestation in all three lines. After 11 weeks, the genetic potential of Sakini poultry could not be expressed.

On the basis of sex

Body weight for Sakini poultry is presented in Table 2. On day-one, there was no significant difference in the body weight between male and female chicks. As the time advances, there was sex dimorphism in

all lines. For all ages, the live body weight were significantly ($p<0.05$) higher in males than females (Table 2).

For the age of 8th week, body weight for males and females were 573.74g and 458.52g, respectively. Present result was higher than the body weight (520.0g) in comparison to the earlier study undertaken in the similar environment (Sharma, 2008) and obviously much higher than the body weight under scavenging system which were 390.1g and 350.1g for males and females, respectively (Sah *et al.*, 2000) . For the body weight of 14th week present result for male group is higher (1036.1g) than that reported (900.1g) by Sah *et al.,* (2000) while the body weight of female is found to be lower than that reported (830.2g) by Sah *et al.,* (2000). In our observation, the females were more prone to diseases which might be the reason for lower weight in females at the age of 14 weeks.

The 16th week body weight of Sakini chicken was lower (1122.7g and 806.9g for males and females, respectively) than the result reported by Raach-moujahed *et al.*, (2011) for Tunisian local chicken (1419.30g and 1166.05g for males and females, respectively) and lower than other local breeds of Thailand (1280g, Jaturasitha *et al.*, 2008) and local Chinese breed Gushi (1419g duo *et al.*, (2009).

CONCLUSION

It is clearly noticeable that the body weight up to 11 weeks of age, considering both age and sex, the observed data are above the finding reported by earlier studies in Sakini chicken. This result indicated that the higher performance in Sakini chicken in the present study might be due to improvement in management, such as feeding and hygienic condition. The results also revealed that there was a great genetic variation in the growth performance among the different ecotype strains of Sakini, which signifies high potentiality of genetic improvement of these chickens through selective breeding. However, heritability of body weight and egg production is high, further work on egg production is recommended to compare the results in different world chicken with Nepalese Sakini chicken.

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SEASONAL VARIATION IN EGG PRODUCTION AND HATCHABILITY OF ARTIFICIALLY AND NATURALLY INSEMINATED HUBBARD BREEDER

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ABSTRACT

A scientific research has been conducted to evaluate the performance of broiler breeder birds with respect to different non genetic factors including seasonal variations at N. N. Hatchery Pvt. Ltd., Mangalpur-9, Sharanpur, Chitwan, Nepal in 2010-2011. The factors were season and type of insemination. The season included the summer and the winter that greatly differs with respect to temperature, rainfall and relative humidity. Types of insemination include the natural method with various combinations of sex ratios and artificial insemination with various frequency of semen insemination. Data recorded at the parent farm for the period of experiment during August 2010 and January 2011. The data were analyzed using the least square procedure given by Harvey (1990). Hen Day Production (HDP), Culled Eggs (CE), and Hatchable Eggs (HE) were significantly ($p<0.001$) affected by the season and type of insemination. Accordingly higher value of HDP was obtained during summer (75.37±0.39%) as compared to winter (66.29±0.39%). Similar type of effect was obtained with type of insemination as HDP was 72.21±0.39% in naturally inseminated birds found to be higher than artificially inseminated bird's 69.25±0.39%. Result of this study also revealed that total hatched (TH), Hatched of Fertile (HF) and Infertile Eggs (IF) were significantly ($p<0.001$) affected by the type of insemination and seasonal influence. However, the total culled chick (CC) was not significant to the type of insemination nor to the seasonal variation. The TH of the Hubbard Breeder was found to be higher during summer (72.58±0.12%) than that of winter (62.61±0.38%) and the TH was higher (73.22±0.11%) in artificially inseminated birds than that in the naturally inseminated birds (69.58±0.11%). Results of this study clearly indicates that it is feasible to apply artificial insemination when total fertility and hatchability considerably decreases in any Hubbard Broiler Parent Farm.

Keywords: non-genetic factors, hen day production, hatchability, sinsemination, Hubbard

INTRODUCTION

The agriculture sector is the main backbone of Nepalese economics, accounting for about 38.2 per cent of the gross domestic product (GDP) and providing employment opportunity to about 65.7 per cent of the economically active population in the country (MOAC 2010). The chicken population in Nepal has been increased from 18619636 in 1999/00 and 39530620 in 2010/11 (CBS, 2010/11). These data indicate the increasing trend of poultry production in Nepal. The annual growth rate during 1988-1998 was 4.2%, which were above all the livestock enterprises (FAO, 1999). Now poultry industry is self sufficient to replace import of feeds, chicks, eggs, and meat products and has great role in national income (Bhattarai, 2005). Total meat production in Nepal has also been increased from 189160 metric ton during 1999/00 to 277625 metric ton during 2010/11 out of that poultry alone contribution is 12659 metric ton (1999/00) and 36085 metric ton (2010/11) (CBS, 2010/11). This justifies the scope of poultry farming to increase the poultry meat in Nepal. The highest annual growth rate of poultry meat (5.2%) as compared to other meat during 1998/ 99 also indicates that poultry meat production is increasing every year over other meat (FAO, 1999) which is 118.34% during 2010/11 (Cbs 2010/11). Beyond the commercial farms, lots of parent farms have been growing rapidly in the country which produces large number of hatching eggs.

The data recorded by animal quarantine office, Tribhuvan international airport, Kathmandu (2011) show that there are 135 broiler hatcheries existing in the country with the total import of 647604, 816426 and 765700 broiler parent in the year 2066/67, 2067/68 and 2068/69, respectively. In the hen, artificial insemination may incur twice the labor cost than natural mating and 10-25 % more investment in cages, but the cost of chicks is reduced (- 10 %). Furthermore they are of better breeding value, more vigorous and heavier at hatching, and have a higher growth rate (Fuquay and Renden, 1980). The poultry industry is therefore becoming more and more interested in artificial insemination with the benefit of the number of cockerels can be reduced to 1-3 per 100 hens, instead of 8-12 with natural mating and the fertilizing rate of eggs can be improved. This study compared broiler breeders maintained in a deep litter using natural mating with their counterparts maintained for artificial insemination in two different seasons. Hence this study aims to evaluate the reproductive and hatching efficiencies of broiler breeder with different mating system in two seasons- summer and winter.

MATERIAL AND METHODS

The study was carried out in Mangalpur VDC of Chitwan district during 2010 and 2011. The experiment was conducted in two different seasons (summer and winter) with varying degree of temperature, rainfall and relative humidity. All together 25 Hubbard male and 250 Hubbard female of aged 20 week were selected, (based upon standard weight, Hubbard Manual farm, 1994). The whole experiment was divided as Trial 1 (for A.I.) and Trial 2 (for N.I.). Design was Completely Randomized Design (CRD) consisting 6 treatments (3 in each trial) with 3 replications. In Artificial Insemination, there were 3 treatments T1, T2, T3. Each treatment had 3 replications. Each treatment of artificial inseminated group were categorized on the basis of frequency of the insemination as T1 as AI in every four day, T2 as AI in every 7 days and T3 as AI in every 10 days. Each Treatment had 10 female birds and for the whole trial of AI 10 males were selected for the semen ejaculation. In the flock trial of Natural Insemination, there were 3 treatments T4, T5, T6. Each treatment had three replications. Each treatment of naturally inseminated group were categorized on the basis of sex ratio as T4 as Male: Female ratio 1:8, T5 as Male: Female ratio1:12, T6 as Male: Female ratio 1:15. Semen was collected from the male and inseminated to the female as the experimental design. Finally egg were collected, culled and sent to the hatchery for incubation. After 18^{th} day of incubation, the fertile egg were selected and transferred to the hatcher for hatching. At the end day 21 the Hatcher was opened. Chicks were ready to be taken off only when most of them are dry and fluffed up with a few (about 5%) still having some moisture on the backs of their necks.

The number of hatched chicks including the normal, weak, abnormal chicks, dead chicks after hatch, the un-hatched eggs and pips were counted separately according to the treatments were recorded. Calculations were made of fertility, hatchability, abnormal chicks and sellable chicks. Data collected in this study were entered, cleaned, and coded using MS-Excel and they are converted into Text MS-DOS. To study the effect of non-genetic factors on different egg production parameters, data were analyzed by Least Square procedure using Harvey (1990) statistical software package.

RESULTS AND DISCUSSION

Hen day production analysis

Result of this study revealed that total Hen Day Production (HDP)

of broiler breeder was 70.93±0.28% which was significantly affected ($p<0.001$) by the type of insemination. Accordingly HDP was higher in naturally inseminated birds (72.61±0.39%) than that in artificially inseminate one (69.25±0.39%). Koohpar et al (2010) also reported the significant effect of the type of insemination on HDP where HDP was lower in Artificially Inseminated birds (65±0.18) % than that in Natural Mating birds (67±0.57%) which was in line with the findings of this study. Since the artificial mating caused stress on the birds, the resultant effect was decrease in egg production, similar to the finding of Moudgal *et al.* (1991) who indicated that immobilization stress for 30 min. daily caused the apparent decline in egg production.

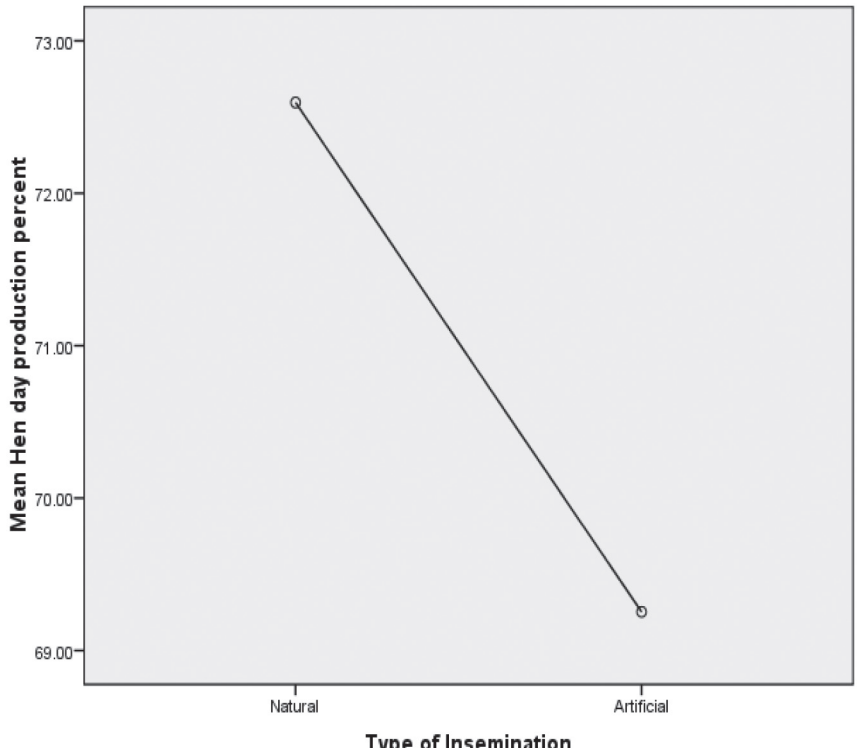

Figure 1. Effect of Insemination on HDP

This study revealed the total HDP highly significant ($p<0.001$) by the seasonal variation. This study showed higher HDP in the summer season (75.37±0.39%) than that in winter season (66.49±0.39%).

The total HDP was highly significant ($p<0.001$) by the sex ratio in which male: female 1:15 (75.50±0.43) followed by the ratio 1:12

(70.89±0.43) and ratio 1:8 (61.36±0.43). It was found that the HDP was highest in the group having AI in every 14 day (71.34±0.59) followed by the group using AI in every 7 day (70.81±0.63) and 3 day (61.36±0.79).

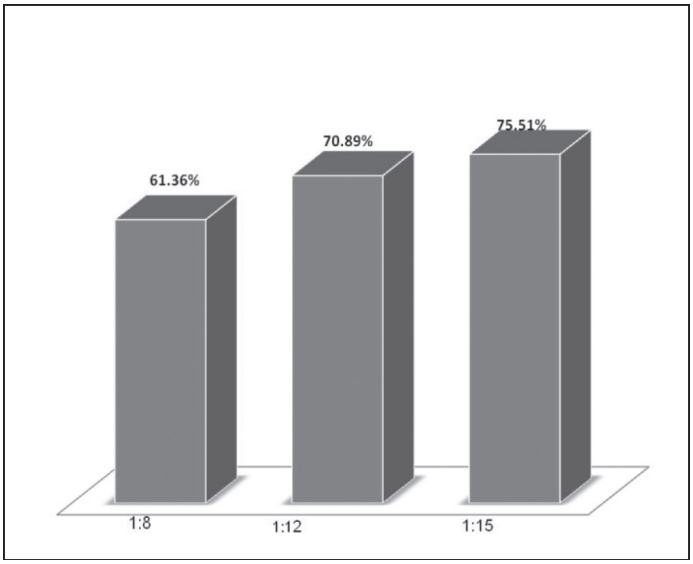

Figure 2. Effect of sex ratio on HDP

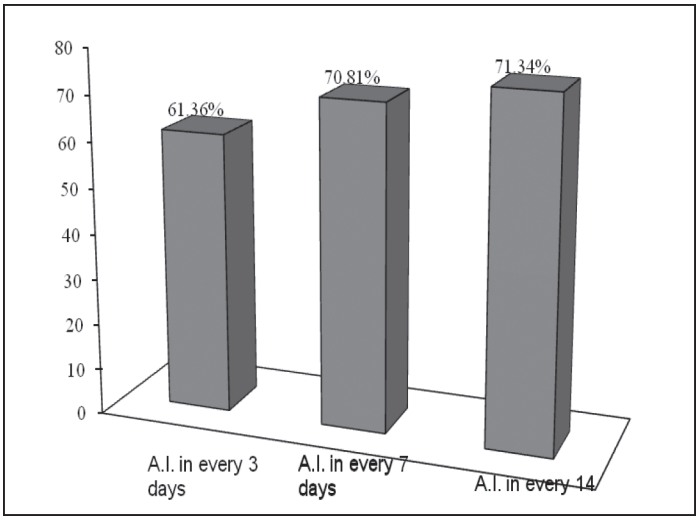

Figure 3. Effect of frequency of insemination on HDP

Total hatched analysis

This study revealed that the average hatchability of the broiler breeder was 70.89±0.79. Similarly the total hatched eggs was significantly affected ($p<0.001$) by the type of insemination, according to which artificially inseminated (73.22±0.11) flock had higher hatchability than that from naturally inseminated ones (69.58±0.11). Sayyazadeh, H. and Shahsavarani, H. (2005) reported significant effect of type of insemination on total hatchability where total hatchability in artificially inseminated birds was 87.2 % as compared to naturally inseminated birds (82.7%) of Arian breed which was in line with the finding of this study. However Koohpar *et al.* (2010), found no significant effect of type of insemination on hatchability ($p<0.36$), while comparing the natural mating with artificial insemination at Mazandran native hen, Iran. The hatchability was also significantly affected ($p<0.001$) by the season; accordingly summer season (72.58±0.12) has higher hatchability than that of winter season (62.19±0.12). This finding was in line with Sanda-Jova (1992), who reported that eggs hatched in November to December tend to have lower fertility (78.5-81.5 %) than those in January to April (81.3 -86.1 %).

However, Ozcelik *et al.* (2006) studied to determine the effect of the hatching month as an environmental factor and the suitable months for hatching. They found that hatching month was statistically significant. The hatchability was low in June as compared to the other months investigated. However Babiker and Musharaf (2008) reported insignificant effect on hatchability due to season while comparing the hatchability of Coral chick and Feed production Farms in Khartoum at different seasons (summer and winter) during the period 1998-1999. Elsayed M. A. (2009) collected 497 ostrich eggs from the breeding flock in Nuclear Research Center from January to October 2006 and reported that peak hatchability was observed in July and lowest at the end of the season (?). Similarly, the result of this study does not agree with the result of Funk (1934) Who reported detrimental effect to hatchability due to high summer temperatures. . Among the interaction between season and type of insemination, significant effect of season-type of insemination on total hatchability was observed. Highest hatchability was obtained during summer by artificial insemination (74.38±0.15), followed by artificial-winter (72.04±0.15), natural-summer (70.76±0.11) and natural-winter (64.41±0.15) respectively.

Table 1. Least square mean and standard error hen day production in broiler breeder (type of insemination versus season)

Factor	No of Observation	LS Mean ±SE	Level of Significance
Overall	1080	70.93±0.28	
Type of Insemination			***(p<0.001)
Natural	540	72.21±0.39[a]	
Artificial	540	69.25±0.39[b]	
Season			***(p<0.001)
Summer	540	75.37±0.39[a]	
Winter	540	66.29±0.39 [b]	
Interactions			***(p<0.001)
Natural × Summer	270	78.52±0.55[a]	
Natural × Winter	270	66.69±0.55[c]	
Artificial × Summer	270	72.20±0.55[b]	
Artificial × Winter	270	66.21±0.55[c]	
CV		12.84	

The total hatched was significantly affected by the sex ratio, accordingly which higher hatched was observed in the ratio 1:8 (82.24±0.77) followed by the ratio 1:12 (70.39±0.77) and the ratio 1:15 (55.05±0.77), (Figure 4) according which lower the male female ratio higher the total hatched. Alsobayel and Albadry (2012) reported the significant effect of sex ratio on fertility and hatchability, compared it's performance maintained under similar conditions with sex ratio 1:6, 1:10 and 1:14 who reported detrimental effect to hatchability due to sex ratio.

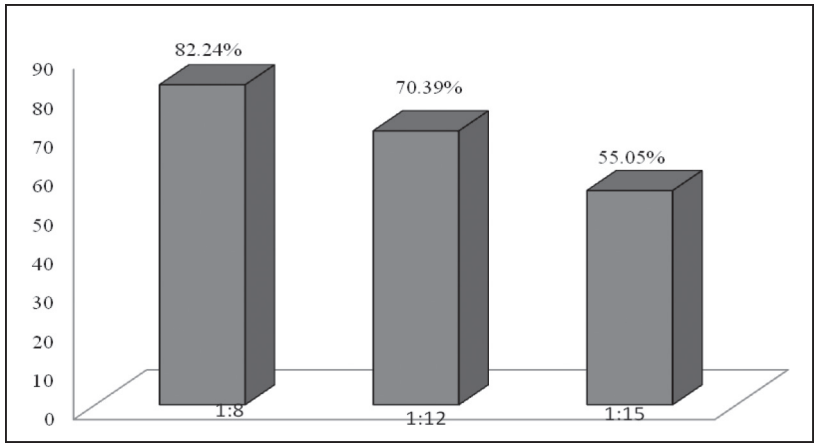

Figure 4. Effect of sex ratio on hatchability

The result of this study revealed that the overall total hatched of the artificially inseminated birds was 77.89±0.44. Similarly the total hatched was significantly affected ($p<0.001$) by the frequency of insemination. Accordingly higher total hatched was observed in the birds that were inseminated every 3 day 87.24±0.77, followed by AI in every 7 day 77.39±0.77 and AI in every 14 day 55.05±0.77, (Figure 5). This result indicates that, more hatchability with short frequency of insemination.

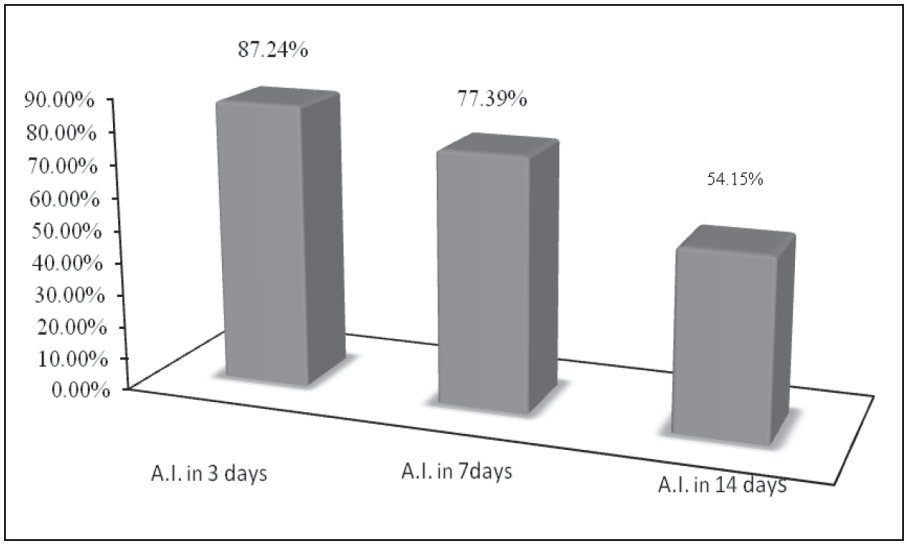

Figure 5. Effect of frequency of insemination on hatchability

CONCLUSION

Result of this study clearly indicates that for any Hubbard Broiler Parent farm it is feasible to apply the artificial insemination rather than the natural insemination when the total fertility and hatchability considerably decreases. However, for the detail study to verify these results, research should be carried out for field test in different breeds and locations before implementing these results at the farmer level.

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EFFECT OF NON GENETIC FACTORS ON REPRODUCTIVE PERFORMANCE OF HILL GOAT IN NAWALPARASI, NEPAL

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ABSTRACT

The genetic characteristics influenced by non genetic traits as location, season of conception, season of kidding, sex, parity and birth type affect the productivity of goat. Considering this fact, a field study was conducted to analyze the effect of non-genetic traits on reproductive performance of hill goats comparing lower and higher altitude in Nawalparasi district during January, 2011 to May, 2012. The data were derived from field record of 100 households (n=895). Harvey (1990) computer software package was used to analyze quantitative data (Least Square Method) and significant different means were compared using DMRT. The findings revealed that the mean age at first conception, age at first kidding, gestation length, kidding interval and post partum estrus of hill goats were 255.18±4.92, 406.72±4.96, 150.54±0.84, 199.98±2.41 and 50.37±0.84 days, respectively. Location had significant ($p<0.001$) effect on age at first conception, first kidding and post partum estrus. Further more, post partum estrus had also significantly ($p<0.001$) affected by birth type and parity of dam. Findings also confirmed that comparatively goat reared at~1000 meter altitude with forest grazing system would be better in expressing their productive and reproductive traits. Further in depth research on various locations are also required to get concrete findings.

Key words: conception, kidding, gestation length, DMRT, non-genetic traits.

INTRODUCTION

Goat contributes about 20% to the total meat production of the nation and ranks in second position followed by buffalo (64.80%) for meat production (MoAC, 2008/09). Goat meat is more common and more preferred than other meat (Dhakal *et al.,* 1985) and it has cultural values for worship of god in certain community. Due to the rapid urbanization, higher income levels, changes in lifestyle and food habits, market of goat meat is expanding rapidly and demand has rising up the multiple

folds (TLDP, 2003). However, the productivity of goats under the prevailing traditional system is very low and also the qualitative and quantitative production of goat has not been increased as the proportion of demand.

Goat farming is a vital part of national economy in many countries, especially for under-developed country like Nepal. So, goat farming can play vital roles in poverty reduction (Kolachhapati, 2006). Goat farming fits for landless, marginal and small farmers because it provides continuous income and employment to the farm family, including women and children requiring less input. Presently, goat-raising appears to provide an income generating opportunity for landless households. Due to these reasons, most of the Governmental and Non-governmental organizations are mainly focusing on small animal promotion program especially goat production. It shows that the goat keeping program is the milestone for poverty reduction even for landless people. Although goat has greater source for generating additional household income among resource poor, but it has been kept on a non-commercial basis (Kolachhapati, 2006).

The genetic characteristics influenced by non genetic factors affect the productivity of goat (Neaupane, 2003). Therefore, a study has been purposed 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. This study focused on different parameters which will help for finding the reproductive efficiency as well as production system in mid hills regions.

MATERIALS AND METHODS

The study area was Deaurali VDC-6 and7 of Nawalparasi district and was conducted from January, 2011 to May, 2012. Altogether 100 household consisting of more than 895 goats were selected for this study. Different reproductive traits such as gestation length, age at first conception and kidding, kidding interval and post partum estrus were recorded. Data collected during the tenure of CLDP project were used to study the effect of non-genetic factors on reproductive performance of hill goat in the study site. The collected data were coded and entered into Ms-excel & converted into text documents (Text MS-DOS). The data were analyzed by least square procedure using Harvey (1990) software package and Mean comparison was performed by DMRT. Among different Harvey (1990) models, fixed effect model was used to estimate the effect of non

genetic factors on age at first conception and kidding.

$Yijklm = \mu+ai+bj+ck+dl+eijklm$

Where, μ = Overall mean

Y_{ijklm} = Total effect on reproductive performance

ai = effect of i^{th} location

bj = effect of j^{th} season of conception

ck = effect of k^{th} season of kidding.

dl = effect of l^{th} type of birth of dam.

e_{ijklm} = effect of random (residual) element assumed as randomly & independently distributed.

Whereas, model used to estimate gestation length and kidding interval was as follows.

$Y_{ijklm} = \mu+ai=bj+ck+dl+fm+e_{ijklm}$

Where, μ = Overall mean

Y_{ijklm} = Total effect on reproductive performance

ai = effect of i^{th} location

bj = effect of j^{th} season of conception

ck = effect of k^{th} season of kidding

dl = effect of dam birth type

fm = effect of parity of dam

eijklm = effect of random (residual) element assumed as randomly & independently distributed.

RESULTS AND DISCUSSION

Present study considered the reproductive traits as age at first conception, gestation length, age at first kidding, kidding interval and post-partum estrus, etc. These are the major economic traits which determine the productivity of goat.

Effect of non genetic factors on Reproductive performance of kids

Age at first conception and kidding

The mean average age at first conception and kidding of hill goats were 255.18±4.92 days and 406.72±4.96 days, respectively (Table 1). These findings matched with the study of Kolachhapati (2006), Shrestha (2002) and Sapkota (2007) reported as 255.11±29.09, 254±9.75 and 265±07 days at Udayapur and Mid western Terai goat at Nepalgunj and Terai and hill goat respectively. Similarly, Sapkota (2007) and Shrestha (2002) reported the similar value of age at first kidding i.e. 411±07 days and 406 days in hill goat and Barbari goat respectively. From the above findings, we may conclude that the age at first conception

depends on particular climatic condition of that locality, availability of better nutrition and breed type.

Effect of location

Location had significant effect ($p<0.001$) on age at first conception and kidding (Table 1). Does at higher altitude conceive (248.09±4.99 days) and kidding earlier (398.41±5.04 days) as compared to those of lower altitude does as 262.27±4.89 days and 414.03±4.93 days respectively. Sapkota (2007) had also found significant ($p<0.001$) effect of location on age at first conception. Kolachhapati (2006) and Sapkota (2007) also found the significant ($p<0.001$) effect of location on age at first kidding. This might be due to the reason that the does at upper altitude were relatively provided with good nutrition and management practices which leads to the activation of reproductive hormones, which was supported by the study of Tiwari (2002). The earlier attainment of sexual maturity of upper altitude might be due to better nutrition, early sunshine that may influence the activation of physiological process.

Effect of season of conception

Season of conception of the dams had significant effect ($p<0.1$) on age at first conception and kidding (Table 1) of the does. It was found that the does born from the dams conceived during summer season were attained earlier (258.24±2.07 days) sexual maturity as compared to those born from dams conceived during winter season (261.41±2.05 days). Similarly, the kids born from the dams conceived during summer season were attained earlier in first kidding (409.03±2.09 days) as compare to the kids born during winter season (413.31±2.07 days). This might be due to the reason that the does in summer season got relatively abundant nutritious fodder and forage which leads to the faster and proper growth of fetus.

Effect of season of kidding

Season of kidding had significant effect ($p<0.05$) on age at first conception but had non significant effect on kidding (Table 1). Kids born conceived during the summer season had earlier maturity (253.05±4.97 days) as compared to those born in winter season (257.31±4.74 days). It was found that summer season born kids had earlier age at first kidding (401.54±5.02 days) as compare to winter season (404.90±4.99 days). Sharma *et al.* (2000) also reported the lower gestation lengths of dams conceived during winter season. Lower value of age at first conception of does born during summer season might be due to the availability of

sufficient green fodder that was not adequately available during winter season and kids born during that period might have been under stress which resulted in late sexual maturity.

Effect of dam's birth type

Dam's birth type had non significant effect on age at first conception and kidding of hill goat (Table 1). However, the dam's born in single birth type had conceived earlier (247.79±4.74 days) as compare to multiple (254.08±5.03). Similarly, the single born dam's had attained earlier first kidding (403.81±4.79 days) as compare to multiple (408.28±5.08 days). Earlier sexual maturity of the does born as single than multiple might be due to proper nourishment by her mother at preweaning stage that helps for earlier maturation of reproductive organs and get proper nutrition.

Table 1. Least squares means and standard errors of age at first conception and kidding (days)

Factors	No. of observations	LS Mean±SE of AFC	LS Mean±SE of AFK
Overall mean	895	255.18±4.92	406.72±4.96
Location		*** (0.001)	*** (0.001)
Lower altitude	280	262.27±4.89^{b}	414.03±4.93^{b}
Upper altitude	615	248.09±4.99^{a}	398.41±5.04^{a}
Season of conception		** (0.01)	** (0.01)
Summer	552	258.24±2.07^{a}	409.03±2.09^{a}
Winter	343	261.41±2.05^{b}	413.31±2.07^{b}
Season of kidding		* (0.05)	NS
Winter	310	257.31±4.95^{b}	404.90±4.99
Summer	585	253.05±4.97^{a}	401.54±5.02
Dam birth type		NS	NS
Single	450	247.79±4.74	403.81±4.79
Twin	365	248.95±4.79	406.18±4.83
More than twin	80	254.08±5.03	408.28±5.08
CV		4.52	3.03

Note: LS= Least Square; SE= Standard error; *** = 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, AFC= Age at first conception, AFK= Age at first kidding

Gestation length, kidding interval and post partum estrus

The overall mean gestation length of hill goats in this study was 150.54±0.84 days with the range of 149- 152 days (Table 2). Kolachhapati (2006) reported similar values of gestation length of hill goats in Surkhet (150.48±2.95 days), Kavre (150.18±4.53 days) and Udayapur (149.89±2.02 days). Likewise, Bhattrai (2007), Pandey (2007) and Sapkota (2007) also reported the similar values of gestation length of Terai and hill goats as 150.79±0.98 days, 149±0.32 days and 150±0.47 days, respectively. Similarly, the overall mean of kidding interval of hill goat as revealed in this study was 199.98±2.41days (Table 2). Neopane (2000) reported the closer value of kidding interval of central Terai goats (218±5 days). However, Shrestha (2002), Kolachhapati (2006), Bhattrai (2007), Pandey (2007) and Sapkota (2007) reported the higher average mean of kidding interval as 229.7 ±9.03 days, 253.4±38.8 days, 246.97±6.130 days, 296.42±4.46 days and 256±6.0 days in Terai and hill goats respectively. Likewise, the overall mean of post-partum estrus interval of the hill goat was 50.37±0.84 days with the range of 43 to 52 days (Table 2). Bhattrai (2007) and Sapkota (2007) reported the mean value of post partum interval were 80 days and 101 days respectively. These values are higher from the findings of this study. Due to the large variation in post partum estrus days, it needs to confirm the status of post-partum estrus interval of goats for further scientific study.

Effect of location

Location had non significant effect on gestation length but had significant ($p<0.05$) effect on kidding interval and post partum estrus ($p<0.001$) (Table 2). In this study, longer gestation length was observed in upper altitude (152.32±0.85 days) as compare to lower (150.76±0.84 days). Kolachhapati (2006) also reported the gestation length in Udayapur (149.89±2.02 days), Surkhet (150.48±2.95 days) and Kavre (150.18±4.53 days). The reason was the hormonal secretion was more active in warm climate as compare to than that in stress environmental conditions. The upper altitude does had lower kidding interval (191.51±2.45 days) as compared to those of lower altitude (199.45±2.40 days). Kolachhapati (2006) and Sapkota (2007) also reported significant effect of location on kidding interval. Likewise, the upper altitude dam had shorter postpartum estrus (48.01±0.85 days) as compare to those lower altitude dam (53.72±0.84 days). Sapkota (2007) also reported the significant effect of location on post partum interval. This result also showed that the dams of upper altitude had shortest postpartum estrus which might be due to the good nutrition and higher light intensities.

Effect of season of conception

Season of conception had non significant effect on gestation length, kidding interval and post partum estrus (Table 2). It was found that the kids born from the dams conceived during summer season had shorter gestation length (150.79±0.35) as compared to those conceived in winter season (151.89±0.35 days). Similarly, the dams conceived during summer season had lower kidding interval (201.00±1.02 days) as compared to those born from dams conceived during winter season (202.11±1.01 days). Likewise, the dams conceived during summer season had shorter post partum interval (50.25±0.35 days) as compare to those born from dams conceived during winter season (50.27±0.35 days). Sapkota (2007) also reported non significant effect of season on post partum interval.

Effect of season of kidding

Season of kidding had non significant effect on gestation length, kidding interval and post partum estrus (Table 2). It was found that the season of kidding during summer had shorter gestation length (150.49±0.85) as compared to those of winter season (152.59±0.85). Similar results were also reported by Pandey (2007) and Sapkota (2007). However, Neopane (1997) and Bhattrai (2007) observed that the gestation length had significantly differed with respect to the kidding season. The gestation lengths in summer season were shorter due to actively secretion of reproductive hormones as compared to winter season (Hafez, 1989). Similarly, the summer season born does had lower kidding interval (199.06±2.44 days) as compared to those born in winter season (200.91±2.43 days). Neopane (1997), Pandey (2007) and Sapkota (2007) also reported the non significant effect of season on kidding interval. Likewise, the summer season born does have longer post partum estrus interval (50.54±0.85 days) as compared to those does born in winter season (50.20±0.85 days). Sapkota (2007) also reported non significant effect of season of kidding on post partum estrus interval.

Effect of dam birth type

Dam birth type had non significant effect on gestation length but had significant ($p<0.001$) effect on kidding interval and post partum estrus (Table 2). It was found that the single born dam had shorter gestation length (150.01±0.81 days) as compare to those of multiple birth (152.20±0.86 days). Similar result was also reported by Neopane (1997). Single born kids had shorter gestation length due to fully

maturation of reproductive organs and get better nourishment in pre weaning stage may get immunity and strength from her mother results to come up faster in reproductive performances. Similarly, it was found that single born does had lower kidding interval (185.16±2.33 days) as compared to those born in multiple birth (206.28±2.47). Likewise, it was found that single birth does have shorter post partum interval (43.81±0.81 days) as compared to the multiple birth (51.47±0.86 days). Multiple born does had longer kidding and post partum interval may due to always struggle for food and survive under stress condition due to limited nourishment from mothers which ultimately resulting slower in productive and reproductive growth and performance.

Effect of parity of dam

Parity of dam had non significant effect on gestation length and kidding interval but had significant ($p<0.001$) effect on post partum estrus (Table 2). It was found that the third and fourth parity had longer gestation length (152.48±0.81) as compared to those of other parity. These findings are well matched with the findings of Neopane (1997), Bhattrai (2007), Pandey (2007) and Sapkota (2007). Shorter gestation length at increase in parity may be due to the fully maturity and efficient function of uterus. Similarly, it was found that the third parity had lower kidding interval (196.10±2.35 days) as compared to those of other parity. Bhattrai (2007), Pandey (2007) and Sapkota (2007) also reported the non significant effect of parity of dam on kidding interval. Likewise, the days of post partum estrus interval also increase from first parity (48.99 days) up to seventh parity (52.78±0.86 days). Similar finding was also reported by Bhattrai (2007). In this study we found that the parity of dams as a source of variation for post partum estrus, hence reproductive efficiency of hill goats can be enhanced by reducing the post partum estrus interval with respect to the variation in parity level of the dams.

Table 2. Least squares means and standard errors of gestation length, kidding interval and post partum estrus (days)

Factors	No. of observations	LS Mean±SE of GL	LS Mean±SE of KI	LS Mean±SE of PPE
Overall mean	895	150.54±0.84	199.98±2.41	50.37±0.84
Location		NS	* (0.05)	*** (0.001)
Lower altitude	280	150.76±0.84	199.45±2.40^{b}	53.72±0.84^{b}
Upper altitude	615	152.32±0.85	191.51±2.45^{a}	48.01±0.85^{a}
Season of conception		NS	NS	NS
Summer	552	150.79±0.35	201.00±1.02	50.25±0.35
Winter	343	151.89±0.35	202.11±1.01	50.27±0.35
Season of kidding		NS	NS	NS
Winter	310	152.59±0.85	200.91±2.43	50.20±0.85
Summer	585	150.49±0.85	199.06±2.44	50.54±0.85
Dam birth type		NS	*** (0.001)	*** (0.001)
Single	450	150.01±0.81	185.16±2.33^{a}	43.81±0.81^{a}
Twin	365	151.22±0.82	197.43±2.35^{ab}	48.05±0.82^{ab}
More than twin	80	152.20±0.86	206.28±2.47^{b}	51.47±0.86^{b}
Parity		NS	NS	*** (0.001)
First	130	151.07±0.83	197.95±2.40	48.99±0.83^{a}
Second	201	150.85±0.81	198.53±2.33	49.06±0.81^{a}
Third	199	151.50±0.81	196.10±2.35	49.86±0.82^{ab}
Fourth	190	152.48±0.81	197.34±2.35	49.84±0.82^{ab}
Fifth - Sixth	114	149.85± .82	198.45±2.38	49.97±0.83^{ab}
Above Seven	61	150.67± .86	198.61±2.48	52.78±0.86^{b}
CV		1.54	2.27	8.96

Note: LS= Least Square; SE= Standard error; NS= Non Significant; CV= Coefficient of Variation, GL= Gestation length, KI= Kidding interval, PPE= Post partum estrus

CONCLUSION

Based on the results of this study, it can be concluded that location, 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. Likewise, goat of upper altitude was superior with relation to reproductive performance that provided the scope of developing nucleus flock of indigenous breed suitable to the mid hills region of Nepal.

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ASSESSMENT OF THE PRODUCTIVE PARAMETERS AND PERFORMANCE OF PROGENIES OF JERSEY AND ITS CROSSES UNDER FARMERS MANAGED FIELD CONDITION OF THE SELECTED DISTRICTS OF CENTRAL AND WESTERN DEVELOPMENT REGIONS OF NEPAL

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ABSTRACT

This study was conducted to assess the productive performance of different genetic groups of Jersey and its crosses (Jersey, Jersey × HF, Local (L). × J., HF × J., HF × J. × J., L. × J. × J. and Jersey >75%) commonly kept by commercial and semi-commercial dairy farmers of Kaski, Tanahu, Gorkha, Nawalparasi, Rupandehi, Chitwan and Makawanpur districts of Nepal in 2011/2012. The effect of genetic and non genetic factors on productive traits such as daily milk yield (DMY), peak daily milk yield (PDMY), lactation milk yield (LMY), lactation length (LL), dry period (DP) of jersey and its crosses were analysed. Data were analysed by least square analysis using Harvey 1990 software package. Theresults revealed that the overall least square mean and standard errors (LS mean and SE) of PPE, LMY, LL and DP were found 65.25±0.80 day, 3496.73±40.55 lit., 298.79±1.48 day and 54.99±0.46 day respectively. Average daily milk yield andpeak daily milk yield were found as 11.44 lit. and 15.23 lit.,respectively. Results also revealed that the parity and performance of dam had significant effect on LMY (P<0.001). It was expected that the effect of genetic and nongenetic factors on productive traits of Jersey and its crosses provide concrete scientific basis for the selection of the best dairy animals for future breeding program and to estimate the breeding value of dairy cattle.

Key words: ProductivePerformance, Genetics, Jersey, Lactation, Heritability, Breeding Value.

INTRODUCTION

Background

Livestock is an integral part of the agricultural farming system of Nepal. Cattle, buffalo, goat, sheep, poultry and pigs are major livestock species in Nepal. Livestock plays a vital role to the Nepalese rural economy and contributes about 12% to the total national GDP and about 25.68% to national Agricultural Gross Domestic Products (AGDP) (MOAC, 20011). Dairying is the most important sub-sector contributing about 63% to the total Livestock Gross Domestic Products (LGDP) which is about 8% of total national GDP. Agricultural Prospective Plan (APP) envisaged that share of livestock sector in AGDP up to 45% in 2015 (APP, 1995). To achieve this target, increase in milk production and productivity is one of the important areas (NLBC, 2010).

Nepal has 2265766 dairy/milking animals of which 43% are cattle and 57% are buffaloes, and produce 1556510 Mt. milk annually. Out of the total milk production, 29% is contributed by cattle and 71% is contributed by buffaloes (MOAC, 2011). In the country, milk production is increasing by 4%where as demand of milk is increasing by 8% annually (Shrestha, 2010). Per-capita availability of milk (51.49 kg/year) in Nepal is far below than the WHO recommendation which is 91.25 kg (NLBC, 2010) per capita per annum.

Genetic improvement is one of the prioritized activities of Government of Nepal to improve the productivity of the Nepalese cattle and buffaloes. The performance of the upgraded cattle herd is rarely evaluated at the field level. Nepalese cattle have been upgraded with different level of exotic blood (Jersey and HF) in farmers' field with variation in production potentialities. Since 50 years of AI program in the country, it is the time to assess the impact on breed improvement of Nepalese cattle and recommend the appropriate genotype for Nepalese Jersey breed for the optimum level of milk production in Nepal. In this perspective, a study was carried out, mainly, aiming toevaluate the Nepalese cattle crossed with Jersey at farmers' field level.

Objectives

The general objective of this study was to determine genetic and non-genetic parameters and assess the performance of the cross bred Jersey cattle in the selected districts of Central and Western Development Regions of Nepal.

The specific objective of this study was:

- To assess the milk production performance of the cattle crossed with different breeds at farmers managed field conditions.
- To analyze the effect of genetic and non-genetic factors and its factorial interactions on production traits of Jersey crossbreds born by AI under farmers managed condition.

MATERIALS AND METHODS

Study site

Chitwan and Makawanpur districts from Central region and Nawalparasi, Rupandehi, Gorkha, Tanahu and Kaski districts from Western region were selected for the study. These districts were purposively selected because of the availability of more number of crossbreeds and higher intervention by artificial insemination in cattle breeding program.

Breed selection and base population

Jersey breed of cattle and their crosses with various indigenous and exotic breeds of cattle from 12 dairy pocket areas of the selected districts were identified and selected as the base population. Data were obtained from 538 Jersey and its crosses (n=538)

Duration of the study

This study was carried out during the period of November 2011 to October 2012 by collecting data through farmers' field survey. Performance recordsof Dairy Cattle Improvement Program (DCIP) were also taken as the reference during the study period.

Sources of data

Sources of primary data and data collection technique

Field survey, observation and information collection

Farmers' field and household survey was carried out on the basis of pretested questionnaire and check list. The questionnaire and check list had incorporated the items as breed, crossbred level, origin, age, parity, milk yield of the animals. The questionnaire has also included the milk production of dam and the information of the sire and its dam as well.

Productive traits

The following productive traits were noted during the farmers' field observation.

Parameters / traits	Descriptions
Daily milk yield	Average daily milk yield of the lactation period (liter)
Lactation milk yield	Total milk yield of the lactation period (liter)
Lactation length	Length of lactation (days)
Dry period	Number of days after the day of stopping milking the cow to the day of calving (days)The highest
Peak milk yield	daily milk yield obtained from a cow during the lactation period

Quantitative data from pedigree performance recording scheme (PPRS)

Breed type, lactation milk yield, monthly milk yield of the selected animal were obtained from Pedigree Performance Recording Scheme (PPRS) of DCIP of Nepal. PPRS data of DCIP were obtained from Animal Breeding Division (ABD), NARC, Khumaltar, Lalitpur that had recorded and analyzed the data from the herds of the selected districts in collaboration with Directorate of Livestock Production (DoLP) and Central Cattle and Buffalo Promotion Office (CCBPO), Hariharbhawan.. The analyzed data on PPRS, such as. breed type (genetic group), parity, date of calving, monthly milk yield and lactation milk yield were obtained from the Data Management Unit (DMU) created under the DCIP at the ABD, NARC .

Model used for analyzing the data

The fixed effect and random effect models of 'Harvey 1990' statistical package were used to analyze all the observations of collected data.

Model used for analyzing the lactation yield

The following fixed effect model was used to express each observation of lactation yield.

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

Where, μ is the overall mean

a_i is the effect of i^{th} sire genetic purity (i=1, 2, 3, 4)

b_j is the effect of j^{th} geographic location (j=1, 2)

c_k is the effect of k^{th} district (k=1, 2, 3, 4, 5, 6, 7)

d_l is the effect of l^{th} breed of cow (l=1, 2, 3, 4)

f_m is the effect of m^{th} parity of cow (m=1, 2, 3, 4)

g_n is the effect of n^{th} herd size (n=1, 2, 3, 4)

h_o is the effect of o^{th} performance of dam (o=1, 2, 3)

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

Model used for analyzing the productive traits (DP and LL) and PPE

The following fixed effect model was used to express each observation of DP, LL and PPE.

$$Y_{ijk} = \mu + a_i + b_j + (a*b)_{ij} + e_{ijk}$$

Where, μ is the overall mean

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

b_j is the effect of j^{th} breed of cow (j=1, 2, 3, 4, 5, 6, 7)

$(a*b)_{ij}$ is the interaction effect of i^{th} geographic location and j^{th} breed of cow (ij=k=1, 2, 3, 4, 5,6, 7, 8, 9, 10, 11, 12, 13, 14)

e_{ijk} is the random element (error mean) assumed to be normally and independently distributed among the sampled population.6

Data analysis techniques

After collecting all required data and information from farmers' field, AI technician and PPRS data from DCIP, the data were grouped and coded using MS-Excel program. All the collected and coded data were analyzed using "Harvey 1990" and "SPSS" computer based statistical package to get the genetic and non genetic parameters of economic traits. Analysis of Variance (ANOVA) was also done by using the Harvey 1990 statistical package. Comparision of the means were compared using DMRT computer software package.

RESULTS AND DISCUSSION

Productive traits (LMY, LL and DP)

The results on Lactation Milk Yield (LMY), Lactation Length (LL) and Dry Period (DP) of different genetic groups of cattle along with the effect of non-genetic factors are presented in Table 1 and Table 2.

Lactation Milk Yield (LMY)

The overall average lactation milk yield (LMY) was found to be 3496.73±40.55 liters (Table 1). Singh and Ram (1998) found 2425 liter of milk production per lactation in Indian crossbred cows, which was lower than present finding. Usman *et al.* (2012) observed in HF cattle that mean LMY was 3438±887.19 liters, which was similar to present finding. Ahmad *et al.* (1985) found in Faisalabad of Pakistan that LMY of HF × Sahiwal cows was 3056.3±106.5 kg, which was slightly lower than present finding. Dhungana (2011) found the overall mean for LMY for 50, 75 and above 75% genetic groups of cattle in Sunsari district were 2212±130, 2936±147 and 3211±107 liters respectively, which were significantly lower than present finding.

Effect of sire genetic purity

Sire genetic purity from 85% and more had no significant effect ($P>0.05$) on LMY (Table 1). However, LMY was found to be highest at sire genetic purity >95% (3572.33±51.65 lit.) followed by <85% (3510.96±57.03 lit.) and 90-95% (3455.79±48.24 lit.). The lowest LMY was found in sire genetic purity 85-90% (3447.85±51.49 lit.). The effect of sires below 85% on LMY could have the significant Usman *et al.* (2012) found Sire, Season and Year of calving had non-significant effect on LMY. In this study sires used for breeding (AI) might have similar on genetic capability.

Table 1. Least square mean and standard error of lactation milk yield (LMY)

Factors	No. of Observation	LS Mean ± SE	Level of Significance
Overall	538	3496.73±40.55	
Sire genetic purity			NS
< 85%	125	3510.96±57.03	
85-90%	149	3447.85±51.49	
90-95%	116	3455.79±48.24	
> 95%	148	3572.33±51.65	
GeographicLocation			
Terai	278	3385.51±118.21	
Hill	260	3607.96±98.08	
District			NS
Kaski	187	3626.70±109.19	
Tanahu	53	3641.95±151.46	
Gorkha	42	3635.54±133.93	
Chitwan	85	3410.83±120.45	
Makawanpur	33	3460.01±110.22	
Nawalparasi	79	3268.88±113.71	
Rupandehi	59	3433.21±115.52	
Breed of Cow			NS
Jersey	336	3516.91±37.97	
HF × J.	60	3504.71±74.94	
HF × J. × J.	62	3455.34±69.67	
Jersey >75%	80	3509.96±51.17	
Parity			***
1-2	164	3329.49±38.08[b]	
3-4	70	3574.18±38.75[a]	
5-6	66	3563.58±62.89[a]	
>7	78	3519.68±92.68[a]	
Herd size			NS
< 8	98	3486.48±59.29	
8-20	95	3435.06±65.24	
20-30	165	3549.19±51.19	
> 30	180	3516.19±50.36	
Performance of Dam			***
< 3000 lit.	173	2825.43±49.20[c]	
3000-4000 lit.	278	3306.79±43.33[b]	
> 4000 lit.	87	4357.96±54.32[a]	
CV (%)			9.84
R			0.838

No. of Obs: Number of observation; *** Significant at 0.1% (P<0.001); NS: Non Significant; L.: Local; J.- Jersey, HF- Holstein Friesian, Jersey >75%- Local or HF × J. ×J. × J.

Effect of geographic location

Geographic location had no significant effect (P>0.05) on LMY (Table 1). However, lactation milk yield was found to be higher at hill (3607.96±98.08 lit.) followed by terai (3385.51±118.21) that may be because of Jersey as anexotic breed from cold region. Therefore,Jersey and its crosses show better performance on slightly cooler area (hill) than warmer area (terai).

Effect of district

There was no significant effect among the distrcits (P>0.05) for LMY (Table 1). However, LMY was found to be highest in Tanahu (3641.95±151.46 lit.) followed by Gorkha (3635.54±133.93 lit.) and Kaski (3626.70±109.19 lit.). The lowest LMY was found in Nawalparasi (3268.88±113.71 lit.). The higher LMY was observed in hilly districts (Tanahu, Kaski and Gorkha) that could be due to more suitable environment for Jersey and its crosses. Farmers of hilly districts like Tanahu, Gorkha and Kaski have also maintained more HF × Jersey crosses and used to feed much more green fodder to their cattle than in other districts. Therefore, there is a very good supply of green round the year which might have helped to produce more milk in these districts than the others.

Effect of genetic group (breed of cow)

Breed of cow (Jersey, HF × J., HF × J. × J. and Jersey > 75%) had found no significant effect (P>0.05) on LMY (Table 1). However, LMY was found to be highest for pure Jersey (3516.91±37.97 lit.) followed by Jersey >75% (3509.96±51.17 lit.) and HF x Jersey (3504.71±74.94 lit.). The lowest LMY was found on HF × Jersey × Jersey (3455.34±69.67 lit.). The similar level of LMY from different genetic group, e.g., Jersey and different level of Jersey crosses might be due to similar amount of feed, fodder and management was provided to the cows and that might be sufficient for Jersey but not enough for different level of Jersey crosses. Furthermore, HF × Jersey crosses might be more prone to diseases and other problems that may be the reasons for the lower LMY.

Effect of parity

Parity of cow (1-2, 3-4, 5-6 and >7) had significant effect (P<0.001) on lactation milk yield (Table 1). Accordingly, lactation milk yield was found to be highest in 3-4 parity (3574.18±38.75 lit.) followed by 5-6

parity (3563.58±62.89 lit.) and >7 parity (3519.68±92.68 lit.). The lowest lactation milk yield was found for 1-2 parity (3329.49±38.08 lit.). Usman *et al.* (2012) indicated that milk production was high in parity 2nd and 3rd. Javed *et al.* (2004) and Tadesse *et al.* (2010) reported calving season and parity had significant effect on LMY. Present results also agree with those findings.

Effect of herd size

Herd size (<8, 8-20, 20-30 and >30) had no significant effect (P>0.05) on LMY (Table 1). However, LMY was found to be highest for herd size 20-30 (3549.19±51.19 lit.) followed by herd size >30 (3516.19±50.36 lit.) and herd size <8 (3486.48±59.29 lit.). The lowest LMY was found for herd size 8-20 (3435.06±65.24 lit.). This result might be because of the commercialization and optimum size of the dairy farming whereas the herd size of more than 30 lactating cows could not be managed well by the farmers of the research sites. The lowest LMY in case of herd size 8-20 can not be justified except to say that it was the chance factor.

Effect of performance of dam

Performance of dam (<3000 lit., 3000-4000 lit., >4000 lit.) had significant effect (P<0.001) on lactation milk yield of their daughters (Table 1). Accordingly, lactation milk yield was found to be highest for group whose dam produced >4000 lit (4357.96±54.32 lit.) followed by 3000-4000 lit. of dams' performance (3306.79±43.33 lit.) and <3000 lit. of dams' performance (2825.43±49.20 lit.). Cows produce more milk whose dams were high milkier, that might be due to strong genetic correlation of milk production and because of the higher degree of heritability of milk production traits of cattle.

Average daily milk yield (DMY)

Average daily milk yield (DMY) from Jersey and its crosses was found to be 11.44 lit. (Figure 1). Amasaib *et al.* (2011) reported DMY in crossbred dairy cows of Sudan under tropical condition was 9.20-11.9 kg which is almost similar to present finding. Vaish (2011) who was also the key person of Model Dairy Farm, Kanpur, India reported that Jersey and Jersey cross cows have daily milk production capacity of 15 to 25 liters per day per animals which is very high than the present finding. It is because of the fact that the Model Dairy Farm, Kanpur is a well managed, well fed and kept in a well hygienic condition whereas the farms under present study are the average farms managed in the

farmers field conditions which obviously cannot produce the milk in comparison to the well managed advanced farms.

Peak daily milk yield (PDMY)

Peak daily milk yield (PDMY) of Nepalese Jersey and its crosses were found to be 15.23 lit. and was found during the period of around second month of calving (Figure 1). Ahmad *et al.* (1985) reported PDMY from HF × Sahiwal cows at Faisalabad in Pakistan was 16.39±0.41 kg and was found at 31.2±2.9 days of calving, which resembles present finding.

Lactation Curve (LC)

Lactation curve (LC), as shown in figure 1, of the cows under study starts from 14.10 lit./day from first month of calving followed by highest 15.23 lit./day at 2nd month of calving and 14.27 lit./day at 3rd month of calving and so on. Cows after 10th month of calving had given milk about 4.19 lit./day (Figure 1) which is about 2 lit per time of milking. Continuing milking after this point is not economical as per he cost and benefit analysis of the milk production.

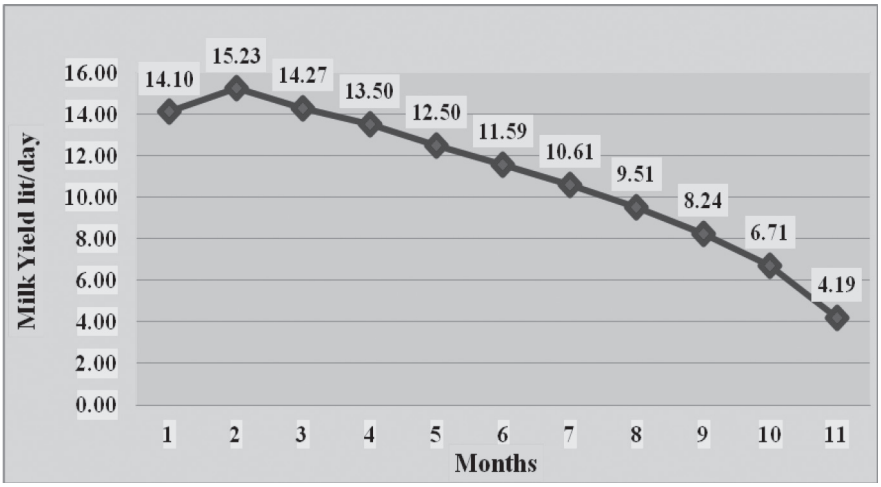

Figure 1. Lactation curve for Jersey and its croses

Dry period and Lactation length

The overall dry period (DP) and lactation length (LL) were found as 54.99±0.46 and 298.79±1.48 days (Table 2). Hutchison *et al.* (2007) reported that it is not wise to reduce theDP below 60 days. So, they

had recommended that Jersey producers should have the targetdDP of 55 days which agrees present finding. Dhungana (2011) reported the overall mean for DP for 50, 75 and above 75% blood groups of Jersey cattle were 64±3, 71±8, 83±22 days respectively, which were slightly higher than present finding.

Singh and Ram (1998) found LL of 299.67 days in Indian crossbred cows which is similar to present finding. Usman *et al.* (2012) observed LL in HF cattle as 366.5±76.71 days, which was higher than present finding. Crossbred dairy cows of Sudan under tropical condition showed an average LL as 267-274 days(Amasaib *et al.*, 2011), which was lower than present finding. Dhungana (2011) found the overall mean of LL in 50, 75 and above 75% genetic groups of Jersey cattle as 344±13, 358±58 and 389±45 days, respectively at Sunsari district of Nepal, which was found much higher than present finding.

Table 2. Least square mean and standard error of PPE, DP and LL (days)

Factors	No. of Obs.	LS Mean ± SE (PPE) (days)	LS Mean ± SE (DP) (days)	LS Mean ± SE (LL) (day)
Overall	393	65.21±0.80	54.99±0.46	298.79±1.48
Geo. Location				
Terai	194	67.29±1.17[a]	55.16±0.67	299.02±2.15
Hill	199	63.14±1.11[b]	54.83±0.64	298.57±2.03
		*	NS	NS
Breed of Cow				
Jersey	93	64.86±1.08	55.14±0.62	304.98±1.98
HF	53	62.79±1.78	54.59±1.02	294.69±3.26
L. × J.	42	66.25±2.44	55.42±1.40	295.33±4.48
L. × J. × J.	40	66.04±2.73	54.17±1.57	295.58±5.01
HF × J.	43	65.24±2.36	56.13±1.35	300.69±4.32
HF × J. × J.	70	66.93±1.37	54.84±0.78	302.79±2.50
Jersey >75%	52	64.38±2.59	54.69±1.49	297.50±4.75
		NS	NS	NS
Interaction effect of Geo. Location and genetic group				
Terai × Jersey	46	65.28±1.41	54.72±0.81	302.91±2.58
Terai × HF	30	62.50±2.67	56.50±1.54	292.00±4.91
Terai × L. × J.	26	72.50±3.46	56.67±1.99	302.17±6.34
Terai × L. × J. × J.	26	70.83±3.45	53.33±1.98	296.67±6.34
Terai × HF × J.	26	68.33±3.45	55.83±1.98	301.67±6.34
Terai × HF×J. ×J.	26	67.81±2.11	55.31±1.22	304.25±3.88
Terai × J.>75%	24	63.75±4.23	53.75±2.43	293.50±7.76
Hill × Jersey	27	64.44±1.62	55.56±0.94	307.03±2.98
Hill × HF	28	63.08±2.34	52.69±1.35	297.38±4.31
Hill × L. × J.	26	60.00±3.45	54.17±1.98	288.50±6.34
Hill × L. ×J. × J.	24	61.25±4.22	55.00±2.43	294.50±7.76
Hill × HF × J.	27	62.14±3.19	56.43±1.84	299.71±5.87
Hill × HF ×J. ×J.	29	66.04±1.72	54.37±0.99	301.33±3.17
Hill × J. >75%	28	65.00±2.99	55.62±1.72	301.50±5.49
		NS	NS	NS
CV (%)		12.96	8.86	5.16
R		0.302	0.213	0.298

No. of Obs: Number of observation; * Significant at 5% (P<0.05); ** Significant at 1% (P<0.01); *** Significant at 0.1% (P<0.001); NS: Non Significant; L.: Local; J.- Jersey, HF- Holstein Friesian, Jersey >75%- Local or HF × J. × J. × J.; Geo. Location: Geographic location.

Heritability of lactation milk yield (LMY).
Heritability of LMY of Jersey and its crosses was found to be 0.204 (Table 3). Freitas *et al.* (1995) found lower heritability of milk yield in cows (0.12) than present finding. Usman *et al.* (2012) reported slightly higher heritability of LMY in Jersey crossbred cows (0.255±0.328) than present finding.

Table 3. Heritability of lactation milk yield.

Factors	h^2 of lactation milk yield
Heritability	0.204

Though the data obtained from the present study may not be enough to calculate the heritability of milk production but the preliminary data suggest that there is the high scope of breed improvement through the intensive selection.

SUMMARY AND CONCLUSIONS

Summary

This study was carried out to assess the productive performance of different genetic groups of Jersey and its crosses (Jersey, Jersey × HF, L. × J., HF × J., HF × J. × J., L. × J. × J. and Jersey >75%) commonly kept by commercial and semi commercial dairy farmers of Kaski, Tanahu, Gorkha, Nawalparasi, Rupandehi, Chitwan and Makawanpur districts of Nepal. The study aimed to determining the effect of genetic and non genetic factors like breed of cow, sire genetic purity, performance of dam, year, geographical location, district, parity, herd size and interaction effect of geographical location and genetic groups on important productive traits, mainly DMY, PDMY, LMY, LL, DP.

Results of this study revealed the overall least square mean and standard errors (LS mean and SE) of lactation milk yield, average daily milk yield andpeak daily milk yield as 3496.73±40.55 lit., 11.44 lit. and 15.23 lit., respectively. Results also revealed that parity and performance of dam had significant effect on LMY ($P<0.001$). The study has shown that there was no significant difference on milk yield from the progenies of the sires more than 85% purity. However, the highest yield was obtained from the cows as the progenies of the sires having more than 95% Jersey blood level. Herd size of 20-30 is found as the best size in terms of average daily per animal milk production. Milk yield from 3rd to 4th parity cows was obtained more than other

parities where as DP was found around 55 days which agrees with the findings of the researches of other countries as well. Per animal milk yield was found higher in Kaski, Tanahun and Gorkha districts which was because of the round the year availability of green and good livestock husbandry practices followed in better ways than the other districts under the study.

Conclusions

Based on the above findings, following conclusions could be drawn:

- The overall mean of productive traits in the present research sites were found better than the findings of the previous researchers in Nepal.
- Productive traits of the breeds under the study were found very promising as compare to the Nepalese local breeds of cattle. It is worthy to note that these parameters are improving every year because of the breed improvement by artificial insemination.. Therefore, dairy farmers are suggested to follow the AI to get the better performance of the progenies of their animals through breed improvement program.
- The performance of pure Jersey on LMY was found higher as compare to other crosses . Therefore, it is essential to develop the Nepalese pureJersey breed of cattle which would be fit as per the geography, climate, farmers' conditions, animal husbandry, hygiene and nutritional situation in Nepal.
- Herd size of 20-30 lactating cows was found the best productive followed by more than30 cows. Therefore, dairy farmers are suggested to keep more animals (about 30) as to be the commercial farmer which would provide much income and ultimately higher profit from the farm.
- Heritability of milk yield was found as the medium level suggesting that there is a good chance of improvement of milk productivity of the animals through cross-breeding (Paudel et al, 2009) . Daughters born from such programs through AI would be the better source of milking animals for the future.

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EVALUATION OF DIFFERENT OAT CULTIVARS AT VARIOUS ALTITUDE OF NEPAL

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ABSTRACT

Twelve multicut oat cultivars including two indigenous cultivars were tested at seven various altitude range locations from 110 to 2200 masl of nepal to find out the best multi-cut oat cultivars making available of nutritious green fodder particularly during the critical winter period suitable for the particular location. The chemical fertilizer and farmyard manure were applied @ 80:60:40 (n: p2o5: k2o kg/ha) and 5 ton/ha, respectively. The seed rate was 100 kg/ha. The plot size was laid out 30 m2. Sowing was done between october to december at various locations during study periods 2003 and 2004. Line sowing was done at 25 cm from row to row. Altogether three cuttings were taken and data were analyzed using statistical analysis system package. Data were recorded on plant height, tiller and leaf numbers per plant, green matter yield/plot and dry matter yield in each cutting from each location. The results have shown that different cultivars of oat are appropriate at different locations for green and dry matter production. The regression analysis of the result showed that the lower the altitude, higher is the green and dry matter production. In sunsari, inauruwa (110 masl), the eastern terai, cultivar awapuni yielded the highest green matter (62 mt/ha) while in banke, paraspur (181 masl), the western terai cultivar 83inc19g3 produced the highest green matter (61.5 mt/ha). In kaski, sisuwa (720 masl), cultivar kent (48 mt/ha) while in dhading baireni (850 masl) cultivar awapuni (42.3 mt/ha) produced the highest yield in the mid hills. In rasuwa, dhaibung (1600 masl) and kavre riyale (1870 masl), cultivar awapuni produced the highest quantity of green matter (26.4 mt/ha and 21.8 mt/ha) respectively. In the higher hill of rasuwa, bhorle (2200 masl) cultivar awapuni (14.9 mt/ha) produced the highest quantity of green matter. Similarly, dry matter yields of oat cultivars varied according to the altitudes. Lower altitude yielded higher dry matter and higher altitude yielded lower dry matter. Among twelve oat cultivars tested cultivars awapuni was foundto be the best variety suitable for terai, mid hills and high hills region for more green and dry matter production.

Keywords: oat cultivars, altitude locations, green matter and dry matter production

INTRODUCTION

Oat (Avena sativa L.) which is commonly called Jai in Nepali is a most important cultivated winter fodder crop for livestock in Nepal. It has been adapted to a wide range of soil types and climatic conditions. It is main winter fodder, multicut in nature, fits well in farming systems for quality and quantity fodder supply during winter feed scarcity period (December to April). It can be utilized in many forms as green forage, silage, hay and grain for all categories of livestock. Oat ranks sixth in the global context after wheat, maize, rice, barley and sorghum. It ranks first in the world within the fodder production statistics (FAO 2010/11).

Cultivation of oat was started almost 100 years ago form the plain terai region of nepal and its areas under forge cultivation are increasing every year due to the yearly increase in the dairy enterprises (pariyar, 2003). Two cultivars of oat (kent and swan) were the first introduced oat cultivars in 1965. Oats have been under testing since 1970s and grown on a relatively large scale to nepalese farmers during the first and second livestock development projects from 1980 to 1994. Since 1980s more than hundred of different oat cultivars were brought from different organizations and countries for forage research and development programs in the country (pariyar 2005).

Oat growing is concentrated mainly on irrigated land in the terai and low-hills and on rainfed land in the low and mid-hills region in the commercial dairy pocket areas. Farmers grow oat up to around 2000 meters. However, the economical fodder production level is about 1600 meters on irrigated land. They are mainly used as green feed for the winter gap but some are already being made into hay, mainly at higher altitudes. The cultivars introduced in this project will probably increase their range of production and farmers are aware of forage cultivation in wider areas. The objectives of this experiment are

- To identify the best multicut oat cultivars for maximum fodder production for different altitude locations, and
- To have more nutritious livestock feed availability particularly during the critical winter period.

MATERIALS AND METHODS

Twelve different oat cultivars including well established Kent-Nepal and Swan-Nepal were tested for their fodder production and farmers acceptance at seven different altitude locations. The oat cultivars used and various altitude locations are presented below. The plot size was 30 m^2. The farmyard manure and chemical fertilizer were applied @ 5 ton/ha and N: P205: k2o @ 80:60:40 kg/ha, respectively. Seed rate was 100 kg/ha. Broadcast method of seed sowing was done. Data recording was taken on different parameters such as plant height, tiller and leaf numbers per plant, green matter yield and dry matter yield/plot in each cutting. Altogether three cuttings were taken. General Linear Model of Statistical Analysis System (SAS) was used to analyze the raw data of different oat cultivars at each location. Regression analysis was carried out to find out the relationship between fodder yield and altitude. The model is Yij=u+ bxj where Yij= i^{th} yield (mt/ha) of the jth location altitude (masl), u= mean of the dependent variable Yijb= parameter estimate associated with the regressor Xj altitude.

Locations	Number of farmers	Oat Cultivars
1. Inruwa Sunsari (110 masl)	30	1.Taiko 2.Canadian 3.83INC19G3 4. Awapuni 5.Longford 6. Hokonui 7. NZ92169,01 8. NZ93209,02 9. Stempade 10. NZ92173,02 11. Kent-Nepal, 12.Swan- Nepal
2. Paraspur Banke (181 masl)	30	
3. Sisuwa Kaski (700-720 masl)	30	
4. Bhaltar Dhading (850 masl)	30	
5. Rasuwa Dhaibung (1500-1600 masl)	30	
6. Kavre Riyale (1750-1870 masl)	30	
7. Rasuwa Bhorle (2000- 2200 masl)	30	

RESULTS AND DISCUSSION

Inaruwa, Sunsari

One of two of Terai locations is Inaruwa (110 masl) of Sunsari district on this experiment. Total three cuttings were taken from each oat cultivar. There were significant differences in the plant heights

between the different cultivars of the oats. However, the other observed parameters were not found to be significantly different. Awapuni (62,1 mt/ha), NZ92176,03 (46.8 mt/ha) and Canadian (42.5 mt/ha) were found the first three ranking for maximum fodder producing cultivars table-1. The fodder production was found influenced by plant height and number of tillers. The highest plant (71.07 cm) was obtained from Awapuni and maximum tillers (11) was produced from NZ92176,03.

Table-1. Performance of twelve of oat cultivars at Inaruwa, Sunsari (110 masl)

Oat cultivars	Plant height (cm)	Tillers/plant (nos)	Leaf no. / plant	Green matter (mt/ ha)	Dry matter (mt/ha)
Taiko	66.03	9	4.0	40.5	7.8
NZ93209, 02	57.67	7	4.3	35.7	7.2
Kent-Nepal	60.40	9	4.0	39.3	7.9
Stempade	63.93	7	4.0	31.4	6.4
Swan-Nepal	64.17	9	4.0	40.4	7.9
83INC19G3	64.13	8	4.0	39.4	8.7
Awapuni	71.07	8	4.3	62.1	11.5
NZ92176,03	65.43	11	4.3	46.8	8.8
Longford	61.10	8	4.0	42.2	8.8
NZ92173,02	67.63	9	4.0	35.2	7.2
Canadian	62.03	8	4.0	42.5	8.8
NZ92169,01	58.40	9	4.0	36.6	7.0
Average	63.50	8.47	4.08	41.23	8.20
F test Between treatment LSD	**	NS	NS	NS	NS

Paraspur, Banke

Among twelve oat cultivars at Paraspur Banke (181 masl), cultivar 83INC19G3 produced the highest green matter (61.5 mt/ha) followed by NZ92169,01 (49.2 mt/ha) and Kent-Nepal (45.7 mt/ha) in total three cuttings. The lowest fodder yield was obtained from NZ92173, 02 (27 mt/ha). Similarly the highest dry matter production was obtained from 83INC19G3 (12 mt/ha) and least was found from Longford (7 mt/ha) table-2. The maximum tillers (11) were obtained from NZ92169,01 which is significant different in different oat cultivars. The least tiller number per plant (6) was found from NZ93209, 02.

Table-2. Performance of twelve of oat cultivars at Paraspur, Banke (181 masl)

Oat cultivars	Plant height (cm)	Tillers/plant (nos)	Leaf no. / plant	Green matter (mt/ha)	Dry matter (mt/ha)
Taiko	63.33	9	4	41.1	8.3
NZ93209,02	57.43	6	3	40.1	7.5
Kent-Nepal	60.03	10	4	45.7	8.2
Stempade	62.10	8	4	36.3	7.0
Swan-Nepal	58.97	9	4	44.2	8.2
83INC-19G3	61.93	10	4	61.5	12.0
Awapuni	56.80	10	4	40.1	7.7
NZ92176, 03	53.23	7	4	37.5	6.8
Longford	56.17	7	4	33.9	7.0
NZ92173, 02	50.80	9	4	27	6.1
Canadian	52.73	10	4	44.9	8.9
NZ92169, 01	61.53	11	4	49.2	7.9
Average	57.92	8.83	3.83	41.79	7.96
F test					
Between treatments	NS	*	NS	NS	NS
LSD 0.05					

Sisuwa, Kaski

Cultivar Kent-Nepal (48.0 mt/ha) was ranked first in producing maximum GM per hectare followed by Canadian (44.1 mt/ha) and 83INC19G3 (37.0 mt/ha) in Sisuwa, Kaski (700-720 masl) in total three cuttings. In the similar pattern maximum DM production (8.3 mt/ha) was found from Kent-Nepal followed by Canadian (7.6 mt/ha) and 83INC19G3 (6.3 mt/ha) table-3. The plant height was found highly significant different within twelve oat cultivars. The maximum plant height was found from 83INC19G3 (66.4 cm) and lowest was obtained from Longford (52.97 cm).

Table-3. Performance of twelve of oat cultivars at Sisuwa, Kaski (700-720 masl)

Oat cultivars	Plant height (cm)	Tillers/plant (nos)	Leaf no. /plant	Green matter (mt/ha)	Dry matter (mt/ha)
Taiko	64.37	8	4.0	28.4	5.0
NZ93209,02	54.50	7	4.0	33	5.4
Kent-Nepal	55.87	7	4.0	48	8.3
Stempede	61.93	8	4.0	28.5	5.0
Swan-Nepal	56.27	7	4.0	32.4	5.3
83INC-19G3	66.40	6	4.0	37	6.3
Awapuni	57.60	7	4.0	29.4	5.4
NZ92176, 03	57.83	7	4.0	35	6.5
Longford	52.97	7	4.0	26.1	4.1
NZ92173, 02	56.63	8	4.0	27.7	5.4
Canadian	59.23	9	4.0	44.1	7.6
NZ92169, 01	45.93	8	4.0	31.6	6.3
Average	57.46	7.31	4.00	33.43	5.88
F test Between treatment LSD 0.05	***	NS	NS	NS	NS

Bholtar, Dhading

In Dhading (800-850 masl) all parameters such as plant height, tillers per plant, leaf number, green matter and dry matter were not found statistically significant different. Awapuni (21.8 mt/ha), NZ92173,02 (41.5 mt/ha) and NZ176,03 (39.3 mt/ha) were the first three oat cultivars among twelve cultivars under study for the maximum GM production. In case of DM the highest yield was obtained from Awapuni (8.0 mt/ha) followed by NZ92176,03 (7.9 mt/ha) and NZ92173,02 (7.3 mt/ha) table-4.

Table-4: Performance of twelve of oat cultivars at Bholtar, Dhading (800-850 masl)

Oat cultivars	Plant height (cm)	Tillers/plant (nos)	Leaf no. / plant	Green matter (mt/ha)	Dry matter (mt/ha)
Taiko	62.33	7	4.0	38	7.4
NZ93209,02	58.37	6	4.0	36.5	6.7
Kent-Nepal	59.10	7	4.0	37.8	7.1
Stempede	56.03	5	4.0	26.8	5.7
Swan-Nepal	58.90	7	4.0	35.2	6.5
83INC-19G3	59.83	6	4.0	30.9	6.7
Awapuni	69.20	7	4.0	42.3	8.0
NZ92176, 03	62.20	6	4.0	39.3	7.9
Longford	59.17	7	4.0	34.8	7.3
NZ92173, 02	65.13	7	4.0	41.5	7.3
Canadian	61.80	6	4.0	28.2	5.8
NZ92169, 01	50.73	8	4.0	25.8	5.4
Average	60.23	6.56	4.00	34.76	6.80
F test Between treatments	NS	NS	NS	NS	NS

Riyale, Kavre

The green matter and numbers of tillers per plant was found significantly different ($P<0.05$) in different oat cultivars. Awapuni, Canadian and Kent –Nepal were found first, second and third ranking oat cultivars on producing GM (21.8 mt/ha), (17.9 mt/ha) and (17.1 mt/ha) respectively in Riyale, Kavre (1750- 1870 masl). Similarly maximum DM production was fond from Awapuni (4.5 mt/ha) followed by Kent-Nepal (4.3 mt/ha) and Canadian (3.4 mt/ha). The maximum tillers (12) was found from NZ92169,01 and least was obtained from 83INC19G3 (5) table-5.

Table-5: Performance of twelve of oat cultivars at Riyale, Kavre (1750-1870 masl)

Oat cultivars	Plant height (cm)	Tillers/plant (nos)	Leaf no. / plant	Green matter (mt/ha)	Dry matter (mt/ha)
Taiko	40.1	8	4	13.3	2.6
NZ93209,02	42.1	5	5	13.7	2.3
Kent-Nepal	43.3	8	5	17.1	4.3
Stempede	42.8	6	4	12.5	2.3
Swan-Nepal	44.0	8	5	15.5	3.0
83INC-19G3	40.4	5	5	11.9	2.4
Awapuni	55.4	6	5	21.8	4.5
NZ92176, 03	40.8	7	4	14.8	2.3
Longford	37.7	6	4	10.8	2.1
NZ92173, 02	40.6	7	5	12.3	2.3
Canadian	43.4	8	5	17.9	3.4
NZ92169, 01	36.9	12	4	10.1	2.3
Average	42.3	7.1	4.5	14.3	2.8
F test Between treatments LSD 0.05	NS	*	NS	*	NS

Dhaibung, Rasuwa

Cultivars Awapuni (26.4 mt/ha), Stempade (22.1) and NZ92169,01 (21.2 mt/ha) were recorded to be the highest GM producers respectively in total three cuttings in Rasuwa Dhaibung (1500-1600 masl). Similarly highest DM production was obtained from Awapuni01 (5.4 mt/ha), NZ92169,01 (5.0 mt/ha) and Stempade (4.8 mt/ha) table-6.

Table-6: Performance of twelve of oat cultivars at Dhaibung, Rasuwa (1500-1600 masl

Oat cultivars	Plant height (cm)	Tillers/ plant (nos)	Leaf no. / plant	Green matter (mt/ ha)	Dry matter (mt/ha)
Taiko	40.0	7	4	20.5	3.8
NZ93209,02	40.2	6	4	14.1	2.7
Kent-Nepal	41.9	6	4	19.8	3.5
Stempede	45.0	6	4	22.1	4.8
Swan-Nepal	40.7	6	4	19.4	3.6
83INC-19G3	41.7	7	4	19.8	4.1
Awapuni	51.9	7	4	26.4	5.4
NZ92176, 03	42.0	7	4	19.3	3.8
Longford	41.2	7	4	20.9	4.2
Hokonui	42.3	6	4	20.6	4.3
Omihi	42.5	6	4	16.6	2.9
NZ92169, 01	43.2	7	4	21.3	5.0
Average	42.7	6.5	4.0	20.1	4.0
F test					
Between treatments	NS	NS	NS	NS	NS

Bhorley, Rasuwa

One of highest location (200-2200 masl) on this experiment and cultivars Awapuni (14.9 mt/ha), Hokonui (14. mt/ha) and Longford (13.1 mt/ha) were the ranked first, second and third in maximum green matter yield per hectare in total three cuttings. A non significant different was found on all parameters taken table-7.

Table-7: Performance of twelve of oat cultivars at Bhorley, Rasuwa (2000-2200 masl)

Oat cultivars	Plant height (cm)	Tillers/ plant (nos)	Leaf no. / plant	Green matter (mt/ha)	Dry matter (mt/ha)
Taiko	42.2	7	4	12.2	2.4
NZ93209,02	42.8	9	4	12.8	3.0
Kent-Nepal	39.0	7	4	11.5	2.7
Stempede	37.9	7	4	10.6	2.3
Swan-Nepal	37.5	6	4	10	1.9
83INC-19G3	39.8	9	4	11.8	2.8
Awapuni	36.7	8	4	14.9	3.2
NZ92176, 03	39.8	7	4	10	2.2
Longford	41.6	8	4	13.1	2.7
Hokonui	40.8	8	4	14.3	3.7
Omihi	39.2	8	4	10.1	2.1
NZ92169, 01	39.2	7	4	9.7	2.2
Average	**39.7**	**7.6**	**4.0**	**11.8**	**2.6**
F test	NS	NS	NS	NS	NS
Between treatments					

CONCLUSIONS

From the results it has been concluded that lower altitude has been found to be more favorable for increased oat production than the oat production at the higher altitude at the similar input and management conditions.

For examples, Inaruwa Sunsari is one of the lowest places of the project site where Awapuni cultivar yielded highest green matter(62 mt/ha) and dry matter(11.5 mt/ha) productions. In similar elevation (181 masl) in Banke Nepalgunj the exotic oat cultivar 83INC19G3 produced the highest green matter(61.5 mt/ha) and dry matter(12.0 mt/ha) productions in total three cuttings.

In the mid hills, the farmers widely adopted cultivar Kent- Nepal yielded highest quantity of green matter (48.0 mt/ha) and dry matter(6.2 mt/ha) productions in total three cuttings in Kaski Sisuwa (700-720 masl). In similar altitude (800-850 masl) of Dhading district, Awapuni cultivar produced the highest green matter(42.3 mt/ha) and dry matter(7.9 mt/ha) yields in total three cuttings.

In the high hills, again Awapuni produced highest quantity of green matter (26.4 mt/ha) and dry matter(5.8 mt/ha) productions in total three cuttings in Rasuwa Dhaibung (1500-1600 masl). In the similar altitude (1750-1870 masl) of Kavre district Awapuni cultivar gave the highest green matter(21.8 mt/ha) and dry matter(4.6 mt/ha) yields in total three cuttings. Similarly in the higher hills Bhorley of Rasuwa (2000-2200 masl) the highest quantity of green matter (14.9 mt/ha) and dry matter(3.3 mt/ha) productions were produced by Awapuni cultivar.

The result showed that cultivar awapuni is suitable for terai, mid hills and high hills. From the regression analysis fodder yield of oat cultivars was directly proportional to location altitude. Both green and dry matter productions were found to be higher at the lower altitudes than the green and dry matter productions at the higher altitudes.

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EFFECT OF FERTILIZATION ON SEED YIELD OF MATURE STANDS OF PERENNIAL FODDER LEGUME

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ABSTRACT

Flemingia macrophylla (Willd.) Merrill. is a perennial legume shrub widely used by Nepalese farmers for winter season fodder in recent years. Decline in seed productivity of mature stands after some years of establishment is an imperative problem of seed production of F. macrophylla facing by the farmers. Despite the importance of fodder crops, limited information is available in the fertilizer management of mature stands of F. macrophylla for seed production. A study was carried out in Chitwan condition to investigate the effect of application of different graded levels of phosphorus on seed productivity of three-year old mature stands. The experiment was conducted in Randomized Complete Block Design (RCBD) with five treatments and four replications. The treatments were five graded levels of phosphorus (P); 0, 10, 30, 50 and 70 kg P ha^{-1} each combined with 30 kg nitrogen (N). Observation on seed attributing characters and seed yields were taken. The results of the study had shown that the number of branches and number of inflorescence per branch were increased significantly ($p<0.01$, $p<0.001$) by the application of increased levels of P with 30 kg N ha^{-1} but branch height, number of pods per inflorescenceand test weight of seeds were not affected ($p>0.05$). Significantly higher ($P<0.001$) seed yield was obtained by the application of 30-50 kg P ha^{-1} with 30 kg N. The seed yield remained constant for the application of P beyond 50 kg ha^{-1} with 30 kg N. So, application of 30-50 kg P ha^{-1} with 30 kg N increases the seed yield of mature stands of F. macrophylla which could be more beneficial to the farmers involved in the fodder seed production.

Key words: Mature stands, perennial, fodder legume, phosphorus, seed yield

INTRODUCTION

Ruminant animal production is the common practice in rural areas of Nepal. Accordingly, year round green fodder supply as a fiber source is the obligation. But, severe winter-spring fodder deficit is continuously faced by the Nepalese farmers for their livestock (Upreti and Shrestha, 2006). Realizing this, national policies and programs of the country have been focusing in the promotion of winter and spring fodders in recent years. In this context, *Flemingia macrophylla*- a perennial fodder legume has gained popularity from Terai to Mid-hills of Nepal in recent years. It is a multipurpose shrub species, basically grown for fodder production for dry season, for enhancement of soil fertility (Schultze-Kraft, 1996) and is used for live soil cover or mulch, erosion barrier, hedge, shade-providing shrub in young coffee and cocoa plantations, and as firewood (Andersson *et al.*, 2002). *F. macrophylla* is well suited in the environments from Terai to Mid-hills (Kshatri, 2000; Singh 2000; Kayastha, 2004) and grows well on a range of soils, including clay and sandy soils, and is well adapted to very acid, infertile soils (Schultze-Kraft, 1996).

Since this species is getting wider popularity in recent years, availability of seed became a limiting factor in many cases due to limited seed production activities (TLDP, 2002). It needs to develop complete cultivation package of seed production for Nepalese context. On the other hand, the farmers involved in the fodder seed production are facing the problem of drastic reduction on the seed yield of *F. macrophylla* after few years of plant establishment. Different authors in different studies reported the variability of *F. macrophylla* in seed productivity which indicates the significance of appropriate nutrient management. Accordingly, Anderson (2006) found that average seed yield of 9-140 g plant^{-1} which was varied with accessions, environment and nutrient management.

F. macrophylla is capable of responding to fertilizers (Andersson *et al.*, 2002). Several nutrients like, nitrogen and phosphorus had their effect on crop physiology, fodder and seed yield (Khatri-Chhetri, 1991). *F. macrophylla* is a nitrogen fixing fodder legume and accumulates the good quantity of nitrogen in the soil after some year of its establishment (Sablan and Marutani, 2003) which may alter nitrogen-phosphorus balance in the soil. Moreover in the case of perennial legumes, the availability of P may be decreased due to P absorption into the plant biomass (Haggar *et al.,* 1991; Suriyagoda, 2011), which needs to maintain balances of addition and removals of P in a cycle (Palm *et al.*,

1991; Salazar, 1991). On the other side, phosphorus deficiency effects N fixation in legumes through its effect on root infection, nodule development and nodule function and plant growth (Haque and Jutzi, 1984; Kennedy and Cocking, 1997). Focus on correcting P, K and S deficiencies for optimum seed yield of legumes is crucial (Malhi *et al.*, 2008). Therefore, the study was carried out in order to investigate the effect of fertilization in the mature stands of *F. macrophylla* on seed yield and seed attributing characters.

MATERIALS AND METHODS

The experiment was conducted in the premise of Rampur Campus, Chitwan at 228 masl and 27° 40' N and 84° 19'E from June 2006 to May 2007. During the experimental period, average monthly minimum temperature was on January (7.8°C) and maximum temperature was on May (35.08°C). The annual rainfall was 2097 mm with higher precipitation in May-August and lower in October-March.

The experiment was conducted by imposing the five graded levels of phosphorus and constant level of nitrogen in a Randomized Complete Block Design (RCBD) with four replications. The treatments were; 0, 10, 30, 50, 70 kg Phosphorus with constant 30 kg Nitrogen ha^{-1}. Before the instigation of the experiment, the defoliation height and spacing of three years old mature stands of *Flemingia macrophylla* were maintained as per the recommendation of Kayastha (2004). The defoliation height was maintained at 75 cm from ground level for all the experimental plants. Plant spacing was maintained by 90 cm x70 cm at the rate of 15873 plants ha^{-1}. Size of each experimental plot was 3.6 m ×2.1 m, and every plot consisted of 12 plants. Manual weeding was done for weed control and no chemicals were used for controlling diseases and pests. No irrigation was provided to the experimental plots during entire experimental period. The fertilizers were manually applied by making the rings around 30 cm apart from the base of the plants.

Initial soil nutrient status was taken before setting the experiment. The soil samples were collected randomly. A total of four samples were taken at 15 cm depth from each experimental plot and mixed thoroughly. Then after, composite samples were prepared for subsequent processing and analysis. The prepared samples were analyzed in the Laboratory of Soil Science Division of Nepal Agricultural Research Council at Khumaltar, Lalitpur (Table 1).

Table 1. Initial soil characteristics of experimental plots at Rampur, Chitwan.

SN	Parameters	Mean±s.d.
1	Soil pH	5.23± **0.18**
2	Organic matter (%)	1.13± **0.08**
3	Nitrogen (%)	0.12± **0.01**
4	Available phosphorus (kg ha^{-1})	32.17± **1.88**
5	Available potash (kg ha^{-1})	178± **11.55**

Source: Laboratory Analysis (2006).

The observations were taken from randomly selected twelve plants for each treatment, three from each plot. All the selected plants were tagged and had given its identification number. Each branch of every selected plant was also tagged for its identification with treatment number, replication number, plant number and branch number. As this plant is an indeterminate type and needs multiple harvesting, several manual and selective picking of ripen inflorescences was performed from Nov 2006 to April 2007. The harvested inflorescences of every branch were collected in individual sample bag with its identification. Number of pods in each inflorescence, number of inflorescence in each branch, and number of branch in each plant were counted. Counting of branch, pods and inflorescence were followed by seed threshing. Threshed and cleaned seeds of individual sample bag were weighed separately. The test weights of the seeds from different treatments were taken by weighing 1000 seeds. Then the seed production and seed attributing characters were calculated.

Data obtained from experiment was analyzed using Analysis of Variance procedure for RCBD design. GenStat Discovery Edition 4 and Microsoft Excel were used for the data analysis. The mean separation was done by using Duncan's Multiple Range Test (Steel and Torrie, 1980).

The statistical model used in the experiment was;

$$Y_{ij} = m + a_i + b_j + e_{ij}$$

Where, Y_{ij} is the random variable representing the response of treatment i observed in block j

m is overall mean

a_i is the i^{th} treatment effect

b_j is the effect of j^{th} block, and

e_{ij} is the random error term associated with ij^{th} observation

RESULTS

Seed attributing characters

The number of branches plant^{-1} and the branch height are presented in Table (2). The number of branches plant^{-1} were significantly higher($p<0.01$) for higher levels of P application with 30 kg N ha^{-1}. The treatments applied with 30, 50 and 70 kg P with constant level of N (30 kg) ha^{-1} contained 13.01, 11.25 and 12.82 branches plant^{-1} which were statistically higher ($p<0.01$) than 0 and 30 kg P with 30 kg N ha^{-1}. But, mean branch height of the plant applied with all levels of fertilizers were statistically similar ($p>0.05$).

Table 2. Mean number of branches, and branch heights of Flemingia macrophylla applied with different levels of fertilizer treatments at Rampur, Chitwan.

Treatments*	Number of branches (plant^{-1})	Branch height (cm)
T_1 (0 kg P with 30 kg N ha^{-1})	9.09 ^{a}	178.7
T_2 (10 kg P with 30 kg N ha^{-1})	7.33 ^{a}	174.5
T_3 (30 kg P with 30 kg N ha^{-1})	13.01 ^{b}	189.5
T_4 (50 kg P with 30 kg N ha^{-1})	11.25 ^{b}	199.8
T_5 (70 kg P with 30 kg N ha^{-1})	12.82 ^{b}	193.0
Probability	**	NS
SEM	1.19	9.7
% CV	22.4	12.3

The means within the same column with different superscripts are significantly different, NS= Non significant at p= 0.05

The effects of graded level of P with constant level of N on number of inflorescence branch^{-1} and number of pods inflorescence^{-1} are presented in Table (3.) Number of inflorescence branch^{-1} were significantly better ($p<0.001$) for T_3, T_4 and T_5 treatments (38.68, 36.35 and 39.63, for 30, 50 and 70 kg P with 30 kg N ha^{-1}, respectively) in comparison to T_1 and T_2 treatments (28.85 and 26.93, respectively). But, the number of pods inflorescence^{-1} was obtained statistically similar ($p>0.05$) for all the treatments, which were in the range of 16.29 to 18.89 pods inflorescence^{-1}.

Table 3. Number of inflorescence and number of pods of F. macrophylla under different of fertilizer treatments at Rampur, Chitwan.

Treatments*	No of observation	No of inflorescence branch^{-1}	No of pods inflorescence^{-1}
T_1 (0 kg P with 30 kg N ha^{-1})	104	28.85^a	16.61
T_2 (10 kg P with 30 kg N ha^{-1})	87	26.93^a	18.89
T_3 (30 kg P with 30 kg N ha^{-1})	168	38.68^b	16.29
T_4 (50 kg P with 30 kg N ha^{-1})	160	36.35^b	16.90
T_5 (70 kg P with 30 kg N ha^{-1})	192	39.63^b	16.42
F-probability		***	NS
SEM		1.88	0.48
% CV		26.3	12.6

The means within the same column with different superscripts are significantly different. NS= Non significant at p= 0.05

Test weight, another important attribute of seed quality and seed yield, has been presented in Table (4). The response of graded levels of P fertilizer (with 30 kg N ha^{-1}) on the thousand seeds weight was not found apparent ($p>0.05$). The test weights of the seeds from five treatments were in the range of 19.67 to 20.78 g which were within the range obtained by Anderson (2006) i.e. 14.75-20 g.

Table 4. Thousand seeds weight of F. macrophylla seeds under different fertilizer treatments of at Rampur, Chitwan.

Treatments*	Thousand seed weight (g)
T_1 (0 kg P with 30 kg N ha^{-1})	19.67
T_2 (10 kg P with 30 kg N ha^{-1})	20.11
T_3 (30 kg P with 30 kg N ha^{-1})	20.78
T_4 (50 kg P with 30 kg N ha^{-1})	20.67
T_5 (70 kg P with 30 kg N ha^{-1})	20.56
Probability	NS
$LSD_{0.05}$	0.857
SEM	0.29
% CV	4.4

NS= Non significant at p=0.05.

Seed yield

Higher seed yield was obtained from the treatments having higher levels of P (with 30 kg N ha-1) application (Table 5). The treatments; T3, T4 and T5 (30, 50 and 70 kg P application with 30 kg N ha-1) had yielded higher seed yield (3.710, 3.612 and 3.625 t ha-1, respectively) in comparison to no or lower levels of P applications (with 30 kg N ha-1). While calculating the covariate seed yields of F. macrophylla with the number of branches plant-1, the similar result was obtained. Application of higher levels of P (30, 50 and 70 kg P ha-1) with 30 kg N had yielded higher ($p<0.001$) seed yield in comparison to lower level of P (0 and 10 kg P ha-1) with 30 kg N ha-1. The treatments; T3, T4 and T5 had yielded 3.208, 3.493 and 3.163 t seed ha-1, which were statistically at par ($p>0.05$) among them.

Table 5. Mean seed yield of F. macrophylla under different fertilizer treatments to at Rampur, Chitwan.

Treatments	Seed yield (t ha^{-1})	Adjusted$^{\Psi}$ seed yield (t ha^{-1})
T_1 (0 kg P with 30 kg N ha^{-1})	1.705^{a}	2.055^{a}
T_2 (10 kg P with 30 kg N ha^{-1})	1.610^{a}	2.343^{a}
T_3 (30 kg P with 30 kg N ha^{-1})	3.710^{b}	3.208^{b}
T_4 (50 kg P with 30 kg N ha^{-1})	3.612^{b}	3.493^{b}
T_5 (70 kg P with 30 kg N ha^{-1})	3.625^{b}	3.163^{b}
Probability	***	***
SEM	0.324	0.206
% CV	7.23	4.45

$^{\Psi}$Covariate mean with number of branches.

The means within the same column with different superscripts are significantly different.

F. macrophylla had shown good response of fertilization on seed productivity. The response of graded levels of P with 30 kg N ha^{-1} is presented in Figures (1 and 2). The scattered plot and trend line (Figure 1) and the response curve (Figure 2) had shown that the increment on seed yield was continuous beyond 30 kg P ha^{-1} and remained constant from the summit between 30 to 50 kg P with 30 kg N ha^{-1}.

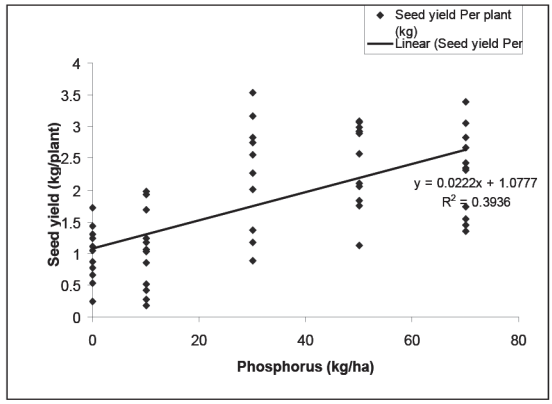

Figure 1. A scattered plot and trend line of the seed yield of *F. macrophylla* responding different treatments at Rampur, Chitwan.

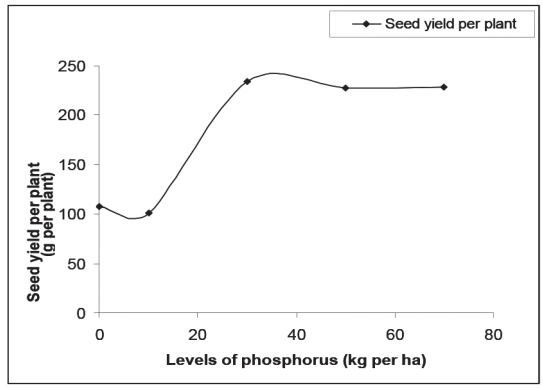

Figure 2. Response curve of different treatments to the seed yield of *F. macrophylla.*

DISCUSSION

The results of the study had revealed that the seed attributing characters; number of branch and number of inflorescence branch^{-1} were apparently ($p<0.01$, $P<0.001$) increased by the treatments of higher levels of P with 30 kg N ha^{-1}. The branch height, number of pods inflorescence^{-1} and test weight of seeds was not adversely affected in the study. Seed yield of *F. macrophylla* was increased by the addition of nitrogen and phosphorus in the soil. Increasing the level of P up to 30 kg ha^{-1}with 30 kg N had continuously increased the seed yield of *F. macrophylla*. Further increment in application of P beyond 50 kg P ha^{-1} with 30 kg N had resulted constant seed yield.

Superior seed attributing characters of the treatments containing higher levels of P with N might have contributed to the higher seed yield in the study. Added nitrogen and higher levels of P could have enhanced the seed attributing characters because; nitrogen is used as a constituent of protein, enzymes and chlorophyll and is involved in all processes associated with protoplasm, enzymatic reactions and photosynthesis. Nitrogen increases seed yields, encourages vegetative growth by multiplication and elongation of leaves and stalks, produce rapid growth, increase green color of plants, and increase protein content of various plant parts. Likely, phosphorus stimulates early growth and root formation, stimulates sexual functions in plants resulting more fertile flowers, contributes to root multiplication and make better exploitation of soils' water and nutrient resources, hasten maturity and promote seed production, decrease flower failure resulting from an excess of nitrogen, contribute to the greater strength of plants (Khatri-Chhetri, 1991; EFMA, 2000; Malhi, 2008). Furthermore, N2 fixation is also depends on soil P availability (Kennedy and Cocking, 1997).

Seed yield of three-years old mature stands of F. macrophylla had shown very good response to higher levels of P with N fertilizers. Continuous uptake of P by the plants for a long time could be the upshot of lower P availability in the soil required for the legume (Table 1) and the seed productivity might have influenced in the treatments having lower or no P application. A huge amount of available P is depleted from the soil where much legume production occurs (Sanchez, 2002). Balances of P additions and removals in alley cropping systems of perennial fodder legumes on infertile and acidic, or fertile (but low in P) soils suggested that imbalance in P addition and removals eventually limited the productivity of these fodders (Palm et al., 1991; Salazar, 1991). Likewise, Phosphorus is the element that theoretically should be most limiting in agroforestry systems when the amounts of P removal are relatively high or cycling is low (Szott and Kass, 1993). Similarly, Haggar et al. (1991) found that after seven year of alley cropping systems utilizing perennial fodder legumes decreased P availability due to P absorption into the tree biomass. It is clear, therefore, that there must be adequate, readily available reserves of P in the soil. A deficiency of P affects not only plant growth and development and crop yield, but also the formation of seeds. Deficiency can also delay the ripening of seeds which can set back the harvest, risking the quality of the produce (EFMA, 2000). On the other hand, the perennial fodder legume like F. macrophylla has tendency to compete for and sequester nutrients such as P (Szott and Kass, 1993). Most unmanured soils contain too little readily available phosphorus to meet the large demand of crops,

particularly during certain periods of the growing cycle. Fertilizers containing P must therefore be added in an interval (EFMA, 2000). In other experiments too, increased levels of P application resulted higher P uptake by the plants and significantly increased yield of perennial legumes (Malhi et al., 2008; Moir et al., 2012).

CONCLUSION

Present study revealed that the seed production of the mature stands of F. macrophylla was increased by the application of the nitrogen and phosphorus fertilizers. Seed attributing characters and seed yield of the three-years old mature stands of F. macrophylla was augmented by 30 to 50 kg P ha-1 with 30 kg N, and was constant for application of P beyond 50 kg ha-1 with 30 kg N. Application of 30 to 50 kg P ha-1 with 30 kg N increased the seed yield of three-years old mature stands of F. macrophylla. The findings of the study will be helpful to mitigate the problem of drastic decline in the seed production of F. macrophylla after some years of establishment which will benefit the farmers involved in fodder seed production.

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GROWTH PERFORMANCE OF GRAZING INTACT MALE KIDS SUPPLEMENTED WITH DIFFERENT LEVELS PROTEIN DIET UNDER FARMERS' MANAGED CONDITION

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ABSTRACT

An experiment was done to determine the effect of concentrate supplementation on growth performance and economics of grazing intact male kids under farmers' managed condition. 24 male kids aged 4-5 months were selected. A Randomized Complete Block Design (RCBD) was employed using four treatments, each with six replications. The treatments were grazing only (T1; control), grazing plus 10% CP diet supplemented (T2), grazing plus 14% CP diet supplemented (T3), and grazing plus 16% CP diet supplemented (T4). Body measurements for morphological traits were taken at the beginning and at the end of 90 days growth period, while weighing was done at 15 days interval to measure growth and productive performance. The results of the experiment concentrate supplementation to the male kids revealed that the mean body weight (kg) at the end of growth, mean body weight gain (kg) during the experiment and mean daily weight gain (MDWG; g) were significantly different (P<0.01) among the treatments. The highest values for mean body weight at end of growth period (15.25kg), and mean body weight gain (7.25kg) over the same period were achieved with T4. Similarly, the highest MDWG was obtained in T4 (80.56g). The findings of economic analysis also revealed that gross return per male kid was recorded highest (NRs.1119.5) in T4 followed by T3 (NRs.929). BCR was highest (1.69) in T4 followed by T3 (1.40). Thus 14 to 16 % CP content in supplemented diet at early growth stage of male kids raising could be recommended practice to the farmers.

Key words: Kid, Protein, SLA, grazing

INTRODUCTION

The distribution of goat population according to the ecological region revealed that the concentration of goat was highest in the hill region (49.44% of total) followed by terai region (36.77%) and the lowest (13.80%) in mountain region. The average annual increment of the goat

population in the country was 2.90 % during the last decade (1997-2007) and same growth rate exist at present (MOAC, 2007).

Goat contributes 12% to livestock gross domestic product (Joshi and Shrestha, 2003). Goat meat (Chevon) is very popular and is preferred over other meat throughout the country (Dhakal, *et al.*, 1985). It is also one of the most expensive meat in the country. The price of the meat has increased by 300% over last ten years (Kharel and Pradhan, 1988) suggesting a high demand of goat meat in the country. Goats are well-liked among rural resource less farmers because goats need less initial economic investment, less feed requirements, simple sheds, and less management requirements (Jindal, 1984). Goat farming is speedily growing enterprise for the country and plays important role to enhance agricultural economy. Small farmers can raise the goat and generate income in short period of time. Majority of poor section of rural population depend on goat to generate household income, besides its use for manure.

Goats, in Nepal, are raised widely on grazing either in migratory or in sedentary management system. Goat production system, in Nepal, is mainly classified into extensive, intensive and semi-intensive system (Shrestha, 1996; Joshi and Shrestha, 2003).

Goat meat production in the country is not meeting its current demand therefore; there is an increasing dependency upon the importation of animals and meat from neighboring countries (India and China). Per capita consumption of meat, in nepal, is 8.7 kg per year, which is below the world average standard (shrestha *et al.*, 2003). Productivity of goat is low due to negligence on breeding and nutrition along with disease, parasites and predators. Nepalese rural farmers are still unknown about the economic potentiality of commercial goat meat production. According to farmers(66%) growth of growing male kid was slow.

Precise information is lacking on the existing goat production system in western Nepal, where forest grazing based rearing is common. Farmers report low level of growth of male kids thus necessitates the study on existing prospects/problems and to find out ways to improve growth and productivity. Concentrate supply with appropriate protein level could help improve early growth.

Limited studies are carried out especially with male goat kids to improve the existing slow growth related problematic situation in

group experience together. So, SLA was used for identifying key issues concerned with existing goat production system at Chhinchu, Surkhet to deal to the objective of this study. The present study utilizes the concept of experiential learning for exploring issues of goat production in farmers group.

Experiential Learning

Past experiences and existing situation of goat production system at Chhinchu had been studied by using the learning cycle as given by Kolb in 1984. Several researchers have applied the theory of Experiential Learning for situation improving specifically in Hawkesbury Agriculture College, Australia (Gamble et al, 1996; Bawden, 1995). Experiential learning is useful in finding issues and improving situation in agricultural systems. Therefore, this methodology is appropriate to explore the existing situation and suggest improving strategies. Key researchable issues related to goat production system with their interrelationship are given in figure 2, on the basis of findings explored by the use of SLA approach.

Concrete Experience(CE)

Low productivity in goats' a major issue

1. Feeds and feeding related problems (shortage of fodder and forage in grazing area lack of concentrate supplementation; insufficient feeding knowledge; degradation of forest area due to heavy grazing pressure, and lack of fodder and forage plantation programs and people participation) were important causes of low productivity associated with goat keeping.
2. Faulty management practices (late castration of buck; no special care of new born ones and pregnant dam; lack of preventive measures against diseases, and traditional management practices and lack of appropriate goat farming innovative idea among farmers and lack of coordination among different agencies for implementation goat program) were also realized important factors of low productivity.
3. Health related problems such as kid mortality, slow growth rate in growing male and female kids; external and internal parasite infestation; pneumonia, and several other diseases and parasitic conditions such as gastroenteritis, mange, abortion, infertility were also responsible for low productivity in goats.
4. Poor housing management practices such as less space in the shed; poor ventilation facility; weak construction of shed, and delayed manure disposal from goat shed were also responsible for low productivity in goats.

5. Breeding related problems; such as inbreeding in the flock; lack of selection of prolific doe; lack of quality breeding buck and no well defined resource centre for Khari goat were also contributing factor for low productivity in goats at Chhinchu, Surkhet.

Reflective observation(RO)

Analysis of causes of low productivity in goat of Chhinchu, Surkhet, was done based on group discussion, key informant interviews and interactions with participants. The information obtained revealed that fodder and forage resources are decreasing due to over exploitation these resources to meet the demand of increasing population of ruminant animals.

Abstract conceptualization

Decision to be made

1. Appropriate feeds and feeding technique implementation
2. Optimum use of natural resources focusing on forest grazing
3. Concentrate supplementation in the diet of growing goat for early growth and better profit.
4. Suitable breeding programs implementation
5. Construction of goat shed with better facility
6. Disease control program implementation.
7. Routine management practices

Active Experimentation (AE)

The following points were obtained with the use of AE Concept.

1. Appropriate feeding techniques should be developed and economics of concentrate supplementation for early growth in male kids was imperative to be examined.
2. Establishment of forage resource centre with superior grass and legumes was suggested.
3. Perennial forage cultivation programs in grazing forest areas as well as in the private land should be implemented with local people.
4. Improving of breeding stock through superior quality buck dis tribution and selection of high performance genetic make up dam with high milk producing ability should be given priority; also considering mechanism to check inbreeding hazards.
5. Construction of shed with facility of cleaning, ventilation and space was also reached on group consensus.

There were many reasons for low productivity of goat in the rural areas, thus agencies concerned with goat development programs should understand goat production as system perspective rather than a single entity. Kolachhapati (2006) reported that growth and reproduction of goats are one of the most important economic, traits, and is highly influenced by the dietary protein and energy content of feeds and fodder provided to them. Farmers as well as different goat program implementing agencies paid very little attention towards feeding and management of goats thus resulted in lower production. Thus goat programs should be viewed from system perspective covering all components of goat production system and their interrelationship with each other.

Findings from biological research

At 90days of observation, treatments difference were significant ($P<0.01$) (Table1). Accordingly, the highest mean body weight (15.25±0.29kg) was recorded with the treatment grazing plus 16 % CP diet supplemented, while the values were lowest (11.82±0.29kg) for grazing only treatment. At this growth period, the mean body weight of kids with grazing plus 16 % CP diet supplemented was significantly different ($P<0.01$) with other three treatments(Table 1). Similarly, the difference was significant also between the treatment with grazing plus 14 % CP diet supplemented and grazing plus 16 % CP diet supplemented. On the other hand, treatment with grazing plus 10 % CP diet supplemented and grazing only were statistically similar ($P<0.05$) (Table 1). This value was slightly lower than the value reported by Kolacchapati(2006) under stall feeding for the same age. The author observed the mean body weight of male Khari goat kids as 16.6kg and 18.4kg at 7-8 months of age, respectively. The result of this experiment was also appeared comparatively lower than those reported by other researchers (Acharya, 2005; Kaderia, 2006). Acharya (2005) reported mean body weight of khari goat as 17.2± 1.37kg in western mid hills of Nepal fed diet containing 14% CP. Kaderi(2006) reported mean body weight of male goat kids supplemented with 14% CP diet as of 20.7kg at age of 7-8 months. The possible cause for this kind of comparatively lower mean body weight gain at the same age as revealed in this study might be due to variation in system of management, because male kids under this study were raised under forest grazing system with limited concentrate supplementation whereas it is learned that goat male kids kept intact leading to lower feed intake (Morand Fehr, 1981) and slow growth (Kumar *et at.*1981 and Mishra *et al.*1986), especially for forest based system. Overall mean body weight gain (kg) of experimental male kids under different treatments is presented in Table 1. Accordingly, the

treatment differences were significant (P<0.01). The mean body weight gain ranged from 3.81kg to 7.25kg. The highest mean body weight gain was for treatment with grazing plus 16% CP diet supplemented at 90days(T4; 7.25kg) whereas the lowest body weight gain (3.81kg) was for the treatment reared under grazing only at 90 days(T1)(Table 1). The mean body weight gain (kg) of male goat kids for 90 days growth period was slightly lower than the value reported by Kolachhapati (2006). The author observed the total body weight gain was 6.5kg at 7-8 months of age under stall feeding with 14% CP diet supplemented male kids whereas in the case of grazing plus 10% diet supplemented treatment of this study the mean body weight gain at 90days of growth period was higher than as reported by Kolachhapti(2006). This reflect the fact that goats under forest grazing could receive additional protein from forest as well as from concentrate supplementation and thus male goat kids of this study had better growth rate. However, the findings of this study are in agreement with the results of Acharya(2005) as the author observed mean body weight gain of 7.12kg with 16% DCP concentrate fed goat kids.

The mean daily weight gain (g) of experimental male goat kids is presented in Table 1. The difference between the treatments were significant (P<0.01). The mean daily weight gain (MDWG) ranged from 42.41 to 80.56 g. The highest MDWG was attained by male goat kids raised under treatment with grazing plus 16 % CP diet supplemented for 90days (T4; 80.56±2.35g), whereas the lowest MDWG(42.41±2.35g) was obtained in the treatment with grazing only and raised for 90 days. The MDWG of the rest of the treatments were in between those two treatments (Table 1). The benefit cost ratio (BCR) was highest (1.69) under grazing plus 16% CP diet supplemented group, followed by grazing plus 14% CP diet supplemented group (1.40) (Table 1). The mean daily weight gain (66.48g/day) of male kids kept under grazing plus 14% CP diet supplemented of this study are thus in agreement with findings of Kaderia (2006) as the author observed 66g MDWG at same protein level and age with Khari and Jamunapari crossbred. Findings of this study are somehow similar but lower than the value reported by previous research work of Kolachhapati (2006) as the author reported MDWG of 72.2g and 73.3g/day for 7-8 months of age under stall feeding with 14% CP diet supplemented castrated male goat kids. The benefit cost ratio (BCR) was also higher with grazing plus16% CP diet supplemented at 90 days of growth period, followed by grazing plus 14% CP diet supplemented treatment than grazing only. This might be due to the fact that kids supplemented with higher protein attained early and faster growth than non-supplemented kids

because protein is essential for growing and muscle growth (Ranjhan, 1999) and improves digestibility resulting in higher feed intake. Acharya (2005) observed higher net return (NRs.535.28) per goat in 14% DCP diet than 12% DCP diet (NRs 451.38) when slaughtered at 8 months of age. This supported the fact that optimum protein level in the diet of ruminants especially for goats is beneficial whereas lower or higher level of protein could have adverse effect on growth of growing kids.

Table 1. The Overall mean body weight (kg), Overall Mean body weight gain, Overall mean daily weight gain (g) and benefit cost ratio of experimental male kids in different treatments at farmers' conditions, Chhinchu, Surkhet, 2008

Treatments	Overall mean body weight (kg)	Overall Mean body Weight gain (Kg)	Overall Mean daily weight gain (g)	Benefit cost ratio
T1(Grazing only)	11.82^{c}	3.81^{d}	42.41^{d}	1.30
T2(Grazing plus 10% CP diet supplemented)	12.57^{c}	4.56^{c}	50.74^{c}	1.10
T3 (Grazing plus 14% CP diet supplemented)	14.07^{b}	5.98^{b}	66.48^{b}	1.40
T4 (Grazing plus 16% CP diet supplemented)	15.25^{a}	7.25^{a}	80.56^{a}	1.69
F (prob)	<0.01	<0.01	<0.01	
LSD	1.02	0.72	8.02	
CV %	4.45	7.86	7.86	
SEM	0.29	0.21	2.35	

Note: LSD stands for Least Significant Difference at (P=0.05), CV equals Coefficient of Variation and SEM denotes- Standard Error of the Mean

CONCLUSION AND RECOMMENDATION

System analysis could be powerful approach of understanding local context and to identify researchable issues that are equally and strongly valid for livestock sub-system of a farming system.

Growth performance of male goat kids could be well linked to the quality aspect of feed as supported for the higher growth rate and weight gain by higher concentration of CP in supplemented diet with grazing based system. Thus 14 to 16 % CP content in supplemented diet at early growth stage of male kids raising could be recommended practice to the farmers if they are raised on grazing based system.

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REPLACEMENT EFFECTS OF SOYBEAN MEAL (SBM) WITH DIFFERENT LEVELS OF SUNFLOWER MEAL (SFM) WITH OR WITHOUT ENZYME ON PERFORMANCE OF COBB-500 BROILERS

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ABSTRACT

The experiment was carried out at Livestock Farm of Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan. The aim of this study was to find out the replacement effects of soybean meal with different levels of sunflower meal with or without enzyme on growth, feed intake, feed efficiency, carcass characteristics and economics of Cobb-500 broilers. Three hundreds, day-old straight run Cobb-500 broiler chicks were brooded in an electric battery-brooder for a period of seven days, where pre-experimental diet was offered. On eighth day, chicks having uniform body weight were randomly allocated into five dietary treatments; T_1 (0% SFM), T_2 (25% SBM replacement with SFM without enzyme), T_3 (25% SBM replacement with SFM + enzyme), T_4 (35% SBM replacement with SFM without enzyme) and T_5 (35% SBM replacement with SFM + enzyme); with four replications (15 chicks in each). The diets were made isoproteinous and isocaloric. Starter and finisher diets were fed from 2-4 weeks and 5-6 weeks respectively. Weekly feed consumption of the bird (g bird^{-1}) was found statistically similar ($P>0.05$) for all weeks of experiment (0-6 weeks). Total feed consumption (g bird^{-1}) was also found statistically similar ($P>0.05$). The results of weekly body weight gain were found statistically similar ($P>0.05$) for first and second weeks of experiment. But, weekly body weight gain was found significantly different ($P<0.05$) in third, fourth, fifth and sixth weeks. The results showed significantly highest ($P<0.01$) final live weight in T_5 which was followed by T_3, T_1, T_2 and the lowest weight was found in T_4 .Dressing percent, giblet weight and other carcass characteristics were also found statistically similar ($P>0.05$). The gross expenditure bird^{-1} was increased with the higher level of soybean meal. However, income bird^{-1} increased with the lower level of soybean meal with enzyme supplementation. It is therefore, concluded that up to 35% soybean meal can be replaced with sunflower meal (SFM) with enzyme (Microzyme) in broiler starter and finisher diets without adverse effect on growth performance of Cobb-500 broilers.

Key words: Soybean meal, Sunflower meal

INTRODUCTION

Poultry keeping has been an important source of income to many households in Nepal. There is growing awareness of nutritive value of meat and eggs among people. Poultry products (meat and egg) are a good source of food with high biological value. Therefore, poultry keeping is becoming an important business enterprise in both the urban and rural areas of Nepal (Bhurtel and Shah, 2002). Chicken contributes about 6.5% of total meat production in the country and 98% of the total egg production (MoAC-2008/09).These data indicate the increasing trend of poultry production in Nepal. ed cost is the major contributing factor of the poultry enterprises. Soybean meal is a fundamental and most commonly used protein feed of broilers diet. It contains 40-48 percent of crude protein (Ravindran and Blair, 1992; Adhikari, 2008; Khanal, 2009). It is particularly rich in lysine. The amino acid availability in soybean meal is also higher than those for other oil seeds meals (Acherne and Kennelly, 1982).

Sunflower meal is also a good source protein source for poultry, provided that some of its nutritional characteristics are taken into account (Senkoylu and Dale, 1999). Sunflower meal contains 32% crude protein, 1-2% fat, 21-29% fiber, 6% ash, 1.14% lysine, 2.46% arginine, 0.55% cystine, 1.75% valine, 1.38% isoleucine, 0.68% methionine, 0.35% threonine and 1.13% tryptophan (NSA, 2008). It is easily available feed ingredient and good source of protein and B-group vitamins (NSA, 2008).

Many commercial enzymes are being used to accelerate the growth of broiler chickens fed on maize-soybean based diets (Wyatt *et al.,* 1997; Zenella *et al.,* 1999; Saleh *et al.,* 2003; 2004; Karki, 2007; Adhikari, 2008). Microzyme one of the commonly used commercial enzymes, which contain several enzymes, viz *Lactobacillus acidophilus, Saccharomyces cervisiae,* amylase, protease, lipase, cellulase, phytase, β-glucanase, pectinase and xylanase. The effect of enzyme supplementation on the performance of broiler fed diets improves weight gain, feed efficiency, carcass yield and reduces the per unit production cost (Sapkota and Ranjan, 1994; Adam, 2000; Karki, 2007, Adhikari, 2008).

However, the soybean meal is most suitable protein source in poultry diets. The availability of soybean meal for animal feed used in Asia is low (APO, 1990). Moreover, absolute amount of the soybean meal utilized by the Nepalese feed industry is imported from other countries,

especially from India (Lohani and Amatya, 2000). Furthermore, soybean meal used as protein source for feeding animals and birds cost high price in the international market, and also directly competes for human food (Gifford, 1971). The productivity of soybean in the tropical climate i.e. Asia is low due to lack of suitable high yielding cultivars and sub-standard agronomic practices. Besides, soybean also contains several anti-nutritional factors including protease inhibitors, a goitrogenic factor, and an estrogenic compound (Liener, 1980). High feed cost and lesser availability of conventional ingredients necessitates the continuous and intensive efforts to seek alternate agro-industrial by products which can replace soybean at cheaper rate without reducing its performance. Taking into consideration of aforementioned problems, an experiment was designed to find out the effect of sunflower meal substituted for soybean meal with or without enzyme on the performance of broiler chicken.

MATERIALS AND METHODS

This study was carried out at Livestock Farm of Institute of Agriculture and Animal Science (IAAS), Rampur, Chitwan from 1st November, 2012 to 12th December, 2012. The objective of the study was to find out the replacement effects of soybean meal with different levels of sunflower meal with or without enzyme on growth, feed intake, feed efficiency, carcass characteristics and economics of Cobb-500 broilers. A total of three hundreds broiler chicks were used for experiment. Day old chicks were group brooded using an electric battery brooder for 7 days, and were fed on pre-experimental standard starter ration before the actual experiment began. Eight-days-old chicks were allocated randomly to 5 different treatments with four replications (15 chicks in each). The experiment was designed in a completely randomized design (CRD). Broilers were fed isoproteinous and isocaloric starter and finisher diets. The dietary treatments were T_1 (0% SFM), T_2 (25% SBM replacement with SFM without enzyme), T_3 (25% SBM replacement with SFM + enzyme), T_4 (35% SBM replacement with SFM without enzyme) and T_5 (35% SBM replacement with SFM + enzyme).

The broilers were raised up to 6th week of age. The experimental birds were fed (*ad-libitum*) on experimental ration according to their treatment. The experimental birds were kept on a deep litter system in separate pens. The pens were thoroughly cleaned, white washed and disinfected before putting the experimental chicks. All the birds were provided similar management conditions like floor space, temperature, relative humidity, ventilation and light. The birds were vaccinated

according to broilers vaccination scheduleThe data of weekly average body weight, weight gain and feed consumption were recorded and utilized to calculate feed efficiency for first to sixth week of broiler's age. Feed cost of different experimental diets was calculated. At the end of six weeks of experimental period, one bird from each replication was slaughtered. The weight of each carcass was recorded and dressing percentage was calculated on the basis of dressed meat. After evisceration, the heart, liver and gizzard of the slaughtered birds were taken out and weighed for their absolute weight. The data thus obtained were used for the calculation of (a) dressing percentage (%) (Dress weight ofbird/Live weight of bird)×100) (b) relative weight of heart, liver and gizzard. After evisceration, relative weights (g) [(weight of organ/live body weight) X 100] of various internal organs such as liver, heart, gizzard of the slaughtered bird were recorded.

The data thus collected regarding weight gain, feed consumption, feed conversion ratio, dressing percentage and relative weights of heart, gizzard and liver were subjected to the analysis of variance (ANOVA) technique in completely randomized design. The differences in the treatment means were compared by the Duncan's Multiple Range Tests using computer program MSTAT-C basic version 1.3 (1975).

RESULTS AND DISCUSSION

Weekly feed intake

The data revealed that the weekly feed intake and total feed intake of the bird (g bird^{-1}) was found statistically similar ($P>0.05$) on first week of experiment. Similar trend was observed in the second, third, fourth, fifth and sixth weeks (table 1)The feed intake slightly increased in second, third and fourth weeks of experiment, however, it tremendously increased in fifth and sixth weeks. It might be due to higher body weight gain in the later weeks.

The data did not show any difference ($P>0.05$) among the feed conversion ratio of the birds of different treatment groups. Pinheiro *et al.* (2002) did not observe any effect on feed intake with or without SFM diets. Sah (2002) also reported that substituting SBM with SFM did not alter the feed consumption significantly. The result is in agreement with Morris (1968) and Vieira *et al.* (1992) who found that over-consumption of energy in SFM rations could indicate another nutrient was deficient. Similarly, the enzyme did not alter the feed intake of the birds in each week. Testing of different microbial enzymes in another study (EI-

Sherif *et al.*, 1997), however, did not indicate any difference between the treatments and the control diet to which no enzyme was added.

Table 1. Response of Cobb 500 broilers fed different levels of sunflower meal (SFM) with or without enzyme on weekly feed intake (g bird^{-1}week^{-1}) in different weeks at IAAS, Rampur, 2012

Treatments	Period (week) and feed intake (g)						Total Feed intake (g)	Feed conversion ratio
	1	2	3	4	5	6		
T_1 = 0% SBM replacement without enzyme	133.45	280.00	479.11	758.34	993.29	1301.10	3945.29	1.84
T_2 = 25% SBM replacement without enzyme	128.93	283.50	491.46	780.07	995.58	1299.40	3978.94	1.79
T_3 = 25% SBM replacement with enzyme	126.67	283.50	501.40	792.28	994.23	1271.98	3970.06	1.79
T_4 = 35% SBM replacement without enzyme	136.06	278.00	495.83	778.08	989.59	1294.70	3972.26	1.85
T_5 = 35% SBM replacement with enzyme	128.93	278.25	496.47	801.58	996.82	1297.82	3999.87	1.76
P	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
CV %	3.82	2.27	7.59	4.48	0.40	2.00	10.21	3.63
LSD	-	-	-	-	-	-	-	
SEm±	1.27	1.38	2.25	7.73	0.96	5.68	3.01	0.13

SBM: Soybean meal, SFM: Sunflower meal, LSD=least significance difference at 5%, CV=coefficient of variation, WOE=without enzyme, E=enzyme, SEm± = standard error of mean

Weekly body weight

The results of weekly body weight gain were found statistically similar ($P>0.05$) for first and second weeks of experiment. Almost similar body weight gain was observed in each treatment. But, weekly body weight gain was found significantly different ($P<0.05$) in third week. The highest body weight gain was found in T1 (416.26 g) followed by T3 (416.11 g), T5 (409.67 g), T2 (372.85 g) and the lowest body weight was found in T4 (343.54 g). Similarly, weekly body weight gain was found significantly different ($P<0.01$) in fourth week. The highest body weight was found in T5 (514.37 g) followed by T1 (473.42 g), T3 (428.25 g), T2 (415.65 g) and the lowest body weight was found in T4 (346.05 g). Similarly, weekly body weight gain was also found significantly different ($P<0.01$) in fifth week. The highest

body weight was found in T5 (695.97 g) followed by T3 (584.17 g), T2 (571.19 g), T1 (530.97 g) and the lowest body weight was found in T4 (508.08 g). In the same context, weekly body weight gain was found significantly different ($P<0.01$) in sixth week of experiment. The highest and the lowest body weight were found in T2 (402.27 g) and T1 (361.39 g) respectively. The weight gain for other treatments were found almost similar i.e. T3 (377.67 g), T4 (375.04 g), T5 (372.50 g). Similarly, significantly ($P<0.01$) highest final live weight (2196.00g) was found in T5 which was followed by T3 (2176.00 g), T1 (2170.25 g), T2 (2139.20 g) and the lowest weight was found in T4 (2134.29 g) (table 2).

Analysis of variance (ANOVA) showed that the body weight gain of the birds at lower level of replacement without enzyme had yielded higher body weight gain than higher level of replacement in almost every week (0-35% SBM replacement levels). But the body weight gain was found higher in treatments having diet supplemented with enzyme. This might be due to digestion of non-starch polysaccharides (NSPs) by the addition of enzyme.

The findings were supported by Rajesh et al., (2006), Connel (1981), Adhikari (2008) and Khanal (2009). Performance of broilers can be affected on SFM diets at higher levels due to abundant quantities of NSP's like cellulose, hemicelluloses, pectins, β-glucans, arabinoxylans and β-galactosides (Rajest et al., 2006). High levels of fiber also reduce the time of food passage throughout the digestive system (Connel, 1981). Adhikari (2008) and Khanal (2009) reported that enzyme increases the digestion of NSP's which significantly improved the weight gain ($P<0.01$).

Table 2. Response of Cobb 500 broilers fed different levels of sunflower meal (SFM) with or without enzyme on weekly body weight gain (g bird^{-1}week^{-1}) in different weeks at IAAS, Rampur, 2012

Treatments	Period (Week) and body weight gain (g)						Final live weight (g)
	1	2	3	4	5	6	
T_1 = 0% SBM replacement WOE	104.59	241.62	416.26^{a}	473.42^{ab}	530.97^{bc}	361.39^{b}	2170.25^{ab}
T_2 = 25% SBM replacement WOE	101.99	235.00	372.85^{ab}	415.65^{b}	571.19^{bc}	402.27^{a}	2139.20^{bc}
T_3 = 25% SBM replacement with E	92.46	235.86	416.11^{a}	428.25^{b}	584.17^{b}	377.67^{ab}	2176.00^{a}
T_4= 35% SBM replacement WOE	89.67	267.09	343.54^{b}	346.05^{c}	508.08^{c}	375.04^{ab}	2134.29^{c}
T_5 = 35% SBM replacement with E	97.75	232.82	409.67^{a}	514.37^{a}	695.97^{a}	372.50^{ab}	2196.00^{a}
P	Ns	Ns	0.0240*	0.0007**	0.0003**	0.000**	0.005 **
CV	11.97	11.32	8.43	9.72	7.72	1.23	1.00
LSD	-	-	49.76	63.83	67.29	467.74	32.60
SEm±	2.65	6.18	9.34	15.50	17.34	7.51	6.85

Mean in column with different superscripts differ significantly by LSD (P<0.05). SBM: Soybean meal, SFM: Sunflower meal, LSD=least significance difference at 5%, CV=coefficient of variation, WOE=without enzyme, E=enzyme, * = Significant at 0.05 level of significance, ** = Significant at 0.01 level of significance; SEm± = standard error of mean

Carcass characteristics. Statistical analysis of the data did not show any difference (P>0.05) between the dressing percentages of the birds among different treatment groups (Table 3). The relative weight of gizzard, liver, heart and giblet were also found statistically similar (P>0.05) for all the treatment groups (Table 2).

Almost similar result was obtained by Wagan (2001), Sah (2002), Adhikari (2008) and Khanal (2009), they reported a non-significant

effect on broiler dressing percentage, relative weight of giblet (heart, liver and empty gizzard) due to inclusion of different levels of sunflower meal with or without enzyme in broiler diet.

Table 3. The mean dressing percentage, relative weight of giblet (gizzard, liver and heart) of Cobb-500 broilers fed different levels of SFM with or without enzyme from 1 to 6 weeks of age

Treatments	Dressed %	Gizzard Weight%	Liver weight%	Heart weight%	Giblet weight%
T_1 = 0% SBM replacement with SFM without enzyme	77.51	2.17	2.49	0.81	5.47
T_2 = 25% SBM replacement with SFM without enzyme	75.23	2.27	2.07	0.64	4.98
T_3 = 25% SBM replacement with SFM + enzyme	77.53	2.13	2.60	0.82	5.55
T_4= 35% SBM replacement with SFM without enzyme	76.55	2.44	2.35	0.71	5.50
T_5 = 35% SBM replacement with SFM + enzyme	76.91	2.68	2.35	0.73	5.76
P	Ns	Ns	Ns	Ns	Ns
CV %	4.15	14.61	12.90	12.89	10.98
LSD	-	-	-	-	-
SEm±	0.81	0.08	0.07	0.02	0.09

Mean in column with different superscripts differ significantly by LSD (P<0.05).

Benefit Cost (B:C) ratio. The gross expenditure bird^{-1} was increased with the higher level of soybean meal. It was found highest in T_1 (0% SBM replacement with SFM without enzyme; NRs 235.82) followed by T_5 (NRs 235.72), T_3 (NRs 234.62), T_2 (NRs 233.94) and the lowest was found in T_4 (NRs 233.74) per bird. And income bird^{-1} increased with the lower level of soybean meal with enzyme supplementation. Highest income NRs 332.70 was obtained from T_5 (35% SBM replacement with SFM + enzyme) followed by T_3 (NRs 329.80), T_1 (NRs 328.80), T_2 (NRs 324.15) and the lowest income was obtained from T_4 (NRs 323.40). Likewise, the net surplus and change in surplus due to feed change were also found highest in T_5 (35% SBM replacement with SFM + enzyme; NRs 96.98 and +4) and followed by T_3 (NRs 95.18 and

+2.2), T_2 (NRs 90.21 and -2.77) and the lowest was found in T_4 (NRs 89.66 and -3.32). Similarly, the benefit cost ratio (B: C) was observed highest in T_5 (1.41) and followed by T_3 (1.40), T_1 (1.39), T_2 (1.39). And the lowest B: C was observed in T_4 (1.38) (Table 4).

Table 4. Mean benefit cost (B:C) ratio of Cobb-500 broilers fed different levels of sunflower meal with or without enzyme from 1-6 weeks of age

Treatments	Gross expenditure (Rs)	Gross income (Rs)	Net surplus (Rs)	Net surplus over basal ration (Rs.)	Benefit cost (B:C) ratio
T_1 = 0% SBM replacement WOE	235.82	328.80	92.98	0.00	1.39
T_2 = 25% SBM replacement WOE	233.94	324.15	90.21	-2.77	1.39
T_3 = 25% SBM replacement with E	234.62	329.80	95.18	+2.20	1.40
T_4 = 35% SBM replacement WOE	233.74	32380	89.66	-3.32	1.38
T_5 = 35% SBM replacement with E	235.72	332.70	96.98	4.00	1.41

Note: Gross expenditure includes cost of feed, chicks, vaccines, litter material, disinfectants, labor cost, water, electricity, vehicle and medicine.

Rajesh *et al.* (2006) reported that replacement of soybean meal by SFM at 0%. 33%, 66% and 100% with or without enzyme had shown the cost of production per kg live weight over feed cost of 19.57, 18.59, 18.63, 18.02, 19.14, 18.44, 19.13 and 19.07 (in Indian Rupees) which was significantly different ($P<0.05$). The author further reported that inclusion of SFM with 33% and 66% soybean replacement with enzymes decreased the cost of production significantly ($P<0.05$) by 8% and 5.7% respectively.

CONCLUSION

The results from the experiment concluded that up to 35% soybean meal can be replaced with sunflower meal (SFM) with enzyme (Microzyme) in broiler starter and finisher diets without adverse effect on growth performance of Cobb-500 broilers.

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TWO DIFFERENT OILS IN FEEDS FOR BROILER; EFFECTS ON FAT DIGESTION

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ABSTRACT

The objective of present study was to investigate the digestibility of fat in the different segments of the small intestine in broiler chickens fed with two different feed containing either 4% soybean oil or 2% rapeseed oil + 2% linseed oil. The feed containing soybean oil resulted in higher fat digestibility percentage (in jejunum 38.8 vs. 36.3% and the first part of ileum 85.8 vs. 74.6%) compared to the rapeseed plus linseed oil diet. Final body weight and liver weight were significantly different in the diet groups ($p \leq 0.05$). Final body weight in the soya oil group was 2137.6 gram and in the rapeseed plus linseed oil group 2019.6 gram, and liver weight was 64 gram in the soybean oil group and 58 gram in the rapeseed plus linseed oil group. There were no significant differences in the gizzard weight in two diet groups. The increased fat digestibility in jejunum and the first part of ileum might be one factor contributing to increased final body weight.

Keywords: digestibility, ileum, jejunum, fat

INTRODUCTION

Chicken meat is popular all over in the world. Due to its large parts of white meat containing low level of saturated fat and high level of long chain polyunsaturated fatty acid (LC PUFAs), the meat is regarded as healthy meat (Haug *et al.*, 2007). Amount of fatty acid in the chicken meat depend on the feed provided to the chicken, (Christophersen & Haug 2011). Fats and oils are important as high energy source in the poultry diets. Chickens that have been kept on low fat diets have shown poor growth rates, poor feathering, edema and high mortality in few weeks of life. Oil seeds are rich sources of linoleic acid (LA, 18:2 n6), Linseed oil is a valuable source of alpha-linolenic acid (18:3 n3, ALA). Linseed oil is allowing to 10 % up to poultry feed. Both ALA and LA are essential fatty acids that the chicken needs for growth and development. ALA is healthy for the broiler due to increased muscle levels (Olomu & Baracos 1991), (Villaverde *et al.*, 2006). Inclusion of linseed oil in

broiler feed can be good for enrichment healthy fat n-3 PUFA (Zelenka *et al.*, 2006**)**. Nguyen *et al.*, (2003) also reported that linseed oil is the main alternate source of fish oil, it contain ALA and dietary inclusion of ALA increase the production of long chain omega 3 fatty acid EPA (20:5 n3), DPA (22:5 n3) and DHA (22:6 n3). Fatty acid composition of meat play important role in the human health. Long chain omega 3 PUFA play an important role in the metabolism in the body. LA and ALA can be converted in the cells to important eicosanoids. The western diet contains much more omega-6 than omega-3 fatty acids. The ratio between omega6 to omega3 in the western diets may be as high as 10:1 or even 20:1, Haug *et al.*, (2007). Balance of omega-6 and omega-3 fatty acid in the animal product is affected by omega-6 and omega-3 intake. An increase of omega-3 in the feed will increase omega-3 in the meat and this meat may result in improved human health.

Omega-3 polyunsaturated fatty acid EPA and DHA are beneficial for the protecting and inhibiting the incident and development of different chronic disease cardiovascular, neurodegenerative, immune and inflammatory disorder in the human beings;(Calder, 2004; Alessandri *et al.*, 2004**;** Sijben, 2007; Calder, 2006)

Baião & Lara (2005) reported that composition of fatty acid in the diet may influence fatty acid profile in the breast and thick muscle and diet with fat source contained high amount of long chain polyunsaturated fatty acid showed less fat deposition in the muscles. Rape seed oil contains high amount of oleic acid (18:1 n9). Soybean oil contains high level of un saturated fatty acid therefore it is highly digested by broiler compared to the animal fat like lard and tallow (Leeson & Atteh, 1995).

Digestibility indicates that the quality of food, due to its ability to determine the proportion of nutrient in the food that are available for the absorption into the body. Digestibility of nutrient is important as it gives the information about the amount of nutrient in the diet and digested by the animals (Case *et al.* 2010). Digestibility is used to measure the quality of feeds in the diet and cost of production. Main role of stomach in the fat digestion is to transport to the small intestine. There are two enzymes necessary for the normal digestion these are lipase and bile. In the digestion process lipase break down the fat and enzymes comes to the lipid molecule. From the stomach fat passes to the intestine in the form of large droplets. Hurwitz *et al.* 1979, reported that jejunum is main part of lipid digestion and ileum is important for the linolenic, stearic acid and palmitic acid absorption.

The small intestine divided into the two parts, jejunum and the ileum, 40% and 60% of total small intestine. Main role of the small intestine

is to breakdown and absorption of the nutrients into the intestinal wall. Muscle in the jejunum wall is thicker and wide compared to that of ileum wall so when feed pass through the jejunum there is very short retention time compared to the ileum (Attara & Ramji, 2012).

Marker method is appropriate for the determination of digestibility in the mono gastric animals such as chicken, dog and pigs. In this method markers are added in to the birds feed. For the determination of nutrient intake in the gastrointestinal tract these marker method is very useful. Jagger *et al.*, 1992, reported that titanium dioxide ($TiO_{2)}$ is the appropriate marker when it was mixed at concentration of 1 g/kg in pig feed. Short *et al.*, 1996 studied that titanium dioxide quantity, and concluded that 5g/kg in the feed as a good dietary marker in the chicken. Krawielitzki *et al.*, 1987 studied marker in the rats and concluded that titanium dioxide is easy to analysis and recovery rate is high. (Hafez *et al.*, 1988) studied the titanium dioxide in the cow for the determination of digestibility. (Titgemeyer *et al.*, 2001) studied that titanium dioxide is suitable for the determination of digestibility in the beef steers. He also reported titanium dioxide ($TiO_{2)}$ is a bright white colored pigment used for the determination of dietary exclusion and intake of nutrient. It is stable for heat, light, oxygen and pH**.**

In the present study we tried to find out the effect of two different fat sources soybean oil and rapeseed plus linseed oil on the fat digestibility in the small intestine in broiler chicken.

MATERIALS AND METHODS

Animal Care

This study was done in the Department of Animal and Aquacultural Sciences, Norwegian University of Life Sciences (UMB), Aas Norway. International rules were followed for the care of animals and this experiment was approved by Research Council of Norway.

Chicken production

There were 600 male Ross 308 broiler chickens used for the experiments. Day old chickens were shifted into two environmentally controlled rooms. Each room size was 30 meter square, with 300 chickens shifted in each room. Different types of diets were given to the chicken in room one and room two; Soybean oil supplemented diet in room 1 and rape seed plus linseed oil supplemented diet were given in room 2. Feed and water was given *ad libitum* through feeder and water trough. The

temperature of each room was maintained at 33 °C and this temperature and light was continued for the first 24 hours and the temperature was maintained 32 °C for the first three days. After first week light was provided for the 23 hour and one hour dark period (no light). Temperature was decreased by the 0.5 °C each day until the slaughtering age week 32. There was two dark period in the room from 17:00 -21:00 and 00:00- 04:00.The birds were daily and weekly monitored and medically checked by veterinary doctor . Mortality rate also recorded.

Feeds

Two types of feed were used in this experiment; the feed ingredients were the same except for fat source, table 1. Wheat, maize gluten, soya flour and oat were same in both diets. One feed supplemented with SO soya oil (4%) and the other feed was supplemented with rapeseed oil (2%) and RLO linseed oil (2%). Titanium oxide marker was mixed at 5 gram per kg into both feed.

Table 1 Feed composition of broiler chicken diet 1 (SO) and diet 2(RLO)

Commodities	Diet 1 (%)	Diet 2 (%)
Wheat	45.00	45.00
maize gluten	10.00	10.00
soy flour	17.00	17.00
oat	15.00	15.00
D-fat	4.00	4.00
soybean oil	4.00	0.00
Rape seed oil	0.00	2.00
linseed oil	0.00	2.00
Choline chloride	0.13	0.13
mono calcium phosphate	1.40	1.40
ground limestone	1.30	1.30
sodium chloride	0.25	0.25
sodium bicarbonate	0.2	0.2
mineral premix*	0.15	0.15
Vitamin A	0.03	0.03
Vitamin E	0.06	0.06
Vitamin ADBK	0.09	0.09
Vitamin D3	0.08	0.08
L-lysine	0.4	0.4
DL-methionine	0.200	0.200
L-threonine	0.200	0.200
Titanium oxide	0.5	0.5
Total	100	100

*Mineral contains –Fe 35 g/kg, Cu 16 g/kg, Mn 55 g/kg, I 0.7 g/kg, Selenium0.3 g/kg from Normin AS Honofoss Norway.

Slaughtering of chicken and sample collection in UMB

Sixteen broilers from each group of the two dietary treatments were randomly selected for the analysis. Birds were slaughtered by knocking the head and cutting the neck. First 2 chickens were killed from SO group and another 2 chicken were killed from RLO group until all 32 chickens were killed. Final body weight of chicken was taken at slaughter. Liver and gizzard weight also recorded.

Small intestine was divided into 3 parts; ileum was divided into two parts Ileum (A) and Ileum (B) and jejunum. Excreta content of Ileum (A), Ileum (B) and jejunum were taken in plastic cups and stored in the refrigerator for the lyophilization and used for the further analysis.

Chemical Analysis

Gut contents were dried at 50°C for the constant weight then analyzed total fat. Feed was analyzed for the fatty acid contents and excreta were analyzed for total lipid percentage. Sample size of feed for the analysis of dry mater, ash and total lipid was 1 mg and for the marker analysis was 0.5mg. TiO_2 was analyzed at Department of Animal and Aquaculture Sciences following the procedure of Short *et al.*, (1996) and total lipid composition analyzed by the procedure as described by Haug *et al.*, (2012) .

Statistical Method

Microsoft Excel 2010 was used for the calculation of mean and standard deviation. T test was used for the analysis of significant of data. The level of significance was presented at $P<0.05$.

RESULTS

Fatty Acid Composition in the feed

Table 2 shows that the composition of fatty acids varied in the two different feeds. Omega -6 and omega-3 content is higher in the SO added feed compared to the RLO feed. SO feed contained more saturated fat compared to the RLO added feed. Myristic acid (C 14:0) is equal in the both feeds , whereas Palmitic acid (C 16:0) is less and stearic acid (C 18:0) is higher in the RLO feed compared to the SO feed. Mono unsaturated fatty acid and poly -unsaturated fatty acid content are higher in the SO feed compared to the RLO feed. LA is much higher in the SO feed while ALA is higher in the RLO feed. Omega 6 to omega

3 ratios is significantly higher in the SO feed compare to the RLO feed 9.82:1 and 1.74:1. (About 10:1 and 2:1)

Table 2: Fatty Acid Composition in the feed after FAME analysis

Fatty Acids	Soybean oil (SO)		Linseed + Rapeseed oil (RLO)	
	Mean	SD	Mean	SD
C14:0	0.88	0.05	0.89	0.03
C16:0	17.25	0.24	15.17	0.13
C16:1	1.10	0.02	1.16	0.01
C18:0	7.79	0.27	8.34	0.06
C18:1,c9	27.20	0.13	33.63	0.06
C18:2,n-6(LA)	35.92	0.88	21.58	0.26
C18:3,n-3(ALA)	3.61	0.09	12.37	0.11
n-6,n-3	9.82	0.06	1.74	0.03
2 total amount SFA	25.92	0.21	24.41	0.06
3Total amount MUFA	28.30	O.15	34.79	0.06
4Total amount PUFA	39.65	0.96	34.05	0.25

LA: linoleic acid, ALA: alfa.linolenic acid,.

1LC n-3 PUFA: 2 Sum SFA: amount of C14:0, C16:0 and C18:0. 3 total amount MUFA: total of C16:1 and C18:1, c9. 4 amount of PUFA: Total of LA, ALA, AA, and EPA.

Comparison of intestinal digestibility of fat in the SO and RLO groups in the broiler chicken

Table 3 shows the intestinal digestibility in the two different oil supplement group SO and RLO. Results clearly showed that there was significant differences of the fat digestibility in the jejunum (38.79 vs 36.20) (p=0.044) in the SO and RLO group. There were also significant differences between the two diet group SO and RLO in the Ileum (A) digestibility (85.78vs74.60) (P=0.009). In ileum (B) (88.01vs 89.60) there were no significant differences between the groups. The highest digestibility percentage was recorded in the ileum B followed by the ileum A and the jejunum 88.01, 85.78 and 38.79 in the SO group similarly, in the RLO group highest digestibility results shown in the ileum (B) followed by the ileum (A) and the jejunum; being 89.60, 74.60 and 36.20 respectively.

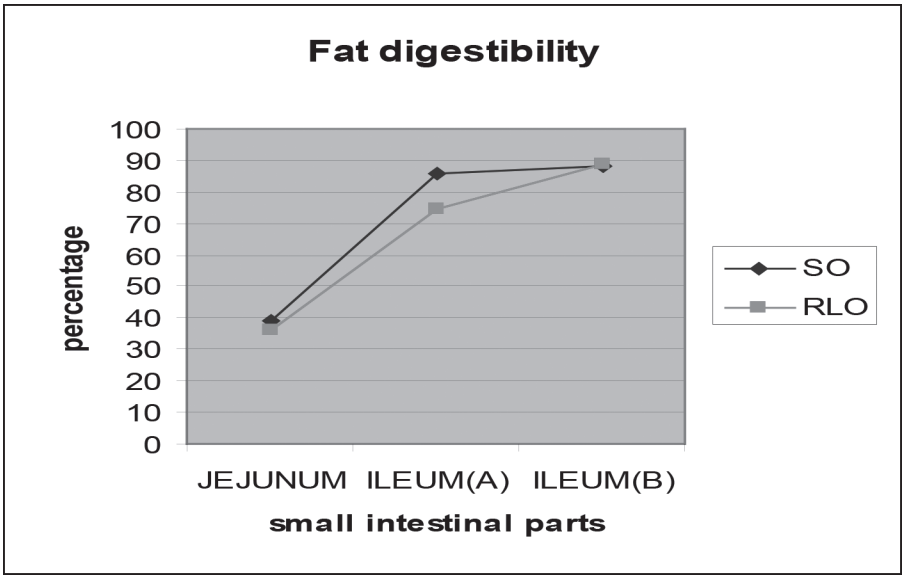

Figure 2. Digestibility of fat in the SO and RLO groups in different segment of intestine of broiler chicken.

Table 3 Digestibility of fat in different segments, final body weight, liver weight and gizzard weight

	Diet composition with fat sources		P value
	SO	RLO	
Digestibility	38.80	36.20	0.044*
segments (%)	88.01	74.60	0.009*
Jejunum Ileum A	85.78	89.60	NS
ileum B	2138	2020	0.029*
	64.10	58.10	0.015*
	61.90	61.90	NS
Final body weight gram liver weight gram gizzard weight gram			

**significant at 5%*

Liver weight of chicken feed with two different feed SO and RLO

Average liver weight of chicken fed SO feed was significantly higher

(p=0.015) 64.1(±129.8) gram than that of RLO diet 58.1(±184.4) gram. Table 3 shows that 10% higher liver weight in SO group compared to RLO group.

Body weight of the broiler chicken fed with two different feed SO and RLO

Final body weight of broiler chicken fed with the SO and the RLO diet group were 2138 and 2020 gram, respectively (Table 3). The SO feed group had slightly higher body weight compared to RLO feed group. There was significant (p=0.029) differences in final body weight between the two groups.

Gizzard weight of chicken fed two different feed SO and RLO

Average gizzard weight of the broiler chicken fed with SO diet and RLO diets are presented in Table 3. There was no significant difference in the gizzard weight in the two chicken groups 61.9 and 61.9 gram, respectively. Results show that similar gizzard weight in both diet groups.

DISCUSSION

Feed composition

In this study, one diet was added 4 % soybean oil, and the other feed contained 2% rapeseed oil and 2% linseed oil. The SO diet contained significantly more of the saturated fatty acids myristic acid (C14: 0), palmitic (C16: 0) and stearic acid (C18: 0) than rapeseed/ linseed oil. So, the SO diet contained 17 % palmitic acid, while RLO contained 15% palmitic acid. In this study there was a higher percentage of linoleic acid (n-6) in SO diet than in the RLO diet, 36% and 22%, respectively, while the amount of α-linolenic acid (n-3) was lower in the SO feed compared to the RLO feed, 3.6% and 12.4 %, respectively. More linoleic acid leads to a unfavorable n-6/n-3 ratio which were found to be 9.8 in the SO diet and 1.7 in the RLO diet. The ratio of n-6/n-3 is important since there is a high intake of n-6 in Western diet, and changing the use of SO to RLO in livestock feed, may reduce this ratio. This study resulted in meat that contributed to a shift to a more favorable ratio between these polyunsaturated fatty acids.

Digestibility of vegetables oils

The study showed that the digestibility of fat from feed with two different fat supplements either supplemented with SO or RLO in the broiler chicken. Intestinal content of two different diets showed low digestibility of the fat in the jejunum compared to the ileum (A) and ileum (B). Krogdahl (1985) showed in her report that transit time is the short in the jejunum for the digestion. Saturated fat decreased the digestibility in the small intestine. In the present study SO diet contained more saturated fat compared to the RLO diet so this could result in lower digestibility. Langhout *et al.*, 1997 reported that digestibility of fat may be decreased when saturated fat is incorporated in wheat and rye based diet**.** Our results are in line with these findings that it is a low digestibility in the jejunum. Sklan & Noy (2003) reported that fat digestibility in the duodenum and upper ileum in the small intestine is 85%. Our studies agree with this result that digestibility percentage of crude fat is 85% in the ileum (A) and 88.1% in ileum (B) in SO diet group and 74.6% and 89.6% in ileum (A) and ileum (B) in RLO diet groups. If the volume and the viscosity of the small intestine content is increased then the digestion in the small intestine become less efficient. Therefore sample content from jejunum is much liquid, and this might be a reason of low digestion.Svihus *et al.*, 2002, showed that intestinal viscosity may affect the fat digestibility. Dei *et al.*, 2006, reported that soya bean oil contained high energy and digestibility compared to other vegetable oils. Negative total fat digestibility value were observed in this study , this might be due to several factor influencing the including anti peristaltic movements, contaminating microbial material, mixing saw dust and separations of marker and digesta studied by (Ayoade *et al.* 2012).

In accordance to our results, Scaife *et al.*, 1994, showed that a diet containing SO resulted in increased feed intake and high liver weight of broiler chicken compared to a diet containing RLO. Final body weight of chicken was significantly different into the groups ($p=0.029$). Body weight was affected by the feed intake and fat sources. SO group had higher body weight than RLO groups. There was no significant difference in the gizzard weight in both groups. In SO group, feed intake was higher than RLO group, Similar study by Sharifi *et al.*, 2013 showed that soya oil in the feed resulted increased body weight in broiler chicken. Chickens in RLO diet had lower weight than chicken in SO diet. This might be caused by lower digestibility of the RLO diet.

CONCLUSIONS

The fat digestibility in the first part of ileum and in jejunum in chickens given a diet containing 4% soybean oil was higher compared to digestibility in the first part of ileum and jejunum in chickens given a diet containing 2 % rapeseed oil plus 2% of linseed oil. Results showed that small modification of diet can provide better quality meat in terms of fatty acids n6 to n3 ratio

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EFFECT OF HEAT TREATED SOYABEAN CAKE FEEDING ON GROWTH PERFORMNCE OF GROWING FEMALE GOATS IN FODDER BASED BASAL DIET

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ABSTRACT

Growth comparison of goats fed with treated and none treated soybean cake is not evaluated so far in Nepal. Therefore, an experiment was carried out on eighteen growing female exotic x khari crossbred goats (50% Jamunapari 6, 50% Barberi 6 and Kiko goats 6) at the Agriculture Research Station (Goat), Bandipur for 90 days after an adaptation period of 7 days. Female goats of average five months age having body weight 11.86 kg were allocated into three groups having six animals in each group by using Completely Randomized Design (CRD). For T1 and T2 concentrate mixture were composed by using procured feed ingredients with 16% crude protein level while T3 was fed with commercial feed. Experimental animals of T1 group was provided forest mixed fodder (adlib) + treated soybean cake (by-pass protein) included concentrate mixture @ 1.5% of body weight, T2 group was provided forest mixed fodder (adlib) + untreated soybean cake included concentrate mixture @ 1.5% of body weight whereas T3 was provided forest mixed fodder (adlib) + commercial concentrate mixture @ 1.5% of body weight. Experiment revealed that higher intake of concentrate feed was recorded for T1 (207.6 g) followed by T3 (199.58 g) and T2 (193.87 g) which was highly significant (P<0.001) among diet groups. Similarly, fodder intake was also noted significantly higher (P<0.001) among diet groups (1969.5 g, 1967.6 g and 1942 g for T2, T3 and T1, respectively). Feed and fodder intake of different genotypes of goats was found to be non-significant among goat breeds. In addition, feed conversion ratio per kg body weight gain was observed higher for T3 (22.49:1) followed by T2 (17.57:1) and T1 (16.24:1). Similarly, initial body weight of T1, T2 and T3 was 12.15 kg, 11.25 kg and 12.18 kg respectively that reached 17.66 kg, 16.33 kg and 16.40 kg during 90 days of experiment for T1, T2 and T3, respectively. Both initial and final body weight was non-significant among diet groups. Similarly, there was also non-significant effect of goat breed on body weight gain. Total body weight gain was recorded higher for T1 (5.50 kg) followed

by T2 (5.08 kg) and T3 (3.98 kg) which was significant (P<0.05) among diet groups. Similarly, average daily gain was also noted higher in T1 (61.2g) with variation of 29-122.6g g followed by T2 (56.48 g) with variation of 21-102.6 g and T3 (44.22 g) with variation of 14-101.3 g.

Key words: goats, bypass protein feeding

INTRODUCTION

Goats are important domestic animals in many parts of the world. In developing countries, goats give a very valuable contribution, especially to the poor in the rural areas. The importance of this valuable genetic resource is underestimated and its extent of contribution to the livelihood of the poor is inadequately understood. Goats are efficient browsers and prefer eating bushy plants along with some other weedy plants found on the ranges. Nevertheless, goats are going to be more important source of livelihood for many more people in coming years and, thus, they deserve greater attention at both the micro and macro levels. Now, it is the time to consider and pay attention to the value and capacity of goats for producing food (Aziz 2010). Neopane and Pokharel (2008) reported that most of the farmers of western hills are rearing Khari goats, crossbred of Khari x Jamunapari and Khari and Barberi). Goat population of Nepal is estimated to be 9.19 million. Out of 9.19 million, goat population of western hills is 1.13 million which account 12.32% of total goat population that producing 5284 mt meat per annum (10% of total goat meat production) (MoAD 2012).

Oil seeds cakes and meals are the residues remaining after removal of the greater part of the oil from oil seeds. The residues are rich in protein and most are valuable feeds for farm animals. Most oil seeds are of tropical origin, they include groundnut, cottonseed, soya bean, mustard, til etc (Bajjlieh 2002). Soybean cake has an average protein content of 40% and oil content of 20% and 2500 to 2800 kcal of metabolizable energy per kilogram. It also has a superior amino acid profile. Soybean protein has great potential as a major source of dietary protein. A by-product from the oil production (soybean cake) is used as a high-protein animal feed in many countries. Moreover, soybean protein is rich in lysine, valine, and isoleucine. The protein content of soybean tend to be 75 to 80% degraded in the rumen (Broderick *et al.* 1988; Promkot and Wanapat 2003), which restricts its inclusion in diets for high-yielding ruminants.

The protein content in diets of ruminant animals is essential for growth and production requirements. Possibility that reasonable portions of high quality protein of feedstuffs may be degraded in the rumen is occurred, which negatively affect animal utilization of the feed. In this context, there are several methods for protection of dietary protein from degradation in the rumen (EL-Shabrawy 1996). The heat treatment is known one of the methods to increase the protection of the proteins. During the process of manufacturing oil seed meals, they are subjected to different degree of heating which partly explains differences in the degree of protection. Thorough heating of protein supplement causes denaturation of protein; it provides effective protection against microbial fermentation in the rumen. Heat treatment of protein meal at 125- 150^0 C for 2-4 hours improves the bypass protein. The main benefit of "*bypass*" protein is that the original amino acids in the protein meal are absorbed in the small intestine instead of converting into microbial protein in the rumen, thereby providing a different balance of essential amino acids for better animal nutrition hence, production (Schroeder 1997).

Growth comparison of goats fed with treated and none treated soybean cake is not evaluated so far in Nepal. Hence, a study was carried out to compare the growth performance of growing female goats fed with heat-treated and none treated soybean meal mixed concentrate mixture at Agriculture Research Station (Goat), Bandipur, Tanahun.

METHODOLOGY

Experimental animals

This experiment was carried out on eighteen growing female exotic x khari crossbred goats (50% Jamunapari 6, 50% Barberi 6 and 50% Kiko cross goats 6) at Agriculture Research Station (Goat), Bandipur, Tanahun from 29 November 2012 to 25 March 2013 (069/8/14 to 069/11/14). Female goats of average five months old age with average body weight of 11.86 kg were allocated into three groups having six animals in each group by using Completely Randomized Design (CRD). They were drenched with Fenbendazole @ 5 mg/kg body weight against internal parasites before assigning in experiment.

Concentrate Mixture Composition

Feed ingredients maize, soybean cake, rice bran, minerals and salt were procured from Khowpa Feed Industry, Bhaktapur. For T1 and T2

concentrate mixture were composed by using procured feed ingredients with 16% crude protein level that has been presented in Table 1 while for T3 commercial compound feed with 15.9% CP was used made by Pancharatna Feed Industry, Narayangadh, Chitwan.

Table 1. Composition of concentrate mixture

S/N	Ingredients	T1		T2	
		Part	Crude protein (%)	Part	Crude protein (%)
1	Maize	50	3.94	50	3.94
2	Soybean cake	28	10.7	28	10.7
3	Rice bran	20	1.77	20	1.77
4	Mineral mixture	1	0	1	0
5	Salt	1	0	1	0
Total		**100**	**16.41**	**100**	**16.41**

Heat treatment of soybean cake

The drying of forage is known to increase the protection of the proteins. Thorough heating of protein supplement causes denaturation of protein; it provides effective protection against microbial fermentation in the rumen. Heat treatment was done by using hot air oven at temperature 125- 150^0 C for 2-4 hours as suggested by Suresh, *et al* (2009).

Experimental diet of the animal

The dry matter requirement of goats was calculated based on 5 kg per 100 kg body weight. Following diets were formulated to the experimental animals (Table 2).

Table 2. Experimental diets of the animals

Treatment	Experimental diet
T1	Forest mixed fodder (adlib) + concentrate mixture with heat treated soybean cake @ 1.5% of body weight
T2	Forest mixed fodder (adlib) + concentrate mixture with untreated soybean cake @ 1.5% of body weight
T3	Forest mixed fodder (adlib) + concentrate mixture from commercial Feed Mill @ 1.5% of body weight

Feeding regime

Concentrate mixture and *adlib* amount of fodder was provided to the experimental animals individually in plastic vessel. Concentrate mixture was provided once a day in the morning whereas fodder twice a day (morning and evening). Quantity of concentrate mixture and fodder given daily to the animals was weighed daily and refusal was weighed in next morning. Experimental animal had free access to drinking water.

Chemical analysis

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

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

Data analysis

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

RESULTS AND DISCUSSION

Chemical composition of feedstuffs

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

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

Ingredient	DM	OM	TA	CP	CF	EE
Maize	87.69	97.97	2.03	8.92	2.34	4.48
Rice bran	87.85	89.5	10.5	11.52	4.83	5.1
Soybean cake	86.87	92.63	7.37	44.29	9.38	0.7
Mixed forest fodder	39.94	90.01	9.99	11.16	NA	NA

The calculated value of crude protein was verified with laboratory analysis, which is presented in Table 4.

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

Particular	DM	OM	TA	CP	CF
Treated soybean cake included concentrate mixture	91.92	92.54	7.46	16.83	5.95
Untreated soybean cake included concentrate mixture	91.58	92.10	7.90	16.92	5.64
Commercial feed	90.74	89.85	10.15	15.94	6.45

Feed intake

Average daily intake of concentrate mixture and fodder by goats during experimental periods is given in Table 5. Higher intake of concentrate feed was recorded for T1 (207.6 g) followed by T3 (199.58 g) and T2 (193.87 g) which was highly significant ($P<0.001$) among diet groups. Similarly, fodder intake was also noted significantly different ($P<0.001$) among diet groups (1969.5 g , 1967.6 g and 1942 g for T2, T3 and T1, respectively), however, dry matter intake was observed almost similar for all treatment group (89.53 kg, 89.33 kg and 89.28 kg for T3, T1 and T2, respectively). Feed and fodder intake of different genotypes of goats was found to be non-significant among goat breeds. In addition, feed conversion ratio per kg body weight gain was observed higher for T3 (22.49:1) followed by T2 (17.57:1) and T1 (16.24:1).

Table 5: Feed intake of experimental animals/day/animal

Feedstuffs	Mean ± SD		
	T1	T2	T3
Feed intake (g)	207.6±57.96	193.87±45.70	199.58±35.15
Fodder intake (g)	1942.3±439.1	1969.5±440.4	1967.6±443.1
Total dry matter intake (DMI) (k)g	89.33	89.28	89.53
Feed conversion ratio (FCR)	16.24:1	17.57:1	22.49:1

Growth performance

Growth is a complex; highly integrated process involving numerous interactions among nutrients, environment, genotype, and many different hormones and receptors of these hormones in various tissues (Spencer 1985).The growth performance of experimental goats is given in Table 6 and Figure 1. Initial body weight of T1, T2 and T3 was 12.15 kg, 11.25 kg and 12.18 kg, respectively that reached 17.66 kg, 16.33 kg and 16.40 kg during 90 days of experiment for T1, T2 and T3, respectively. Both initial and final body weight was non-significant among diet groups. Similarly, there was also non-significant effect of goat breed on body weight gain. Total body weight gain was recorded higher for T1 (5.50 kg) followed by T2 (5.08 kg) and T3 (3.98 kg) which was significant ($P<0.05$) among diet groups. Similarly, average daily gain was also noted higher in T1 (61.2g) followed by T2 (56.48 g) and T3 (44.22 g) which also significant ($P<0.05$) among diet groups.

Table 6. Growth performance of goats

Parameter	Mean ± SD		
	T1	T2	T3
Initial Body weight (kg)	12.15±4.43	11.25±3.11	12.18±2.27
Initial metabolic weight (kg)	6.5	6.14	6.51
Final Body weight (kg)	17.66±4.48	16.33±3.03	16.40±2.56
Final Metabolic weight (kg)	8.61	8.12	8.14
Total weight gain (kg)	5.50±0.36	5.08±1.06	3.98±0.40
Average daily gain (g)	61.20±4.01	56.48±11.87	44.22±4.48

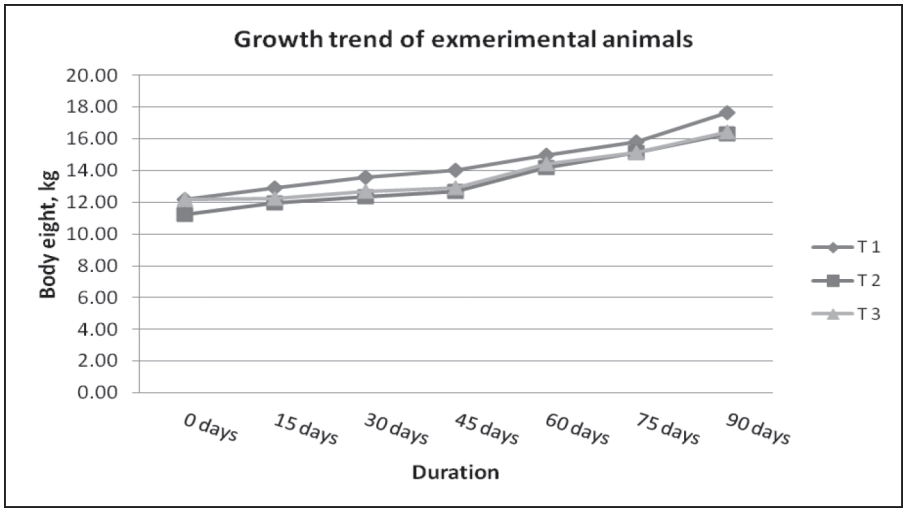

Figure 1. Body weight gain trend of goats during experiment period

DISCUSSION

This study was initiated with objective to find out effect of heat treated soybean cake on the growth performance of female goats of different breeds as against untreated soybean cake incorporated concentrate mixture, and commercial concentrate on fodder based basal diet. Result revealed that concentrate feed and fodder intake was highly significant ($P<0.001$) among diet groups. Both initial and final body weight was not significant among groups, however, total weight gain and average daily gain of experimental animals significantly ($P<0.05$) differed among diet groups. Similarly, result proved that there was no significant effect of breed in feed intake and body weight gain. This experiment revealed that heat treatment of soybean cake significantly improves the feed intake and body weight gain in comparison to soybean cake without heat treatment.

Limea *et al.* (2011) tested the effects of a treated soybean cake incorporated concentrate diet on 32 Creole goats for growth, carcass fat, and fatty acid composition of muscle (supraspinatus), perirenal and intramuscular adipose tissues. They found feeding increased concentrate did not increase the content of any cholesterol-increasing saturated fatty acid in meat.

Sahlu *et al.* (2012) also reported no differences ($P>0.05$) in body weight gain from their study on heat treated and untreated soybean meal mixed concentrate diet feeding on female Angora goats. Similarly they

reported significant increase in mean DMI ($P < 0.01$) as dietary CP level increased but was not affected significantly ($P < 0.05$) by heat treatment of the dietary protein. Their observations were in agreement with those of Roffler *et al.* (1978), Barney *et al.* (1981) and Blauwiekel and Kincaid (1986). Other workers have reported a decrease in DMI when dietary CP was increased (Foldager and Huber 1979; Edwards *et al.* 1980; Grieve *et al.* 1980). A recent study indicated that DMI increased linearly in young growing goats as dietary CP level increased (Lu and Potchoiba 1990).

CONCLUSION

Our experiment revealed that there is a significant effect of heat-treated soybean cake on feed and fodder intake, and total body weight gain of goats; however, it could not be measured as mentioned in different literatures. Perhaps it might be due to winter season of experiment conduction when most of the protein and energy were spent for body warming. Therefore, it is suggested that this type of experiments should be continued in future also considering winter loss of energy of animals.

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EFFECT OF SUBSTITUTION OF SOYBEAN MEAL WITH FULL FAT SOYBEAN ON BROILER PERFORMANCE

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ABSTRACT

This study was conducted at Institute of Agriculture and Animal Science, livestock farm Rampur, Chitwan to find out the effect of roasted soybean in broiler. The experiment was conducted in completely randomized design consisting of five treatments and three replications. Two types of diet, broiler starter (2-4 weeks of age) and broiler finisher (5-6 weeks of age) were fed adlib. Broiler starter contained 3050 ME kcal/kg energy and 21.5 percent protein and finisher contained 3150 ME kcal/kg energy and 20 percent crude protein. Significantly ($P<0.05$) higher final average cumulative body weight (2112.43 g) was recorded on T_3 in which broiler fed diet 50% soybean meal substituted by full fat soybean and lowest (2017.13 g) on T_5, fed 100 percent of soybean meal substituted with full fat soybean. It was found that soybean meal could be substituted up to 100% with roasted full fat soybean without any detrimental effects on growth performance of broiler. Overall mean good feed efficiency was observed on diets supplemented with T_3 (2.00) and poor feed efficiency (2.08) on T_5. Digestibility coefficient of DM, CF and CP was recorded maximum on T_3 (77.86%), (21.53%) and (79.60%) respectively. The net income per bird was observed maximum (Rs 38.00) on T_3 and minimum (Rs 31.20) on T_5.

Key words: broiler, full fat soybean, soybean meal, weight gain.

INTRODUCTION

Commercial poultry farming in Nepal has been growing tremendously in recent years. Poultry rearing is a common practice in rural areas mainly with indigenous breeds under scavenging systems whereas commercial farming is confined in urban and sub-urban areas. Feed alone cost 65 to 75% of total broiler production and ultimately results high price of poultry meat (Johari and Hussain, 1996). Feed cost can be reduced by manipulating appropriate cheap source product and other locally available ingredients. Soybean meal is the primary source of plant protein in poultry diets (Arnold, *et al.,* 1971). Interest has

developed in the use of full fat soybeans as a replacement for both soybean meal and fat in chicken diets (Leeson *et al.,* 1987). The use of full fat soybeans would eliminate the cost of oil extraction and allow the use of a homegrown protein supplement in poultry diets (Leeson *et al.,* 1987). Full fat soybean is an excellent source of energy and protein, with special value in diets for young animals when a high nutrient concentration is required (Waldroup, 1982). Correctly processed full fat soybean can be used at high levels (over 20%) in commercial diets for poultry (Monari, 1996). As for other feed ingredients, the level of inclusion of full fat soybean in diets depend on its relative cost to other energy (mainly animal fat/soybean oil) and protein (fish meal and soybean meal) sources. In our context, limited works have been done in the use of full fat soybean in broiler diets. Considering the economic importance and nutritive value of full fat soybean in the poultry, this study is designed to see its impact on the overall performance of broiler production.

MATERIALS AND METHODS

The experiment was conducted at the Institute of Agriculture and Animal Science, livestock farm, Rampur, Chitwan. The birds were vaccinated as per vaccination schedule. The chicks were kept in brooder for one week under special care and management. After 7 days the birds were transferred into pens having standard floor space. Feeding trial was conducted in complete randomized design consisting of five treatments and replicated thrice. The birds were fed *ad libitum* in all treatments during the entire feeding trial. Soybean meal was replaced by roasted soybean (i.e. Full fat soybean). Each dietary treatment had similar nutrient composition. The treatments of the experiment were as follows.

T_1= 0% Full fat soybean + 100% Soybean meal

T_2= 25% Full fat soybean + 75% Soybean meal

T_3= 50% Full fat soybean + 50% Soybean meal

T_4= 75% Full fat soybean + 25% Soybean meal

T_5= 100% Full fat soybean + 0% Soybean meal

Two types of broiler diets were formulated using a computer based feed formulation program as nutrient required for Vencobb broiler. Broiler starter diet (2-4 weeks of age) contained 3050 ME kcal/kg and 21.5 percent crude protein. Similarly, broiler finisher diet (5-6 weeks of age) contained 3150 ME kcal/kg and 20.0 percent crude protein.

Weekly body weight gain, feed consumption, and economics of broiler production were recorded. All the data obtained in the experiment were subjected to statistical analysis by using MSTAT for the analysis of variance and Duncan's Multiple Range Test (DMRT). Difference between treatments (significant or non significant) were tested by using MSTAT, Michigan University Version 1.3. Digestibility trial was conducted in order to find out the digestibility coefficient of different nutrient.

RESULT AND DISCUSSION

Cumulative weekly body weight

Effect of substitution of soybean meal with full fat soybean on cumulative weekly body weight of broiler chicken is presented in table 1. Significant difference ($P<0.05$) in cumulative weekly body weight was observed in second, fourth and fifth week of feeding trial. Average initial cumulative body weight of broilers showed no significant differences among treatments ($P>0.05$). It might be due to random distribution of chicks among the different treatments. In the first week of feeding trial, higher (357.33 g) as well as lower (345.33 g) cumulative body weight was recorded in T_3 and T_5 respectively but the differences were non significant ($P>0.05$). It was due to bird required some period to take responses of nutrient. In second week of feeding trial, the highest cumulative body weight (698.86 g) of broiler was observed in T_4 and the lowest (661.06 g) in T_5. These values differed significantly ($P<0.05$) but were par with the result 693.86 g, 689.16 g and 674.50 g respectively for T_3, T_2 and T_1. In third week of feeding trial, higher cumulative body weight (1158.10 g) was recorded on T_3 than T_4, T_2, T_1 (1152.23, 1150.53, 1125.13g) and low (1119.23 g) in T_5. These values were not significantly different ($P>0.05$). In the fourth week of feeding trial, the highest cumulative body weight (1639.90 g) was recorded in T_3 and the lowest (1571.66 g) in T_5. These values differ significantly ($P<0.05$) and par with the result T_4 (1622.20 g), T_2 (1605.90 g) and T_1 (1592.10 g). Similarly in fifth week of feeding trial, the highest cumulative weekly body weight (2112.43 g) was recorded on T_3 which differed significantly ($P<0.05$) with T_5 (2017.13g) and T_1 (2045.43 g) but were similar with the results of T_4 and T_2 (2086.10 and 2066.13 g).

Table 1. Effect on cumulative weekly body weight gain of broiler chicken(g)

Treatments	Week					
	Initial	1	2	3	4	5
T_1= 0% Full fat soybean + 100% Soybean meal	152.40	349.66	674.50^{ab}	1125.13	1592.10^{ab}	2045.43^{bc}
T_2=25% Full fat soybean + 75% Soybean meal	157.83	348.13	689.16^{ab}	1150.53	1605.90^{ab}	2066.13^{abc}
T_3= 50% Full fat soybean + 50% Soybean meal	155.06	357.33	693.86^{ab}	1158.10	1639.90^{a}	2112.43^{a}
T_4= 75% Full fat soybean + 25% Soybean meal	148.70	352.43	698.86^{a}	1152.23	1622.20^{ab}	2087.10^{ab}
T_5= 100% Full fat soybean + 0% Soybean meal	150.80	345.33	661.06^{b}	1119.23	1571.66^{b}	2017.13^{c}
Mean	152.96	350.58	683.49	1141.70	1606.66	2065.67
LSD	Ns	Ns	32.25	Ns	52.35	58.45
CV %	3.45	2.38	2.59	2.52	1.79	1.55
SEm±	3.04	4.81	10.24	16.58	16.61	18.45

It was found that weight was increased as the level of substitution of soybean meal with full fat soybean increased and reached to the peak at 50% substitution levels. At 75 % substitution levels the weight was slightly decreased and at 100% substitution level the weight was further decreased and was found below than weight of $T_{1.}$ Significantly ($P<0.05$) the highest cumulative weekly body weight was recorded on T_3 where broiler fed (50%) substitution of soybean meal with full fat soybean. This was due to proper combination of ingredient and better utilization of nutrient in such group of birds. This finding was supported by many authors; Hamilton and Niven. (2000), Anderson *et al.* (1992), Maclsaac *et al.* (2005) and NRC (1994).The optimum performance should be obtained when the ratio of roasted full fat soybean to soybean meal is about 2:1 in the starter diets of broiler chicks (Hamilton and Niven. 2000). Turkey fed the diet containing the 66.6:33.3 ratios of roasted soybean to soybean meal were heavier than birds fed any other diet. The use of processed beans improved production performance over soybean meal (Maclsaac, *et al.,* 2005). Anderson *et al.* (1992) reported that the digestibility of lysine, methionine, cystine and threonine and other essential amino acids was greatly increased as the result of heat treating soybeans. NRC (1994) reported that heating reduces the content of antiproteases and lectins and improves the digestibility of amino acids and the bean's energy.

Feed conversion ratio

Effect of substitution of soybean meal with full fat soybean on feed conversion ratios of broiler chicken is presented in table 2. Feed conversion ratios differ significantly ($P<0.05$) in second week of feeding trial but was not different significantly to the rest of week. In first week of feeding trial, high feed conversion 1.87 was recorded in T_5 and low 1.75 in T_4. These values were not differ significantly ($P<0.05$). In second week of feeding trial, the highest feed conversion (2.02) was recorded in T_5. This value was different significantly ($P<0.05$) with T_2 (1.88), T_4 (1.88) and T_3 (1.90) but was par with T_1 (1.94). The average weekly feed conversion ratios was high for T_4 (2.06) and low for T_2 (1.96) in third week of feeding trial. In fourth week of feeding trail, high and low feed conversion ratios 2.25 vs. 2.11 for T_2 and T_3 respectively. In fifth week average feed conversion ratios was high for T_5 (2.33) followed by T_4 (2.31), T_1 (2.31) and T_2 (2.30) and T_3 (2.26).Overall mean feed conversion ratios was high on T_5 (2.08) followed by T_2 (2.04), T_4 (2.04), T_1 (2.03) and T_3 (2.00) respectively.The feed conversion was higher on 100% substitution level of soybean meal with full fat soybean due to higher level of feed consumption than weight gain.

Table 2. Effect on feed conversion ratio

Treatments	Week					Overall mean
	1	2	3	4	5	
T_1= 0% Full fat soybean + 100% Soybean meal	1.78	1.94^{ab}	1.97	2.16	2.31	2.03
T_2= 25% Full fat soybean + 75% Soybean meal	1.81	1.88^{b}	1.96	2.25	2.30	2.04
T_3= 50% Full fat soybean + 50% Soybean meal	1.78	1.90^{b}	1.97	2.11	2.26	2.00
T_4= 75% Full fat soybean + 25% Soybean meal	1.75	1.88^{b}	2.06	2.18	2.31	2.04
T_5= 100% Full fat soybean + 0% Soybean meal	1.87	2.02^{a}	1.99	2.21	2.33	2.08
Mean	1.80	1.92	1.99	2.18	2.30	2.04
CV %	3.81	3.96	3.46	3.53	3.21	-
LSD	Ns	0.0996	Ns	Ns	Ns	-
SEm±	0.048	0.032	0.041	0.045	0.060	-

Similar results were obtained by many authors Waldroup and Cotton (1974), Vest and Duvall (1985) and Maclsaac *et al.,* (2005) who observed that there was no effect of roasted soybeans to soybean meal on feed conversion.

Digestibility

Effect of substitution of soybean meal with full fat soybean on digestibility coefficient of DM, CP, EE, CF and TA is presented in table 3. The maximum digestibility coefficient of DM was recorded on T_3 (77.86%) while minimum on T_4 (72.57%). Similarly, maximum digestibility coefficient of CP was also recorded on T_3 (79.60%) while minimum was recorded on T_4 (73.75%). The maximum CF digestibility coefficient was recorded on T_3 (21.53%) and minimum on T_1 (8.15%). Likewise, the digestibility coefficient of EE was high (74.46%) on T_4 and minimum on T_5 (60.30%) and the digestibility coefficient of ash was high (21.67%) on T_2 and minimum on T_5 (11.03%).

Table 3. Effect on digestibility coefficient of broiler chicken

Treatments	Digestibility coefficient, %				
	Dry matter	Crude Protein	Crude fiber	Ether extract	Total ash
T_1= 0% Full fat soybean + 100% Soybean meal	72.73	76.75	8.15	67.35	15.35
T_2=25% Full fat soybean + 75% Soybean meal	75.03	77.52	13.34	62.85	21.67
T_3= 50% Full fat soybean + 50% Soybean meal	77.86	79.60	21.53	71.15	19.36
T_4= 75% Full fat soybean + 25% Soybean meal	72.57	73.75	16.86	74.46	12.46
T_5= 100% Full fat soybean + 0% Soybean meal	73.32	74.52	15.67	60.30	11.03

Supplementation of diet with (50%) substitution level of soybean meal with roasted soybean (i.e. FFS) had marked improvement in the digestibility coefficients of DM, CP and CF. This might be due to the associative effect of proper combination and nutrient availabilities of feed ingredients, as a result nutrient digestion and absorption increased. The findings were supported by Polin (1980) and Jones *et al.* (1992). Polin (1980) reported that lecithin, which is found in full fat soybean increased digestibility of fat, because lecithin enhances micelle formation. Jones *et al.* (1992) found that addition of lecithin to normal diet increased the digestibility of GE, DM, EE and CP.

Economic analysis

Effect of substitution of soybean meal with full fat soybean on economic analysis of broiler chicken is presented in Table 4. The production cost

per kg starter diets was maximum (Rs.18.44) for T_5 and minimum (Rs.18.37) on T_2. Similarly, the maximum production cost for finisher diets (Rs19.50) and minimum cost (Rs.18.45) were in the treatment T_1 and T_4 respectively. Gross expenditure/kg was observed high in T_5 (Rs 64.17) and low in T_3 (Rs 61.70). The net income per bird was maximum (Rs.38.00) on T_3 and minimum (Rs.31.20) on T_5. Benefit/cost (B/C) ratio was also high for T_3 (1.30) and low for T_5 (1.24).

During the experimental period the cost of soybean meal and soybean with processing cost was same. The result showed that substitution levels of soybean meal (50%) with full fat soybean were more profitable than basal diets. The reason for it might be due to improved availability and digestibility of nutrients in such group of birds which consumed less feed and improved overall performance of weight gain.

Table 4. Effect on economic analysis

Particulars	T_1	T_2	T_3	T_4	T_5
Cost of starter feed/kg, Rs	18.38	18.37	18.43	18.41	18.44
Cost of finisher feed/kg, Rs	19.50	18.50	18.46	18.45	18.46
Gross expenditure, Rs	130.90	129.84	130.10	131.02	129.44
Income/bird, Rs	163.16	164.48	168.09	166.12	160.66
Expenditure/kg, Rs	64.00	62.84	61.70	62.80	64.17
Net income/bird, Rs	32.00	34.64	38.00	35.10	31.20
Benefit/cost (B/C)	1.25	1.26	1.30	1.27	1.24

Low cost of production and high net income/bird fed on roasted soybean is supported by Swick (1996) and Pone and Fomunyam (2004). Pome and Fomunyam (2004) had found that suboptimal production performance at given current market prices, replacing imported soybean meal with locally produced roasted kidney bean meal, roasted soybean or cotton seed meal would allow farmers to save 1%, 19% and 28%, respectively on feed cost. Roasting soybeans in place of imported Soybean based meal allowed farmers to save about 19% for each CFA franc spent on a kilogram of live bird at 8 weeks of age. The full fat soybean based meal is often an attractive ingredient and will be readily used in least cost formulations depending on its price relative to soybean meal, other protein sources and energy sources; fat (Swick, 1996).

CONCLUSION

From this study it was concluded that the better cumulative live weight at sixth week of age (2112.4 g) was obtained when birds were fed

diets with 50% substitution of full fat soybean. It can be concluded that soybean meal could be substituted up to 100% with roasted full fat soybean without any detrimental effects on growth performance. Overall performance of broiler was found more economical when soybean meal was replaced with 50% full fat soybean in both starter and finisher ration.

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BROODFISH MANAGEMENT STATUS AND RATE OF INBREEDING IN CARP HATCHERIES IN NEPAL

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ABSTRACT

Over sixty-five carp hatcheries in Nepal, at the public and private sectors, have been breeding three indigenous and four exotic fish species and contributing more than 95% of the total fish seed (96 million fry) requirement of the country. At present, all hatcheries function as isolated genetically closed units raising their own stock of breeders and producing fish seed for distribution to grow-out areas. Lack of any fish breeding plan in the hatcheries results in generation of genetic underclass carp seeds and leads to low production of fish in culture operations. There is growing concern that hatchery stock may be deteriorated due to poor broodstock management and inbreeding depression. Poor reproductive performance, retarted growth and morphological deformaties of hatchery produced seeds have been unsubstantially claimed.

In this paper, effective population size (N_e) and the rate of inbreeding (ΔF) have been estimated for 12 hatcheries, representing plain Terai and mid hill region of the country, on the basis of numbers of new individual recruited as brood stock each year and the variance of their reproductive success. Effective population size ranges from as low as 4 to a maximum of 32, and the rate of inbreeding from 1.6 % to 13.9% per year. Rapid inbreeding of hatchery stocks of the carp is apparent. This may be due to poor brood stock management, unconscious negative selection of brood stock, mating female and male spawners from a finite population, unplanned cross breeding in hatchery stock, close mating of spawners etc. Possible ways to control accumulation of further inbreeding in hatchery stock has been suggested. The paper also recommends setting up of a national-level network among the public and private hatchery, fish seed traders, nursery operators, and scientists concerned for development of a sustainable fish seed production industry in the country.

Key Words: Brood stock, Fish hatchery, Inbreeding, Effective population size

INTRODUCTION

Aquaculture in Nepal revolves the cultivation of native and exotic carps. Carp aquaculture in Nepal is polyculture. The general practice is to rear together seven carp species in the same pond: *Cyprinus carpio* (common carp), *Hypophthalmichthys molitrix* (silver carp), *Ctenopharyngodon idella* (grass carp), *Aristichthys nobilis* (bighead carp), *Labeo rohita* (rohu), *Cirrhinus mrigala* (naini) and *Catla catla* (catla). With the notable exception of *C. carpio* which mature and spawn easily in ponds, all major carps attain maturity but do not spawn naturally in the confined environment. Induced spawning of these carps by hypophysation has been common practice in Nepal since 1970/71 (Karki, 1998). Today hatchery-produced fry/fingerlings dominate the overall aquaculture production of the country. About 54 hatcheries have been established in the private sector. These hatcheries contribute 73% of the total seed production (70 million), the rest coming from the public sector (DoFD, 2008).

Although, the Directorate of Fisheries Development reported that during 2007-08, the country produced about 96 million fry-sized fish seeds from these hatcheries, the market fish production from aquaculture has not improved significantly. If the produced fry-sized seeds survived to the stage of market size (assumed: each fish on average grows to 500 g in one calendar year), the annual fish production would have increased to about 48000 mt. However, the current fish production of the country from aquaculture is stated to be 24295 tons (DoFD, 2008). It is assumed that either there is a large-scale mortality during the early stage of fish or slow growth of the produced seeds. Lack of quality fish seeds may be one of the primary reasons for the low fish production in the country, as the fish seeds of desirable quality is the basic input for aquaculture in ponds and for culture-capture fisheries.

There is growing concern that hatchery stocks may be deteriorated due to poor broodstock management, inbreeding depression and unplanned breeding activities. At present, most hatcheries rear their own broodstock and usually do not recruit brood stock from out sources (natural habitat) or exchange breeders between farms. All hatcheries function as isolated genetically closed units raising their own stock of breeders and producing fish seed for distribution to grow-out areas. It is usually observed that most of the hatchery operators lack knowledge

of simple broodstock management practices and do not follow any principles or guidelines in selecting adequate sized brooders and mating unrelated male and female spawners. In many hatcheries of Nepal, every year initially only the fast growing fry or fingerling sized fish seeds are sold and surplus unsold seeds are stocked in ponds at a high density. Some of these fish seeds showing comparatively slower growth rate' are reared in ponds until they attain sexual maturity. Selection of brood fishes from this stock may be termed as negative selection. If such small-sized brood fishes are considered for induced breeding, due to heredity factor, the resultant off springs shall not only exhibit slow growth rate but also shall be weaker and most shall die before attaining stocking size.

Common practice in small hatcheries often involves the use of a small number of brood fish of each species because the fecundity of carps allows adequate seed production in this situation. A small number of breeding individuals may produce all of the progeny in each succeeding generation and this lead to increased inbreeding. Over successive generations, low effective population sizes lead to inbreeding depression with reduced growth rates, loss of fecundity and poor survival (Kohinoor *et al.*, 2002). Unsubstantiated claims that stock deterioration in hatchery population due to poor broodstock has been often reflected in farmers' complaints in terms of retarded growth, reduction in reproductive performance, morphological deformities, increased incidence of disease and mortality of hatchery produced carp seeds in the country. The types of traits most frequently reported to show inbreeding depression in fish species have been: increased fry abnormalities (Kincaid, 1976; Stiles, 1981), reduced survival (Kincaid, 1976), reduced growth rate (Moav and Wohlfarth, 1968; Ryman, 1970; Fujino, 1978; Gjerde et al., 1983), and lowered reproductive success (Kincaid, 1976, Mrakovcic and Haley, 1979).

Interspecific hybridization in some carp species has also been reported in the country (Bayne et al., 1992). Anecdotal evidence suggests that hybridization between the silver carp and bighead carp is common, at least partly due to shortage of mature bighead carp male towards the end of breeding season. This introgression of silver carp species has probably contaminated the silver carp stock in some of the hatcheries of the country, as the hybrid is not sterile. If the unplanned breeding activities are allowed to continue, it will jeopardize the seed production industry of the country.

Presumably, a large quantity of such poor seed is being used in aquaculture. Moreover, there is stock enhancement plan to mitigate the effect of damming in river for hydroelectricity generation (for instance Kali Gandaki) through the stocking of hatchery produced seeds of several native species. There is widespread concern that stocking of such genetically poor quality stocks in lakes, rivers and gholes (shallow wetland) might cause serious feral gene introgression in wild stocks which would ultimately adversely affect aquaculture and inland open water fish production in the country. To avoid loss of genetic diversity and inbreeding depression problems in hatchery populations, proper brood stock management strategies and effective breeding plans for commercially important fish species has yet to be designed and implemented. Neither institutions of the country have earlier taken any initiatives to create awareness on these issues and monitor the hatchery activities. The objective of the present study is to obtain practical estimates of the rates of inbreeding in Nepalese hatcheries involved in large-scale production and distribution of fish seed to grow-out areas; and if significant, suggest way of controlling inbreeding in broodstock populations.

INBREEDING AND EFFECTIVE POPULATION SIZE

Inbreeding is the loss of genetic variance (heterozygosity) as a consequence of the mating of close relatives. The degree of relationship between mating pairs is measured by the coefficient of inbreeding (F). The rate of inbreeding is a function of the characteristics of the foundation stock as well as limited population size in subsequent generation (Falconer, 1989). It is inversely related to the effective population size (N_e). In finite genetically closed aquaculture populations, during hatchery propagation, it is quite possible that among the relatively few individuals randomly selected for mating, some pairs are more closely related than others (Eknath and Doyle, 1990). Inbreeding occurs when genetically closely related individuals used for breeding and the progeny for replenishment of broodstock come from within the same farm.

The key parameter for estimating rate of inbreeding (ΔF) is the effective population size (N_e). It reflects the actual number of individuals that contribute progeny to the next generation. To derive this parameter, the breeding structure in a given hatchery should be known. N_e is the function of the total number of breeding individuals, the sex ratio, the mating system employed and the variance (enequality) of family size in the production of fish that are used to produce next generation.

Conventional techniques for estimating inbreeding rates based on pedigrees can not be applied because the data necessary for such analysis are not available. Doyle and Talbot (1986), Eknath and Doyle (1990) have derived simple expressions for estimating N_e in extensive aquaculture system and rate of inbreeding based on Hill's (1979) formulations. The approach is to derive N_e as a function of the number of new individuals of each sex recruited to the broodstock population each year and the variance of their reproductive success. The rate of inbreeding can then be calculated using standard techniques.

MATERIALS AND METHODS

The data and information on hatchery size, seed production trend and source of brood fish (foundation and replenishment stock) were collected during 2008 from 12 public and private fish hatcheries located in hills and southern plain (Terai) of Nepal. For estimating effective population size and the rate of inbreeding, breeding data of three consecutive years (2004 to 2007) were collected through semi-structured questionnaire. The various parameters derived (using the primary data) to estimate N_e and ΔF following Hill (1979) and Eknath and Doyle (1990) are as follows:

3.1 Primary data collected from the hatcheries

T= Total number of male and female breeders maintained in the farm.

S= Total number of males and females actually spawned for fish seed production.

N_n= Number of new breeders of each sex added to the broodstock pond (N_{nm}= males; N_{nf}= females).

N_r= Number of new individuals that contribute to replenish the broodstock (N_{rm}= males; N_{rf}= females)

Derived parameters

Generation length (L) has been fixed at 2 years for *H. molitrix*, *A. nobilis* and *C. catla* and 3 years for other species in private hatcheries. High mortality of post spawned brood fish and limited pond facilities to rear broodstock does not allow breeders for extending generation length. In government operated fish hatchery, *C. carpio*, *H. molitrix* and *A.*

nobilis are bred for at least three year while other fish species are bred for four year. This seems to be more realistic assumption because the general practice in government hatcheries is to recruit relatively larger individuals during their third and fourth year of life, although a small proportion of male matures in the first (*C. carpio*) or second year (*C. idella*, *L. rohita*, *C. mrigala*).

Variance of family size and replacement success

Family size refers to the number of progeny of a parent that become breeding individuals in the next generation. There are two groups in the broodstock: individual whose progeny are retained in the farm for the replenishing the broodstock (fertile parents), and the progeny from the rest which are sold to grow-out areas (infertile parents). Among the fertile parents, the opportunity to eventually replenish broodstock differs because of variation in survival of their progeny; in other words, there will be non-random variation in family size. One important consequences of this variation is that a greater proportion of the next generation may come from a smaller number of parents. Variance of family size will be different for males and females because of their mating scheme. Male and female parents are assumed to produce equal numbers of males and females among their progeny- covariance in the number of male and female progeny of a parent is ignored.

Variance of family size is assumed to follow a Poisson distribution with zero values followed (Eknath and Doyle, 1990). The sum of squares (SS) for each sex consists of weighted SS of the infertile and fertile parents around the population mean plus the SS of the members of each group around their group means (Doyle and Talbot, 1986). The variance of family size of a female (V_f) may be calculated as:

$$SS_f = N_{of} (N_t/N_{nf})^2 + N_{rf} \{(N_t / N_{rf}) - (N_t / N_{nf})\}^2 + N_t$$

$$V_f = SS_f / N_{nf}$$

Where N_t= total number of new breeders added to the broodstock ($N_{nm}+N_{nf}$); N_{of}= ($N_{nf}-N_{rf}$)= the number of new females that do not cotribute progeny to replacement of broodstock ('infertile females'); V=variance of family size from all causes (V_f for females; V_m for males).

The annual effective population size (N_e) may be calculated as (Hill, 1979 simplified by Doyle and Talbot, 1986):

$1/N_e = \{(1/16N_{nm}L) \times (2+V_m)\} + \{(1/16_{nf}L) \times (2+V_f)\}$

The annual rate of inbreeding accumulation (ΔF) was estimated from the formula (Falconer, 1989):

$\Delta F = 1/2N_e$

RESULTS

Farm size and annual seed production of fish hatcheries

Most of the surveyed hatcheries are located in central and eastern part of the Nepal (Figure 1). Fish production from these regions contributes about 68% of the total aquaculture production of the country. Public (government) hatcheries were established in years 1962 to 1973 and the seed production of all seven carp species commenced from these hatcheries since 1978. Private (farmer owned) hatcheries were established during 1992 to 1999 to overcome the short supply of fish seed to the rapidly expanding aquaculture area in the country. Public hatcheries are larger in water surface area (2.4 to 7.3 ha) corresponding to have large space (1.3 to 2.5 ha) for broodstock keeping. Private hatcheries are relatively small in farm size (0.7 to 2.9 ha) and have limited space (0.4 to 1.3 ha) for broodstock management (Table 1).

Seed production of all seven carp species takes place in hatcheries under study. Majority of hatcheries produce and sell three categories of fish seed, i.e. hatchling (larvae started to exogenous feeding), fry (0.3 to 1.0 g) and fingerling (≥ 5.0 g) to nursery operator and growout areas. Corresponding to number of broodfish maintained and the nursey area average production rate of fish seed is higher in public hatchery (Table 1). Private hatcheries, despite of having small area for fish seed nursing, produce and distribule relatively large number of fry (2.3 million/year/hatchery). This indicate that the private hatcheries utilies broodfish and nursing facilities more intensively for fish seed production.

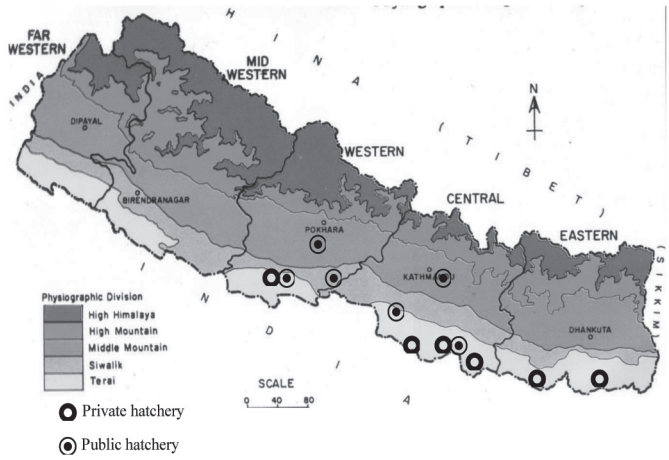

Figure 1. Map of Nepal showing surveyed location of surveyed public and private hatcheries

Table 1. Area and number of ponds; and annual seed production of surveyed carp hatcheries in Nepal.

Hatchery Name	Established year	Pond area and number				Annual production of fish seed (million)		
		Total area (ha)	Total pond No.	Brood Pond (ha)	Nursery Pond (ha)	Hatchling	Fry	Fingerling
Private hatchery		**1.6**	**15.2**	**0.78**	**0.85**	**13.0**	**2.3**	**0.34**
Chaudhary Fish Farm, Sunsari	1992	1.6	16	0.6	1.0	1.3	0.36	0.14
Agri Breeds Pvt. Ltd., Morang	1995	1.2	16	0.4	0.8	-	1.4	-
Shanti Fish Farm , Dhanusha	1999	2.2	15	1.3	0.9	20.8	4.1	-
Sanjay Fish Seed Production Centre, Siraha	1990	2.9	20	1.3	1.6	2.3	4.5	0.43
Bhola Fish Farm , Mahottari	1993	0.7	9	0.4	0.3	-	2.1	0.1
Mandal Fish Hatchery, Rupandehi	1997	1.2	15	0.7	0.5	27.7	1.5	0.7
Public hatchery		**5.8**	**39**	**2.2**	**3.0**	**22.7**	**1.5**	**0.82**
Fisheries Development Centre, Dhanusha	1962	7.3	61	2.5	4.8	-	1.4	0.67
Fisheries Development Centre, Chitwan	1970	5.0	21	3.2	1.8	22.9	2.5	0.84
Fisheries Development Centre, Rupandehi	1962	5.6	25	2.1	3.5	74.3	0.7	1.6
Fisheries Research Division, Lalitpur	1976	2.4	24	1.3	1.1	0.55	0.23	-
Fisheries Research Centre, Kaski	1962	6.0	60	2.0	4.0	3.6	1.6	0.5
Fisheries Development Centre, Makwanpur	1973	7.6	41	2.6	2.9	12.3	2.6	0.5

Status of brood fish management

In general, the breeding procedure followed in fish hatcheries involves selection of potential breeders about 2-3 months prior to the breeding season, followed by induced spawning until the seed production target is met. Replenishment of the broodstock occurs as and when found necessary. The common practice in the majority of fish hatcheries in Nepal is to replenish broodstock from internal sources (from the hatchery itself) or from nurseries and grow out areas that received hatchlings or fry from that particular hatchery (Figure 2). Only few hatcheries collecting fingerlings or breeders from grow out ponds which have received fish seed from other hatcheries. Among hatcheries, only one public hatchery made wild inclusion of broodstock of *C. catla* and *L. rohita* from natural sources (river).

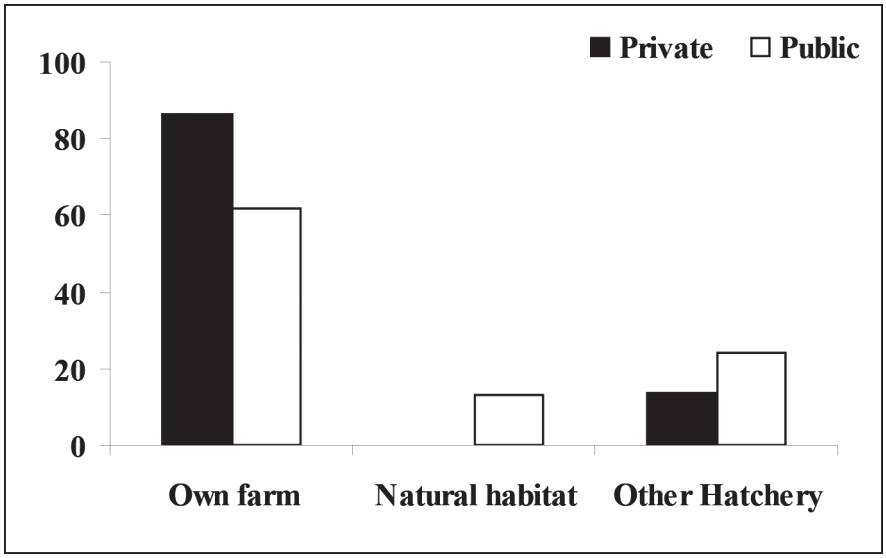

Figure 2. Frequency of sources of future brood fish in private and public hatchery

There has been unconscious negative selection in most of the hatcheries, more specifically in private hatcheries, as relatively bigger and fast growing individuals from growout ponds are sold and smaller (and hence slow growing) fish are used for broodstock replacement. After the seed production/distribution target is met, the individuals as replenishment stock are selected from the 'left-overs'. No systematic breeding effort is made to prepare replenishment stock representative from each spawned sets.

Although many breeders mature and breed in the farm during a production cycle, the N_e is determined not by the total number of breeders used for seed production but by the number of individuals that eventually contribute progeny for the replenishment of the broodstock. In most of the hatcheries, the progeny for the replenishment stock come from a few parents and usually from a last segment of breeding season (Figure 3). It is generally the bigger breeders (probably fast-growing) that are induced to spawn during the on-set of breeding season and seed produced are sold to grow out areas (i.e. their replenishment rate is zero). Seed produced in the last segment of breeding season from relatively smaller individuals (probably slow-growing) are retained to build up broodstock, which ultimately result in indirect or negative selection. It is clear that the contribution of progeny by small proportion of parents that determine the N_e and ΔF accumulation in the broodstock populations.

The number of breeders used for seed production has been usually less than the total number of individuals in the broodstock ponds in hatcheries in Nepal for reasons: selection of small number of broodstock; high fecundity of carps, limited nursery area restrict the rearing of large number of broodstock for spawning; loss of broodstock from the broodstock ponds due to periodic harvesting of individuals showing a decline in reproduction; mortality after spawning; and diseases. Loss of potential broodstock resulting from improper management (poor water quality, disease control, brood handling and post spawning care) led to use of new breeders along with old broodstock to fulfill vacant niches. This practice might increase temporal variations in the number of breeders and the age structure of the broodstock. Overlapping generations is common in all carp species under aquaculture, which further decrease N_e and can potentially lead to mating between relatives of all kinds.

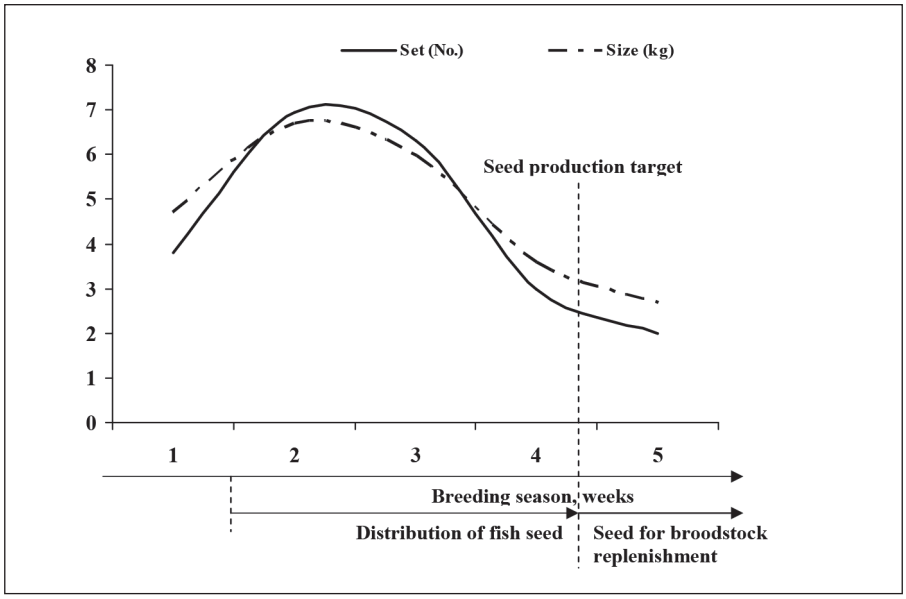

Figure 3. Number of a spawning sets and body weight of breeding individual used during a typical breeding season in hatcheries of Nepal

Effective population size is also determined by the number of males and females contributing progeny. Unequal sex ratios reduce N_e, with the less numerous sex having the greatest effect. Survey revealed that in induced propagation of carp a spawning set, depending on the size of brooders, consists of two males and one female or three males and two females. In brief, broodstock management in hatcheries in Nepal is complex and not sound with respect to maintenance of genetic variation.

Effective population size and rate of inbreeding

A large number of breeders are maintained in brood stock ponds (Table 2a and 2b) but the numbers of breeders used for seed production (S) is frequently less than the total number (T). S ranges from 21% to 89% and 21% to 94% of the total number of broodfish for male and female, respectively, in private hatcheries. Despite the large number of brood fish maintained in public hatcheries, the percentage of broods used for spawning is not significantly different ($P>0.05$) to that of private hatcheries. The number of new breeders (N_n) recruited to the broodstock is approximately 24% and 32% of T for male and female in

private hatcheries. It is approximately 17% and 20% of T for male and female in public hatcheries. However, it is important to note that the new breeders that eventually contribute progeny to the replenishment of broodstock (N_r) is low in both type of hatcheries. It is approximately 7% for male and 7-8% for female of the total number of breeders of the broodstock in hatcheries surveyed. When parents have an equal chance of contributing progeny to the next generation, the variance of family size (V) will be 2. In the present observation, V is much greater than 2 indicating the non-random opportunities of contributing progeny. The variance of family size for females is about 1.8 times greater than the variance observed for males because of the particular mating system followed.

The estimated effective population (N_e) and annual rates of accumulation of inbreeding are presented in Table 3. The effective population size (N_e) ranges from as low as 3.9 to a maximum of only 32; consequently, the rate of accumulation of inbreeding (ΔF) ranges from 1.6% to 9% in public hatcheries. Private hatcheries are small and invariably concentrate on seed production of all species. The pond area available for broodstock maintenance is limited and the replenishment rate of breeders is relatively small which led to decrease in N_e and higher ΔF in private hatcheries. The effective population size (N_e) ranges from 3.6 to a maximum of only 31.6 and ΔF ranges from 1.8% to 13.9%.

In general, the estimation based on the of numbers of new individual recruited as broodstock each year and the variance of their reproductive success revealed that high level of inbreeding evidenced for all seven carp species in relatively small private hatcheries to that of the large scale public hatcheries. On the average, ΔF of *L. rohita* and *C. mrigala* is between 1.6 to 4.5. ΔF of *C. carpio* in hatcheries is between 1.7 to 4.0 at 3 years generation length (GL); if GL is fixed at 1 year the ΔF will be approximately tripled. As *C. carpio* mature within one year in southern plain of Nepal and some small private hatcheries use this undersized fish as breeding individual. The four commonly preferred species for aquaculture in Nepal; *C. catla*, *A. nobilis*, *H. molitrix* and *C. idella*, are probably the most highly inbred in small private hatcheries. These species exhibits ΔF levels ranging from 6.0% to 13.9%, 2.4% to 12.5%, 1.8% to 8.5% and 1.9% to 8.3%, respectively. The present estimation warned high inbreeding level of *C. catla* (3.9% to 9.0%) and *A. nobilis* (1.6% to 5.2%) in public hatchery.

DISCUSSION

The rate of accumulation of inbreeding (ΔF) is high particularly for the four most desirable carp species. It appears that species by species some or most of the hatcheries are rapidly inbreeding their stocks.

In this study, the annual rate of inbreeding resulting from the mating of older individual in the broodstocks are unknown. This aspect requires data pertaining to the number of mature individuals in each age class, broodstock age distribution, contribution to total reproduction of each group and expectation of breeding life (Eknath and Doyle, 1990). Such data are very difficult to obtain from any aquaculture system. Nevertheless, the analysis presented here provides approximations to the asymptotic rate of increase in inbreeding and should be a valuable guide for understanding the genetic consequences of routine broodstock management decisions.

Table 2a. General length (L, year), total number of breeders, spawners, new breeders added and their reproductive success in private fish hatcheries of Nepal, range (mean)

	Total Number (T)		Spawner (S)		New brood (Nn)		New replace (Nr)		
Species	Male	Female	Male	Female	Male	Female	Male	Female	L
Cyprinus carpio	16-70 (48)	16-50 (31)	14-60 (32)	10-35 (21)	5-15 (9)	3-15 (8)	3-6 (4)	2-4 (3)	3
Hypophthalmichthys molitrix	25-127 (91)	24-118 (74)	21-114 (62)	14-88 (48)	6-18 (14)	3-22 (12)	4-8 (6)	2-6 (3)	2
Aristichthys nobilis	26-90 (49)	14-90 (48)	14-70 (35)	9-50 (26)	1-22 (11)	1-17 (11)	1-5 (4)	1-7 (4)	2
Ctenopharyngodon idella	11-108 (41)	8-60 (26)	8-90 (32)	4-60 (22)	3-16 (8)	3-14 (8)	1-5 (4)	1-4 (3)	3
Labeo rohita	34-117 (63)	18-80 (39)	20-75 (40)	14-46 (24)	6-11 (8)	5-13 (8)	2-5 (4)	1-3 (2)	3
Cirrhina mrigala	12-175 (97)	14-150 (66)	13-100 (59)	9-90 (42)	3-16 (7)	4-13 (7)	2-11 (5)	2-4 (3)	3
Catla catla	5-28 (16)	4-20 (11)	2-8 (6)	1-6 (4)	8-16 (11)	8-15 (11)	(1)	(1)	2
Spawning rate, %			21-89 (63)	21-94 (61)					
New breeders (Nn) recruited to the total breeders, %					3-76 (24)	3-95 (32)			
New breeders that contributed to the progeny, % of the total breeders							1-25 (7)	1-25 (8)	

Table 2b. General length (L, year), total number of breeders, spawners, new breeders added and their reproductive success in public fish hatcheries of Nepal, range (mean)

	Total Number (T)		Spawner (S)		New brood (Nn)		New replace (Nr)		
Species	Male	Female	Male	Female	Male	Female	Male	Female	L
Cyprinus carpio	38-136 (93)	19-139 (70)	18-80 (63)	11-48 (37)	9-16 (12)	7-15 (11)	4-9 (6)	3-5 (4)	3
Hypophthalmichthys molitrix	10-186 (96)	10-114 (63)	6-153 (70)	4-90 (42)	8-22 (14)	5-18 (13)	3-8 (5)	3-5 (4)	3
Aristichthys nobilis	5-176 (92)	5-125 (65)	4-136 (62)	2-74 (38)	8-18 (12)	5-15 (11)	2-8 (6)	2-6 (4)	3
Ctenopharyngodon idella	29-152 (66)	22-94 (44)	9-88 (36)	6-59 (25)	9-30 (15)	4-15 (10)	3-6 (5)	2-4 (3)	4
Labeo rohita	28-107 (67)	20-71 (42)	16-81 (40)	8-49 (25)	9-13 (10)	5-9 (7)	3-7 (5)	2-5 (3)	4
Cirrhina mrigala	14-108 (49)	9-82 (39)	8-57 (30)	5-32 (19)	5-13 (7)	4-11 (8)	2-5 (3)	2-4 (3)	4
Catla catla	21-28 (24)	15-23 (19)	5-18 (12)	3-11 (7)	4-11 (6)	(5-8) 6	1-3 (2)	1-4 (2)	4
Spawning rate, %			22-93 (61)	19-78 (55)					
New breeders (Nn) recruited to the total breeders, %					6-67 (17)	9-60 (20)			
New breeders that contributed to the progeny, % of the total breeders							3-17 (7)	3-40 (7)	

Table 3. Family size variance, effective population size and rate of inbreeding of carps in hatcheries of Nepal, range

Species	Sum of square		Variance (V)		N_e	ΔF%
	SSm	SSf	Male	Female		
Private hatcheries						
Cyprinus carpio	15-134.9	23-170.8	3-13.5	4.7-17.1	12.6-20.6	2.4-4
Hypophthalmichthys molitrix	15.8-151.1	36-277.4	2.6-8.4	10.6-21.3	5.9-27.8	1.8-8.5
Aristichthys nobilis	2-350.1	2-166.8	2-15.9	2-11.8	4-21.2	2.4-12.5
Ctenopharyngodon idella	11-153.8	30-190.7	2.8-10	4.9-13.6	6-26.1	1.9-8.3
Labeo rohita	34.1-259.6	35.5-555.7	4.3-23.6	6.5-42.7	8.3-22.5	2.2-6.0
Cirrhina mrigala	15.2-52.9	19.3-174.6	3.3-6	4.4-13.4	11.8-31.6	1.6-4.2
Catla catla	309.6-931.9	154.4-927.9	31-58.2	19.3-61.9	3.6-8.4	6-13.9
Public hatcheries						
Cyprinus carpio	46.3-163.1	67.1-207.2	4.2-10.2	6.8-13.8	19.2-30.3	1.7-2.6
Hypophthalmichthys molitrix	67.5-167.3	26.3-271.1	6.7-9.8	5.3-20.3	16.8-29.6	1.7-3.0
Aristichthys nobilis	41.3-108.6	72.9-229	4.9-10.5	6.6-17.6	9.7-31.3	1.6-5.2
Ctenopharyngodon idella	33.1-315	53.1-585	3.8-14.6	6.6-39	12.8-29.6	1.7-3.9
Labeo rohita	39.5-72.9	64.8-112.6	4.1-8.1	7.2-22.5	11.2-32.0	1.6-4.5
Cirrhina mrigala	23-91.5	27.4-191.8	5-11	3.9-18.3	14.8-24.4	2.1-3.4
Catla catla	35-248.7	26.7-220.8	8.8-22.6	4.4-44.2	5.6-12.8	3.9-9.0

With the rapid expansion of fish culture operations in recent times, farmers solely depends on hatcheries for their seed requirements in Nepal. The present analysis revealed that there is every possibility of inbreeding in these hatcheries, where female and male breeders are chosen from a finite (small) population for mating, with a greater chance of crossing sib or closely related fish. Kincaid (1995), Gjedre et al. (1983), Su et al. (1996) have produced relatively high inbreeding level (ΔF%= 10-25%) through sib mating on salmonids.

It is well established that inbreeding affects traits associated with reproductive capacity and physiological inefficiency (Falconer, 1989). The deleterious effects of inbreeding in aquaculture have been reviewed by Kincaid (1983). In hatcheries, substantial variation in growth and reproductive performance of aquaculture stocks is a widespread phenomenon. Continuing decline in the rates of fertilization, hatching, fry survival and decrease in the volume of milt particularly among the grass carp and silver carp in Indian hatcheries (Eknath and Doyle, 1990). Moav and Wohlfarth (1976) stated that a single full sib mating of a particular fish might result in 10-20% depression in growth and a considerable proportion of individuals might show physiological abnormalities.

To prove that inbreeding is one of the major causes of the observed decline in growth and reproduction performance, one has to cross-breed stocks from different hatcheries and demonstrate heterosis effect, if any. This is a one of the practical approach because the founder stocks of Chinese carp and common carp in almost hatcheries have originated from other hatcheries. The hatchery populations, therefore, can be considered as isolated sub-populations of original ancestral population of source hatcheries. Genetically, they are isolated inbred lines of the same population.

There are several possible ways of reducing the accumulation of inbreeding and build genetically improved stocks. The base population for Indian major carps (*L. rohita, C. mrigala* and *C. catla*) could be collected from natural waters (lakes, rivers etc.) or from a known source. For building genetic stock of other carp species, the fast-growing and best-looking individuals from nursery/growout ponds should be selected for raising as broodstock and few individuals from as many stocks as possible for each species is required. While increasing the total breeding population, one has to consider the economics and the resources necessary for maintaining the increased population and also those required for spawning them effectively.

By maintaining full pedigree records of stocks inbreeding can be reduced by avoiding mating between close relatives (Hussain and Mazid, 1999). Organizing broodstock population structure by pedigrees may be expensive, and it is highly complex to handle. It is, however, worthwhile to pedigree the stocks wherever such opportunities exist in order to delay the rate of accumulation of inbreeding (Eknath and Doyle, 1990).

A more realistic approach to the problem is to use effective population size, the size of an ideal population having the minimum amount of drift and inbreeding (Ryman and Stahl, 1980). The effective number of parents (N_e) is influenced by several factors, however, the ratio among the breeders being the most conspicuous in the context of fish breeding. With the limited number of breeders the largest effective number of parents is obtained when both sexes are equally frequent. When sex ratio are highly skewed the effective number of parents is best approximated by the least numerous sex. There is practical limit at which ΔF is only slightly affected by a further increase of N_e and this limit occurs approximately at 40-60 effective parents (Ryman and Stahl, 1980). Beside maximizing N_e, a well-planned selective breeding and

line-crossing program would improve desirable trait in founder stocks. Systematic line crossing schemes – serves to eliminate the mating of full sibs and therefore, effectively to reduce the rate of inbreeding accumulation below that found in random mating populations of equal population size at least during the early generations (Kincaid, 1983). Selection program can be incorporated into most systematic line crossing schemes. There is need for the establishment of 'brood banks' where wild germplasm can be preserved and maintained and genetically improved broodstock developed.

The most immediate practical approach is to reduce the variance of family size and thereby increase the effective population size. In simpler terms, individuals for replenishment of broodstock should be chosen equally from all families or spawning sets. If an equal number of parents are taken from each family, there will be no variation of family size and the resulting effective population size will be essentially twice the actual number (Gall, 1987). A more exact expression is Ne= 2N-1 (Crow and Kimura, 1970), where N is the number of breeding individuals.

Overlapping generations (Hill, 1979) is also expected to increase rate of inbreeding in aquacultured fish (Eknath and Doyle, 1990). If fish populations can be maintained as separate year classes for short period, and some crossing between year classes at regular intervals, for example two or three generations, will restore genetic variability for the population as a whole.

CONCLUSION

Stock deterioration in hatcheries of Nepal due to poor broodstock management and inbreeding depression is evident. Decentralization of seed supply and coordination among seed actors is essential without which there is an attendant risk of gene pool mixing of fish stocks and exchange of genetic material among hatcheries is difficult. There is a strong need for genetic monitoring of carp stocks with the objective of reorienting existing farm management practice and establishing genetic information of important production traits to maximize their genetic potential. Government should formulate seed production norms and impose restriction on the minimum size and age of fish to be used for breeding in order to control indiscriminate use of inferior quality broodstock for seed production by the hatcheries.

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DNA MARKER BASED GENETIC VARIATION OF ROHU (*LABEO ROHITA*) POPULATIONS FROM HATCHERIES AND RIVER OF NEPAL

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ABSTRACT

Six polymorphic microsatellites were used to study within and between genetic variation of populations of rohu (Labeo rohita) from hatcheries and river of Nepal. The number of allele per locus among six populations ranged from 2.66 (±0.52) to 3.17 (±0.41) and the average number of alleles from 3 to 5. The mean observed (H_o) and expected (H_e) heterozygosity ranged from 0.10 (± 0.17) to 0.18 (±0.26) and from 0.34 (± (0.27) to 0.50 (±0.11) respectively. High F_{ST} values averaged across loci indicated significantly population differentiation among the populations. The distance value obtained in the present study fall within the range of congeneric.

INTRODUCTION

Polyculture of seven carps, which includes common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), Bighead carp (*Aristichthys nobilis*), catla (*Catla catla*), rohu (*Labeo rohita*) and mrigala (*Cirrhinus mrigala*) is a common practice in Nepal. These species contributed 95% of total aquaculture production from terai region of Nepal. *Labeo rohita* (**Figure 1**) is the most important among the three Indian major carps used in Indian carp polyculture systems. This species is the natural inhabitant of Indo-Gangetic riverine system spread across northern and central India, and the rivers of Pakistan, Bangladesh, Nepal and Myanmar. It is a major indigenous aquaculture fish species of Nepal since early 1960s. Both private and public fish hatcheries are using captive (hatchery bred) population of this species for seed production. The increasing demand of carp

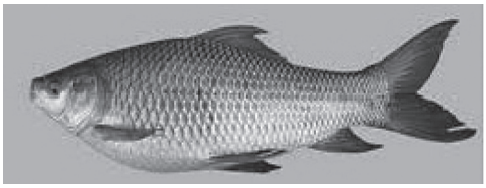

Figure 1. Rohu (*Labeo rohita*)

seeds due to the rapid expansion of aquaculture practices promoted establishment of as many as 54 carp hatcheries across the country. Thus major dependence on nature for the supply of seeds of Indian major carps has been replaced by hatchery produced seeds. Hatcheries rear their own brood stock and usually do not recruit individuals from outside (viz. riverine source) or exchange brood fish among them. Each hatchery, therefore, can be considered as an isolated, self sustaining and genetically closed unit. In Nepal carps are repeatedly bred in the hatchery with a limited number of effective parents (N_e) to keep the production costs to a minimum. As a result, genetic erosion may have occurred through inbreeding, genetic drift and the bottleneck effects. Retarded growth, poor reproductive performance, morphological deformities & diseases of hatchery seeds have been frequently reported by the farmers. Identification of pure stock of domesticated fish species, genetic characterization and identification at population at species level for species under domestication is essential to establish base population for following future genetic improvement program of species in aquaculture. Microsatellites DNA markers can be used to identify genetically distinct populations. Due to their exceptional variability and relative ease of scoring, microsatellites are now generally considered the most powerful genetic markers. Microsatellites, or simple sequence repeats (SSR), have many attributes making them excellent for scientific studies, such as abundant polymorphisms, co dominant heredity and easy detection. The study aims to quantify the magnitude of genetic variability of this important indigenous fish species using molecular marker (microsatellite DNA) to establish foundation population for initiating selective breeding program to improve their aquaculture characteristics.

MATERIALS AND METHODS

A total of 397 fin clip samples of rohu (*Labeo rohita*) were collected from five fish hatcheries and Koshi River of Nepal (**Figure 2).** DNA was extracted following standard procedures (Tagard *et al.,* 1992). Six polymorphic markers developed from *Labeo rohita*: *Lr*-1, *Lr*-3, *Lr*-10, *Lr*-14b, *Lr*-21, *Lr*-24 were used. Polymerase Chain Reaction (PCR) amplifications were performed using a program with 40 cycles on Thermocycler (MyGene^{TM}). PCR product from each sample was separated electrophoretically on 2% (w/v) agarose gel containing ethidium bromide in 1x TBE buffer at 250 V for 2 hours **(Figure 3).** Genetic variability was assessed using POPGENE32 software (3.2). Differences in heterozygosity between populations were tested using

independent sample comparisons (Archie, 1985). The program TFPGA was used to calculate F-statistics, deviation from HWE and genetic distance. All the results were adjusted for multiple simultaneous comparisons using a sequential Bonferroni correction (Rice, 1989).

Figure 2. Map of Nepal showing sampling sites of *Labeo rohita*

RESULTS

The sizes of the alleles of rohu were small ranged from 100 to 200 base pair. Paired sample T-test revealed that Tarahara hatchery populations exhibit significantly lower ($P<0.05$) number of alleles per locus compared to that of other populations.

Figure 3. PCR amplified alleles from Rohu *rohita* individuals at 2 microsatellite loci.
B 29 & B35= samples from Bhairahawa, D24=Janakpur
K15 to 24=Koshi River

Table 1. Measure of genetic variability (allelic diversity and polymorphism) of hatchery and river populations of Labeo rohita in Nepal

Population	No. of sample per locus	No. of alleles per locus (±SD)	Effective number of allele per locus (±SD)	Polymophic loci (%)
FRC,Pokhara	71	2.83 (±0.75)[a]	2.00 (±0.46)	100.0
RARS, Tarahara	76	2.66 (±0.52)[b]	1.77 (±0.77)	100.0
FDC, Kailali	64	3.17 (±1.17)[a]	2.12 (±0.59)	83.0
FDC, Bhairahawa	75	3.17 (±0.41)[a]	2.02 (±0.30)	100.0
MFH, Dhanusha	74	2.83 (±1,47)[a]	1.91 (±0.86)	83.33
Koshi River	37	2.83 (±1.17)[a]	2.22 (±0.76)	83.33

Superscripted with the same letter in a column are not statistically different (P>0.05) between populations (Archie, 1985)

Independent sample comparison (Archie, 1985) revealed that there is significant different in observed and expected heterozygosity after bonferroni correction (P<0.001) within populations. All populations under study did not conform to the Hardy-Weinberg equilibrium at the 1% level after Bonferroni correction (Rice, 1989).

Table 2. Measure of genetic variability (heterozygosity, fixation index (F_is), Hardy-Weinberge exact test value* (Bonferroni corrected; P=002) of hatchery and river populations of *Labeo rohita* in Nepal

Population	No. of sample per locus	Heterozygosity		F_{is} ^
		H_o (±SD) #	H_e (±SD)	
FRC, Pokhara	71	0.15 (± 0.29)[a]	0.48 (±0.14)	0.69
RARS, Tarahara	76	0.12 (±0.15) [a]	0.34 (±0.27)	0.65
FDC, Kailali	64	0.12 (± 0.20) [a]	0.48 (± 0.24)	0.75
FDC, Bhairahawa	75	0.10 (±0.17) [a]	0.50 (±0.11)	0.80
MFH, Dhanusha	74	0.18 (±0.26) [a]	0.40 (±0.25)	0.55
Koshi River	37	0.16 (± 0.16) [a]	0.49 (±0.26)	0.67

*Markov chain method, # Nei's expected heterozygosity,
^Fis =(He-Ho)/He

Most of the locus wise F_{is} values within each population were different from 0 (P<0.01) after Bonferroni correction (Table 3). Among the significant test all populations at Lr1, Lr3 and Lr10 were relatively high.

Table 3. Locus-wise F_{is} (Weir and Cockerham, 1984) within each of six populations of *Labeo rohita* in Nepal

Locus	FRC, Pokhara	RARS, Tarahara	FDC, Kailali	FDC, Bhairahawa	MFH, Dhanusha	Koshi River
*Lr*1	1.000	1.000	0.8529	1.000	1.000	1.000
*Lr*3	1.000	0.8613	1.000	1.000	1.000	0.5057
*Lr*10	1.000	1.000	1.000	1.000	-	0.9134
*Lr*14b	1.000	0.5742	-	0.9527	0.8734	-
*Lr*21	-0.3174	0.2701	0.0799	0.2158	0.2240	0.4787
*Lr*24	0.7394	0.8836	0.8583	0.6686	0.0738	0.5262

F_{st} (0.2012) did show significantly population differentiation among

the hatchery populations of *Labeo rohita* (Table 4). Pair-wise genetic differentiation was also significant in all loci of the five hatchery populations.

Table 4. Values for F-statistics of hatchery populations of *Labeo rohita* in Nepal

Locus	F_{is}	F_{st}
Lr1	0.9747	0.3496*
Lr3	0.9905	0.2969*
Lr10	1.0000	0.1014
Lr14b	0.8681	0.2024*
Lr21	0.2274	0.1107
Lr24	0.6965	0.0860
Mean	0.7589	0.2012
Jacknifing over loci ± SD	0.7548±0.1404	0.2018± 0.506

* Statistically significant (P< 0.001-Bonferroni correction

Values of Nei's (1972, 1978) Genetic distance between *Labeo rohita* populations fall above the conspecific taxa (Table 5). The genetic distance between populations of Koshi River and FDC, Kailali is largest indicating that these two populations divergent mostly. The genetic distance between FDC, Bhairahawa and MFH, Dhanusha hatchery is smallest (Figure 4).

Table 5. Genetic distance (Nei's 1973) for six populations of *Labeo rohita* below the diagonal and identity above the diagonal.

	FRC, Pokhara	RARS, Tarahara	FDC, Kailali	FDC, Bhairahawa	MFH, Dhanusha	Koshi River
FRC, Pokhara	-	0.7644	0.7212	0.7365	0.7269	0.7069
RARS, Tarahara	0.2686	-	0.8426	0.7907	0.8099	0.7323
FDC, Kailali	0.3269	0.1713	-	0.8023	0.7384	0.5862
FDC, Bhairahawa	0.3059	0.2348	0.2203	-	0.8919	0.7282
MFH, Dhanusha	0.3190	0.2108	0.3033	**0.1144**	-	0.7816
Koshi River	0.3469	0.3116	**0.5342**	0.3172	0.2464	-

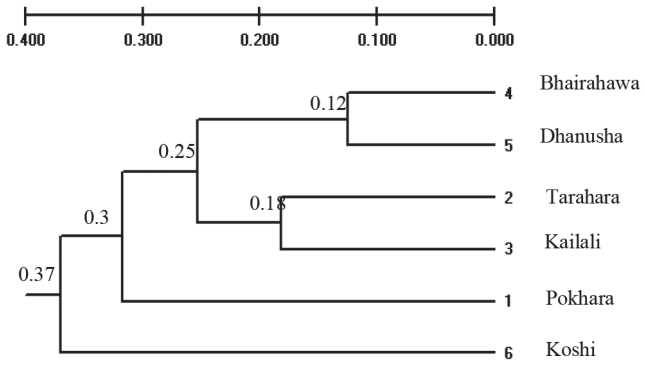

Figure 4. UPGMA dendrogram showing genetic relationship among six populations of Labeo rohita

CONCLUSION

The sizes of the alleles of rohu were small ranged from 100 to 200 base pair. Therefore to separate PCR products of rohu differing in only a few base pair in length by using microsatellite markers, 6-10% polyacrylamide gel electrophoresis (PAGE) need to be used. Low level of observed heterozygosity found in this study might have resulted from small effective population size. High F_{ST} values averaged across loci indicated significantly population differentiation among the populations. The distance value obtained in the present study fall within the range of congeneric. It is possible that lesser differences among these populations may be found by increasing the number of loci surveyed.

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IMPACT OF COMMUNITY FOREST ON FARM FODDER CULTIVATION AND LIVESTOCK PRODUCTION SYSTEM: A CASE OF SUDARBAZAR VDC, LAMJUNG

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ABSTRACT

A study was conducted at Sundarbazar Village Development Committee, Lamjung District, Nepal from 2067-02-01 to 2067-06-30 to assess the effect of community forest on the farm fodder cultivation and livestock production of the particular area. All together, 45 farmers were sampled randomly from the area with 9 participants form each ward number. Pre-tested semi structured questionnaire was taken for individual interview. The finding revealed that majority of the family members (47.56%) were fully engaged on agricultural occupation. All farmers were cultivating grain crops on their land and only 21 farmers out of 45 were cultivating fodder crops. Similarly, the livestock population was decreasing per year due to lack of fodder/ forage and lack of labor. The land under community forest was high and becoming easy for fodder collection and the high quality fodder/ forages were disappearing. So, for conservation of the disappearing fodder/forages as well as uptime the livestock production, alternative way for fodder availability should be searched. The study found that the community forest where, no fodder/forage plantation was done upto now due to lack of technical knowledge, is a potential area for fodder/forage cultivation to increase the livestock production as well as the dependency of farmers on farmland for fodder/forage collection.

Key words: Fodder trees, local knowledge, Livestock production, conservation

INTRODUCTION

Nepal is an agricultural country, which contributes about 41% to the total national GDP. The main source of household income is crop in terai region, while it is animal in the mountains and hills. More than 28% of the total national income is fulfilled by the animal production. Due to commercialization and privatization of the forest, farmers in the recent years are actively engaged on livestock production, both in terai as well as in the hills. Traditionally farmers grow fodder trees in their

farmland as an alternative source of fodder. There are negative effects of tree shade, mainly to the annual food crops resulting reduction in yield and production. Community forestry is an approach of managing communal forests by the local inhabitants. The concept allows local people to manage their forest resource to harvest fuel wood, timbers, fodder and other non-timber forest products in a sustainable manner. Simultaneously farmers also grow fodder trees in the farmland mainly to supply fodder to the livestock.

Community forestry in Nepal was originally conceived to protect forest and to fulfill the needs for forest products of the local population. For example, during 1980's, the sixth five-year plan of the Government of Nepal defined the target for the community forestry program as the protection and improvement of 82,189 hectares of forestland. Community forestry was also closely linked to the afforestation program as both programs were to be implemented in the hills to meet the urgent need of people for forest products such as timber, firewood, and fodder for cattle and other domestic animals (Manandar, 1980). Community forestry was also emphasized due to the fact that, many published reports indicated that the hill forests of Nepal were endangered and would disappear soon (Eckholm, 1978; Sharma and Amatya, 1978; TU, 1976). Later, in 1990's, the Panchayet Forests (Panchayet was the local administrative unit of the Government until 1990) and Panchayet Protected Forests were changed to community forests managed by Forest User Groups. The current legislation as well as the policy with regard to forestry sector in Nepal is considered to be very progressive (ICIMOD, 1993; Talbot and Khadka, 1994). For that reason the forest's user groups in the country have been bestowed with the authority to protect and manage community forests. Furthermore, the forest Act (HMGN, 1993) and Rules (HMGN, 1995) allow the community forest user groups to sell and distribute forest products (such as firewood, grass/fodder, poles, and some timber if available in the community forest) independently.

However there is a lack of scientific forest management practices; the current level of forest productivity is much lower that it's potential (Kafle, 2000; Kanel, 2000; Sowerwine, 1994). Therefore, the long-term management of community forests is necessary. So that scientific management, which benefits to the Government of Nepal, is encouraged. This is also stated clearly in the Ninth Five Year Plan (1997-2002) and is clarified in the Forest Act of 1993. Similar emphasis has been given about scientific management of community forestry in the up coming Tenth Five-Year Plan as well. The linkage between farming,

forestry, and livestock management have been understood very well by lay people as well as the forestry and development professionals in Nepal (Mahat, 1987). However, the potential role of community forestry in promoting sustainable rural development through income generation or generation of community forestry user group funds has not been fully explored (Chhetri and Jackson, 1995). Nevertheless, management of community forest in general has been taken as a potential fund raising opportunity by most community forestry user' groups and some may have even become too "econocentric" (Chhetri, Tiwari and Sigdel, 1998). This is also well reflected by the fact that the significance of non-timber forest products in the rural economy and for subsistence has been revealed by a number of studies (ANSAB, 1999; Edwards, 1996; Olsen, 1998; Olsen and Helles, 1997; Kanel, 1999; Malhotra *et al.*, 1992). For instance, as reported by ANSAB (1999) a number of forest user groups in Humla district are reported to be making substantial income annually by collecting royalties from non-timber forest products. Olsen's (1998) study in Gorkha district found out that collection of "Jaributi" (herbal medicines) provides 15-35% of the annual income of poor households in the northern and middle part from the community forestry. Simultaneously, according to Chhetri (2000), many government agencies, projects and NGOs on the community forestry area have been focusing on the off forest income earning opportunity such as livestock raising, vegetable, and bee keeping. Although the legislation and policy to day allow for the multiple use management of community forestry in the country, the practices so far tend to be biased towards managing the forests to maximise timber resources at the cost of other products including herbal medicines (Chhetri, 1999).

Fodder trees in farmland have been continuously growing by Nepalese farmers since time immemorial (Carter and Gilmour, 1989). The main use of fodder trees is to feed growing livestock population, mainly during scarcity period of winter and spring season. Livestock is one of the major domains of agriculture in Nepal that contributes about. 28% to the Agricultural Gross Domestic Products. Recent statistics of livestock found 7.04 millions cattle, 3.41 millions buffaloes, 0.86 millions sheep and 6.08 millions goats (MOA, 1999). Milk from cattle and buffaloes, and meat from goats and sheep are one of the main sources of household income, mainly in rural areas of Nepal. Fodder trees support directly to these huge livestock population. However, there is no clear-cut research findings about fodder trees and its role or contribution to the livestock production (Schreier *et al.*, 1991). Gilmour and Nurse (1991) described how edible tree leaves are used

for animal fodder, particularly during the winter months, when grass and other ground herbs are in short supply. The pressures of increasing population, reduced landholding size, declining returns to labour and the out migration outlined above, do not lead inevitably to resource degradation. For example, the introduction of stall feeding for animals in certain areas enables a reduction in numbers while maintaining or enhancing productivity, including the more efficient use of manure and labour (Campbell *et al.*, 1990). Increased fodder and fuel shortages provide the incentive for the increased cultivation of trees on farms, where enough land is available (Gilmour, 1988). In the mean time, community forestry has become a very popular concept to the local community to rely on forest products. Communities, besides harvesting non-forest timber products, have been continuously exploring range of fodder species to feed their growing livestock population. Under these circumstances, there should have been low level of concern about farmland fodder trees growing as communities are fairly utilizing forest resource for feeding livestock. On the other hand, the concept of planting fodder trees in farmland could have been still valid and thus continued irrespective of benefits (mainly fodder) from the community forestry. This situation has clearly warranted for a need of comprehensive study about role of community forestry, mainly to emphasis its impact in the farmland fodder trees plantation. As fodder trees have a negative effect to the cropland, such study will have a great contribution in line with supporting appropriate policy for a farmland tree plantation as well as for a wise utilization of natural resources such as community forest (Bastola, 2000).

Under the circumstances, there is a question of impact of community forestry to the trend and status of fodder trees to be grown at farmland. In one hand, the community forest provides fodder and forage to their livestock while they also plant fodder trees in their private farmland. It is important to understand the impact of community forestry to the importance or need of fodder trees and its relation to the household mainly through livestock sub system. It is worthy to understand trend of fodder trees (in terms of number of trees, species diversification, quality and quantity of fodder production) in relation to the community forestry. The central question of research is to know whether community forestry individually or in combination with fodder trees has any impact to the livestock production and to the household economy so that appropriate policy could be formulated or suggested on farm fodder trees management. The study was conducted to fulfill the following objectives:

- To analyze trend in farmland fodder cultivation in relation to community forestry and
- To see the effect of community forest on livestock production system

MATERIALS AND METHODS

All wards of Sundarbazar VDC were selected for the study because of researcher's easy access, willingness of local farmers to cooperate with the researcher and availability of community forest on the site. Randomly selected 45 farmers (5 farmers from each ward) comprise the sample size for the study. The information required for achieving the stated objectives was collected / obtained by entertaining personally the interview schedules to the selected farmers by using semi-structured pre tested questionnaire. The collected information was analyzed basically with the help of MS-Excel software. Descriptive statistics like average and percentage were extensively used to analyze the collected information related to the research.

RESULTS AND DISCUSSION

Household characteristics

The average household size including HH of the surveyed area was 5.47 persons per household (HH) and the male female ratio was also nearly 1:1 (48.81% male and 51.19% female). The total population of all ages was 246 on the targeted HH. the proportion of economically active people (15<age<60 years) was very high (59.35%), whereas, old population (>60 years) was only 6.5%. regarding to the education status of the family, only 4.88% population was illiterate (below school age). the highest population was fall under school level education category, in which, only 105 persons were occupationally students and the rest were engaged in agriculture. due to low qualification level, only 8.54% people were engaged in salaried job and rest (a large mass 117) were fully engaged in agricultural occupation.

Table 1. Household characteristics of sampled farmers

Particulars	Actual value	Percentages
No. of households (HH)	45	
Average HH size (no. of members)	5.47	
Male	2.67	48.81
Female	2.8	51.19
Age<15	84	34.15
15<age<60	146	59.35
60<age	16	6.5
Illiterate	12	4.88
School level	189	76.83
University level	45	18.29
Agriculture (farming)	117	47.56
Salaried job	21	8.54
Private business	3	1.22
Students	105	42.68

(Source: field survey 2010)

Land holding and utilization

Table 2 presents the average land holding and its distribution by types of land and use. in this table lowland represents irrigated parcels where rice is grown by making bunds and the marshy lands which is the low quality land where only one crop (rice) a year is taken. As the proportion of marshy type of land was very low it was described under the category of lowland. Out of 45 households, 39 households had lowland but only 12 of them had private forest. Regarding to the total area, it was decreased with type of land ie; lowland was 11.23 ha whereas private forest was only 0.93 ha and average area holding was 0.29 ha/household for lowland, 0.14 ha/household for upland and grazing land and only 0.08 ha/household for private forest. The average area per household was calculated on the basis of actual household holding the classified land type only. Similarly, from the same table it was found that 45 household cultivated grains in 15.78 ha whereas only limited area (less that 2 ha individually) was under vegetable, fruit, grass and forest cultivation. The average land holding per household for grain cultivation was 0.36 ha which was highest and only 0.04 ha per household was under vegetable cultivation. low land holding could be due to early family separation, and the land is used for grain production for daily consumption instead of fruit or grass production.

Table 2. Average land holding by the farmers according to the land type and use

Particulars	No. Of HH with parcels in each land type	Total area in each land type (ha)	Average area in each land type (ha)
Average land type by each household (ha)			
Lowland	39	11.23	0.29
Upland	37	5.18	0.14
Grazing land	21	2.87	0.14
Private forest	12	0.93	0.08
Average land use by major crops (ha)			
Grains	45	15.78	0.36
Vegetables	41	1.66	0.04
Fruits	15	0.82	0.06
Grass	21	2.67	0.14
Private forest	12	0.83	0.08

(Source: field survey 2010)

Livestock production

Table 3 and 4 shows the average livestock holding per HH and livestock dynamics of five years. Among 45 HH, maximum 43 HH had kept 191 goats (5goat per HH) and only 11 HH involved in cow rearing with average cow holding one per HH. Buffalo rearing was also found major occupation of the surveyed area. All together, 35 HH were involved in buffalo rearing with average one buffalo per HH, whereas, per HH average animal was highest in case of chicks. Low number of cow could be due to unavailability of high yielding breed, lack of knowledge on feeding management to the cow and disease problem. Whereas, number of goat was high due to easy available of fodder for goat and easy for management.

Table 3. Average livestock holding by HH and change in livestock population

Particulars	Cow	Bullock	Buffalo	Goats	Chicks
Average livestock holding per household (HH)					
No. Of HH holding livestock	11	25	35	43	19
Total livestock population	11	48	40	191	234
Average livestock holding per HH	1	2	1	5	12
Livestock differences between present and five years ago					
Increased	1	1	1	7	2
Decreased	2	10	20	18	13
Constant	8	14	14	18	4

(Source: field survey 2010)

It was found that the number of farmers was limited who expressed increasing trend on livestock population. majority of the HH expressed the decreasing trend of livestock population due to labor problem and disease problem. the number of livestock was declining due to labor problem and feeding problem. it could be due to high migration towards foreign county of economically active population.

Livestock feeds and feeding

Table 4 presents the source of feed to the livestock reared by the farmers of surveyed area. The major feeds used by the farmers were maize, rice bran, rice straw, maize stover grasses and tree fodders for their animals. among the various feeds, majority of the feeds came from cultivated land (62.67%) with compared with other sources as purchase (16.43%) and the lowest feeds collected from the grazing land. only three HH were collecting feeds from the grazing land where 42 HH were collecting the feed from their own cultivated lowland as well as upland. use of community forest was limited only on five HH.

Table 4. Livestock feed source and average dependency (month)

Feed source in use	Actual value	Percentage	Average dependency (month)
Cultivated land	42	62.67	9.56
Community forest	5	7.46	1.09
Grazing land	3	4.48	0.23
Purchase	11	16.43	0.62
Private forest	6	8.96	0.5

(Source: field survey 2010)

Regarding to the dependency for feeding to the livestock, more than 9 months was fulfilled by the cultivated land in the form of grasses, maize, rice bran, rice straw, and maize stover and other time was supported by the other sources. Among other sources, community forest is first (1.09 months) in the form of grasses, tree fodder, grazing etc.

Table 5. Best livestock feed sources found on the research site

Sources	Forage Productivity		Availability		Animal Productivity		Accessibility	
	Actual Value	%	Actual Value	%	Actual Value	%	Actual Value	%
Ownland	39	86.67	40	88.89	44	97.78	43	95.56
Private forest	4	8.89	3	6.67	0	0	1	2.22
Community forest	1	2.22	1	2.22	1	2.22	1	2.22
No difference	1	2.22	1	2.22	0	0	0	0

(Source: field survey 2010)

Similarly, according to forage productivity, ownland shared beigest percentage (86.67%) and community forest was lowest. a little farmers (2.22%) argued that the forage productivity on the community forest was best. Nevertheless, the feed source for animal production was highest in ownland for availability for forage, animal productivity, and accessibility of the forage (table 5), whereas, private forest was worsted an terms of animal productivity.

Fodder/forage availability on the vicinity (the plant name is local name)

The major fodder/forage and tree fodder available on the surveyed area was Badahar, Bakaino, Bamboo, Banso, Berseem, Bhadaure, Dabdabe, Dinanath, Dubo, Gande, Ginderi, Ipil Ipil, Juane, Kabro, Kansh, Khanayo, Kimbu, Madilo, Mothe, Napier, Nimaro, Pakhuri, Stylo, Teosinte, etc. some of them were very common and some were found only limited HH. among the various fodder/forage, Badahar was used by 42 farmers out of 45 farmers and then the Banso grass was used for livestock feeding whereas, the improved grasses as Napier, Stylo, Teosinte etc. were used in very low frequency ie. 42.22%, 8.89% and very less respectively (table 6).

Table 6. Average household using different fodder/forage for their livestock feeding

Fodder/forage	Actual value	Percentage
Badahar	42	93.33
Banso	39	86.67
Bakaino	30	66.67
Napier	19	42.22
Kane	5	11.11
Stylo	4	8.89

(Source: field survey 2010)

Among the various fodder/forage available on the area, Banso, a local grass was the best according to the farmers perception (64.44%), followed by Bakaino, a fodder tree suitable for goat feeding (33.33%) and Napier, an introduced non-leguminous grass (31.11%). in farmers' practice, Stylo ranked at last (2.22%), although it was a introduced forage species (table 7).

Table 7. Best fodder/forage for livestock feeding according to the farmers' perception

Fodder/forage	Actual value	Percentage
Banso	29	64.44
Bakaino	15	33.33
Nepier	14	31.11
Badahar	7	15.55
Stylo	1	2.22

(Source: field survey 2010)

Cultivation of fodder/forage by the farmers

There was so many fodder/forage cultivated by the farmers' on their ownland. Among the 45 HH, 39 HH were cultivated different fodder/forage on their ownland. Among them, fodder tree cultivation was high ie, Bakaino cultivated by 76.92%, Badahar by 64.1% and so on, whereas, cultivation of fodder grasses were limited. Only 23 HH out of 39 HH cultivated Napier and only 12.82% farmers were cultivated Stylo on their ownland. But cultivation of fodder/forage on the community forest was very limited. Only 13 HH told about cultivation of fodder/forage on the community forest out of 45 HH. Among them, cultivation of Napier grass on the community forest was found highest (76.92%), whereas, other cultivated fodder/forage were Stylo, Ambriso bamboo etc. found on the community forest. Instead of this, only limited farmers' (13.33%) had not cultivated fodder/forage on their ownland due to lack of land (50%), lank of seed (50%) and lack of labor (16.67%). but majority of the farmers' (32 farmers out of 45) told that cultivation of fodder/forage on their community forest was not done due to various problems. out of the various problems, the major problem was lack of technical knowledge (59.37%) for fodder/forage cultivation on the community forest. only limited farmers' (9.38%) perception was the existing grass of community forest is sufficient.

Table 8. Cultivation of fodder/forage by the farmers on their ownland and community forest

Characteristics	Fodder/forage	Actual value	Percentage
Cultivation in ownland			
Yes		39	86.67
No		6	13.33
	Lack of land	3	50
	Lack of seed	3	50
	Lack of labor	1	16.67
Cultivation of fodder/forage in community forest			
Yes		13	28.89
No		32	71.11
	Lack of knowledge	19	59.37
	Lack of appropriate land	6	18.75
	Open grazing	6	18.75
	Existing grass is sufficient	3	9.38

(Source: field survey 2010)

Table 9 presents the effect of community forest on fodder/forage availability and livestock production system. Firstly, the community forest was open and it was used for grazing animals and collection of timber and fire woods by the people of the vicinity. After the forest was managed by the community, it was termed as community forest and farmers' perception was, became difficult for grazing their animals (26.67%) but majority of the farmers' (73.33%) had no effect of community forest on their livestock production.

Table 9. Effect on fodder/forage availability before and after community forest

Characteristics	Actual value	Percentage
No difference	33	73.33
Easy for forage collection	12	26.67
Difficult for grazing	12	26.67

(Source: field survey 2010)

Fodder/forage dynamics

The fodder/forage availability at present was very high. in village level as well, availability of Napier was found very high (28 farmers had Napier on their land out of 45) whereas, indigenous grasses like Smbriso, and Nimaro were limited due to introduction of new fodder species. Out of 45 farmers, 11 farmers argued about no change in fodder availability during the last five years. Similarly, Banso grass was disappeared within five year according to 20 farmers out of 45 participants. Whereas, according to farmers, Madilo, Siru and Kansh were at risk

Table 10. Fodder/forage present or disappear within five years

Fodder/forage availability at present but not 5 years ago		**Fodder/forage availability before 5 years but not now**	
Fodder/forage	Actual value	Fodder/forage	Actual value
Napier	28	Banso	20
Teosinte	19	Madilo	7
Stylo	13	Siru	3
Oat	3	Kansh	1
Ambriso	3		
Ipil ipil	3		
Berseem	2		
Kimbu	1		
Nimaro	1		
Nothing	11		

(Source: field survey 2010)

CONCLUSION AND RECOMMENDATION

The present study indicated the drastic decrease on livestock population over the year. Although the total population of the surveyed area was engaged on agricultural occupation (47.56%), majority of the farmers were focused on grain production (all farmers of the survey sample with average area under grain cultivation 0.36 ha per household). Livestock population was also decreasing due to unavailability of fodder/forage because the land under fodder cultivation per household was only 0.14 ha. Similarly, the major fodder source for livestock

was cultivated land (more than 9 months). It shows that the livestock is under nutrient deficit condition due to high dependency on crop by products. The result also showed that the best fodder/forage for livestock feeding were Badahar, Bakaino, Napier, Banso etc. which were commonly using by the farmers for their livestock. Similarly, the area under community forest was very high. Therefore, one possible solution for increasing fodder/forage availability could be community forest where all the above mentioned crops can be grown successfully. Nevertheless, limited farmers were cultivating few fodder crops on their own land but majority of the farmers were not cultivating fodder/ forage on the community forest upto now due to lack of technical knowledge (59.37%) which also emphasize the proper utilization of community forest for higher livestock production.

The result of the study also showed that when the community forest was established, it was easy for fodder/forage collection (26.66%). This is also a major importance of community forest for livestock production system. However, the best fodders on farmers' opinion were disappearing year after year due to lack of proper protection mechanism. Therefore, the community forest should be utilized for fodder/forage production parallely with timber production as well as trees and wildlife conservation to optimize the livestock production on Sundarbazar VDC of Lamjung District.

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IMPORTANT SOCIO-ECONOMIC DETERMINANTS AND THEIR EFFECTS TO THE BUFFALO FARMING SYSTEM IN MID-HILLS OF NEPAL

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ABSTRACT

Some of the important socio-economic determinants of farming households affect the buffalo farming systems in Mid-hills of Nepal. This study has first of all characterised farm households, identified different socio-economic determinants and analysed important of them in detail. Altogether, 107 farmers of 18 villages from three Mid-hills districts of the Western Development Region (WDR), Nepal were surveyed using pre-tested structured questionnaires. Positive correlations have been found between the household heads' education and practice of artificial insemination in their buffaloes ($r=0.29$; $p<0.01$), daughter schooling ($r=0.20$; $p<0.05$) and milk selling by women ($r=0.17$; $p<0.05$). However, no significant ($p>0.05$) correlation has been found between the household heads' education and breed preference. Significant correlations have been found between land-size and herd-size per holding ($r=0.42$; $p<0.001$), and land-size and year-round green forage availability ($r=0.29$; $p<0.01$). The study concludes that household heads' education, land-size per holding, year-round green forage availability and women involvement in milk selling are the most important socio-economic determinants for the improvement of the buffalo farming systems in Mid-hills of Nepal. These factors have to be considered by the policy makers for the commercialization of the buffalo farming in Nepal.

Key words: Buffalo farming, correlation, gender, education, land size, year-round green.

INTRODUCTION

Socio-economic factors of the society may affect the adoption of new innovation in specific and of the country in general. Socio-economics refers to environmental, economic, social and institutional patterns, and their linkage that compose the context of development (Huisinga, 1997). Lubwama, 1999 argued that social and economic

factors at various levels of social systems form an environment where people interact through roles and relationships defined by gender, age, ethnicity and other social variables. Karki *et al.*, 2006 have identified several socio-economic determinants, e.g., farm size, education, forage situation, labour force, veterinary services, credit, training and experience, group membership, and marketing facilities as the socio-economic determinants of the buffalo farming in Nepal.

Because of low productivity of agricultural sector, poverty* is rampant among those who are engaged in agriculture (NPC, 2007). Nepal has made slow and steady progress in reducing poverty for last decades. It has been estimated that poverty has been declined to 31% in 2004 from 42% in 1996 (ADB, 2007; MOF, 2007). Social and human development indicators, such as life expectancy, maternal and infant mortality rates, and adult literacy, have improved noticeably during last decade. Despite of the decade long conflict, Nepal has made notable progress in the Millennium Development Goals (MDGs) (www.adb.org/nepal). However, Nepal still remains one of the poorest countries in the world with per capita income of US$ 388 per annum, human development index 0.534 (UNDP, 2008), wide income disparities, large gender gap and poor access to basic needs and social services by a large section of the population (ADB, 2008).

Out of the total contribution of livestock 53, 38 and 9% is derived from Hills, Terai and Mountain regions, respectively (Shrestha and Aacharya, 2004). So, socio-economic understanding of the mode of production of the Hills farm-households vis-à-vis their association with the livestock production, one of the vital components of farming systems, is very important.

Economic importance of buffaloes in Nepal has been realised only when they have been reported to contribute 53% of the livestock share in the national GDP (Shrestha, 2004). The government has adopted an agricultural prospective plan (APP) as a 20-year priority focused forward looking strategy (Regmi, 1999) which has given first priority to milk and then meat (MOAC, 1998). Milk is by far the most important livestock commodity which shares nearly half of livestock GDP, with meat next, much of which is by-product of the milk sub-sector (APP, 1995). Buffaloes are ranked as the first animal to contribute these products, milk and meat, to national production.

* *The United Nations Committee on Economic, Social and Cultural*

Rights, in its statement on poverty, defined poverty as "a human condition characterized by the sustained or chronic deprivation of the resources, capabilities, choices, security and power necessary for the enjoyment of an adequate standard of living and other civil, cultural, economic, political and social rights." (http://www.unhchr.ch/development/poverty-02.html).

However, more than 85% of the total buffaloes of Nepal are indigenous. Though indigenous buffaloes are well adapted across different agro-ecological zones because of their smaller body size, forage digestion ability and cold tolerance, their average productivity is very low (Rasali and Crow, 1999; Amatya *et al.*, 2000). In spite of four decades efforts of breed improvement by cross breeding the local buffaloes with Murrah breed, the adoption rate is still very low in Nepal (Shrestha, 2004).

The conceptual framework for the study was prepared after the participatory rapid appraisal (PRA) works with the selected farmers (40 farmers in each district) and key-informants of the research areas conducted by the research team. The framework showing the interactions of main socio-economic determinants in buffalo farming in Mid-hills of Nepal is presented in Fig 1.

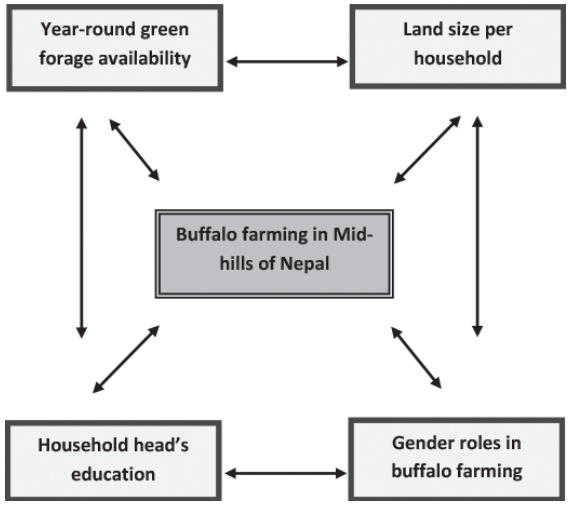

Figure 1. Conceptual framework for the study

In this study, major socio-economic determinants such as, educational status, family size, land holding, forage situation and gender issues are analysed in detail. The main objectives of the study were:

1. To characterize the farming households keeping buffaloes in the Mid-hills
2. To investigate the socio-economic determinants of buffalo farming in the Mid-hills
3. To understand the mode of association of some of the important determinants that are relevant to promoting buffalo farming in the Mid-hills
4. To facilitate discourse among scientists, development workers, policy makers, farmers and entrepreneurs to enhance development in the field of buffalo farming sector in Nepal.

MATERIALS AND METHODS

Research area

This study was carried out in Mid-hills of Western Development Region (WDR) of Nepal. Mid-hill is the most important region for the buffalo production. Buffalo is perceived as the first ranked animal in this area (Amatya *et al.*, 2000). Three out of 11 Mid-hill districts of WDR, namely, Baglung, Gulmi and Arghakhanchi, were purposively selected for this study (Fig 2). Baglung district is located between 28^{O} 27' North latitude and 83^{O} 60' East longitude where as Gulmi and Arghakhanchi districts are located in between 28^{O} 4' North latitude and 83^{O}15' East longitude, and 27^{O} 55' North latitude and 83^{O} 4' East longitude, respectively. The main activity of these areas is rain-fed agriculture followed by livestock keeping and off-farm activities. The main staple food crops are rice and maize followed by wheat, barley and millet. Buffaloes and cattle are the important animals followed by goat and poultry (Paudel *et al.*, 2007).

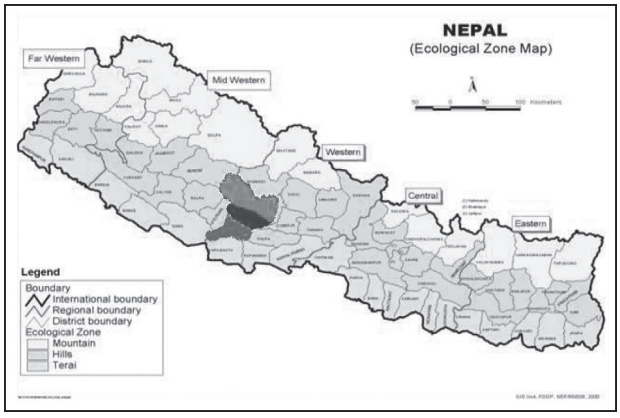

Figure 2. Map of Nepal showing the research areas

Sampling procedure, data collection and analysis

Altogether 107 farmers from 18 villages of three districts were randomly selected for the questionnaire based survey. The selected farmers should have:

1. Atleast one buffalo with each of them
2. Interest and willingness towards the research work.

Some of the variables tested in the research have been listed in Table 1. The information recorded were analysed with the Statistical Package for Social Sciences SPSS-PC version 15.0 (SPSS Inc., 2006).

Table 1: Variable description code

Variable code	Description	Level of measurement
ANIMNUM	Animal numbers per household	Head (number of different animal species)
ANIMTYPE	Type of animals with the farmer	1= Buffalo, 2= Cattle, 3= Goat, 4= Chicken
BREEDBUF	Breeds of buffalo	1= Lime, 2= Parkote, 3= Murrah-cross, 4= Murrah
DAUSCH	Daughter schooling	Head (number)
FAMISIZE	Family size per household	Family members per household (number)
FEEDHAY	Method of feeding hay	1= treated with urea, 2= mixed with mineral mixture, 3= chopping and soaking, 4= mixing with green forage, 5= no treatment
HHEDU	Household head education	1= illiterate, 2= can read and write only, 3= primary school, 4= middle school, 5= high school , 6= college education
HHSEX	Household head sex	Male or female
HOUSTYPE	Type of house	1= thatched roof, 2= slate roof, 3= galvanised steel roof, 4= RCC type
INCOMUSE	Use of income from milk selling	1= in education, 2= in family nutrition, 3= family health, 4= clothing
INSEPRAC	Insemination practiced in buffalo	1= artificial insemination, 2= natural insemination, 3= whichever is available
LANDSIZE	Size of land per household	Area in Ropani (1 Ropani= 500 m^2)
MILKSELL	Selling of milk mostly by	1= women, 2= men, 3= both men and women, 4= children

Variable code	Description	Level of measurement
MPREFBUF	Most preferred buffalo by farmers	1= Lime, 2= Parkote, 3= Murrah-cross, 4= Murrah
YRGFAVAI	Availability of year-round green forage for	1= less than four, 2= four to six, 3= six to nine, 4= nine to twelve months
SIRESELC	Criteria for sire selection	1= distance to the sire, 2= parental merits, 3= body confirmation, 4= do not care at all
SONSCH	Son schooling	Head (number)
TNUMBUFF	Total number of buffalo/ household	Head (number)

RESULTS

Household heads' education

In this study, more than 90% household heads have been found literate[1]. However, about 58% household-heads have been found having only primary school education (from grade 1 to 5). Past evidences have proved the positive effects of education on adoption of new technology and has been able to increase the agricultural productivity (Birdsall, 1993). But no research data in relation to education and livestock production, and productivity is available on Nepal.

Family size

The average family size (mean ± SD) has been found as 7.39 ± 3.85 (Table 2) which is almost similar to the national average (CBS, 2001). Maximum family numbers per household was found 24 where as minimum was found as 1.

Table 2: Family size statistics of the farmers under the study.

Family members/household	Frequency	Percent
1-4	16	15
5-7	56	52.4
8-12	26	24.3
More than 12	9	8.3

House type

More than half of the farmers of the research sites have been found with slate roof with mud-wall house followed by galvanised steel (Asbestos sheet), thatched roof and reinforced concrete cement (RCC) type

(Table 3). The research sites were nearer from the local mines of slates which could be the reason to have higher percentage of houses with slate roofs.

Table 3: House types of the farmers under the study (n =107).

Types of house	Frequency	percent
Thatched roof with mud-wall	4	3.8
Slate roof with mud-wall	61	57
Galvanised steel (Asbestos sheet) roof with mud-wall	39	36.4
RCC type	3	2.8

[1]*National literacy policy, 2003 of Nepal defines a literate person as a person who is able to read and write short and simple sentences related to daily life in his/her mother tongue or national language with understanding and who is able to communicate with others and perform simple tasks of calculations (http://www.accu.or.jp/litdbase/policy/npl/index.htm).*

Land holding

Though the average land-size per holding of Nepal is only 0.79 hectares (NPC, 2002b) there is a great variation between the rich and poor households. NPC (2002b) reports that 75% of the total holdings of Nepal own less than one hectare land per household which accounts only 38.9% area of the total land whereas only 0.75% holdings own more than 5 hectares land per holding which accounts around 7.5% area of the total land of Nepal. So, majority of the real farmers do not have enough land for cultivation whereas some elite people have more than needed land. This could also be a reason of lower national agricultural production of the country. The average land-size (mean ± SD) per holding in the research sites has been found as 23.97 ± 17.36 Ropanies (1 Ropani= 500m^2). The minimum land size was 4 Ropanis where as that of maximum was 92 Ropanis per holding (Table 4).

Table 4: Land-size (Ropani) per holding of the farmers under the study.

Types of land	Minimum land size	Maximum land size	Mean ± SD
Upland	1	86	17.3 ± 14.78
Lowland	0	30	6.67 ± 6.59
Total land	4	92	23.97 ± 17.36

Land area 1 Ropani = 500m^2

Animal types and number with the farmers

In general, integrated farming system is practiced in Nepal. A single farmer, normally, cultivates his/her farm for cereal crops, vegetables, cash crops and keeps animals like, buffalo, cattle, goat, poultry, etc. The animal statistics of the farmers in the research sites have been shown in Table 5.

Table 5: Major animal statistics with the farmers under the study (n=107)

Types of animals	Total number	Minimum number	Maximum number	Mean ± SD
Buffalo	251	1	7	2.33 ± 1.29
Cattle	176	0	10	1.64 ± 1.72
Goat	226	0	22	2.2 ± 2.76

Breed types and number of buffaloes with the farmers

It has been found that farmers have significantly higher number of Parkote buffaloes ($p<0.01$) followed by Lime, Murrah-cross and Murrah (Table 6). The difference was not significant ($p>0.05$) between Murrah-cross and Murrah breeds.

Table 6: Breeds and number of buffaloes with the farmers under the study (n=107)

Breed of buffalo	Total number	Minimum number	Maximum number	Mean ± SD
Lime	70	0	3	0.65 ± 0.70 [a**]
Parkote	101	0	3	0.94 ± 0.81 [b**]
Murrah-cross	34	0	2	0.32 ± 0.58 [c***]
Murrah	18	0	1	0.17 ± 0.38 [c***]

[ab]means in the same column with different superscript are significantly different.

**p<0.01

***p<0.001

Availability of year-round green forage

Only 6 farmers reported that they get green forage almost round the year for their buffaloes where as 12, 42 and 47 respondents replied that they get round the year green forage only for less than 4, 4 to 6 and 6 to 9 months, respectively (Table 7). Farmers reported that the scarcity of the green forage for more than six months was one of the main reasons of not rearing Murrah and its cross buffaloes. This was also the cause of lower productivity (litre/lactation) of buffalo in Nepal.

Table 7: Possibility of year-round green forage for buffalo in Mid-hills (n=107)

Duration of green forage availability	Number of respondents (frequency)	Percent
For less than 4 months	12	11.2
For 4 to 6 months	42	39.3
For 6 to 9 months	47	43.9
For 9 to 12 months	6	5.6

Feeding hay to animals

Farmers have to rely upon the poor quality hay, mostly rice and wheat straw in Nepal. The technology of hay treatment still seems to be inside the boundary of the research farms (Singh *et al.*, 2002). Almost all (99%) farmers under the survey responded that they feed hay to their animals without any treatment. Only 1% respondent reported that they mix some green forage with the hay during feeding animals. None of them had practiced urea treatment or mineral mixture in feeding hay. This also could be one of the major reasons for the low production of the buffaloes in Nepal.

Correlation between some socio-economic parameters related to buffalo farming

The correlations between some important socio-economic parameters are presented in table 8.

Table 8: Correlation between some socio-economic parameters related to buffalo farming

Socio-economic parameters	r-value	p-value
ANIMNUM and LANDSIZE	0.418***	0.000
FAMISIZE and HHEDU	0.126	0.196
FEEDHAY and HHEDU	-0.163	0.063
HHEDU and DAUSCH	0.203*	0.036
HHEDU and MPREFBUF	0.00	0.997
HHEDU and RYGFAVAI	0.084	0.314
INCOMUSE and HHEDU	0.073	0.405
INSEPRAC and HHEDU	0.29**	0.001
LANDSIZE and HHEDU	0.076	0.434
MILKSELL and HHEDU	0.168*	0.042
MILKSELL and LANDSIZE	-0.185	0.057
MPREFBUF and LANDSIZE	-0.139	0.153
SIRESELC and HHEDU	0.004	0.96
SONSCH and DAUSCH	0.246**	0.011
TNUMBUFF and LANDSIZE	0.363***	0.000
TRAINING and MPREFBUF	0.043	0.663
YRGFAVAI and LANDSIZE	0.287**	0.003

Pearson correlation was used for normally distributed, ratio or interval variables; Kendall-tau_b correlation was used when the variables were both ranks and not normally distributed; Spearman correlation was used when the variables were either of ratio or interval and ranks

DISCUSSION

Socio-economic determinants of farming households are intimately related to the agricultural production systems world wide (Thys *et al.*, 2005; Singh and Bohra, 2006). Out of many socio-economic determinants that may affect farming system (Singh *et al.*, 2002; Chand and Raju, 2008), household heads' education, land size per household, forage availability and gender roles have been perceived as the most important determinants (Karki *et al.*, 2006) for the buffalo farming in Mid-hills of Nepal. These determinants not only affect on the number of buffaloes per holding but also on the breed type, production system and overall profitability from the farming.

Among the socio-economic determinants, education plays a pivotal role in any farming system. Education is supposed as a key to increasing economic efficiency and social consistency. Average literacy rate in present research districts, Baglung, Gulmi and Arghakhanchi, was 61.4, 57.4 and 55.9%, respectively (CBS, 2001). More than 90% household heads of this study have been found literate. However, the correlations between the household heads' education and breed preference, methods of feeding, availability of year-round green forage, sire selection are found not significant ($p>0.05$). It might be because of the buffalo farming has become a long tradition (Dhakal and Grabowki, 1987; Shrestha, 2004), not enough land and poor extension services for year-round forage production. So, even the educated household heads do not want to change their farming systems. However, there is significant positive correlation between the household heads' education and daughter schooling ($p<0.05$), A.I. practice in buffalo ($p<0.01$), and milk selling by women ($p<0.05$). These are the positive signal for the development of the society. Öztürk (2001) states that "a nation which does not educate its women cannot progress" and "educating girls and women is probably the single most effective investment a developing country can make, whether or not women work outside the home". The significant positive correlation between the household heads' education and A.I. practice shows the positive trend for the breed improvement by cross breeding programme. Educated households also try to reduce the gender gap (Quisumbing *et al.*, 2004). In this study too, we found the positive correlation between household heads' education and milk selling by women. It increases the access of the women to the income and reduces the gender gap.

Land is being a limiting factor for the agriculture farming in Nepal (Ghimire, 2008). No significant ($p>0.05$) correlations were found between the land-size per holding and household heads' education, house type, most preferred breeds and selling of milk. However, there is a significant positive correlation between land size and total animal per household ($p<0.001$), availability of round the year green forage ($p<0.01$), and total number of buffaloes per household ($p<0.001$) (Table 7.10). It denotes that farmers can practice year-round green production programme and can increase the herd size with the increase in their land-size. However, their preferences to the breeds of buffalo may not change with the change in the land size because there is no significant ($p>0.05$) correlation between these two parameters.

The productivity of animals depends not only upon their genetic make-up but also depends upon the way of feeding, housing and health care management (Singh and Pundir, 2001). The positive correlations between the land-size and herd-size and between the land-size and green forage availability denote the positive relationship between the herd-size and forage availability. Methods of feeding hay also depend upon the availability of the green forage in the farm (Singh *et al.*, 2002). Since there is no significant correlation between land size and breed preference but there is the positive relationship between the forage availability and land size, keeping the land constant, if we could increase the forage availability, which might be possible (Banstola *et al.*, 2004), by introducing improved seeds, technology, extension services and irrigation facilities, farmers' preferences would be changed from indigenous to Murrah-cross breeds of buffalo. This would be a positive guideline for the breed improvement programme in Mid-hills of Nepal.

Though gender division of labour varies from region to region in mixed crop-livestock production system, based on the culture, religion and socio-economic variable (Tangka and Jabbar, 2005) women play significant role in buffalo feeding, forage collection, health care and management (Paudel *et al.*, 2007). However, their involvement has been found very low in quick income generating activities, e.g., milk selling. The positive correlations between the household heads' education and daughter schooling and household heads' education and milk selling by women are appreciative signals to the buffalo farming enterprise in Nepal. It will reduce the gender gap in the society and will have the multiplier effect not only in buffalo farming but also for the development of the society as a whole.

CONCLUSION

Buffalo farming it is highly correlated with several socio-economic characteristics in the Mid-hills of Nepal. Practice of A.I., which can be taken as a major factor for upgrading indigenous buffaloes, has been found significantly correlated with the household heads' education. The herd-size is found significantly correlated with the land-size of the household. Milk selling by women is significantly correlated with the household heads' education. Year-round forage production is also significantly correlated with the land-size. This study suggests that change of farmers' preference to the improved breeds of buffalo may be possible with the provision of year-round green forage in their farms. Hence, education, land size, year-round green forage and women involvement in milk selling are found most important socio-economic

determinants for the improvement of buffalo farming system in Nepal.

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