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RESEARCH ARTICLES

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RESEARCH ARTICLES

Response of Plant Geometry and Fertigation on Quality Attributes and Leaf Nutrient Status of Cherry Tomato (*Lycopersicon esculentum* var. *Cerasiforme*) under Zero Energy Polyhouse Conditions

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ABSTRACT

An experiment was conducted at the Hi-Tech Horticulture Unit, Rajasthan College of Agriculture, Udaipur, Rajasthan in 2011 to study the response of plant geometry and fertigation on quality characters and leaf nutrient status of cherry tomato cultivar BS.834 under zero energy polyhouse conditions. The experiment consisted of twelve treatment combinations of four plant geometry and three levels of fertigation with three replications in factorial completely Randomized Design. The results revealed that there was significant influence of the fertigation levels on quality parameters and NPK status of leaf. Among the different fertigation levels used F3 (NPK @ 250:125:125 kgha-^{1}) were found statistically superior to enhance quality characters like total soluble solids (8.81), acidity (0.202),dry matter content (7.31%), moisture content (92.69%), pulp recovery (83.44%), lycopene content (3.34 mg/100 g) and carotenoids (8.36 mg/100 g). Similarly, F3 fertigation level gave maximum nitrogen (1.58%), phosphorus (0.401%) and potassium (1.539%) content in leaf over other fertigation levels. Effect of plant geometry had non -significant influence on total soluble solids (TSS), acidity, lycopene, carotenoid content and NPK content of leaf and significant influence on dry matter content, moisture content and pulp recovery (%) of cherry tomato. Cherry tomato grown in wider plant geometry i.e. S4 (75cm×60cm) improved the quality aspect of fruit, which might be due to increased plant height, stem thickness, fruit size and weight. Likewise, interaction effect of plant geometry and fertigation had significant influence on most of the quality and pigment parameters except pulp recovery (%) and lycopene content of fruit. Interaction effect of plant geometry and fertigation had significant influence on phosphorus and potassium content of leaf.

Key words: Plant geometry, fertigation, cherry tomato, leaf nutrient, polyhouse

INTRODUCTION

Cherry tomato (*Lycopersicon esculentum* var. *cerasiforme*) is small sized solanaceous fruit vegetable have recently gained popularity among consumers because they can be eaten without being cut, they are deep red in colour, and their flavour is intense and pleasant. It is gaining popularity in Europe, Asia as well as private sector of Rajasthan, India. The average fruit weight is 12-20 g depending on variety with high TSS ranging from 6.8-7.0 percent; and therefore ideal for salad purpose (Singh and Sirohi, 2006). It is an important crop for the food processing industry, and many commercial products like soup, ketch up, sauce, juice and powder are prepared. Quality characteristics are important for value addition, market potentiality and consumer acceptance. Fruit quality is a crucial factor in the production of greenhouse tomatoes, and it is strongly influenced by Potassium (K). With adequate K nutrition, the fruit is generally higher in total solids, sugars, acids, carotene and lycopene, and has better keeping quality (Munson, 1985). Thus, there is prime need to increase quality and productivity of cherry tomato. Greenhouse cultivation could be suitable to increase the productivity of cherry tomato because any crop can be grown in any season of the year depending on the market demand, excellent quality of the produce, disease free produce. Tomato crops grown under polyhouse conditions were earlier to flower and had higher yield than those in the field (Nagalakshmi et al., 2001).

Greenhouse cultivation actually achieves higher water and nutrient use efficiencies. It requires suitable production technology like crop geometry, water and nutrient management to produce quality economic yield. Among the various factors responsible for low production, crop geometry and fertilizer application are important factors. Adequate nutrient supply is essentials for optimum production and productivity of cherry tomato. Cherry tomato yield could be increased through suitable spacing with appropriate fertigation levels. Fertigation is a technique for application of fertilizers in the irrigation water and it can be applied through buried or surface drip lines or through sprinkles. Fertigation is an excellent method of optimizing the utilization of water and nutrients to improve the sustainability of greenhouse production, since it enables both the water movement in the soil and nutrient supply to be controlled. In fertigation, nutrient use efficiency could be as high as 90 percent as compared to 40-60 percent in conventional methods (Olaimalai et al., 2005). Fertigation improved nutrient availability, enhanced nutrient uptake, reduced fertilizer application rate and water requirements, minimized nutrient losses through leaching and prevents salt injuries to root and foliage. The nutrient uptake is proportional to total yield of crop. Fertigation enables accurate supply of water and nutrients to the individual plant. Considering these aspects, this study was undertaken to find out the response of plant density and different levels of fertigation on quality attributes and leaf nutrient uptake of cherry tomato under zero energy polyhouse conditions.

MATERIALS AND METHODS

The experiment was conducted during 2011 at the Hi-Tech Horticulture Unit, Department of Horticulture, Rajasthan College of Agriculture, Udaipur, situated at 240 34' N latitude and 73042' E longitude at an elevation of 582.17 meters above mean sea level. The daily climatic data during the study period were obtained from the polyhouse. The experiment was laid out in factorial Completely Randomized Design with three replications and twelve treatment combinations of four plant geometry i.e. 45cm×45 cm (S1), 60cm×45 cm (S2), 60cm×60 cm (S3) and 75cm×60 cm (S4) and three level of fertigation viz., NPK @ 150:75:75 kgha-^{1} (F1), NPK @ 200:100:100 kgha-^{1} (F2) and NPK @ 250:125:125 kgha-^{1} (F3). The plot area for each treatment allocated was 3 m2 and F1 hybrid BS.834 cherry tomato was taken for evaluation of treatments. In fertigation method nitrogen, phosphorus and potassium was applied through irrigation water as source of NPK mixture and Urea twice in a week as per treatment. All crop operations stacking, training, intercultural operations, irrigation and plant protection measures were carried out as per required. A pocket digital refractometer was used to measure TSS and titration was done against N/10 NaOH to record acidity of fruit. From each treatment ten fruits were randomly selected for assessment of quality characteristics of cherry tomato fruit. The plant leaves sample i.e. leaf next to most recent fruiting cluster were collected at peak fruiting period from each treatment and dried in oven at 70^{0} C and N,P and K contents were determined by using standard methods.

RESULTS AND DISCUSSION

Total soluble solids (TSS)

TSS content of cherry tomato was significantly influenced by fertigation (Table 1). The data showed that maximum TSS content (8.81%) was observed in F3 (NPK 250:125:125 kgha-^{1}) as compared to minimum (7.96%) in F_1 (NPK 150:75:75 kgha-^{1}). The increase in TSS content might be due to evaporation of water and dehydration and degradation of pectin substances of pulp in soluble solids, which cause concentration of pulp and hydrolysis of poly saccharides (starch) into mono-saccharides (sugars) because of appropriate level of fertigation. This observation was in close conformity with the results of Youssef et al. (2001), Rana et al. (2005), Aruna et al. (2007) and Imamsab et al. (2011) in tomato. Greenhouse tomato fruits were superior to fruits of open field crop in view of fruit size, TSS content, ascorbic acid content and pH (Gulshan and Singh, 2006). Quality parameters, such as pH, TSS and lycopene content, under 100 percent of the recommended NPK applied through drip irrigation were superior to solid fertilizers + surface irrigation in tomato (Kadam and Karthikeyan, 2006). The effect of plant geometry had non-significant influence on TSS content of cherry

tomato. Similar results were observed by Charlo et al. (2007) that no significant difference was observed by different spacing between treatments for TSS in cherry tomato. Further, interaction effect of plant geometry and fertigation on TSS content of fruit had significant influence. Treatment S1F2 had maximum TSS (9.28%) followed by S2F3 (9.09%) as compared to minimum (7.84%) in S1F1 which was statistically at par with S3F1 (7.86%) and S4F1 (7.88%).This may be due to combined effect of both factors. Kotepong et al. (2003) reported that nutrient concentrations affected the ascorbic acid and total soluble solids contents, and titrable acidity in the fruit sap of cherry tomato.

Acidity of fruits

The acidity of fruits showed non-significant influence on different plant geometry, while effect of fertigation had significant influence on acidity content of fruit in cherry tomato (Table 1). The maximum acidity of fruit (0.202%) was recorded for F3 (NPK 250:125: 125 kgha-^{1}); whereas, F1 (NPK 150:75:75 kgha-^{1}) resulted into the minimum acidity of fruit (0.180%). The present results are supported by the reports of Aruna et al. (2007), Imamsab et al. (2011) and Rana et al. (2005) in tomato.

Further, the acidity content of fruit was significantly affected by interaction effect of plant geometry and fertigation (Table 2). The maximum acidity (0.232%) was observed for S1F3 followed by treatment S1F2 (0.215%) and minimum acidity (0.158%) was recorded in S1F1 followed by S4F1 (0.180%). The acidity content of fruits showed increasing trend with increasing fertigation dose. This might be due to optimum levels of nutrients uptake by plants which helped in chemical interaction between organic constituents and action of enzymes.

Dry matter content (DM)

The dry matter (DM) content of cherry tomato had significant effect of plant geometry and fertigation. Maximum dry matter content (6.47%) was recorded in S4 (75cm×60cm) as compared to minimum (5.78%) in S1 (45cm×45cm). The maximum DM (7.31%) was observed in F3 (NPK 250:125: 125 kgha-^{1}) as compared to minimum DM (5.60%) in F1 (NPK 150:75:75 kgha-^{1}). Interaction effect of geometry and fertigation as depicted in Table 2 showed significant effect on dry matter content. The maximum DM (8.15%) was recorded in S3F3 followed by S4F3 (7.84%). It might be due to combined effect of plant geometry and fertigation. Dry matter accumulation was always higher in fertigated plants than in those conventionally irrigated and fertilized (Alcantar et al., 1999) tomato. The results of the present investigation are in agreement with the results of Zuraiqi et al. (2001), Kadam and Karthikeyan (2006) in tomato and Qawasmi et al. (1999) in capsicum.

Moisture content

The data presented in Table 1 revealed that moisture content of cherry tomato was significantly affected by various plant geometry treatments. Maximum moisture content (94.22%) was reported in spacing S1 (45cm×45cm) as compared to minimum (93.53%) in S4 (75cm×60cm). It is evident from the data (Table 1) that the fertigation treatments had significant effect on moisture content. The maximum moisture content (94.40%) was observed in F1 (NPK 150:75:75 kgha-^{1}), where as minimum moisture content (92.69%) was recorded in F3 (NPK 250:125: 125 kgha-^{1}). Moisture content was differed significantly (Table 2). Among all the treatment combinations, maximum moisture content (95.46%) was noticed in S2F1 and minimum (91.85%) in S3F3. Drip irrigation and fertigation enhanced the quality characteristics (Singh et al., 2010) in sweet pepper.

Table 1 Effect of plant geometry and fertigation on TSS, acidity, dry matter content, moisture content and pulp recovery of cherry tomato under zero-energy polyhouse conditions

Treatments	TSS (%)	Acidity (%)	Dry matter content (%)	Moisture content (%)	Pulp recovery (%)
(a) Geometry					
S_1(45cm X 45cm)	8.55	0.202	5.78	94.22	84.12
S_2(60cm X 45cm)	8.49	0.193	6.21	93.79	82.91
S_3(60cm X 60cm)	8.40	0.190	6.46	93.54	79.44
S_4(75cm X 60cm)	8.37	0.184	6.47	93.53	78.93
SEm±	0.103	0.005	0.159	0.159	1.099
CD at 5%	NS	NS	0.464	0.464	3.206
(b) Fertigation					
F_1(NPK 150:75:75 kgha^{-1})	7.96	0.180	5.60	94.40	79.43
F_2(NPK 200:100:100 kgha^{-1})	8.60	0.195	5.77	94.23	81.18
F_3(NPK 250:125:125 kgha^{-1})	8.81	0.202	7.31	92.69	83.44
SEm±	0.089	0.005	0.138	0.138	0.951
CD at 5%	0.260	0.014	0.402	0.402	2.777

Dry matter content increased with increased spacing and fertigation dose while moisture content decreased. This might be due to more space for plants, and effect of light and surrounding temperature and NPK dose through fertigation level.

Pulp recovery (percent)

Data on various plant geometry and fertigation had significant effect on pulp recovery of cherry tomato (Table 1). Highest pulp recovery (84.12%) was observed in S1 (45cm×45cm) and lowest (78.93%) in S4 combination (75cm× 60). Likewise maximum pulp recovery (83.44%) was observed in F3 (NPK 250:125:125 kgha-1) as compared to minimum (79.43%) in F1 (NPK 150:75:75 $kgha^{-1}$) whereas, interaction effect of plant geometry and fertigation on pulp recovery of cherry tomato fruit had non-significant influence under zero energy polyhouse conditions. Better pollination and fertilization during the development of fruits reduced hollowness or unfilled puffy fruits thus resulting in more pulp recovery percentage of the fruits which might be due better fertigation level (F3) enhanced fruit development.

Table 2 Interaction effects of plant geometry and fertigation on TSS, acidity, dry matter content, moisture content, and pulp recovery of cherry tomato under zero-energy polyhouse conditions

Treatments	TSS (%)	Acidity (%)	Dry matter content (%)	Moisture content (%)	Pulp recovery (%)
S_1F_1	7.84	0.158	6.24	93.76	81.92
S_1F_2	9.28	0.215	5.37	94.63	84.77
S_1F_3	8.53	0.232	5.72	94.28	85.65
S_2F_1	8.23	0.193	4.54	95.46	80.61
S_2F_2	8.14	0.192	6.55	93.45	83.39
S_2F_3	9.09	0.195	7.55	92.45	84.75
S_3F_1	7.86	0.187	5.21	94.79	77.71
S_3F_2	8.37	0.190	6.01	93.99	78.30
S_3F_3	8.98	0.193	8.15	91.85	82.30
S_4F_1	7.88	0.180	6.41	93.59	77.49
S_4F_2	8.62	0.184	5.15	94.85	78.25

S_4F_3	8.62	0.187	7.84	92.16	81.06
SEm±	0.178	0.009	0.275	0.275	1.903
CD at 5 %	0.520	0.027	0.804	0.804	NS

Lycopene and Carotenoid content

The result obtained (Table 1) that different crop geometry had non-significant effect on lycopene content and carotenoid content of cherry tomato. Various fertigation treatments had significant effect on lycopene and carotenoid content of cherry tomato. The highest lycopene content (3.34 mg/100 g) and carotenoid (8.36 mg/100 g) was recorded for F3 (NPK 250:125: 125 kgha-^{1}) as compared to lowest (3.12 mg/100 g) and (7.00 mg/100 g) in F1 (NPK 150:75:75 kgha-^{1}) respectively. These results are in accordance with Kadam and Karthikeyan (2006) and Imamsab et al (2011) in tomato, while Imamsab and Patil (2011) reported there was no significant difference with respect to different fertigation levels on lycopene content of fruit However, maximum lycopene (8.44 mg) content of fruit was recorded in F3 (100% recommended dose of NPK).

The interaction effect of plant geometry and fertigation had non-significant effect on lycopene content of cherry tomato while, carotenoid content of fruit was significantly influenced by interaction effects of both factors (Table 2). The highest total carotenoid content (8.86 mg/100 g) was obtained in S2F3 followed statistically at par with S1F3 (8.79 mg/100 g) as compared to minimum (6.78 mg/100 g) with treatment S2F1 followed by treatment S1F1 (6.85 mg/100 g). The level of lycopene is directly related to ripeness and increasing pH. The variation in the redness of different plant geometry and fertigation is mainly due to a difference in the levels of lycopene accumulated in their skins and the only carotenoids constituent in the skin is lycopene.

Leaf nutrient status

The results of the present investigation revealed that leaf nutrient status with respect to nitrogen; phosphorus and potassium content were significantly influenced by fertigation treatments. The highest value of nitrogen content (1.58 %), phosphorus (0.401%) and potassium (1.539%) of leaf were recorded under F3 (NPK 250:125: 125 kgha-^{1}) as compared to lowest value (1.41%), (0.2604%) and (1.349 &) in F1 (NPK 150:75:75 kgha-^{1}), respectively (Table 3). This might be due to application of adequate fertilizer through drip fertigation practices were effectively utilized by the plants as these inputs were placed near crop root zone and also applied at desired amount (Singandhupe et al., 2005). Segura et al. (2007) reported that tomato crop showed a positive response to an increase of the nutrient

solution NPK concentration, which raised the NPK extraction; yield and number of fruits truss-1. These results are quite analogous with findings reported by Elia et al. (2007) in tomato and Tumbare and Bhoite (2002) in capsicum.

Leaf nutrient status of present results was confirmed by the earlier reports of Ayeni et al. (2010) that application of poultry manure and 300 kgha-1 NPK fertilizer significantly ($P<0.05$) increased plant N, P and K in tomato. Application of 10 t ha-1 poultry manure gave similar values of plant N, P and K and yield components compared with 300 kg ha-^{1} NPK fertilizer. They stated that NPK at 300 kg /ha resulted N (1.68%), P (0.30%) and K (1.62%) content of leaf in late season tomato plant.

Table 3 Effect of plant geometry and fertigation on pigment and leaf nutrient status of cherry tomato under zero-energy polyhouse conditions

Treatments	Lycopene content (mg/100 g)	Carotenoid (mg/100 g)	Total N (%)	Total P (%)	Total K (%)
(a) Geometry					
S_1(45cm X 45cm)	3.20	7.55	1.47	0.311	1.411
S_2(60cm X 45cm)	3.24	7.59	1.47	0.311	1.413
S_3(60cm X 60cm)	3.24	7.64	1.51	0.312	1.418
S_4(75cm X 60cm)	3.25	7.67	1.52	0.312	1.444
SEm±	0.023	0.078	0.016	0.004	0.016
CD at 5percent	NS	NS	NS	NS	NS
(b) Fertigation					
F_1(NPK150:75:75 kgha^{-1})	3.12	7.00	1.41	0.260	1.349
F_2(NPK200:100:100kgha^{-1})	3.24	7.47	1.49	0.273	1.376
F_3(NPK250:125:125kgha^{-1})	3.34	8.36	1.58	0.401	1.539
SEm±	0.020	0.067	0.014	0.003	0.014
CD at 5%	0.059	0.196	0.040	0.009	0.041

It is clear from the result as shown in Table 3 that different crop geometry had non-significant effect on nitrogen, phosphorus and potassium content of leaf. The result presented in Table 4 that interaction effect of geometry and fertigation had also non-significant influence on nitrogen content of leaf. It is depicted from the data presented (Table 4) that interactional effect of geometry and fertigation had significant influence on phosphorus content of leaf. The data showed higher value of phosphorus content (0.441%) in S_2F_3 followed by treatment S_1F_3 (0.419%)

and minimum value (0.244%) was recorded in S_2F_2 followed by S_2F_1 (0.249%). Similarly, the interaction effect of plant geometry and fertigation had also significant influence on potassium content of leaf. However, maximum total potassium content (1.713%) was observed in S_1F_3 followed by treatment S_2F_3 (1.565%) and minimum value of potassium content (1.249%) was recorded in S_1F_1 followed by S_1F_2 (1.270%).

Table 4 Interaction effect of plant geometry and fertigation on pigment and leaf nutrient status of cherry tomato under zero-energy polyhouse conditions

Treatments	Lycopene content (mg/100 g)	Carotenoids (mg/100 g)	Total nitrogen (%)	Total phosphorus (%)	Total potassium (%)
S_1F_1	3.08	6.85	1.398	0.259	1.249
S_1F_2	3.21	7.00	1.426	0.255	1.270
S_1F_3	3.30	8.79	1.572	0.419	1.713
S_2F_1	3.13	6.78	1.410	0.249	1.280
S_2F_2	3.25	7.14	1.469	0.244	1.393
S_2F_3	3.34	8.86	1.544	0.441	1.565
S_3F_1	3.13	7.19	1.409	0.259	1.415
S_3F_2	3.25	7.85	1.517	0.308	1.417
S_3F_3	3.35	7.88	1.609	0.368	1.422
S_4F_1	3.15	7.20	1.428	0.274	1.452
S_4F_2	3.25	7.88	1.551	0.286	1.423
S_4F_3	3.36	7.93	1.586	0.375	1.456
SEm±	0.040	0.134	0.028	0.0061	0.028
CD at 5 %	NS	0.392	NS	0.018	0.082

CONCLUSION

Based on the above findings, it may be concluded that the quality parameters and leaf nutrient status of cherry tomato of cultivar BS.834 (F1 hybrid) is influenced by different fertigation levels as well as interaction effect of plant geometry and fertigation. Among various fertigation levels, fertigation F3, i.e. (NPK @ 250:125:125 kgha^{-1}) and plant geometry S4 (75cm×60cm) was found significantly superior with respect to quality and pigment characters of fruit. Cherry tomato grown in wider plant geometry, i.e. S4 (75cm×60cm) improved the quality aspect of fruit which might be due to increased plant height, stem thickness, fruit size and weight. Similarly, F3 fertigation level gave maximum nitrogen (1.58%),

phosphorus (0.401%) and potassium (1.539%) content in leaf over other fertigation levels. Therefore, it could be recommended that cherry tomato cultivar BS.834 should be grown at a spacing of 75cm×60cm along with F3 (NPK@ 250:125:125 kgha-^{1}) fertigation practices for sustaining the higher fruit quality under zero energy polyhouse conditions.

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Effect of Organic Nutrient Management on the Growth and Yield of Carrot *(Daucus carota)* and the Soil Fertility Status

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ABSTRACT

A study was conducted at Machhegaun VDC in Kirtipur to find out the effect of organic nutrient management on the growth, yield and soil nutrient status (NPK) of carrot (Daucus carota) during October, 2011 to March 2012. There were seven treatments with different combinations of organic manures. The experiment was laid out in Randomized Complete Block Design (RCBD). The plant growth and root yield were found best in combination of vermicompost and FYM. The available phosphorus and potassium content was observed higher in application of poultry manure and compost combination. However, application of vermicompost was found to be the best treatment for available soil nitrogen content in the field.

Key words: NPK, Poultry Manure, Vermicompost, FYM, Soil nutrient

INTRODUCTION

Carrot (*Daucus carota*) is an important vegetable crop grown all over the world in spring, summer and autumn in temperate regions and during winter in tropical and sub- tropical regions. It falls under the family Umbelliferae. Genus Daucus contains about 60 species of which very few are cultivated (Salunkhee & Kadam, 2005). It is dicotyledonous herbaceous crop, which is grown as annual for its root. From the center of origin and initial domestication in Middle Asia, most likely Afghanistan, carrot spread under Arab influence to eastern Mediterranean; by 12^{th} century the crop was being grown in Spain (Thompson & Kelly, 1972). Morphologically carrot has distinct tap root which is modified as conical and has hollow, erect, very short stem with quadripinnate leaves. The optimum growing temperature for carrot is 18^0 C to 20^0 C. Carotene may deplete below 15^0C and above 21^0 C. Long–day plant carrot has high level of cross pollination. Historically, carrots were used primarily for medicinal purposes and their use as food crop dates back to 16th century (Thompson & Kelley, 1972).

Carrot is very popular in Nepal because of its excellent nutritional properties. Carrot roots are used as a vegetable for soups, stews, curries and pies, grated roots are used as salad, tender roots as pickles and gajar halwa is a delicious dish. Carrot jam is also popular and the roots in the form of disc and slices can be dehydrated. Carrot juice is a rich source of carotene and is sometimes used for colouring buffer and other food articles. Carrot tops are used for extraction of leaf protein, as fodder and also for the poultry feed (NADAF, 2007).

Carrot root is valued as food components mainly because it is rich source of beta-carotene, precursor of vitamin A and good provider of carbohydrates and minerals like Ca, P, Fe (Ganapathi, 2006).Moisture content varies between 86 and 89percent. Edible portion of carrot contains about 10percent carbohydrate, 0.8- 11 gm protein/100gm. It also contains appreciable quantities of thiamine, riboflavin; folic acid etc. (Salunkhee & Kadam, 2005).

Organic farming is based on the use of all knowledge, techniques and materials available to work with nature, and sustainable management of natural resources in a given agro–ecological system (Rajbhandari & Gautam, 1998).Organic cultivation has been emerged as an alternative practice to meet the current situation. It involves the grain production system accomplished by generous use of organic fertilizers (crop residue, animal residue, on- & off- farm wastes) and crop rotation, etc. In the recent times, the organic nutrient management which has taken as a new connotation claims to have the potential to provide benefits in terms of environmental protection, conservation of surplus products and also deals with supplying and managing nutrients to meet crop production requirement, focusing on optimization of agronomic production and economic returns to the crop production.

Modern crop production technology has considerably raised output (Reddy & Reddi, 1992) as it is highly influenced with the extensive use of agro-chemicals. The production has almost been high input- high output system. So the consumer to be free from any kind of chemical residues in the food is almost impossible. At the same time, there is a growing realization that a manorial treatment should aim not only at transient increase in crop yield but simultaneously support a lasting maintenance and improvement of soil (Ray & Yadav, 1996). This is the bitter reality in present world including Nepal too. Soil fertility has been highly contaminated and deteriorated due to the imbalanced use of chemical fertilizers. One of the reasons behind this may be lack of interest in exploring possible use of the organic manures. Even though Nepalese farmers traditionally have been aware about the importance of organic manures which have ability of supplying a range of nutrients and improving the physical and biological properties of soils, they are reluctant to use. It is distinct that such ignorance in use of organic manures may lead to nutrient imbalance and may be a threat to ecological sustainability. It is

also well understood that the ideal soil condition for maximum yield of crop can be created through the combination of organic manures.

This study was carried out in order to know precisely the advantageous organic manure to get maximum yield, sustainability of yield and soil health environment.

MATERIALS AND METHODS

The study was conducted during October, 2011 to March, 2012 at farmer's field in Kirtipur, Kathmandu, Nepal. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The size of each experimental plot was 2 sq. meters. There were seven treatments in the experiment (Table 1).

Table 1 Treatments with different manures and their combinations

Treatments	Manures
T_1	FYM @ 6 t/ha
T_2	Compost @ 4 t/ha
T_3	Poultry manure @2 t/ha
T_4	Vermicompost @ 2.4t/ha
T_5	½ poultry manure 1t/ha +compost 2t/ha
T_6	$^1/_2$ vermicompost 1.2t/ha+ FYM3t/ha
T_7	Control

Note: Recommended dose of fertilizer (NPK: 60: 40: 40 kg/ha)

Growth

The plant height was measured from the ground level to the growing point. The observation was recorded at the end of the growth period for each treatment and expressed in centimeters. Whereas, the total numbers of effective leaves were counted. Green photosynthetically active leaves were considered as effective. Very young emerging leaves were excluded while counting

Yield

The observations on root weight for each treatment were recorded at the time of harvest. After each harvest the individual root were weighted and the data on root weight was summed up and expressed in gm. After harvesting the root from each plant were weighted and expressed in Kg per plant then it was converted in yield per hector.

Determination of Soil nutrient status

Collection and preparation of soil samples

For the analysis of soil physical and chemical properties, soil samples were collected from 0-15cm depth, regarding each treatment and replication. Three samples were taken from each plot and mixed to produce a composite sample. The soil sample thus collected were dried and sieved through 2mm 'bronze' sieve and stored in cloth bags. Available Nitrogen was estimated by alkaline permanganate method as modified by Subbiah and Asiz (1956). Available phosphorus was determined by Modified Olsen method (Olsen et al., 1954). Available potassium was determined by ammonium acetate method (Hanway and Heidel, 1952).

The statistical analysis of the data was carried out as per method described by Corchan and Cox (1963). The treatments effects were tested percent level of significance.

RESULTS AND DISCUSSION

Effect of Organic manures on the growth of carrot (*Daucus carota)*

Plant height

Maximum increment in the plant height (16.27cm) was found in treatment T_6. However, the minimum plant height (13.88 cm) was with T_7 (Table 2) .The combination of vermicompost and FYM significantly increased the growth of carrot in term of plant height. Combination of vermicompost and FYM was found superior to other treatments in increasing plant height.

Organic manures in the combination rather than sole use have better efficiency. Since manure like vermicompost provide the micronutrients such as zinc, copper, iron and manganese etc. in the adequate amount to the plant. Besides, the FYM application influenced a great extent, the yield and its attributing characters like

plant height, tuber emergence, number of stems per hill, weight of foliage. The increase in plant height by the application of FYM might have occurred due to favorable physico-chemical properties of soil and thereby adequacy of nutrients available to the crop during vegetative phase. The findings strongly agreed with, Kandil and Gad (2009) who reported that using organic manure gave significant promoted effect on plant growth, heads yield, chemical constituents and mineral composition of broccoli.

Number of Leaves per plant

The maximum number of leaves (11.3) per plant was recorded in T_6 which was statistically at par with T_2 followed by T_3, and T_4. The minimum leaf number per plant (9.83) was produced by T_7 treatment (Table 2).

Table 2 Effect of organic manures on growth of carrot

Treatments	Plant height (cm)	Number of leaves per plants
T_1	14.33	10.53
T_2	15.79	11.03
T_3	15.50	10.7
T_4	15.47	10.96
T_5	15.23	10.6
T_6	16.27	11.3
T_7	13.88	9.83
CD (0.05)	**1.347**	**1.005**
F-Value	**3.643**	**2.088**
CV(%)	**4.98**	**5.28**

The results clearly demonstrated that numbers of leaves per plant was highly influenced by different organic manures applied singly as well as in combination treatments of vermicompost and FYM. This treatment produced maximum number of leaves per plant, which is attributed to direct addition and slow release

of nutrients through vermicompost (Bharadwaj and Omanwar, 1994); thus enriching available nutrient pool of the soil that resulted in more number of leaves per plant. Bendegumbal (2007) also mentioned that FYM @ 12.5 t per ha (50%) + vermicompost @ 2.1 t per ha (50%) produced maximum leaves per plant at 60 DAT and at harvest in onion that might be due to the fact that N thus provided by the manure is associated with high photosynthetic activity and vigorous vegetative growth. This result revealed the beneficial effects of the combined treatment in number of leaver per plant, which is in agreement with findings of Azad (2000). He mentioned the maximum number of loose leaves in cabbage with combined application of organic manure.

Effect of organic manures on yield of carrot (*Daucus carota*)

Root Weight

The data showed that the treatment T_6 gave the highest root weight (59.66 g) which was statically at par with T_2, T_3, T_5. The minimum root weight (35 g) was found in control (T_7) (Table 3).

Table 3 Effect of organic manures on yield of carrot

Treatments	Root weight Yield per (gm) plot (kg)		Yield per hectare (ton/ha)
T_1	41.66	2.41	12.08
T_2	59	3.42	17.11
T_3	56.66	3.28	16.43
T_4	48.33	2.80	14.01
T_5	55	3.19	15.95
T_6	59.66	3.46	17.03
T_7	35	2.03	10.15
CD (0.05)	**17.131**	**0.975**	**5.0114**
F-Value	**1.968**	**0.065**	**0.064**
CV(%)	**18.62**	**18.78**	**19.21**

This was attributed due to solubilization effect of plant nutrients by the addition of FYM and vermicompost leading to increased uptake of NPK .Besides, Organic manure plays a direct role in plant growth as a source of all necessary macro and micro–nutrients in available forms during mineralization, improving the physical and physiological properties of soil (Kumar et al., 2009).

Yield per plot

The maximum yield (3.46 kg) was recorded in T_6 which was statistically at par with T_2, T_5, and T_3. The minimum yield per plant was found in treatment (T_7) with value of (2.03 kg) (Table 3). The reason for increased yield by the application of vermicompost and FYM could be due to the solubilization effect of plant nutrients by addition of FYM and vermicompost leading to increase uptake of NPK Subbaiah *et al.* (1982). The findings are similar with Agarwal et al. (2010) which showed growth and yield of lady's finger (*Abelmoschus esculentus*), were found superior with cow dung compost and vermicompost. The results are also in agreement with experiment conducted by Renuka and Ravishankar (1998) who have recorded maximum fruit size, more number of fruit per plant in application of vermicompost +FYM in tomato. .It is inferred that tomato crop would respond well to the application of organic manures in combination with FYM. Further, organic manures application helps to maintain good soil health. Similar finding is also given by Subbaiah et al. (1982) stated the increased mean fruit weight and fruit yield in chilly by the application of NPK with FYM and vermicompost.

Effect of organic manures on the soil macro nutrients status of carrot (*Daucus carota)*

Available Nitrogen

The maximum available N (366.12 kg/ha) was found higher in T_4 which was statistically at par with T_6 followed by T_3 (poultry manure 2 t/ha). The lowest value was obtained in T_7 (Table 4). The findings agreed with that of Khatri (2009), reported N content was higher with Vermicompost in cauliflower. This may be attributed due to that the organics like vermicompost holds nutrients and retained from losses. So the higher value of total nitrogen in vermicompost treated soil is due to release of nitrogen slowly and continuously rather than loss incurred through leaching and volatilization. The similar results was also found by K.C. (2008) while studying effect of vermicompost and NPK fertilizers on growth and yield parameters of amaranths.

Available phosphorus

Maximum available P was found in T_5 with value of (126.63 kg/ha) which was statistically at par with T_3. However the minimum value (94.26 kg/ha) was found in T_7 (Table 4). The total N and P contents of poultry manures and litters are among the highest due to its rapid mineralization. So, poultry manure was recognized as a valuable source of plant nutrients for crops Somners and Sutton (1980).The increase in phosphorus content of organically grown vegetables may be attributed to increased availability of soil phosphorus due to the solubilizing effect of organic acids, which are produced from decomposing organic manures.

Table 4 Effect of organic manures on macro nutrients status of carrot

Treatments	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
T_1	304.22	107.19	460.55
T_2	314.40	113.74	481.03
T_3	343.23	123.69	466.48
T_4	366.31	112.49	476.24
T_5	335.12	126.63	513
T_6	348.61	111.53	508.61
T_7	287.15	94.26	402.40
CD (0.05)	6.69	5.031	4.811
F-Value	162.02	53.69	565.61
CV(%)	31.81	0.57	2.52

Available potassium

The maximum available potassium (513 kg/ha) was found higher in T_5, which was statistically at par with T_6. The minimum value (402.40 kg/ha) was found in treatment T_7 (Table 4) .The higher value of Potassium was recorded with poultry manure and compost in the conjunctive use. This study is at par partially with the results reported by Bhattarai and Kunwor (2011) that the potassium content is

quite higher in the treatment with poultry manure. The available potassium content in the soil is directly influenced by the parent material and organic manure used. The incorporation of compos along with poultry constitutes a valuable resource for supplying potassium and some micronutrients (i.e. boron and zinc) as stated by Gallardo Lara (1987). The results are also in agreement with the findings of Khatri (2009).

CONCLUSION

It is concluded that the application of different types of organic manures significantly influenced in growth, yield and soil nutrient status of carrot. Application of Vermicompost @ 1.2 t/ha and FYM @ 3 t/ha was found effective in improving the growth and yield. The application of poultry manures @ 1 t/ha and compost @ 2 t/ha was found effective in available Phosphorous and Potassium contents. However, the application of Vermicompost @ 2.4 t/ha alone was the best treatment in improving the available soil nitrogen content in carrot field.

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Economics of Conservation Agriculture-Based Technology in Chitwan District of Nepal

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ABSTRACT

Proper soil-crop-environment management strategy is the vital for optimum return with sustainability of agriculture. Conservation agriculture (CA) in rice-wheat farming system is an important tool to save cost of cultivation. The main objective of this study was to assess the economics of CA based technology (Zero Till-wheat, Reduced Till-wheat and Direct Seeded Rice) in Chitwan District of Nepal. Randomly selected 60 respondents from Patihani, Phoolbari, Sharadanagar and Shivanagar VDCs of Chitwan District were interviewed. For local knowledge documentation Focus Group Discussion was conducted. Economic analysis showed that CA based-technology was more cost effective than conventional. On an average CA based technology was 1.52 times cost effective as compared to conventional practices. ZT-Wheat, RT-Wheat and DSR (rice) technology was found 1.47, 1.51 and 1.57 times cost effective as compared to respective conventional practices respectively. B:C ratio of ZT-Wheat (2.44), RT-wheat (2.08) and DSR (2.25) was found higher than that of respective conventional practices (1.61 in Conventional (C)-wheat and 1.46 in Conventional (C)-rice). On an average cost of cultivation of DSR was NRs 22021.75 per ha against NRs 34649.50 per ha in C- rice. Similarly, on an average cultivation cost of ZT-wheat was NRs 22577.00 per ha and RT-wheat was NRs 21957.25 per ha while that was found NRs 33195.25 per ha in C-wheat. It has been suggested that benefit can be optimized through CA adoption; and therefore government should harmonize the policy to develop and adopt suitable CA based technology.

Key words: Zero tillage, reduced tillage, labour efficiency, soil fertility

INTRODUCTION

In Nepal, a rice-based cropping system is dominant In Terai (flat land), where as a maize-based cropping system is dominant in the Hills. However, the long-term fertility of the rice and wheat systems indicates stagnating and declining yields of rice and wheat crops. Even though overall national yield data of these cereal crops indicate that it is increasing slowly, the productivity and profitability is declining due to soil fertility decline, weed problems, disease and insects, labor and power scarcity, and high costs of inputs (Tripathi et al., 2003). Population in Nepal is

expected to continue growing rapidly in the foreseeable future with the population growth rate of 2.25 percent in 2009 (CBS, 2010). As a result food security in the region remains a challenge for the future. Unless we act now, within the nest few decades we will almost certainly find ourselves unable to produce agricultural oroducts sufficient to meet the demand of the increased population (Rajbhandari & Bhatta, 2008). Integrated holistic systemic approaches concerning plant nutrient management, pest management, crop management as well as water management are the best options that the small farmers ib the developing countries should follow to address the problems of hunger, poverty, food/nutritional security, sustainable livelihoods and conservation of natural ecological bases including biodiversity (Ibid). In this context, it is realized that conservation agriculture (CA) could be the ultimate solution to enhance production and productivity, and maintain the sustainability of the agro eco-system.

Rice-wheat systems provide the staple grain supply for about 80 percent of the world's population, making these systems critically important for global food security (Ladha et al., 2003) in Nepal. Agriculture is one of the most important sectors in the economies of most nations like Nepal. At the same time, conservation is the use of resources in a manner that safely maintains a resource that can be used by human. To reduce the cost of cultivation and maintain the sustainability of the soil crop agro-ecosystem, different conservation techniques can be used. Conservation tillage, surface seeding, direct seeding are main techniques that can be used in rice-wheat systems. "Conservation agriculture (CA) is concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production level while concurrently conserving the environment" (FAO, 2007).

The lack of suitable mechanization and modernization with proper soil-crop management strategies is probably the cause of higher cost requirement and low return in Nepalese agriculture. Current crop cultivation practices in rice-wheat systems degrade the soil and water resources thereby threaten the sustainability of the system (Ladha et al., 2003). At the same time, rapid urbanization decreases the land available for agriculture and *increasing* trend of labor export results in the labor scarcity and increases the cost of cultivation. So the concept of alternative agricultural system like conservation agriculture (CA) has been put forward to improve the net return with minimum resource use from crop cultivation. Conservation agriculture (CA) can help in sustainable use and maintenance of natural resources for optimum return. The most widely adopted resource conserving technology in Nepal has been zero-tillage (ZT) wheat after rice and reduced tillage (RT) wheat and direct seeded rice (DSR) (Marahatta, 2010). The resources used in CA are also minimized, and therefore the cost of production becomes more effective and economically profitable. It becomes a technical tool in agriculture to conserve resources of production via their proper, optimum and scientific use for sustainable production.

Soil and water are primary resources for economic growth of Nepal. The farming of fragile land has further increased the soil erosion rate, which is already very high because the mountains are geologically young (DSCWM, 2008). Land productivity conservation measures enhance the productivity of land via appropriate management of land on the basis of its capabilities (DSCWM, 2008). The techniques that are involved minimize or avoid soil-damaging effects often associated with conventional tillage based crop production methods; particularly in tropical zones are also components of CA (FAO, 2001). In addition to soil and water conservation, CA enhances soil biodiversity in terms of both macro- and micro-fauna, increases the soil organic matter pool, and improves the environment. Soil water sequestration via conservation agriculture reduces the rate of increase of atmospheric carbon dioxide and mitigates global climate change. Other advantages are the saving in time by 30-40 percent and resources required for the seed bed preparation and a longer growing season (FAO, 2004). This study was conducted in 2010 to assess the economics of conservation agriculture based agriculture adopted by rural farmers of Chitwan district.

MATERIALS AND METHODS

This study comprised of two components viz. household survey and focus-group discussions (FGD). For household survey; four VDCs namely; Patihani, Phollbari, Sharadanagar and Shivanagar VDC of Chitwan district were selected purposively. All farmers adopting conservation agriculture based technology (ZT and RT in wheat and DSR in rice) of respective VDCs constitute the research population. A total of 156 Households (45 for RT-wheat, 51 for DSR and 60 respondents for ZT-wheat, conventional wheat and conventional rice from four VDCs) were selected randomly for household survey. The primary data were collected through semi-structured pre-tested questionnaire administering direct interview. A total of 11 experienced farmers were selected for focus group discussion (FGD) and district level FGD was conducted and discussion was made on the study topic with check list. The data thus obtained were coded, tabulated, and analyzed by using MS excel and SPSS. Cost of production, return from the product and B:C ratio of respective technologies was calculated as economic variables.

The benefit-cost analysis was carried out by using following formula (Gitinger, 1982).

$$B/C = \frac{Gross.return}{Total.cost}$$

Gross return = Price per unit of the produced crop X Total quantity produced by adoption of respective practices

Total cost = Total variable cost + Total fixed cost

RESULTS AND DISCUSSION

Land holding and cropping pattern

In this study the average size of total own land holding was 1.10 (± 0.26) ha, which is higher than the national average size of land holding 0.80 ha in 2010 (ABPSD, 2010). Beside cultivation of their own land farmers were found to be involved in cultivation of leased land (Table 3).

The average size of leased land was found 0.34 (± 0.21) ha. Rice, wheat and maize were the dominant components of the cropping system across the study sites and Rice – wheat cropping system was major cropping system of low land across all study sites (Table 4).

Table 3 Land holding (ha) by VDC

VDC	Total land holding		Leased land holding		Own land holding		Total own land
	Irrigated	Un-irrigated	Irrigated	Un-irrigated	Irrigated	Un-irrigated	
Patihani	1.04±0.21	0.13±0.13	0.20±0.20	0.00	0.84±0.23	0.13±0.13	0.97±0.38
Phoolbari	1.00±0.42	0.29±0.13	0.00	0.04±0.04	1.00±0.42	0.25±0.13	1.25±0.56
Sharadanagar	2.33±0.78	0.00	1.88±0.98	0.00	0.44±0.19	0.00	0.44±0.19
Shivanagar	1.35±0.40	0.08±0.08	0.00	0.00	1.35±0.40	0.08±0.08	1.43±0.49
Total	1.28±0.23	0.16±0.06	0.33±0.20	0.01±0.01	0.94±0.19	0.15±0.06	1.10±0.26

Table 4 Cropping patterns practiced in the study sites

Low land		***Up land***
Rice – Wheat – Maize	Rice – Wheat – Cowpea	Maize + Sesame – Fallow
Rice – Lentil – Mize	Rice – Potato – Cowpea	Buckwheat – Daincha – Fallow
Rice – Mustard- Sesame	Rice – Wheat – Daincha	Maize – Seasonal vegetables
Rice – Mustard – Maize	Rice – Pea – Maize	Potato –Fallow –Potato

Cost of production

Cost of cultivation per hectare of land was higher in conventional techniques of crop production as compared to conservation agriculture based techniques because of less labor and other inputs such as seed, fertilizers and irrigation requirement in CA based technology than that of conventional practices. The study revealed that

on an average CA based technology was 1.52 times cost effective as compared to conventional practices. On an average ZT-Wheat, RT-Wheat and DSR (rice) technology was found 1.47, 1.51 and 1.57 times cost effective as compared to respective conventional practices, respectively (Table 5).

Table 5 Cost of cultivation (NRs/ha) of different conservation agriculture practices by VDC

VDC	Conventional Rice	Conventional Wheat	ZT-Wheat	RT-Wheat	DSR
Patihani	28082.00	40258.00	25919.00	28448.00	20690.00
Phoolbari	40284.00	31192.00	19150.00	18298.00	20063.00
Sharadanagar	39757.00	36275.00	28700.00	25492.00	26056.00
Shivanagar	30475.00	25056.00	16539.00	15591.00	21278.00
Average	34649.50	33195.25	22577.00	21957.25	22021.75
Cost effectiveness as compared to respective conventional farming (times)			1.47	1.51	1.57

Returns per hectare

Return per hectare of land from ZT-wheat was found higher than conventional wheat farming (Table 6). However, return from the production of wheat and rice with RT and DSR technique, respectively was found lower as compared to that with respective conventional techniques. There was big debate on returns from rice and wheat cultivation by adopting CA practices among FGD members as it depends on yield. All members of FGD concluded that optimization of sowing time and less irrigation requirement in ZT-wheat is the major reason for higher yield which resulting higher return in ZT-wheat.

Table 6 Return (NRs/ha) of different conservation agriculture practices by VDC

VDC	Conventional rice	Conventional wheat	ZT-wheat	RT-wheat	DSR
Patihani	56565.00	60764.50	66267.70	48840.90	51327.50
Phoolbari	50409.60	51083.10	51652.80	50513.40	47200.00
Sharadanagar	53900.00	51316.20	49725.00	39382.20	47740.00
Shivanagar	41670.60	51840.00	52920.00	44280.00	52350.00

Average	50636.30	53750.95	55141.38	45754.13	49654.38

Benefit cost ratio (B:C ratio) of conservation agriculture and conventional agriculture

B:C ratio of wheat and rice production with conservation agriculture based technology was found higher as compared to that of conventional agriculture (Table 7). It was found that the B:C ratio for ZT-wheat (2.44 ± 0.23) was higher than RT-wheat (2.08 ± 0.37) and followed by wheat production in conventional agriculture (1.61 ± 0.92). Similarly, B:C ratio was found higher in DSR (2.25 ± 0.47) than that for rice production in conventional agriculture (1.46 ± 0.13). It shows that the conservation agricultural practices were more worthy than conventional practices in rice-wheat farming system across the study sites.

Table 7 B/C ratio (NRs/ha) of different agricultural practices by VDC (2010)

VDC	Conventional rice	Conventional wheat	ZT-wheat	RT-wheat	DSR
Patihani	2.01 ± 0.42	1.50 ± 0.93	2.55 ± 0.67	1.71 ± 0.68	2.48 ± 0.07
Phoolbari	1.25 ± 0.13	1.63 ± 0.76	2.69 ± 0.72	2.76 ± 0.05	2.35 ± 0.25
Sharadanagar	1.35 ± 0.57	1.41 ± 0.46	1.73 ± 0.25	1.54 ± 0.48	1.83 ± 0.22
Shivanagar	1.36 ± 0.73	2.06 ± 0.89	3.19 ± 0.97	2.84 ± 0.01	2.46 ± 0.02
Average	1.46 ± 0.13	1.61 ± 0.92	2.44 ± 0.23	2.08 ± 0.37	2.25 ± 0.47

CONCLUSION AND SUGGESTIONS

The study has revealed that conservation agriculture based technology in rice - wheat farming system was more economical than conventional practices. The benefit cost ratio was higher in CA based technology as compared to conventional practices. B/C ratio was found higher in ZT – wheat among all three categories of CA based technology.

A number of advantages were identified with CA based technology. Therefore the government should harmonize their policy for adoption, promotion and extension of CA based technology; and import of suitable and affordable farm machineries.

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A Biological Study of Angoumois Grain Moth, *Sitotroga cerealella* (Olivier) in Stored Rice in Kailali District of Nepal

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ABSTRACT

The biological study was conducted by releasing virgin male and female moths in individual Jar. The study showed that the average lengths of eggs, larvae, pupae and adults were 0.048 mm, 5.38 mm, 4.4 mm and 5.2 mm, respectively. The length of female (6.2mm) was longer than male (4.4mm). One mature female during her life cycle laid about 52.0 eggs, having oviposition period of 3.2 days, incubation period 8.6 days and egg hatchability 58 percent. The larval period was 21.4 days, pupal period 8.2 days and total development period was 38.0 days. The female could live 7 days and male for 5 days; and male to female ratio was 0.94:1.3.

Key words: Angouinous grain moth, *S. cerealella*, Biology, *Oryza sativa*

INTRODUCTIOIN

Rice (*Oryza sativa* L.) is the predominant cereal crop in South Asia (Basnet 2000). The cultivated area under rice is 1496476 ha of land with 4460278 MT production and 2.981MT/ha productivity (MoAC 2011). The loss of food grains between harvest and consumption in cereal is estimated to be 15 to 20 per cent (PHLRD 2002/2003). Rana and K C (1977) mentioned most commonly occurring insect-pests in the storage are Angoumois Grain Moth (*Sitotroga cerealella* O.), Rice Weevil (*Sitophilus oryzae* L.), Saw Toothed Grain Beetle (*Oryzaephilus surinamusis* L.), Red Flour Beetle (*Tribolium castaneum* Hbst.), Lesser Grain Borer (*Rhyzopertha dominica* F.) and Black Fungus Beetle (*Alphitobious sp*.). Among them, *S. cereallela* is one of the major pests of stored grains (Neupane 2003). The adult is a buff gray, brown of straw colored moth. The moth has a wing-spread of 11 to 16 mm, but not more than 9 mm at rest (Fleurat-Lessard 1988) with grayish/yellowish darker spots on forewings. While sitting the wings are completely folded in a sloping manner over the abdomen (Girish 1983). Female moths have a longer life span than the males, the duration being 10.3, 7.5, 6.6, and 4.3 days at 20, 25, 30 and 35^{0}C, respectively (Atwal and Dhaliwal 2002). The female moths lay several hundred, very minute eggs, singly, or in clusters of

as many as 20 on the grains, where the larvae feed (Metcalf and Fint 1951). The number of eggs laid per female ranged from 46-136 (King 1918). Among the total number of eggs approximately 44 percent were laid on the first day, 53 percent on the second day & only 3 percent on the third day (King 1918). The young larvae of the first stage are active and seek grains suitable for their installation. Upon hatching the larva measures about 1.5 mm and passes unnoticed (Fleurat-Lessard 1988). The pupal period varied from 10 to 17 days (King 1918), 5 to 10 days (Simmons 1933). At constant temperatures of 20, 25, 30 and 35^0 C, the duration of pupal stage was 12.5, 9.1, 6.5 and 12.2 days, respectively (Atwal and Dhaliwa 2002).

MATERIALS AND METHODS

Half kilogram grains were held in plastic jars (13 x 15 cm). Living insect specimens of *S. cerealella* were collected from infested stores. Fifty pairs of freshly collected adult moths were released in each plastic jar and were covered with white muslin cloth fastened by rubber band. About 2/3 part was kept free space and rest occupied by grains for easy movement of moth (Prakash et al 1987). The jars were closed and placed in rearing room. There were five such rearing jars to get sufficient numbers of virgin adults for different activities at a time. The sex of *S. cerealella* was identified mainly by size and morphological appearances. While mass rearing the male and female moth were identified by observing morphological characters by naked eyes and hand lens. Similarly, during study on oviposition and fecundity the virgin moths were placed in study jar and covered with muslin cloth and observed daily.

For study, the emergence of adult moth, male and female (1:1) were placed in transparent plastic jar covered by piece of black cloth. In this jar, some paddy grains were placed for feeding to larva and pupa. This study was conducted with 5-replication. The eggs hatched cloth was unfold and place in other jar with kin observation by magnifying glass. Observations were continued until the female died. The total number of eggs cluster, colour of eggs and total eggs laid during its life cycle was also counted.

For observation of incubation period, ovipositional cloth was placed in new jar; 20 eggs were placed in new jar with paddy grains having 5-replication and data were recorded daily. The eggs conditioned were recorded at morning, afternoon and evening, i.e, thrice a day. The morphological changes were also recorded at the time of egg observation periods. Eggs were counted by empty egg shells, which were transparent, white and shiny. It was supported by un-hatched eggs- they were red in color; sterile eggs were wrinkled and milky white (Shazali and Smith 1985). The total number of eggs hatching was recorded by observing the morphology of eggs. In addion to this, various parameters like both larval and pupal periods were

calculated as suggested by Pandey and Pandey (1976). Larval period is the time period between the days of egg hatching to two days after the formation of silken capping on grains hole made by larva. Pupal period was calculated by counting the time period from 2 days after the formation of silken cap to the emergence of adult. The sex ratio was observed on the basis of their external characteristics; the male was comparatively shorter, abdomen pointed and female was blunt (Pandey and Pandey 1976).

RESULTS AND DISCUSSION

Observation on morphological changes and behaviors of different stages

Newly laid eggs looked like white in color, which changed into bright red color when hatching. The same finding was also reported by Pedigo (2002), Atwal and Dhaliwal (2002). At the time of hatching, the larva continued to bite away the egg shell until raged hole was opened through which it crawled leaving the shell. Freshly hatched larva was yellowish-white in color with brown head. The fully grown larva was white in color with a brown head and distinct light brown rectangular like patch on the dorsal side of abdomen. The fully developed larva was 5.38 x 1.5 mm in size (Table 1). Fully matured larva formed delicate silken cocoon around the body in the paddy grain that was covered with silken cap. The larva made a hole in the paddy grain at the apical end of the grain. The pupa was 4.4x0.1 mm in size and weighed 4.34 mg. The adult emerged from circular hole. The adult moth was grey in color, the male moth was more active and smaller with thinner pointed and blackish abdomen while female moth had well developed abdomen without blackish coloration. The size of male was 4.4 x 1.18 mm and female was 6.22 x 1.4 mm in size (Table 1).

Measurement of different stages of *S. cerealella*

Table 1 showes the average length, width and body weight of *S. cerealella* at different stages.

Table 1 Measurement of different stages of S. cerealella in Kailali, 2011

Stage	Length (mm)	Width (mm)	Weight (mg)
Egg	0.48±0.2	0.264±.006	0.0098±0
Larva	5.38±0.059 (5.2-5.5)	1.5±0 (1.5-1.5)	6.42±0.16 (6.1-6.8)
Pupa	4.4±0.13 (4-4.6)	0.1±0 (0.1-0.1)	4.34±0.04 (4.2-4.4)
Male	4.4±0.07 (4.2-4.5)	1.18±0.02 (1.1-1.2)	3.4±0 (3.4-3.4)
Female	6.22±0.09 (6-6.5)	1.4±0.07 (1.2-1.5)	4.27±0.025 (4.2-4.3)

The figures in parenthesis indicate range and (±) indicate standard error

Nigam and Kumar (1990) reported that full grown larva measures about 6 mm in length.

Oviposition, fecundity, incubation and hatchability of eggs of *S. cerealella*
The average oviposition period was 3.2 days. Fecundity was 52.2 and incubation period was 8.6 days with 58 percent hatchability (Table 2).

Table 2 Oviposition, fecundity, incubation and hatchability of *S. cerealella* in Kailali, 2011

S.N.	Particular	Period / number/ %	Range (Days/ number/ %)
1	Oviposition (day)	3.2±0.254	(2.5-4)
2	Fecundity (number)	52.2 ±2.782	(45-60)
3	Incubation period (days)	8.6±0.509	(7-10)
4	Eggs hatchability (%)	58±2.420	(50-65)

The figures in parenthesis indicate range and (±) indicate standard error

The number of eggs during her life cycle can lay upto 52, which was supported by the findings of King (1918). He reported that *S. cerealella* lay up to 46-136 eggs during her life cycle. King (1918), Simmons (1933), Nigam and Kumar (1990), Mishra (1994) reported the incubation period of egg ranges from 7-12 days. However, the experiment conducted in Kailali district showed that, the incubation period ranges from 7-20 days.

Development period

The average days taken to complete their life cycle was 35.4 days whereas the larval and pupal period was recorded as 21.4 days and 8.2 days, respectively (Table 3).

Table 3 Larval, pupal and development period of *S. cerealella*, Kailali, 2011

S.N.	Periods	Days and range
1	Larval period (days)	21.4±0.678 (19-23)
2	Pupal period (days)	8.2±0.374 (7-9)
3	Development period (days)	35.4±0.509 (34-37)

The figures in parenthesis indicate range and (±) indicate standard error

The larval period were observed from 19-23 days. The same larval period also mentioned by Atwal and Dhaliwal (2002), but he stressed that the larval period depends on the temperature of the environment. The larval period range about 20-24 days (Metcalf and Flint 1951), 14-21 days (Mishra 1994), 18-25 DAYS (Singh 2004). The 8.2 days pupal period was recorded in the study. However, the pupal period were mentioned as 10-17 days (King 1918), 5-10 days (Simmons 1933), 7-10 days (Chand 1995; Mishra 1994; Singh 2004). 35 days of total, development period was recorded in the study. The same kind of result were mentioned by Singh (2004), Pedigo (2002), Mishra (1994), Reddy (1968), Nigam and Kumar (1990).

CONCLUSION

One mature female of Angoumois Grain Moth, *Sitotroga cerealella* (Olivier) during her life cycle laid about 52.0 eggs, having oviposition period of 3.2 days, incubation period of 8.6 days and egg hatchability 58 percent. The total development period was 38.0 days with larval and pupal periods of 21.4 days and 8.2 days, respectively.

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Survey on Brinjal Shoot and Fruit Borer (*Leucinodes orbonalis* Guen.) in Brinjal (*Solanum melongena* L: Solanaceae) Growing District of Nepal

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ABSTRACT

The survey was conducted in each VDC of three districts Bara (Fatepur), Parasa (Bindawasini) and Rautahat (Saruhatta) in 2009 to know the brinjal pest status and management practices adopted by the farmers. A total of 54 farmers were randomly selected for the study. A set of semi structured questionnaires were developed and pre-tested to collect information. Data were thoroughly observed and analyzed by simple statistical analysis packages as Microsoft Excel. Survey research result depicted that more than 42percent farmers cultivated brinjal in more than two kattha in these area. The major production constrains of brinjal was brinjal fruit and shoot borer (BFSB) where more than 50percent of fruits damaged by borer alone. To control BFSB, 73percent of farmers sprayed chemical pesticides in their brinjal field. Furthermore, majority (70 %) of brinjal grower were sprayed pesticides @1-2 ml/lit of water and the frequency of spraying pesticides were every 7-10 days by 52percent respondents. Surprisingly more than 85percent of respondents didn't know about integrated pest management (IPM) during survey period. However, one third of respondent farmers were familiar with the negative impact of pesticides on human beings and other non- target animals. The study depicted there should be urgent need to communicate the growers about the safely production of brinjal with maximum utilization of IPM tools whenever needed.

Key words: *Solanum melongena*, *Leucinodes orbonalis*, insecticides, IPM

INTRODUCTION

Brinjal (*Solanum melongena* L.) also called aubergine is a cheap vegetable commonly growing in South Asian countries (Butani and Jotwani 1984) including Nepal (Hada et al 2008). It is a widely grown vegetable from hill to terai in Nepal. Single planting of brinjal can harvest many times as compare to other vegetables like cabbage and cauliflowers. In Nepal, about 13 insect pests were recorded (Neupane 1993) in brinjal field. Besides the economic aspect brinjal fruits are

immense source of vitamin P (7200 milligrams per kilogram fruit). This vitamin known as "permeability vitamin" can strengthen one's body between cell the cell adhesive power and improve the capillary force, which ultimately reduce the cerebral blood clots (Anonymous 2010). In addition brinjal fruits are rich in nicotine than any other edible vegetables. Although gaining popularity among the vegetable consumers the crop suffered from various kinds of biotic and abiotic constrains. Among the biotic factors insect pest are major limiting factor for successful brinjal cultivation. Some frequently encountering insect pest in Nepalese brinjal fields are fruit and shoot borer, white fly, red spider mites, spotted beetle (Gyawali 1999). Among them, the Shoot and Fruit Borer (*Leucinodes orbonalis* Guenee) was found to be a prominent insect pest (Entomology Section 1999; Neupane 1993; AVRDC 1994; Joshi 2003) particularly in Terai, Low and Middle mountains of Nepal. Every year extensive fruit damaged was occurred ranges from 40 to 45percent (Entomology Section 1999; Joshi 2003). The female laid eggs in younger parts of the plant either. The young larvae bore in to petioles and midribs of large leaves and tender shoots causing shoot tips and in advanced stage the bored shoot start to wilt. Once they found fruit bud female laid eggs underneath the fruit bud. The young larvae start to scarp fruit from inside and are growing together with fruit. Until this situation fruits are looking healthy though larva is inside. We only noticed the damaged fruit when larva makes a hole to expel out to become pupae. At this moment the fruits aren't suitable for marketing. So that single larva is more than enough to spoil a whole fruit.

Consequently, farmers have been using chemical pesticides indiscriminately to manage this pest even without considering frequency and doses which results numerous side effects like health hazards, environmental pollution, residual affect and secondary pest outbreaks. Hence it is important to know the present scenario of farmers' pest management strategies. So that the objective of this study was to identify the farmers' perceptions regarding the management strategies adopted by farmers to manage fruits and shoot borer adopted.

METHODOLOGY

A set of semi structured questionnaire related to brinjal shoot and fruit borer and its management practices were developed and pre-tested. The pocket areas and list of farmers were randomly selected with consultation of District Agriculture Development Officer of respective districts. Fatepur and Prastoka (Bara), Bindawasini and Bahuwari (Parsa) and Saruhatta and Motipur (Rautahat) were purposefully selected for the survey because these areas already been selected as a vegetable pocket area by respective DADOs. The representative samples were collected in which 11 growers from Bara, 23 from Parsa and 20 from Rautahat districts. Altogether 54 farmers were interviewed in order to collect the

information regarding the brinjal shoot and fruit borer severity and its management strategies in these areas. The collected data were analyzed with simple statistical Microsoft program Excel and presented them with the help of tables and graphs.

RESULTS AND DISCUSSION

Area under brinjal cultivation

The survey result showed that majority of farmers (47.02%) have grown brinjal within the area of 1 to 2 katha followed by > 2 katha by 42.48 percent and 10.49 percent grow less than 1 katha of land. In Bara and Parsa majority of farmers have cultivated brinjal upto 2 katha of land whereas in Rautahat majority grown more than 2 katha of land. The details of areas coverage under vegetable cultivation mentioned in Table 1.

Table 1 Coverage area under brinjal cultivation, Survey, 2007

Area	Bara (N= 11)	Parsa (N=23)	Rautahat (N= 20)	Total
<1 kattha	9.09 (1)	17.39 (4)	5.0 (1)	10.49 (6)
1-2 kattha	54.55 (6)	56.52 (13)	30.0 (6)	47.02 (25)
> 2 kattha	36.36 (4)	26.09 (6)	65.0 (13)	42.48 (23)

Note: Outside and inside value of parenthesis indicate percent and number respectively.
30 Kattha = 1 hectare

Management practices to control shoot and fruit borer

Both local and chemical methods were commonly practiced by the farmers to control insect pest in brinjal. In local method they were followed the field sanitation, removal of damaged shoot and fruit, spraying of ash, neem leaf extract and irrigation of field. These techniques were commonly practiced only in kitchen garden scale, however the majority of commercial grower frequently dependent on chemical materials for pest management.

In Rautahat all (100%) respondent were using chemical pesticides to control shoot and fruit borer which was 73.91 percent and 45.54 percent farmers in Parsa and Bara respectively. In total more than 70 percent of farmers were familiar with chemical and rest of them were adopting both chemicals as well as local methods for borer management.

Dose of chemical pesticides

Regarding the dose of chemical pesticides, majority of the respondents in the survey areas were commonly sprayed chemical pesticides by making 1-2 ml/lit of water whereas very few respondents were sprayed very little (>1ml/L) and very

high dose (>2ml/lit). The details of dose of pesticides application in the survey districts mentioned in table 3.

Table 2 Perception of respondents on current management practices, Survey, 2007

Practices	Bara (N= 11)	Parsa (N=23)	Rautahat (N= 20)	Total
Chemicals	45.45 (5)	73.91(17)	100.0 (20)	73.12 (42)
Chemicals+ local	54.55 (6)	26.09 (6)	0.00 (0)	26.88 (12)

Note: Outside and inside value of parenthesis indicate percent and number respectively

Table 3 Perception of respondents on dose of pesticide application, Survey, 2007

Dose (ml/lit)	Bara (N= 11)	Parsa (N=23)	Rautahat (N= 20)	Total
1	36.36 (4)	13.04 (13.04)	20 (20)	73.12 (42)
1-2	63.64 (7)	73.91(17)	70 (14)	26.88 (12)
>2	0 (0)	13.04 (3)	10 (2)	-

Note: Outside and inside value of parenthesis indicate percent and number respectively

Common types of pesticides application

In survey areas, majority of farmers were rely on chemical pesticides recommend by local Agrovet (seeds, pesticides trader). The very common (among growers) pesticides were Metacid, Ripcard, Thimet, Furadon, Monosil, Shakti, Thiodan, Kontaf, Nuvan, Chloropyrifos, Superkiller, Marshal, Rogar, Cypermethrin, Quinalphos, Alfamethrin, etc. Among them very few pesticides were safe in terms of health and environments prospective and majorities were harmful to human beings and non-target organisms.

Table 4 Types of pesticides application one at a time

Types	Bara (N= 11)	Parsa (N=23)	Rautahat (N= 20)	Total
Single	0.00 (0)	30.43 (7)	60.0 (12)	30.14 (19)
2 Types at a time	54.55 (6)	65.22 (6)	25.0 (5)	48.25 (26)
>Two	45.45 (5)	4.35 (5)	15.0 (3)	21.60 (9)

Table 4 depicts that majority of respondents applied by mixing two types of pesticides at a time followed by only one (30.14%) and more than two types of pesticides (21.60%), respectively

In Parsa district, 65.22 percent respondents applied by mixing two pesticides followed by 54.5 and 25.0 percent in Bara and Rautahat districts, respectively.

Likewise, 60 percent of respondent of Rautahat and 30.43percent in Parsa used only one pesticide. The details of pesticide application were depicted in table 4.

Interval of pesticides spraying

It was found (Table 7) that 52.31 percent of respondent sprayed chemical pesticides at an interval of 7-10 days interval followed by 44.79 percent used 10 days and 2.90 percent respondents at 7 days interval, respectively.

The maximum percentage of respondents (85.0 %) in Rautahat district applied the chemical pesticides at 7-10 days interval followed by Bara (54.5%) and Parsa (17.3%) growers, respectively. The details were depicted in Figure 1.

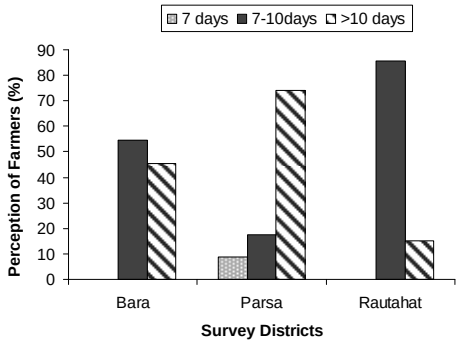

Figure 1 Perception of farmers on pesticide application interval (Bara,N=10; Parsa, N= 23; Rautahat, N=20)

Knowledge about integrated pest management (IPM)

It was observed that majority of farmers were not familiar about integrated pest management (IPM). Hundred percent respondents of Rautahat district were not familiar about IPM followed by Parsa (82.61%) and Bara (72.7%) respondents. Likewise, 27.3 percent and 17 percent of Bara and Parsa district had knowledge of IPM. Thapa (2003) reported that more than 90 percent of the farmers in Terai and mountain could not read or understand the language written on pesticide label.

Hazards of chemical pesticides on human beings and other non target animals

It highlights the acquisition of knowledge about harmful impact of pesticides on human and other non-target animals during and after pesticide application. Comparatively equal percentages of respondents were familiar about harmful aspect of chemical pesticides whereas 22.96 percent of people didn't about its negative impact. In survey area of Parsa district, 91.3 percent respondents knew

the harmful aspects followed by Rautahat (15.0%) and Bara (9%) respondents respectively. The details are presented in Figure 3.

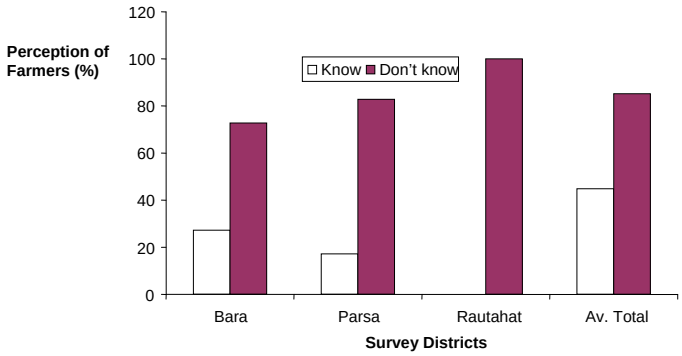

Figure 2 Farmers perception about knowledge of Integrated Pest Management (Bara,N=10; Parsa, N= 23; Rautahat, N=20)

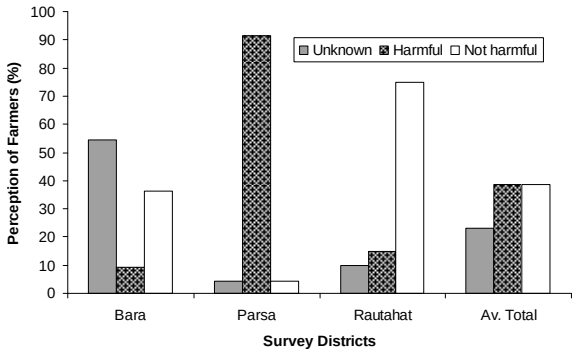

Figure 3 Perception of farmer about hazardous effect of chemical pesticides (Bara N=10; Parsa N= 23; Rautahat N=20).

CONCLUSION AND SUGGESTIONS

Cultivation of brinjal is profitable business in the survey areas. Despite their knowledge about growing brinjal in these areas, the cost of production has been increasing day by day by pest attack in general. And the severe is pest shoot and fruit borer in particular. Majorities of farmers were applying chemical pesticides some areas even banded pesticides for the purpose of borer management.

Haphazard using of chemical pesticides aggravates worsening the human life and our environments as a whole. Consequently infestation of borer is increasing day by day because of disappearance of its natural enemies; and borers have developed resistance against pesticides. Hence, it is needed to develop the alternative methods of pest management tactics with maximum utilization of local resources. The documentation of farmer's practices, their current trend of pesticide application and development of safe and useful techniques of pest management without degrading out environment ecology would be current needs.

The following suggestions on brinjal borer's management have been made:

1. Promotion of integrated pest management (IPM) system at farmers' level to develop the expertise on harmful aspects of chemical pesticides.
2. Collection and evaluation of local landraces of brinjal and test them against pest and diseases.
3. Collection and documentation of indigenous knowledge of pest management in brinjal crops.
4. Extension of farmers' awareness program in safer use and store of pesticides.

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Evaluation of Quality Protein Maize and Normal Maize for Growth Performance of Crossbred Piglets in Wester Hills of Nepal

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ABSTRACT

A study was carried out on growing crossbred male piglets (Landrace x Yorkshire) piglets of 35 days old with body weight of 8 kg at Regional Agricultural Research Station, Lumle, Kaski for 150 days to compare the growth performance of piglets fed with QPM and normal maize. Piglets were allocated into two groups having six piglets in each group by using Complete Randomized Design (CRD). Two types of concentrate mixture were prepared for piglets; starter (18% CP) and grower (16% CP). Piglets of T1 were provided adlib amount of normal maize included concentrate mixture whereas piglets of T2 received QPM included concentrate mixture in adlib amount. Concentrate mixture was provided to the piglets of both groups twice a day for both periods (starter–60 days and grower–90) of experiments. Experiment of 150 days revealed that average feed intake of T2 was higher (1.65 kg/day/piglet) than T1 (1.48kg/day/piglet), however, it was not significant (P>0.05), between diet groups. Furthermore, total dry matter intake was higher in T2 (235.12 kg) than T1 (210.9 kg) whereas, feed conversion ratio (FCR) per kg live weight gain was higher for T2 (3.26:1 kg) than T1 (2.6:1 kg) which was not significant (P>0.05) between diet groups. Similarly, total body weight gain of experimental piglets was recorded higher in T1 (80.92 kg) than T2 (72.2 kg) which was also non-significant (P>0.05) between diet groups. Average daily gain of piglets was 571 and 511.0 g for T1 and T2, respectively.

Key words: quality protein maize, pigs, feeding, Nepal

INTRODUCTION

The pig population of the country is estimated to be 1.1 million and producing 17923 MT meats per annum, that accounts 4.75 percent of total livestock population and 6.45 percent of total meat production of the country (MOAC 2010/11). The pig farming constitutes the livelihood of rural poor belonging to the lowest socio economic strata and they have no means to undertake scientific pig farming with improved stock, proper housing, feeding and management. The

importance of pig is highest feed conversion efficiency, can utilize wide range of feedstuffs, highly prolific with shorter generation interval, requires small investment on building and equipments and dressing percentage ranges 65-80percent in comparison to other livestock species. Similarly, pork is most nutritious with high fat and low water content and has better energy value than that of other meats. It is rich in vitamins like thiamin, niacin and riboflavin. Moreover, pig farming provides quick return since the marketable weight of fatteners can be achieved within a period of 6-8 months and has good demand in domestic as well as export markets for pig products such as pork, bacon, ham, sausages, lard etc.

In recent days, acceptance of pork consumption has been growing in the Nepali society; therefore, rearing of pig and consumption of pork is no more a matter of culture or religion. Simultaneously, increased urbanization and individual's access to cross cultural environments has increased the acceptance of pork in almost all societies of the country (Dhauwadel and Ghimire 2004). As the internal production is not sufficient to meet the demand of the nation, live pigs worth of NRs 470.26 million and frozen pork of worth NRs 327.02 million was imported during the FY 2010/11 (MOAC 2010/11).

Maize is a primary source of energy supplement; and can contribute up to 30 percent protein, 60 percent energy and 90 percent starch in animal's diet. About 70- 80 percent of maize production is used as a feed ingredient in the world. Although, normal maize contains between eight and nine percent protein, the quantity of two essential amino acids (lysine and tryptophan) is below nutritional requirement for monogastric animals. QPM possess balance of essential amino acids, and can reduce the dietary inclusions of protein - rich ingredients such as fishmeal and synthetic lysine; and thereby resulting in savings on the cost of feed and making animal products more affordable (Okai et al 2005; Vasal 2006). Researchers (Ortega et al 1986; Sproule et al 1988; Osei et al 1999) have compared the chemical composition of QPM with normal maize. The percentage lysine content of QPM varied between 0.33 and 0.54 with an average of 0.38. This was 46 percent higher than normal maize, and QPM contained 66 percent more tryptophan (0.08%) than normal maize. Therefore, utilization of QPM can correct this deficiency and may be advantageous in the diets of livestock and monogastric animals (Hai et al 2010). QPM contains nearly twice as much usable protein as other maize grown in the tropics and yields 10 percent more grain than traditional varieties of maize. These two amino-acids allow the body to manufacture complete proteins (Palit and Babu 2003).

Several research works conducted by different researchers around the world reported that performance of piglets fed with QPM was much better over normal maize fed piglets; however, feeding value of QPM has not been evaluated

adequately in pigs and poultry in Nepal. Therefore, an attempt was made to evaluate the feeding value of normal maize and QPM on growing piglets at Regional Agricultural Research Station Lumle, Kaski of western hills. This study was carried out with an objective to compare the growth performance of crossbred piglets fed with normal maize and QPM incorporated concentrate mixture.

MATERIALS AND METHODS

Experimental Animals: The experiment was carried out on growing crossbred male piglets (Landrace x Yorkshire) at Regional Agricultural Research Station, Lumle, Kaski from 13 December 2011 to 13 May 2012 (068/8/28 to 069/1/28). The experimental piglets were procured from Livestock Farm, Lampatan, Pokhara, Kaski of about 35 days old with average body weight of 8.0 kg were allotted into two groups having six piglets in each group by using Complete Randomized Design (CRD). All experimental animals were drenched with Fenbendazole @ 5 mg/kg body weight against internal parasites and vaccinated with swine fever vaccine @ 1 ml/kg body weight before putting in the experiment.

Diet Composition: Feed ingredients such as soybean cake, rice bran, normal maize, minerals, methionine and salt were procured from "Khowpa Feed Industries", Bhaktapur while QPM was bought from National Maize Research Program, Rampur, Chitwan. Two types of concentrate mixture were composed for experimental animal; starter (18 % CP) and grower (16% CP) which are given in Table 1. Methionine was added in both concentrate mixture @ 100 g/100 kg of concentrate mixture (Table 1).

Table 1 Composition of concentrate mixture (%)

Ingredients	Starter Ration		Grower Ration	
	Part	CP(%)	Part	CP(%)
Normal maize / QPM	50	3.94	50	3.94
Rice bran	16	1.42	22	1.95
Soy bean cake	32	12.68	26	10.30
Mineral	1	0	1	0
Salt	1	0	1	0
Total	**100**	**18.04**	**100**	**16.19**

Experimental Diet: Following diets were formulated to the experimental piglets (Table 2)

Table 2 Experimental diets of the piglets

S/n	Treatment	Experimental diets
1	1	Normal maize included concentrate mixture *adlib*
2	2	QPM included concentrate mixture *adlib*

Feeding Regime: Concentrate mixture feeding was done on group basis was provided to the piglets of both groups twice a day (morning and evening) in *adlib* amount for both periods (starter – 60 days and grower – 90 days) of the experiment. Quantity of concentrate mixture given daily to the piglets in groups weighed daily and refusal was weighed in the next morning. Drinking water was provided thrice a day in adequate amount.

Chemical Analysis: The samples of feed ingredients were sent to the Animal Nutrition Division, Khumaltar, Lalitpur for proximate analysis. Representative samples from offered concentrate mixture were analyzed for Dry Matter (DM), Crude Protein (CP), Crude Fibre (CF), Ether Extract (EE) and Ash contents (TA). The DM was determined by oven drying at 100°C for 24 hrs. Crude protein of the samples was determined 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 Ether of the samples was determined using the Van Soest method (Goering, H.K. and Van Soest 1970). Similarly, samples of normal maize and quality protein maize were sent to Food Lab of Agriculture Botany Division of NARC tryptophan and lysine content analysis. Tryptophan was analyzed as suggested by Hornandez H and Bates L.S. (1969) and Lysine as suggested by Doll H. and Koie B. (1975).

Data Measurement: The trial period consisted for 150 days (60 days starter and 90 days grower) after an adaptation period of 7 days. Total feed intake by the piglets in the group was recorded daily for both experimental periods. The body weight gain of individual piglet was measured at biweekly interval in the morning before feeding.

Data Analysis: Data of feed intake and body weight gain were analyzed by "t" test for every measurement using statistical package Minitab 2003, versions 13.20.

RESULTS AND DISCUSSION

Chemical Composition of feed ingredients

The results of chemical analysis and amino acids contents are given in Table 3.

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

Ingredients	DM	OM	TA	CP	CF	EE
Normal maize	87.69	97.97	2.03	9	2.34	4.48
Quality protein maize (QPM)	89.36	97.62	2.38	9	6.26	5.12
Rice bran	87.85	89.5	10.5	10	4.83	5.1
Soybean cake	86.87	92.63	7.37	44	9.38	0.7

Comparison of nutritional composition of QPM and NM is given in Table 4 and Figure 1.

Table 4 Comparison of the nutritional composition of QPM and Normal maize (on dry basis)

Nutrient	Ortega, *et al*.,1986		Osei *et al*., 1999		Our analysis, 2012	
	NM	QPM	NM	QPM	NM	QPM
Crude Protein, percent	9.8	9.8	8.92	9.11	9	9
Ether Extract, percent	NA	NA	4.48	5.12	4.48	5.12
Crude Fibre, percent	NA	NA	1.93	2.14	2.34	6.26
Organic matter	NA	NA	98.10	98.40	97.97	97.62
Ash, percent	NA	NA	1.90	1.60	2.03	2.38
Lysine, percent	0.27	0.43	0.24	0.32	0.19	0.28
Tryptophan, percent	0.06	0.10	0.06	0.08	0.04	0.07

Table 5 revealed that in starter period, piglets of T2 had higher feed intake (0.83 kg), total dry matter intake (47.31 kg) and FCR (2.86:1 kg) than that of T1 which were for feed intake (0.82 kg), total dry matter intake (46.74 kg) and FCR (2.45:1 kg) whereas average daily gain was higher in T1 (291 g) than that of T2 (274.8 g). Feed intake and average daily gain were not significant ($P>0.05$) between diet groups. Similarly, in grower period of experiment, there was noted higher feed intake (2.29 kg), average daily gain (688 g) and total dry matter intake (195.8 kg) and FCR (3.16.1) in T1 than that of T2 which were for feed intake (1.74 kg), average daily gain (616 g), total dry matter intake (148 kg) and FCR (2.68:1 kg). In this period, average daily gain was not significant ($P>0.05$) and feed intake was significant ($P<0.01$) between diet groups. Likewise, in 150 days of experiment, T2 was recorded higher in feed intake (1.65 kg), total dry matter intake (235.12 kg) and FCR (3.26:1 kg) than that of T1 that were for feed intake (1.48 kg), total dry matter intake (210.9 kg) and FCR (2.6:1 kg) whereas average daily gain was noted higher in T1 (571 g) than that of T2 (511 g).

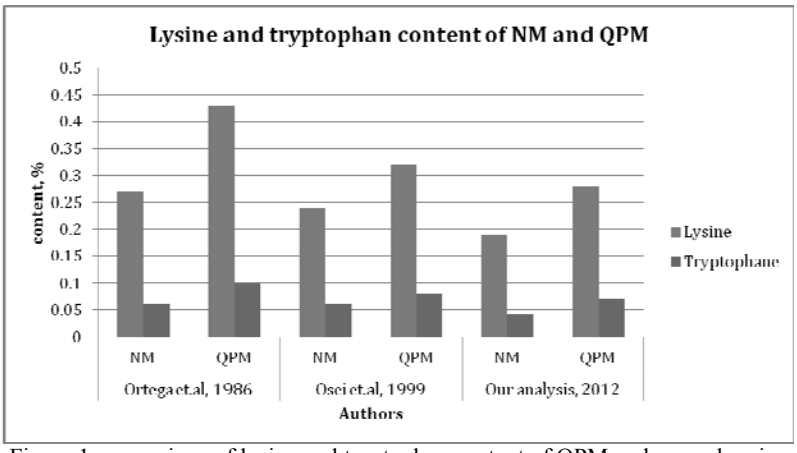

Figure 1 comparison of lysine and tryptophan content of QPM and normal maize

Table 5 Average feed intake of experimental piglet/day

Concentrate mixture	(Mean ± SE)	
	T1	T2
Starter (60 days)		
Feed intake, kg	0.82±0.11	0.83±0.13
Average daily gain, g	291±24.0	274.8±30.0
Total Dry Matter Intake (DMI) per animal, kg	46.74	47.31
Feed Conversion Ratio (Feed: Gain), kg	2.45:1	2.86:1
Grower (90 days)		
Feed intake, kg	2.29±0.35	1.74±0.26
Average daily gain, g	688.0±103	616±127.0
Total Dry Matter Intake (DMI) per animal, kg	195.8	148.77
Feed Conversion Ratio (Feed: Gain), kg	3.16:1	2.68:1
Entire trial period (150 days)		
Feed intake, Kg	1.48±0.34	1.65±0.27
Average daily gain, g	571±0.02	511±0.01
Total Dry Matter Intake (DMI) per animal (150 days), kg	210.9	235.12
Feed Conversion Ratio (Feed: Gain), kg	2.6:1	3.26:1

Feed Intake

Average daily intake of concentrate mixture by piglets for both experimental periods is given in Table 5.

Growth Performance

The growth performance of experimental piglets is given in Table 6 and Figure 2. The initial body weight of experimental piglet of T1 and 2 was almost similar (8.08 and 8.15 kg) and reached 89.0 and 80.17 kg by the end of experiment (150 days) for T1 and 2, respectively. Both initial and final body weight was found to

be not significant (P>0.05) between diet group. The highest body weight gain was recorded for T1 (80.92 kg) than that of T2 (72.02 kg). Similarly, highest average daily gain was observed for T1 (571 g) than that of T2 (511g), however, it varied from 248 to 773 g for T1 and from 195 to 722 g in T2.

Table 6 Growth performance of piglets (Mean± SE)

Parameter	T1	T2
Initial Body weight, kg	8.08±0.47	8.15±0.37
Initial metabolic weight, kg	4.79	4.82
Final Body weight, kg	89.0±3.67	80.17±2.75
Final metabolic weight, kg	28.97	26.79
Total weight, gain, kg	80.92	72.02
Average daily gain, g	571±0.02	511±0.01

Results of growth trial suggested that there was no significant (P>0.05) effect of QPM over normal maize on growth performance of piglets. It might be due to crossing of QPM with local varieties, subsequently it reduced the lysine and tryptophan content of QPM as mentioned in literatures. However, Cromwell et al (1967), Sihombing et al (1969), Marroquin et al (1973), Maner (1975), Asche et al (1985), Sullivan et al (1989), and Gao (2002) reported that QPM significantly (P<0.05) improved average daily gain and feed conversion ratio (FCR) in all phases (starter, grower and finisher) of piglet fattening.

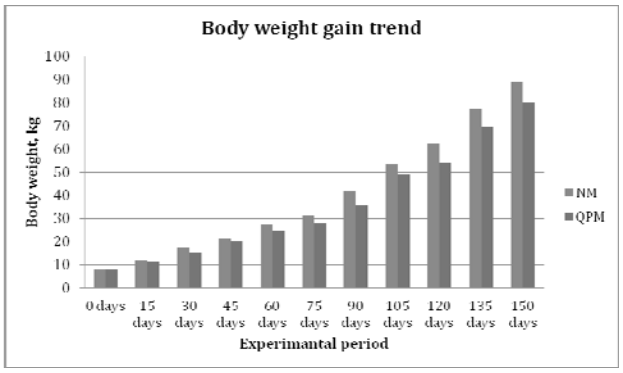

Figure 2 Body weight gain of piglets fed with QPM and normal maize

Anon (2012), reported that mean body weight of Giriraja chicken was higher in normal maize fed group (18.64± 1.01 kg) than that of QPM fed group (17.21±1.28 kg), however, it was not significant between diet groups.

CONCLUSION

This experiment revealed that quality protein maize varieties that are available in Nepal are to be crossed with local varieties due to which content of essential amino acids such as lysine and tryptophan is reduced than as mentioned in literatures. Therefore, QPM could not exhibit better performance over normal maize on growth performance of growing piglets.

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A Study on Renal Disorders in Dog

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ABSTRACT

A study was conducted to evaluate the renal disorders in the dogs from January to May 2011. A total of 50 samples were collected showing the common signs and symptoms of renal disorders. All the serum samples were analyzed in the Laboratory of the Mount Everest Kennel Club, Baneshwor. The result showed 40 percent prevalence of renal disorders. Among breeds, pure breeds were found to have higher prevalence (25.6%). In sex-wise distribution, males were found to be more vulnerable than females. Similarly, in the age-wise prevalence, age groups of 10-15 years were found to have higher renal disorders followed by 5-10 and 0-5years, respectively.

Key words: Breed, Creatinine, Plasma urea, Nitrogen, Protein

INTRODUCTION

The kidneys excrete the end-products of tissue metabolism and maintain homeostasis of fluid and electrolyte metabolism, including acid-base balance. Disease conditions in kidneys, urinary bladder and urethra causes renal insufficiency (Blood et al, 2000). Renal dysfunction is detected by urine analysis and determination of blood urea nitrogen (BUN), serum creatinine (SC). Urea is a NPN (Non-protein Nitrogen) substance formed in the liver as the end product of amino acid breakdown. Estimation of BUN gives a test of renal function, however, as a test of renal function, plasma urea is inferior to plasma creatinine, since 50 percent or more of urea filtered at the glomerulus is passively reabsorbed through the tubules, and this fraction increases if urine flow rate decreases, such as dehydration. When the concentration of BUN exceeds 35-45 mg per 100 ml, then it indicates diminished GFR (Glomerular Filtration Rate). BUN between 10-30 mg per 100 ml is usually considered normal (Thapa et al, 2007).

The term renal function tests include those tests in which various functions of kidney are measured by biochemical means. The estimation of the level of urea in blood is most commonly used but tests for non-protein nitrogen or creatinine are also available. The levels do not rise appreciably above the normal range until 60 to 75 percent of nephrons are destroyed (Godkar & Godkar, 2005). Creatinine is synthesized in liver, kidney and pancreas, and is transported to main brain and

muscle. About 1-2 percent of total muscle creatinine pool is converted daily to creatinine through the spontaneous non-enzymatic loss of water. Circulation of blood throughout the body results in continuous exchange of ions, metabolites and proteins between the intracellular and extracellular fluids. Thus the composition of serum often reflects the integrity of cells and organs. Various patterns of change can be expected in biochemical profiles as the result of cellular injury or organ dysfunction. For the diagnosis of hepatic and renal disorders evaluation of biochemical parameters plays an important role (Yadav et al, 2005).

METHODOLOGY

A study was conducted at Mount Everest Kennel Club, Baneswor, Kathmandu. Samples were collected from the dogs which were brought at Mount Everest Kennel Club showing signs and symptoms of renal disorders like difficulty in urination, hypertension, uremic smell from body and breath, renomegly and retinal lesion

Collection of sample: The blood for test was collected by venupuncture. The site was prepared aseptically with use of antiseptic, 70 percent alcohol or iodine. The vein was raised by applying presence with help of tourniquet around elbow. Then blood around 5ml was taken from vein in syringe and transferred to lab at 2-8^0 C using ice pack.

Sample processing: In lab, sample was centrifuged at 1500 rpm for 15 min for separation of serum. The separated serum was transferred into labeled sterile vacutainer with the help of a sterile disposable syringe.

Estimation of blood urea nitrogen [BUN]: The blood urea nitrogen was determined as per as Bertha lot kit where urea enzyme reagent, urea cromogen reagent, urea diluents and urea standard is present.

Procedure: For the procedure three dry test tubes were labeled as Blank [B], Standard [S] & Test [T].

Addition Sequence	Blank	Standard	Test
Working reagent	1000µl	1000µl	1000µl
Distilled water	10µl	-	-
Urea standard	-	10µl	-
Specimen	-	-	10µl

These were mixed well and incubated for 5 min. at 37^{0}C.

Urea reagent	1000µl	1000µl	1000µl

Again incubated for 5 min. and absorbance of standard & test sample against the blank were measured at 578nm.

Calculation: Urea conc. In mg/dl of test specimen; Abs T÷ Abs S×50
Blood urea nitrogen [BUN] in mg/dl; Urea in mg/dl×0.467

Determination of Creatinine in serum: The creatinine level were determined as per as Cogent kit. [Alkaline picrate method]

Procedure:
Deproteinization of test sample
Serum/plasma - 0.5ml
Purified water- 0.5ml
Reagent1; picric acid- 3.0ml
This was mixed well and kept in a boiling water bath exactly for one minute and immediately cooled under running tap water then it allows for centrifuge.

Color development	Blank [B]	Standard[S]	Test [T]
Supernatant from above sample	-	-	2ml
Working standard	-	0.5ml	-
Purified water	0.5ml	-	-
Reagent 1; picric acid	1.5ml	1.5ml	-
Reagent 1; sodium hydroxide,0.75 N	0.5ml	0.5ml	0.5ml

These were mixed well and allowed to stand at R.T. exactly for 20 min. and immediately the optical density of Blank, Standard & Test against purified water was measured on a colorimetry with a green filter.

Calculation

Serum Creatinine in mg/100ml; Abs of Test [T] –Abs of Blank [B]/Abs of STD[S]-Abs of Blank [B] ×3.0

RESULTS AND DISCUSSION

Prevalence of positive and negative cases

Total 50 samples were analyzed for renal disorder from study site. Among them 40 percent (20 samples) of total sample were found to have renal disorder. In this study, prevalence of renal disorders was found almost similar to that of Rai (2004) which may be due to equal number of sample size (50). The prevalence was higher in the study done by Sharma (2010). This may be due to the higher sample size in the study. Incidence of renal disorders was found increasingly in dogs. The

main reason behind it was inadequate knowledge about dog management, nutrition, care and health, as well as indiscriminate uses of drugs by non qualified veterinary practitioners and high use of commercially available protein rich dog food.

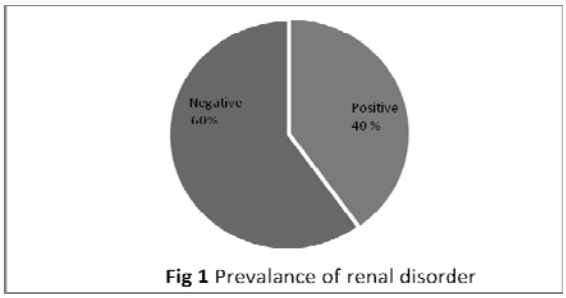

Fig 1 Prevalance of renal disorder

Breeds wise prevalence of renal disorder

Breed sample were divided into three groups- pure, cross and mongrel. Among 20 positive samples, higher prevalence is found in pure breed 50 percent (10 samples) followed by cross 30 percent (6 samples) and mongrel 20 percent (4 samples). Pure breeds were found to have higher incidence of renal disorders. Pure breeds of dogs inherit a genetic predisposition for these disorders (Fogle, 2002). Cross breeds ranked second position, this might be due to the higher supplementation of protein in their regular diet. The reason behind lower incidence in Mongrels may be due to least number of samples taken. The trend keeping Mongrel at home has been decreased; and most of the owner love to keep pure breed rather than mongrel.

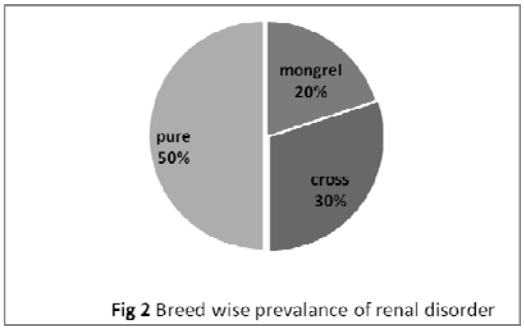

Fig 2 Breed wise prevalance of renal disorder

Sex-wise distribution of renal disorder

Among 20 positive samples, 12 were male (60%) and 8 were female (40%). Sex-wise prevalence showed higher incidence in male than female. More preference is

given to male dogs in our context. People do not want a bloody mesh at their home during menstruation. This might be the reason for higher prevalence in male dog.

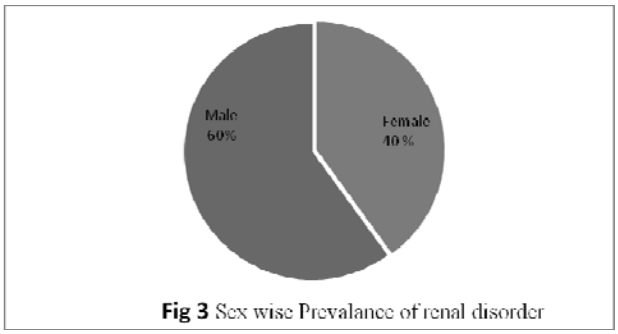

Fig 3 Sex wise Prevalance of renal disorder

Age-wise representation of sample

Dogs were divided into three groups according to their ages: 0-5 years (10 samples), 5-10 years (24 samples), and 10-15 years (16 samples). Among three age groups, 10-15 years of age group were found to be more affected (50%) followed by 5- 10 years (40%) and 0-5 years (10%). The glomerular filtration and blood flow rates declined in linear fashion; and the incidence of sclerotic glomeruli increased with advancing age. The ageing kidney is at high risk of failure when functioning nephron numbers are reduced (Anderson, 1986).

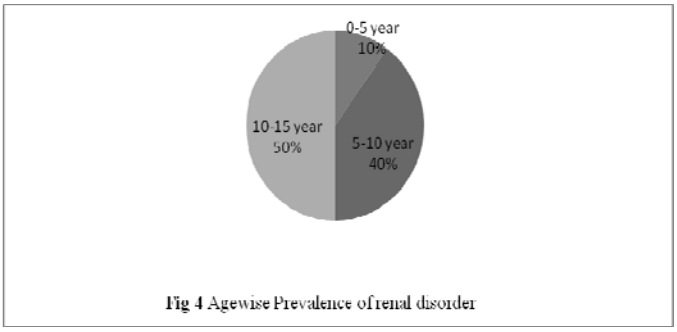

Fig 4 Agewise Prevalence of renal disorder

CONCLUSION

The study was completed with pointing out 40 percent prevalence of renal disorder in dogs by examination of BUN and Creatinine in blood sample. From this study, it was found that renal disorders are increasingly seen in dogs of

Kathmandu valley. It is recommended for all dog owners to check up their dogs routinely and/or consult veterinary centres in case of any doubt.

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Decreased Organic Manure Application in Kathmandu Valley Vegetable Fields Threatens the Soil Productivity

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ABSTRACT

Kathmandu valley is one of the fertile lands in Nepal with higher productivity. Organic manure application was the main soil fertility management method among ancestors. However, in the past few decades, availability of organic manure has dropped off and has become a commercial commodity. Therefore, a study was conducted to document current nutrient management practices among peri-urban vegetable farmers and to determine the soil fertility status in Kathmandu valley vegetable fields. Questionnaire survey and soil analysis was performed to gather the information. Results showed that organic manure application practice was fallen (only 60percent respondents) and rate of application was very less (890 kg ha^{-1}). Despite this fact, soil fertility status was maintained except available potassium content. Reduction in organic manure application has resulted into decline in the soil available potassium content. For environment friendly sustainable agriculture, Kathmandu valley farmer should apply optimum amount of organic manure in the field.

Key words: Soil fertility, Sustainable agriculture, Available potassium, Organic manure

INTRODUCTION

Soils in Nepal are mostly Inceptisols and Entisols (Dhakal, 2007). Kathmandu valley soil was formed by alluvium and lacustrine deposit (Karki, 2003; Baniya, 2008), so it is one of the most productive farmlands in the country. Fertile land contributed to the development of the civilization and the creation of the heritages for the world. After restoration of democracy in 2047 B.S. (1990), population in Kathmandu valley burgeoned due to centralized facilities and services in Kathmandu, the capital of the country (Zurick and Rose, 2009; MRCP, 2011). The more desperate fact is that the unmanaged urbanization has resulted into urban sprawling converting fertile lands to the concrete structures. As land is the basic source of food production, decreasing arable lands has threatened the food security in Kathmandu valley. Kathmandu valley is dependent on other countries for fresh vegetables (Baniya, 2008; Khanal, 2010). Nevertheless, farmers are growing crops in the peri-urban areas that has prevented the skyrocketing price of

daily fresh vegetable (Bhandari, 2006). Before green revolution, farmers in Nepal were default organic using organic manures (OM) as the only input for the crop production. After green revolution, we learnt to use chemical fertilizer during early 1960s (Shrestha, 2010). Afterwards, high response of chemical fertilizer increased the chemical fertilizer use in the fields, whereas organic manure application rate decreased continuously (Bhandari, 2006; SSD, 2007). For example, Puri (2004) showed that more than 90 percent vegetable farmers at Sipadole VDC in Bhaktapur were applying OM regularly. After nine years, Maharjan (2012) conducted another survey in the same VDC and found only 70 percent farmers were applying OM in the field. Another study in Lalitpur (Dukuchhap VDC) by Sapkota (2008) revealed that only 40 percent farmers were applying OM in their field. Insofar farmers have not realized the function of OM in supplying micronutrients and maintenance of soil physical, chemical and biological properties. Past studies showed that Kathmandu valley soil was not deficient in the micronutrients as farmers were applying enough OM to supply those nutrients (Karki et al., 2005). In the recent decades, farmers are applying less amount of OM as it has become a market commodity as well. Previously, OM manure was a free commodity, and farmers could get it free of cost from other households as well. Moreover, buying OM is not yet a culture among the Nepali farmers in general.

Traditionally, farmers in Kathmandu valley were using human excreta as manure in the fields. Later on, concern about transfer of diseases (Cameron et al., 1997) and change in the sewage system deterred those practices. These days, only farmers near the stream apply irrigation water containing sewage. Additionally, different projects are promoting recycling of human urine for compost preparation (Gantenbein and Khadka, 2009; Pradhan et al., 2011). Decline of phosphorus deposit in the world (IFDC, 2010; Granthum, 2012) has also rejuvenated the concept of recycling human excreta as a phosphorus source (Childers et al., 2011). Potash fertilizer is not a commonly available fertilizer even in the capital market of Nepal (Karki, 2003). Potash, being a macronutrient, has a significant role in the staple food production (Regmi et al. 2002; Karki, 2006).

This study aimed to garner the data about current fertilizer use practices among the peri-urban vegetable farmers; and determine the soil fertility status in Kathmandu valley vegetable farms.

MATERIALS AND METHODS

This study was conducted in December 2012 in Kathmandu valley. Semi structured questionnaire survey and soil sample analysis for physical and chemical properties were done. Altogether 47 soil samples were collected from Bhaktapur

(18), Kathmandu (17) and Lalitpur (12). Soil properties were analysed using standard procedures (Table 1).

Table 1 Soil analysis procedures

Soil properties	Method
Moisture content (%)	Oven drying at 105°C
Texture	Hydrometer method
Bulk density (g cm^{-3})	Graduated cylinder method
Particle density (g cm^{-3})	Pycnometer method
Soil reaction (Soil pH)	1:10 soil:0.01 M $CaCl_2$ solution (potentiometric method)
Organic matter content (%)	Wet digestion method
Available nitrogen content (ppm)	MgO – Devarda's alloy method
Available phosphorus content (kg P_2O_5 ha^{-1})	Sodium bicarbonate method
Available potassium content (kg K_2O ha^{-1})	Ammonium acetate method

Data were processed using Genstat fifteenth edition (VSN International Limited). Descriptive statistics and regression analysis were done.

RESULTS AND DISCUSSION

Farming Practice

Vegetable farmers were applying different amount of chemical fertilizers like urea, diammonium phosphate and muriate of potash. Chemical fertilizers were applied in higher doses than recommended whereas OM was applied inadequately (Table 2). Vegetable farmers were satisfied with the yield obtained with such quantity of fertilizers.

Table 2 Amount of fertilizer used in Kathmandu valley vegetable fields (mean±standard error)

Parameter	Organic manure	Urea	Diammonium phosphate (DAP)	Muriate of potash (MoP)
Average (kg ha^{-1})	890±330	273±95	273±115	117±59
Standard recommendation*	2500	180	180	80

* (ABPSD, 2012)

Most of the farmers applied urea (83%) followed by organic manure (60%), diammonium phosphate (19%) and muriate of potash (17 %) (Figure 1). Farmers had applied these fertilizers on the field at least one month before soil samples were collected.

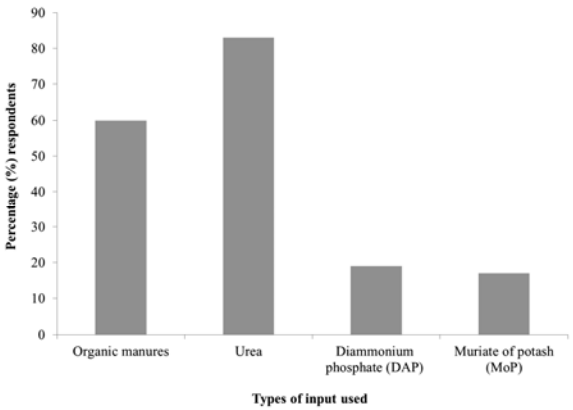

Figure 1 Fertilizer use practice among Kathmandu valley vegetable farmers

Soil Physical Properties

Vegetable growing soil in Kathmandu valley was moist (19.89% soil moisture) even during the dry month of December (Table 3). Soil texture was determined mostly sandy loam (45%), followed by loam (15%), loamy sand (10%), sandy clay loam (8%), silt clay and clay soil were also found.

Table 3 Soil physical properties in Kathmandu valley vegetable farms

SN	Parameter	Mean±standard error
1	Soil moisture (%)	19.89±1.29
2	Soil separates (%):	
2.1	Sand	55.55±2.88
2.2	Silt	27.03±2.03
2.3	Clay	17.15±1.50
3	Bulk density g cm^{-3}	1.17±0.03
4	Particle density g cm^{-3}	2.26±0.06

Soil Chemical Properties

Vegetable growing soil pH of Kathmandu valley was slightly acidic (6.0 to 6.5). Soil organic matter content was medium (2.5% to 5.0%). Available phosphorus content in the soil was very high (> 110 kg P2O5 ha-1). Soil available potash content was high (280 to 500 kg K2O ha-1) (Table 4).

Organic Manure Application

Compared to the past, Kathmandu valley farmers were applying fewer amounts of organic manures in the fields (Puri, 2004; SSD, 2007; Maharjan, 2012). It is perhaps due to change in the life style. Decreased livestock rearing have drastically reduced the amount of manure produced in peri-urban areas. Additionally, culture of fast food has diminished the organic wastes produced from the households. Furthermore, public waste collecting services has minimized the possibility of organic manure production at home. The bitter truth along with this is buying organic manure is very new and unattractive option for the traditional farmer.

Table 4 Soil chemical properties in Kathmandu valley vegetable farms

SN	Parameter	Mean±standard error
1	Soil pH	6.0±0.1
2	Organic matter (%)	4.24±0.35
3	Available nitrogen (ppm)	55.41±7.67
4	Available phosphorus (kg P2O5 ha-1)	880.37±101.80
5	Available potash (kg K2O ha-1)	380.06±31.92

However, OM content in the vegetable fields was higher compared to past years (Table 4 and 5). It was may be that Kathmandu valley soil data by Dahal (2007) included all the fields where OM application may not be a general practice whereas OM application is a traditional practice in the vegetable farm. Agreeing with Allison (1973) OM has lessened soil bulk density (Figure 2). Addition of OM results into aggregate formation, increases porosity, and increases below ground activities resulting in less bulk density. Furthermore, it makes soil easy to cultivate and conducive for the plant root development (USDA, 2001).

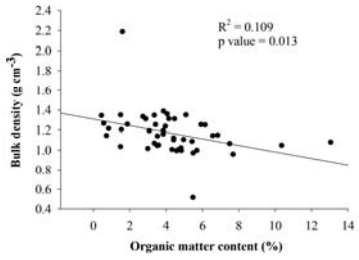

Figure 2 Relationship between soil organic matter content and bulk density

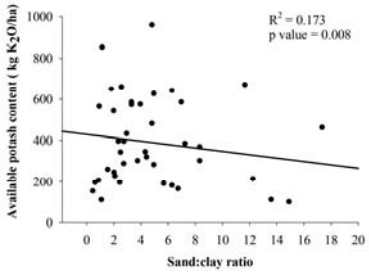

Figure 3 Role of sand: clay ratio in soil available potash content

Soil Available Potash Content

Defending Shrestha (2007) traditional practice among farmer was applying potash fertilizer only during the planting time as a basal dose. However, luxury consumption of available potash during early stage results into the deficiency of potash during later stage resulting decreased yield (Marschner, 2012).

On par with Baumler et al. (1997) proportion of sand and clay has determined the amount of exchangeable potash in the soil (Figure 3). As increase in the sand proportion, cation exchange capacity (CEC) in soil is reduced and for clay it is vice versa (Brady and Weil, 2012). The clay content (Table 3) has contributed to hold and release the exchangeable potash (Mengel and Rahmatullah, 1994). The higher sand content played role in making higher amount of potash available in the soil solution. In addition, sand content also promotes leaching (Karki, 2003) of available potash from the root zone depth as Kathmandu valley soil is sandy (Table 3) in nature.

On par with (Karki, 2006) OM content has contributed to the soil available potash content (Figure 4). Decomposition of OM and stimulated weathering of minerals by complexation (Osman, 2013) may be responsible for the contribution of potash from the parent materials in Kathmandu valley soil (Karki, 2003) i.e. mica-pedogenic chlorite and chlorite interlayered vermiculite type (Baumler et al., 1997). Therefore, OM can contribute to the potassium requirement of the vegetable crops. In addition, exchangeable potash (K^+) release by OM is slower compared to MoP fertilizer. Hence, OM can supply potassium for longer time as well.

Soil Reaction

In contrast to Dahal and Routray (2011), in this study soil nitrogen content was high at high soil pH (Figure 5). That may be because Dahal and Routray (2011) analyzed soil for total nitrogen. Moreover, they did not find any significant relationship between soil reaction and total nitrogen content. Ammonium form of nitrogen applied through urea, DAP and OM (Granli and Bøckman, 1994) were more available at high soil pH compared to less soil pH. It may be because ammonium form was more adsorbed to soil colloids at less soil pH. At high soil pH, ammonium N is released as ammonia (NH_3) (Granli and Bøckman, 1994).

Soil Fertility Status

Since 1995, soil reaction was within the range of soil pH 5 to 6 (Table 5). However, soil available potash content has declined sharply possibly due to increase in the cropping intensity and use of nutrient exhaustive plants and

varieties (Karki, 2003). In contrast, soil fertility evaluation of organic farm in Panga, Kirtipur by Bhattarai (2010) revealed better status of soil with average good nutrient contents (Table 5).

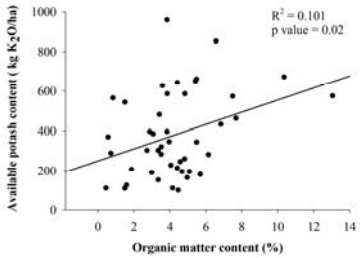

Figure 4 Role of organic matter in soil available potash content

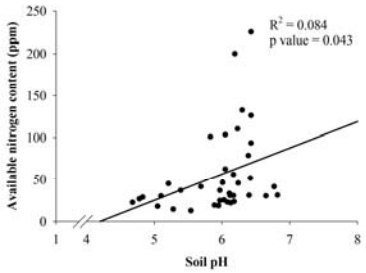

Figure 5 Role of soil pH in the soil available nitrogen content

This study (Table 4) also revealed that Kathmandu valley vegetable farms have higher amount of OM (4.2%).

Table 5 Soil fertility status in Kathmandu valley soil from 1995 to 2010

Reference	Soil pH	Organic matter (%)	Total nitrogen (%)	Available phosphorus (kg P2O5 ha-1)	Available potash (kg K2O ha-1)
SSD (1995)¶	5 - 6	-	0.10 – 0.22	> 55	111 - 280
Karki (2003)	5.1	2.05	0.11	-	739.06
Dahal (2007)	5.3	3.59	-	167.37	470.93
Baniya (2008)	5.6	2.50	0.14	148.15	196.88
Bhattarai (2010)	6.8	3.41	0.16	324.00	528.00

¶mode range is given

CONCLUSIONS

As Kathmandu valley soil is sandy and slightly acidic in nature, application of OM as the source of nutrients is more productive and efficient in the long term compared to the chemical fertilizer.

For better maintenance of soil productivity and environment friendly farming, agriculturists and farmers should opt for improved practice of applying optimal amount of OM on the crop lands.

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Prospect of Lentil (*Lens culinaris*) Cultivation for Livelihood Improvement and Nutritional Security in Hills of Nepal

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ABSTRACT

There is tremendous potential for intensifying lentil cultivation and boost its production in hill. With the objective to promote and establish lentil as one of the key crops in the cropping system in hills, a program was carried out by Agronomy Division under Nepal Agricultural Research Council in western hilly districts of Nepal, namely Tanahu and Gorkha districts, for three years starting from 2007. Major activities of the program were community training on the benefits and production package of lentil, evaluation of high yielding lentil varieties, demonstration of BNF technology and rhizobium inoculation in lentil. Activities were systematically executed that promoted and popularized lentil crops among the farming families.Mean lentil yield of 1055 kg/ha was recorded from the evaluation of 1800 sets of different lentil varieties at the two sites during three years. Furthermore, rhizobium inoculation was very useful in improving lentil yield in the range of 18 to 30 percent. 82 new households and 25 regular growers at Champbas and Khare in Tanahu district and 60 new households and 12 regular growers at Chyangli tar in Gorkha district benefited directly from the program.

Key Words: BNF technology, Yield, System sustainability, Nutrition

INTRODUCTION

Lentil (*Lens culinaria* Medikus) is an important winter legume crop in Nepal. It is produced in all 75 districts of Nepal except two Trans-Himalayan districts Mustang and Manang **(**Anonymous, 2004**)**. However, Terai region (Hot and humid climate) dominates lentil commercial production. Lentil represents 60 percent of the national pulses production and 90 percent of the pulse exports **(**Deve, Munakarmi, and Biji, 2007**)**. Nepal ranks among the ten world's major producers and exporting countries. Bangladesh, India, Sri Lanka and Pakistan are the major countries importing Nepalese lentils. If improvement in the quality and quantity can be made, there is a good opportunity for its export to Middle East countries **(**ibid**)**.

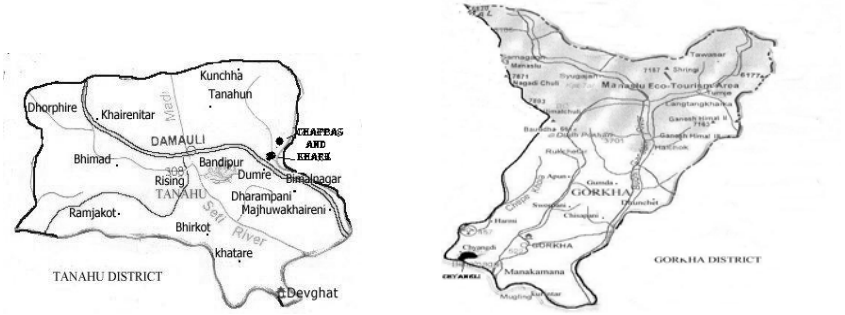
Farmers in hills are yet to realize the multiple range of benefits from lentil cultivation namely; nutritional, systemic and economical benefits. Its export potentials and possible means to sustainable economic gain is still untapped opportunity by farming families in hills. In recent years, the consumption of lentil is increasing in hills as lentil seed cooks faster than other pulses, and hence economy in fuel. Moreover, price of lentil is lower compared to other legumes like pigeon pea and black gram.

In line with this, government sectors are yet to realize this opportunity because not many efforts have been exerted in the research and development of lentil in hills. With the fine tuning of existing technology and recommended varieties, there is ample scope for the expansion of area and increase in production of lentil in hills. However, exemplary work was initiated by Agronomy Division under Nepal Agricultural Research Council (NARC) during 2003. Lentil improved varieties were tested at hilly districts like Gorkha, Ramechhap, Myagdi and Baglung. The outcome of these multi-location tests was encouraging. The average yield of the tested lentil varieties in Gorkha district was recorded 1020 kg/ha and 1800 kg/ha in Reamchap district (Anonymous, 2006). A consensus was developed to further accelerate such activities in wider areas of hills and at the same time popularize and promote its cultivation. Thus with an aim to explore the performance and popularization of lentil as a commercial crop in hills of Nepal, a three years program was launched at mid-western hilly districts Tanahu, Gorkha and Lamjung by Agronomy Division, NARC during 2007. The objective of the program was to popularize and intensify lentil cultivation through integrating lentil in Rice-fallow and Rice-Fallow-Spring rice systems in hills. A vast land area in the country most of it in hills (0.39 million ha of cultivated land) remains fallow after rice in winter due to inadequate soil water status or lack of irrigation facilities. This paper summarizes the activities of the program, its findings and how it has affected the farming families at large in Tanahu and Gorkha districts.

MATERIALS AND METHODS

A. Participatory Research Appraisal (PRA) and Reconnaissance survey (RS): Secondary data published by various agricultural organizations were studied to identify the possible districts in hills to carry out the program. Based upon the review, three districts in western hills districts namely Tanahu, Gorkha and Lamjung districts were taken into consideration for participatory research appraisal (PRA). Existing lentil acreage and community interest, indicators like marginalized communities, cropping pattern and access/availability of community based organizations/farmers groups were the focus of the survey. The outcome of program at Champbas (Ward No 1) at Bhanu Village District Community (VDC) in Tanahu district and Chyangli Taar at Chyangli VDC in Gorkha district are discussed in this paper (Figure 1). Reconnaissance survey technique was applied

to establish benchmark information on bio-physical, socio-economic, farming constraints, farmer's need and researchable problems related to lentil cultivation.



A B

Figure 1 Maps of project sites: (A) Tanahu and (B) Gorkha districts

B. Community training program: Numerous training programs on different aspects of lentil cultivations were organized during two years. The training covered different aspects of lentil cultivation including, management, and post harvest activities to marketing.

C. Varietal evaluation: 1800 sets of minikit comprising five different high yielding lentil varieties; Maheswor Bharati, Sagun, Shikhar , Simal and Simrik were tested in the farmers field during three years period (2007-2009).

D. Demonstration: Inoculation of lentil (Maheswor Bharati) with rhizobium strain bacteria (2 g/kg seed) has been proven very effective technology in increasing lentil productivity. Demonstration of this technology in the farmers' field (3 farmers in each district) (Plot size 30 sq m) in each site was organized. In two post rice lentil plots, one plot was treated with rhizobium while no rhizobium treatment was done on the second plot. Details of the demonstration were as presented in Table 1.

RESULTS AND DISCUSSION

A. Sites Descriptions

a. General feature of the sites is summarized in Table 1.

Table 1 General feature of the program sites in Tanahu and Gorkha districts

General features		Agro-ecological sites	
		Champbas/Khare, Tanahu	Chyanglitar, Gorkha
1	Recommendation domain	River basin	River basin and tar
2	Altitude range	440-550 masl	420-680 masl
3	District	Tanahu	Gorkha
4	VDC	Bhanu	Chyangli
5	Number of house holds	255	168

6	Walking distance from road head	0 hour	0.10 hour
7	Nearest local market	Turture	
8	Climatic condition	Sub-tropical	Sub-tropical
9	Rainfall Maximum Minimum	May-Sep. (80 percent)* August November	1492 mm - -
11	Hailstone occurrence	May-June (64 percent)	April-June
12	Frost occurrence	December-January	November-January

b. Food self sufficiency

The farming households were classified into three wealth categories viz. food surplus category (food enough for ≥ 12 months), food sufficient (>6 ≤12 months) and food deficit (≤ 6 months). High numbers of farming families at Champbas site were under food sufficient category than families at the site at Chyangli taar (Table 2).

Table 2 Percent distribution of food self-sufficiency by sites during 2007

Food self-sufficiency category	Agro-ecological sites	
	Champbas/Khare	Chyanglitar
Surplus category	44	20
Sufficient category	40	42
Deficit category	16	38
Total	100	100

c. Cropping Pattern

Cropping pattern prevalent at Champbas/Khare and Chyangli taar are presented in Table 3. It is evident that vast agricultural lands are left fallow at both sites after the harvest of rice. Rice is followed by potato, wheat, mustard and/or lentil is persistent in various degrees. Winter and summer legumes like, black gram, cowpea, chick pea, pigeon pea and soybean were found grown by households in Champbas/Khare. Lentil local cultivars like Rato sthaniya and Sano kerou were common among the lentil growers. Lentil is grown as a relay crop with rice (90%) by majority of households while a few households grow post rice lentil (10%). Lot of diversity was observed in the farmer's field at Tanahu sites.

Table 3 Percentage distribution of khet cropping patterns by sites during 2007

Khet cropping pattern	Agro ecological sites	
	Champbas/Khare	Chyanglitar
Rice-Potato-Fallow	25	8
Rice –Fallow	44	58
Rice-Wheat-Fallow	8	6
Rice/Lentil-Maize	8	4
Rice-Mustard-Maize	4	8
Rice-Fallow-Spring Rice	11	16
Total	100	100

B. Lentil scenario

Information regarding lentil cultivation is based upon the PRA and RA carried out among the 25 and 12 households at Champbas/Khare and Chyngli tar respectively during the initial phase of the program. Yield of native lentil cultivars at two sites were in the range of 640-800 kg/ha. Local or recycled lentil cultivars named "Rato Sthanaya'' and "Sano Kerou" are common. As a relay crop it is planted during the last week of Kartik in rice field but as post rice crop it is planted during first week of Mansir. In general it is harvest from Falgun second week onward. Farm Yard Manure (FYM) was the primary source of nutrient input.

Poor seed quality, problem of insect/pest, weeds, lack of proper management practices etc had cumulative deteriorating effect on lentil production and productivity. Pests and weeds in the field are severely affecting the lentil crop (Table 4). Hairy caterpillar and hoppers were common pests observed while sporadic occurrence of wilt and blight were reported. Moreover, unscientific harvest and post harvest to storage (Table 5) have further deteriorated the quality and quantity of both the commodity and seed.

Table 4 Common weeds observed at the sites during 2007

Scientific Name	Common Name	Local Name	Weed Type
Ageratum conyzoides L.	Goat weed	Gandhe	Broadleaf weed
Anagolis arvensis L.	Pimpernal	Krishnanil	Broadleaf weed
Capsellabursa-pastories (L.)	Lady's purse	Chaulani	Broadleaf weed
Ceratopteris thalictroides (L.) Brongn.	Water sprite	Jhyau	Fern
Coronopus didymus L.	Water cress	Chamsure Jhar	Broadleaf weed
Enchinochloa colona (L.) Link	Jungle grass	Banso	Grass weed
Vicia hirsute	Common vetch	Kutil kosa	Broadleaf weed
Euphorbia sp.	-	Doote phool	Broadleaf weed

During lentil harvest 40 percent of the households chop the mature plants from the ground and left them on the field for 4 to 5 days for drying. Then threshing was done on the field and grains taken for storage while the plant was left on the field. While 60 percent households unearthed the whole plant from the ground and after 4 to 5 days of drying in barn threshing was done and the grains were stored while the plant parts used in making composts. More than 45 percent of the growers sell lentil to the local or nearby market Even though, the crop is being grown under poor management condition with inadequate inputs, farmers are very much keen on lentil cultivation as they are realizing the lucrative domestic and international market value of the crop. From interaction with the farming families who are the regular growers of lentil, it was understood that more households are attracted toward growing lentil if they get good return from the crop in order word they were anxious about the stable market demand.

Table 5 Storage methods of lentil commodity and/or seed in households

Storage of seed	Percent distribution of households following the methods of storage*
1. Grain stored in sac which is used later as seed	43
2. Grain mixed with ash and stored in sac which is later used as seed	22
3. Seed selection from the bulk of harvested crop; mixed with ash and stored in sac	16
4. Grain stored in sac with the treatment of Celphose	14
5. Seed selection and treated with Celphose and stored in a sac	8

*Based upon the survey among 37 households at the sites in Tanahu and Gorkha districts.

C. Performance of Lentil varieties

The mean yields of lentil minikit sets from two sites are summarized in Table 6.

Table 6 Performance of lentil varieties in the farmers field from 2007-2009

SN	Varieties	Plant height (cm)	Flowering (days)	Maturity (days)	Seed Yield (Kg/ha)	Percentage yield increase over local lentil cultivar
1	Maheswor Bharati	26	80	107	1050*	>98
2	Sajun	23	75	113	815*	>80
3	Simal	28	95	119	900*	122
4	Shikhar	25	100	124	1150	113
5	Simrik	26	92	128	1000	>95
6	Sthaniya Masuro	24	103	120	540**	-

*Average yield of 360 minikits of each variety distributed during 3 years
**Average yield of local cultivar of 81 plots during 3 years

Farmers were convinced to try new activities during the lentil cultivation namely maintaining optimum plant population, balanced use of fertilizers and timely crop management practices. Thus with these interventions, incidence of insects/pests were relatively lower and the plants also looked healthy and lush green. Two times hand weeding: first 30-35 days of sowing and second 70-75 days of sowing were very effecting in controlling weeds.

Eighty two new households and 25 regular growers at Champbas and Khare in Tanahu district and 60 new households and 12 regular growers at Chyangli tar in Gorkha district benefited directly from the lentil minikits program. Survey at the end of the project had revealed that farmers were very much attracted toward lentil cultivations that they themselves visited markets and government institutions in search of quality lentil seeds. They sell their lentil commodity in local agro vet or retail store as seed or food item. However, as realized by the growers and Agronomy division, more is needed to be done on improving the quality of the produce and on market network exploration and strengthening.

D. Effects of *Rhizobium* inoculation

Rhizobium inoculation, a promising biological nitrogen fixation (BNF) technology, can substantially increase yields of soybean, black gram and lentil and other grain legumes (Rajbhandari, 2011); and in Nepal BNF increased the yield by 10-65 percent (Maskey and Bhattarai, 1995). With an aim to assess the effectiveness of BNF technology, comparative demonstrations were held in the farmer's field in both sites. The results are presented in table 7.

Table 7 Effect of Rhizobium inoculation on grain yield of lentil in Champbas/Khare and Chyangli Taar

Sites	Mean yield (Kg/ha)		Increase in yield (%)
	Without *Rhizobium*	With *Rhizobium*	
Champbas/Khare	694.0	902.0	30
Chyangli Taar	583.0	689.0	18

The result was very encouraging with 18 to 30 percent increase in lentil yield. It was thus obvious that BNF technology holds ample potentiality to increase lentil yield in the hills of Nepal. However, there are numerous constraints to its extensive use (Pandey et.al, 1998). Major limiting factors for its extensive use are soil factors such as soil acidity, low phosphorous, low organic matter content, micro-nutrient (Bo and Mo) deficiencies.

E. Effect on system sustainability

Farmers at the sites were well aware of the fact that the rapid depletion of soil fertility due to increased rice-based cropping intensity is a big threat to the sustainability of the system as a whole. Thus, with an intervention on the traditional system through lentil inclusion, we not only control this problem but also revitalize the soil health as well. Lentil has a built-in capacity to utilize atmospheric nitrogen through symbiotic nitrogen (N) fixation, so in the long run they play important role in soil fertility maintenance. The amount of N contributed by the lentil for the succeeding cereal crop was approximately 50 kg/ha as it is estimated that in Nepal this amount of N is fixed by lentil in one hectare land (Saraf et.al., 1998; Rajbhandari, 2011). So, it was explained to the farming communities at the sites that if they continued to grow lentil they will have numerous benefits in the long run namely N fixation by lentil, break cycle of pests and diseases, improvements in physical, chemical and microbial characteristics and increased activity of soil micro-fauna e.g., earthworms.

CONCLUSION

The results of field trials have established that with technological and institutional innovation, farmers can enhance lentil productivity and trade. Combination of technical interventions had led to the increment of lentil upto 33 percent, i.e. from 800 kg/ha to 1200 kg/ha. With lentil incorporation in fallow land after rice harvest, not only additional nutritious food was made available but also sustainably utilized fallow land, helped improve soil fertility by supplying nitrogen to soils and contribute on additional income to households through its trade.

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Effect of Stocking Density, Bedding Materials and Probiotics on the Performance of Broiler

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ABSTRACT

An experiment was conducted with the objective to investigate the effect of stocking density in relation to bedding materials, and probiotic supplementation on the growth, feed consumption, feed efficiency, economics, and carcass traits of broiler. The experiment used a Complete Randomized Design (CRD) with 2x2x2 factorial combination of treatments: two levels of stocking density (1 and 0.75 sq. ft), two levels of bedding material (rice husk and saw dust), and two levels of probiotics supplementation (with or without probiotic). Each treatment was replicated thrice using 24 pens consisting 312 birds. Chicks were fed two types of ration ad libitum: starter (2-4weeks) and finisher (5-6 weeks). Starter had 2900 ME K Cal/Kg and 22.05 percent crude protein, whereas finisher ration had same level of energy, and 20.00 percent crude protein. The data on growth performance, feed consumption, moisture absorption, and feed cost were recorded and analyzed statistically using computer software. Rice husk as bedding material significantly increased in feed consumption ($P>0.05$) from 2^{nd} to 6^{th} week. Whereas, probiotic supplementation significantly ($P<0.01$) contributed to the higher weekly cumulative feed consumption. The feed conversion ratio was significantly ($P<0.05$) higher during 2^{nd} to 6th weeks when birds reared with 1 square. ft stocking density compared to that of birds reared with 0.75 square ft . Birds reared with 1 sq. ft spacing also had significantly higher ($P<0.05$) growth rate. Supplementation of probiotics in diets significantly ($P<0.05$) increased body weight during the entire experimental period, compared to without probiotics. Results of this study revealed that the poultry grower can successfully rear broiler by providing 1sq.ft/bird floor space which could have better performance on feed consumption, and live weight gain. Likewise, either rice husk, or saw dust alone can be used as alternative bedding materials as bedding materials did not affect to the growth. Probiotics supplementation shared a better result without affecting meat traits and economy of broiler production. However, to verify the results of this experiments further research is needed considering in a wider scale and location before recommending the technology.

Key Words: Broiler, Stocking density, Bedding material, Probiotics

INTRODUCTION

Poultry farming has emerged as a major income generating enterprise in agriculture sector to fight against poverty, and malnutrition. It has been recognized that poultry industry in Nepal is one of the most rapidly growing segment of the agriculture sector. The total fowl population is 25760373, laying hen is population 7290875, egg production is 629793000, and chicken meat production is 17551 MT (MOAC, 2009/10). Birds at a lower stoking density will be exposed to less ammonia, and will likely be healthier, grow faster, and have higher performance rates (Reece et al., 1981). Casey et al. (2005) defined the litter as combination of bedding material, excreta feather, wasted feed, and wasted water. An effective bedding material must be an absorbent, lightweight, inexpensive, and non-toxic. Ideal material will have moisture absorption, and release qualities to minimize litter caking. Sub therapeutic feeding of antibiotics has historically been a practice in some sectors of the commercial broiler industry to increase performance by suppressing potential performance impairing enteric infections. (Patterson and Burkholder, 2003) found that many bacteria from several different genera have been used as probiotics since the inception of this form of growth promotion and disease prevention. These include, but are not limited to, Bacillus, Bifidobacterium, Enterococcus, Escherichia coli, Lactobacillus, Lactococcus, and Streptococcus Many researchers are now focused on identifying viable alternatives to antibiotics that offer similar benefits, such as increased BW gain, increased FE, and increased protection from bacterial infection. Probiotics represent potential replacements for antibiotics in the food animal industry because of their reported ability to reduce enteric disease in poultry and potential foodborne pathogen contamination of poultry or poultry products. The current study was designed to determine effect of stocking density in relation to bedding materials and probiotics supplementation on the growth performance of broiler.

MATERIALS AND METHODS

A total of three hundred and twelve, day-old, strait- run-broiler chicks were brooded and fed with commercial pre-starter diets for seven days. Thereafter, the chicks were randomly distributed to 24 pens. Eight treatments with 3 replications were randomly allocated to 24 pens following a Complete Randomized Design with factorial combinations (2x2x2 factorial). Two levels of stocking density (1sq.ft and 0.75sq.ft), two types of bedding materials (rice husk vs saw dust), and with or without probiotics having the following treatments were used: T1= Stocking density 0.75sq ft +Rice husk + Probiotic; T2= Stocking density 0.75sq ft+ Rice husk + without probiotic; T3= Stocking density 0.75sq ft+ Saw dust + Probiotic; T4= Stocking density 0.75sq ft+ Saw dust + without Probiotic; T5= Stocking density 1.00.sq ft + Rice husk + Probiotic; T6= Stocking density 1.00.sq

ft+ Rice husk + without Probiotic; T7= Stocking density 1.00.sq ft+ Saw dust + Probiotic; T8= Stocking density 1.00.sq ft+ Saw dust + without Probiotic. The birds were vaccinated with Marex vaccine (HVT) by necktive method and New Castle disease vaccine (F1) by ocular method for day-old chick at the hatchery. Next vaccine was given for New Castle disease, B1 type, at 6th day by occular method. IBD Vaccine for Gumbaro D78 type was also given at 12th day by occular method. Second IBD Vaccine for Gumbaro was given at 22nd day by occular method, and Lasota vaccine for New caste disease was given at 28th day through drinking water with skimmed milk powder @ 6g/liter of water. The starter and finisher diets contained 22.05 % and 20.00 % CP, respectively. Both diets were formulated contained 2900 Kcal/kg, ME, and were adequately supplemented with required vitamins, minerals, and amino acids. The chicks were fed starter diets for 8 to 28 days and finisher diets from 29 to 42 days of age *ad libitum.* Basal diets of treatments 1, 3, 5 and 7 were supplemented with commercial probiotic Biovet-YC @1kg per ton of feed. This ration was prepared on weekly basis so, the birds always got the fresh feed. The DM, CP, CF, EE, and Ash contents of starter and finisher rations were analyzed by using proximate analysis of feeds (AOAC, 1997) at the Animal Nutrition Division, NARC, Khumaltar, Lalitpur. Weekly feed consumption of each pen was recorded by subtracting the weight of the left over feed from the weight of feed offered in each week. The initial and weekly body weights of the birds were taken using a spring balance. Body weight gain was obtained by subtracting previous weight of the birds from their corresponding body weight for each week. Data obtained from the experiment was analyzed by using analysis of variances (Gomez and Gomez, 1984), mean comparison using, DMRT and LSD at 5%; and Mstat-c version 1.3 Michigan University 1994.

RESULTS AND DISCUSSION

Chemical composition of broiler starter and finisher rations

The percent analyzed chemical compositions of starter, and finisher ration is presented in Table 1. The percentage DM (92.46%) was higher in finisher ration than starter ration. Likewise CP (21.93%), CF (5.80) %, EE (5.01%), and TA (5.95%) content were also higher in starter ration than finisher.

Table 1 Percent analyzed chemical compositions of broiler starter and finisher rations used

Ration	Dry Matter (DM, %)	Crude Protein (CP, %)	Crude Fiber (CF, %)	Ether extract (EE, %)	Total Ash (TA, %)
Starter Ration	91.81	21.93	5.8	5.01	5.95
Finisher Ration	92.46	20.35	6.1	4.24	5.77

The nutrient composition of rations was calculated on the basis of tabulated value that is why the analyzed value showed a slight variation in their composition.

4.2 Moisture Absorption

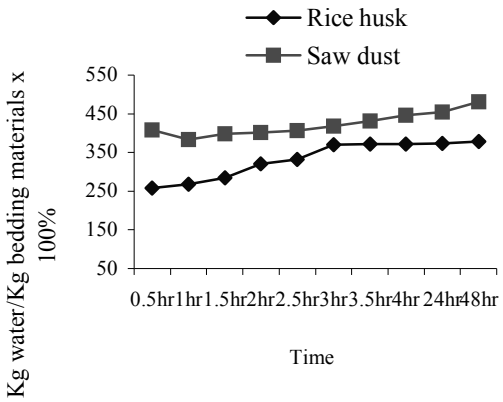

Figure 1 Moisture holding capacity of rice husk, and saw dust bedding materials

Moisture holding capacity of various bedding material is presented in figure 1. On the basis of weight of water absorbed per unit weight of bedding materials, saw dust absorbed more water than the rice husk. A number of factors determine the amount of water absorbed by a material. According to Pearson et al. (1999) the amount of water present in the original product will reduce the amount of additional water that can be absorbed. Therefore, the higher moisture holding capacity of rice straw coincided with lower moisture content. Smaller particle size absorbs more water, but too small particles may cause a dust problem for broilers (Pearson et al., 1999).

Feed Consumption

Mean weekly cumulative feed consumption under different treatment of ven-cobb broiler is presented in Table. 2. The analysis of variance did not show significant ($P>0.05$) difference among treatments on cumulative feed consumption from 2nd to 6th week in respect of stocking density. However, rice husk as bedding material resulted in significant ($P<0.05$) increase in feed consumption from 2nd to 6th week. Higher feed consumption 338.33g, 596.67g, 826.67g, 926.67g and 1026.00g during 2nd, 3rd, 4th, 5th and 6th week respectively of rearing periods were recorded from birds reared with rice husk as bedding materials. Likewise, probiotic supplementation in bedding materials from 2nd to 6th week of rearing periods caused a highly significantly ($P<0.01$) higher weekly cumulative feed

consumption 355.00g, 605.00g, 831.67g, 931.67g, and 1031.67g during 2nd, 3rd, 4th, 5th and 6th week respectively.

Table 2 Mean weekly cumulative feed consumption under different treatment of broiler

Treatments	Periods in weeks and feed consumption (g)				
	2	3	4	5	6
Stocking density (A)					
0.75 sq ft	325.00	583.33	812.50	912.50	1012.50
1.00 sq ft	336.00	583.33	810.00	910.00	1010.00
Probability	ns	ns	ns	ns	ns
SEm ±	4.79	8.58	8.68	8.68	8.68
Bedding materials (B)					
Rice Husk	338.33	596.67	826.67	926.67	1026.67
Saw dust	323.33	570.00	795.83	895.83	995.83
Probability	*	*	*	*	*
SEm ±	4.79	8.58	8.68	8.68	8.68
Probiotics (C)					
Probiotics	355.00	605.00	831.67	931.67	1031.67
Without probiotics	306.67	561.67	790.83	890.83	990.83
Probability	**	**	**	**	**
SEm ±	4.79	8.58	8.68	8.68	8.68
CV%	5.02	5.10	3.71	3.30	2.98
SEm ±	9.59	17.17	17.37	17.37	17.37

Note: SD= Stocking density, RH=Rice husk,W/P= Probiotics, W/0P= Without Probiotics, ** Significant at 1% (P<0.01), *Significant at 5% (P<0.05) and nsNot-significantly different (P>0.05).

Growth performance of broiler

Mean weekly cumulative live weight (g) under different treatment of ven-cobb broiler is presented in Table 3. Results of the study showed significantly higher body weight in every week in birds reared on stocking density of 1 sq. ft than that of birds reared on 0.75 sq. ft stocking density. So far as the bedding material was concerned, the body weight did not differ significantly in all weeks among treatments except the 3rd week in which birds kept on rice husk showed significantly (P<0.05) higher body weight. Supplementation of probiotics in diets significantly (P<0.05) increased the body weight in all weeks compared to that without probiotics. Interaction effect of stocking density, bedding material, and probiotics on weekly cumulative live weight was at par during experimental period (P>0.05).

This result is in agreement with the finding of (Feddes *et al.,* 2002) who found that when bird density was reduced live body weights were decreased. This result is also similar with the finding of (Gill and Sharma, 1992) who found that at week 4 birds raised at 1 sq. ft stocking density were significantly (P<0.05) heavier than bird raised at 0.75sq.ft/bird stocking density. However, no significant differences were observed at 6 week age in body weight.

Table 3 Mean weekly cumulative live weight (g) under different treatment of ven-cobb broiler

Treatments	Periods in week					
	Initial	2nd	3rd	4th	5th	6th
Stocking density (A)						
0.75 sq ft	127.33	300.83	612.50	1029.17	1432.08	1930.00
1.00 sq ft	124.10	310.83	628.33	1079.17	1522.92	2041.67
Probability	ns	**	**	**	**	**
SEm ±	0.00	2.20	2.89	8.90	9.10	8.61
Bedding materials (B)						
Rice Husk	126.35	306.67	625.00	1062.50	1483.33	1989.58
Saw dust	125.08	305.00	615.83	1045.83	1471.67	1982.08
Probability	ns	ns	*	ns	ns	ns
SEm ±	0.00	2.20	2.89	8.90	9.10	8.61
Probiotics (C)						
Probiotics	126.52	316.67	640.00	1098.33	1514.58	2033.33
Without probiotics	124.92	295.00	600.83	1010.00	1440.42	1938.33
Probability	ns	**	**	**	**	**
SEm ±	0.00	2.20	2.89	8.90	9.10	8.61
CV%	3.79	2.50	1.61	2.92	2.13	1.50
SEm ±	0.01	4.41	5.77	17.80	18.20	17.22

Note: SD= Stocking density, RH=Rice husk, W/P= Probiotics, W/0P= Without Probiotics ** Significant at 1% (P<0.01), *Significant at 5% (P<0.05) and nsNot-significantly different (P>0.05)

Dawkins *et al.* (2004) stated that target and actual stocking densities were due to the difficulty of estimating how fast birds would grow, because actual growth rate depends on stocking density. Higher densities led to an increase in incidence of poor gait, and a reduction in growth rate (Dawkins *et al.,* 2004). There were no significant differences in live weight among the treatments. The growth promoting effect of probiotics observed in this study is in accordance with many investigators (Kannan *et al.,* 2007). Bacillus subtillis in broiler chicken diets effectively improved body weight at market age and such increment was at the AGP levels (Carvalho, 2005).

Weight Gain

Mean weekly cumulative weight gain under different treatment of ven-cobb broiler is presented in Table 4. Results of the study showed significantly (P<0.05) higher body weight gain in birds reared in stocking density of 1 sq. ft in all weeks except 3rd than the birds reared in 0.75 sq. ft stocking density. But the bedding materials used did not significantly affect the body weight gain in birds in all weeks between treatments. Supplementation of diet with probiotic significantly (P<0.05) increased the body weight gain in all weeks except 5th in which birds had higher body weight gain than the probiotics supplemented group of birds.

Table 4 Mean weekly cumulative weight gain under different treatment of ven-cobb broiler

Treatments	Periods in weeks				
	2nd	3rd	4th	5th	6th
Stocking density (A)					
0.75 sq ft	173.50	311.67	416.67	402.92	497.92
1.00 sq ft	186.73	317.50	450.83	443.75	518.75
Probability	**	ns	**	**	*
SEm ±	2.20	2.35	7.26	6.62	6.25
Bedding materials (B)					
Rice Husk	180.32	318.33	437.50	420.83	506.25
Saw dust	179.92	310.83	430.00	425.83	510.42
Probability	ns	*	ns	ns	ns
SEm ±	2.20	2.35	7.26	6.62	6.25
Probiotics (C)					
Probiotics	190.15	323.33	458.33	416.25	518.75
Without probiotics	170.08	305.83	409.17	430.42	497.92
Probability	**	**	**	ns	*
SEm ±	2.20	2.35	7.26	6.62	6.25
CV%	5.50	2.60	5.80	5.42	4.26
SEm ±	5.62	4.71	14.53	13.25	12.50

Note: SD= Stocking density, RH=Rice husk, W/P= Probiotics, W/0P= Without Probiotics ** Significant at 1% (P<0.01), *Significant at 5% (P<0.05) and nsNot-significantly different (P>0.05)

Dozier et al (2006) stocking density increased 5 kg BW/m^2 beyond 25 kg BW/m^2, final BW and breast fillet weight were decreased by 41 and 12 g, respectively. We conclude that increasing stocking density beyond 30 kg BW/m^2 adversely affects growth responses and meat yield of broilers grown to 1.8 kg, but does not alter physiological stress indicators.

CONCLUSION

Results obtained from this study can be inferred that the broiler can be better raised by using 1 sq. ft area per bird compared to 0.75 sq. ft area per bird as revealed by the information as live weight, live weight gain, and feed consumption. Likewise, either rice husk, or saw dust can be used as an alternative bedding materials for better performance, where as probiotics can also be supplemented in diet to achieve satisfactory results of growth. However, to verify the results, extensive research covering multi-location, and large number of birds need to be conducted before coming into concrete conclusion.

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Defoliation Calendar of Fodder Trees in Mid Hills of Nepal

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ABSTRACT

In order to construct the seasonal calendar of defoliation of fodder trees in the mid hills of Nepal, literatures were reviewed and the secondary data from Agriculture Research Station (Goat), Bandipur were used. Moreover, a multidisciplinary team had conducted the PRA surveys in Bakrang of Gorkha and Baradi of Tanahun districts. The PRA tools used in the study were; key questions and interviews, transaction walk, ranking and seasonal calendar. The calendar was constructed on the basis of meeting of some criteria as possible, viz. higher biomass production, the seasons in which the fodders become more palatable, adverse effect of fodders on animal health and adverse effect of defoliation on tree health. Kavro, Dumri, Bakaino, Rai khanayo, Khasre Khanayo, Katus, Dhayero, Pakhuri, Chuletro, Ipil-ipil, Kimbu, Sal, Chiple, Pipal, Archal are the major tree fodders that defoliated in Baishakh, Jestha and Asar months. Similarly, Bakaino, Katus, Ipil-ipil, Kimbu, Sal, Archal, Karam, Dabdabe, Ginderi, Kharseto and Nimaro defoliated from Shravan to Ashoj. Likewise, from Kartik to Magh- Rai Khanayo, Khasre Khanayo, Katus, Chuletro, Ipil-ipil, Sal, Chiple, Pipal, Dabdabe, Ginderi, Nimaro, Badahar, Sajh, Barro, Bhimal, Tanki, Kutmiro, Gayo, Dudhilo, Panchpate, Koiralo, and Syalphusre had defoliated. The biomass from Rai Khanayo, Khasre Khanayo, Dhayero, Pakhuri, Chuletro, Ipil-ipil, Kimbu, Chiple, Bhimal, Kutmiro and Koiralo were harvested in Falgun and Chaitra. The constructed calendar of defoliation practices is useful to the farmers with ruminants; for higher amount of biomass supply with higher intake rate to their animals, preventing from health disorder due to tree fodders, maintaining tree health and also in planning the year round supply of tree fodders to their animals.

Key Words: Defoliation, Calendar, Biomass, Palatability, Tree health

INTRODUCTION

Ruminant production is the mainstay of agricultural production systems in the mid hills of Nepal; and these traditional and unique crop-livestock mixed farming systems contribute to produce different types of feedstuffs. The ruminants in the mid hills of Nepal are offered grasses, tree fodders, straws and sometimes grains

(FAO, 2000). Tree fodders are the main roughage constituents of the ruminant (especially goat) diets in the mid hills whether they are grazed or stall-fed (Poudel and Tiwari, 1992; Pariyar, 2008).

Tree fodders are often the only source of green materials of relatively high protein content used by the farmers to supplement low protein diet based on crop residues. The contribution of the tree fodders varies from 8 to 60 percent of the total fodder supply depending on the management of the ruminants. Well over 200 species of trees and shrubs are being used as fodder (Shrestha and Pradhan, 1995). Results of feeding trials of these tree fodders have been encouraging, but uptake by farmers in contrast to these results is daunting for a variety of reasons in farming conditions (Joshi and Thapa, 1992). Defoliation management is one of these important factors that influence the biomass yield of the fodder trees (Amatya and Lindley, 1992). Defoliation of tree fodders by only considering the biomass yield retained in the tree may deteriorate the yield from consecutive harvestings, fodder utilization, fodder tree health, and sometimes their losses.

The importance of trees and shrubs as a feed resource and their defoliation management have encouraged developing the package of appropriate defoliation seasons, which will be beneficial to the commercial ruminant production through year round fodder production. The better utilization of those species and development of feeding system will improve the contribution of these plants to the livelihoods of smallholder farmers (Pariyar, 2008). For that reason, basis for species selection, estimation of number of fodder trees to be cultivated (for year round fodder production) during the planning of ruminant enterprises is necessary. No standard packages of practices have been developed for the harvesting and utilization of fodder. The farmers are exploiting their fodders according to their own experiences; and the system of growing and utilization of tree fodders has been passed on from generation to generation. Therefore, a little conscious effort in participation with farmers in this regard has been done with the objective of constructing a defoliation calendar of fodder trees in mid hills. It will facilitate in planning for the species selection and quantifying the number of fodder trees for the commercial ruminant production at the time of fodder plantation for year round fodder production. It will also be helpful to manage health of animal, fodder tree health, and increase the voluntary intake of the fodder.

MATERIALS AND METHODS

The literatures available in libraries and electronic media were reviewed and the secondary data from Agricultural Research Station (Goat), Bandipur also were used for the construction of the calendar.

A Participatory Rural Appraisal (PRA) survey at Bakrang of Gorkha and Baradi of Tanahun was conducted by a multidisciplinary team consisting of two pasture fodder specialists, a livestock production and management expert, a school teacher and two leader farmers. The farmers of Bakrang of Gorkha were informed about the objective of the study. Firstly, the criteria, with the help of which they decide the season of the defoliation of their fodder trees were collected and discussed. Identified criteria were listed from high to low priority by using ranking tool. Among those criteria top four were considered for the construction of defoliation calendar.

Then after, the names of the fodder trees used in locations were listed out in discussion with the farmers. The team had made a transect walk for further information. Four different seasonal calendars were constructed on the basis of each top ranked criterion and prepared key questions. Then the groups of farmers were interviewed and discussed on the basis of the collected information and with the use of prepared key questions. The process was repeated in another site of the study, i.e. Baradi of Tanahun too. Collected data from both sites were compiled and analyzed. Similarities and dissimilarities between the information collected from two sites were identified during the analysis of data. The team had again visited both of the sites and discussed about dissimilar data; and the information was verified.

Then, four different seasonal calendars prepared by shading in cells of tables were merged for each species. The shaded cells having overlap of maximum numbers of criteria were taken for the construction of final defoliation calendar. The prepared calendar was verified with the secondary data collected on biomass yield and fodder quality. Finally, the defoliation calendar was prepared by including all the criteria to the possible extent, i.e. achieving higher biomass and more palatable fodders, less adverse effect on animal health, and less adverse effect of defoliation on tree health, year round fodder harvesting and fodder quality management throughout the year.

RESULTS AND DISCUSSION

Ranking of decision making criteria

Among the collected criteria for choosing the seasons of harvesting of tree fodders, top four criteria ranked by the farmers are given in Table 1.

RANK I- Biomass production: The farmers responded that they look to harvest higher biomass from each tree. After defoliation, the fodder tree starts coppicing and biomass increases gradually. The farmers usually give priority to defoliate the

fodder trees during the highest biomass retaining seasons before tissue turnover (especially leaf portions) become negative.

Table 1 Top four criteria developed by the farmers for choosing the season of the defoliation of the fodder trees

S/N	Rank	Criteria
1	I	Biomass Production
2	II	Palatability
3	III	Adverse effect on Animal Health
4	IV	Adverse effect on Fodder tree health

RANK II- Palatability: Palatability of the tree fodders generally varies in different seasons. The palatability directly influences the voluntary intake of the fodders. Therefore, the farmers ranked it for second.

RANK III- Adverse effect on animal health: Some tree fodders, although they are not actually the poisonous plants, may cause adverse effect on the animal health in some seasons. They may cause digestive disorders, mild toxicity, anorexia etc. in some particular seasons. The farmers had given third rank to this criterion.

RANK IV- Adverse effect on fodder tree health: Most of the fodder trees have its own appropriate seasons for defoliation and/or coppicing. Lopping the fodders in inappropriate seasons may cause deterioration in coppicing capacity, tree mortality etc. which directly reduces the fodder productivity from forthcoming harvestings. The farmers had ranked this criterion as fourth that affect the decision of defoliation.

Major fodder trees in use in Western mid hills

The major tree fodders used for ruminants (especially, small ruminants) listed by the both groups of farmers in Western mid-hills of Nepal are as follows:

1. Kavro (*Ficus lacor*)	17. Dabdabe (*Garuga pinnata*)
2. Dumri (*Ficus glomerata*)	18. Ginderi (*Premna integrifolia*)
3. Bakaino (*Melia azedarach*)	19. Kharseto (*Ficus hispida*)
4. Rai Kahanayo (*Ficus semicordata*)	20. Nimaro (*Ficus roxburghii*)
5. Khasre Khanayo (*Ficus semicordata*)	21. Badahar (*Artocarpus lakoocha*)
6. Musure Katus/ Dhalne katus (*Castanopsis* sps.)	22. Sajh (*Terminalia alata*)
	23. Barro (*Terminalia belerica*)
7. Dhayero (*Woodfordia fruticosa*)	24. Bhimal (*Grewia optiva*)
8. Pakhuri (*Ficus glaberrima*)	25. Tanki (*Bauhinia purpurea*)
9. Chuletro (*Brssiopsis hainla*)	26. Kutmiro (*Litsea monopotela*)
10. Ipil ipil (*Leucaena leucocephala*)	28. Dhudhilo (*Ficus nemoralis*)
11. Kimbu (*Morus alba*)	29. Panchpate/Kapase (*Sassuria* spp)
12. Sal (*Shorea rubusta*)	30. Koiralo (*Bauhinia veriegata*)
13. Chiple (*Machilus gamblei*)	27. Gayo (*Bridelia retusa*)
14. Pipal (*Ficus religiosa*)	31. Syal phusre (*Grewia tiliaefolia*)
15. Archal (*Securinega leucopyrus*)	

16. Karam (*Holoptela integrifolia*)	

Biomass yield, palatability, effect on animal health and tree health in different seasons

The information collected from the interview and discussion is presented in Table 2 and Table 3. Higher biomass is produced by the Kavro (*Ficus lacor*) from Baishakh to Asar, but the fodder becomes more palatable from Chaitra-Jestha. Feeding new sprouts of Kavro in Falgun-Chaitra may cause throatling/chocking to the animals and defoliation of the fodders from Asar-Falgun may cause adverse effect on tree coppicing.

Higher biomass retains in the tree of Dumri (*Ficus glomerata*) from Shravan to Ashoj, but fodder becomes more palatable from Chaitra to Jestha. Feeding new succulent sprout in Falgun/Chaitra may cause throatling or chocking and defoliation of fodder in Kartik/Mangsir reduces coppicing capacity.

Bakaino (*Melia azedarach*) produces higher biomass from Baishakh to Kartik while fodder becomes more palatable from Bhadra to Poush. Feeding Bakaino fodder in any seasons does not have adverse effect on the health of animals. But, defoliation from Asar to Bhadra reduces coppicing capacity.

Khasre Khanayo and Rai Kahanayo (*Ficus semicordata*) produce higher biomass from Shravan to Magh and the fodders become more palatable from Ashoj to Baishakh. Feeding these fodders in any season does not have adverse effect on animal health, but defoliation from Asar to Ashoj may cause tree mortality.

Higher biomass retains in the tree of Katus (Musure and Dhale both, *Castanopsis* sps.) from Ashoj to Magh. The fodder becomes more palatable in Baishakh/Jestha and from Bhadra to Poush. New sprouts reduces voluntary intake while feeding to the animals and defoliation from Asar to Mangsir reduces the coppicing capacity.

Higher biomass produced by Dhayero (*Woodfordia fruticosa*) from Shravan to Poush while the fodder becomes more palatable from Mangsir to Falgun. Dhayero does not have adverse effect on animal health while feeding to the animals in any season and does not have adverse effect on plant health while defoliated in any season.

Pakhuri (*Ficus glaberrima*) produces higher biomass from Asar to Mangsir while the fodder becomes more palatable from Magh to Baishakh. Feeding this fodder to the animals in any season does not have adverse effect, but defoliation from Asar to Poush may reduce coppicing capacity drastically. In another study the author found that *Ficus glaberrima* yielded most during November and exhibited

considerably lower leaf biomass yields during March in lower altitudes. However, absolute yield is not the only factor determining the timing of lopping: many farmers postpone lopping of tree that retain foliage in a palatable form to the period March to May, as this is the period when fodder supplies are restricted (Amatya and Lindley, 1992).

Chuletro (*Brssiopsis hainla*) produces higher biomass from Bhadra to Poush, although, the fodder becomes more palatable in Chaitra/Baishakh. Feeding this fodder in any season does not have adverse effect on animal health. Defoliation of this fodder in Asar to Ashoj reduces coppicing capacity.

Higher biomass retains in Ipil ipil (*Leucaena leucocephala*) tree from Baishakh to Asar, although, the fodder becomes more palatable from Ashoj to Jestha. But, this fodder does not have adverse effect while feeding to animals in any seasons. Similarly, it does not have adverse effect while defoliated in any season.

Higher biomass retains in the Kimbu (*Morus alba*) from Falgun to Jestha. The fodder becomes palatable throughout the year, but remains most palatable from Chaitra to Jestha. Feeding newly sprouted leaves may cause diarrhea to the animals and defoliation from Kartik to Poush may causes tree mortality or reduces coppicing capacity heavily.

Sal (*Shorea rubusta*) produces higher biomass from Bhadra to Poush, but fodder becomes more palatable from Baishakh to Ashoj due to its succulence. It does not have adverse effect on animal health while feeding in any seasons of the year. Frequent defoliation during sprouting may cause tree mortality.
Chiple (*Machilus gamblei*) produces higher biomass from Kartik to Magh, although the fodder becomes more palatable from Poush to Chaitra. This fodder does not have adverse effects while feeding of fodders to the animals in any seasons and defoliation of fodders in any seasons.

Pipal (*Ficus religiosa*) produces higher biomass from Jestha to Ashoj, although the fodder becomes more palatable to the animals from Chaitra to Jestha due to its succulence. Feeding to the animals and defoliation of the fodders in any seasons do not have adverse effect on animal health and tree health.

Archal (*Securinega leucopyrus*) trees have higher biomass from Asar to Kartik and the palatability becomes better in the same period. Feeding of newly sprouted leaves of Archal may cause diarrhea to the animals. Defoliation of the fodder from Mangsir to Chaitra may deteriorate the coppicing capacity drastically.
Karam (*Holoptela integrifolia*) produces higher biomass from Asar-Ashoj, but in contradiction, the fodder becomes palatable from Ashoj to Mangsir. It does not

have any adverse effect on animal health while feeding in all seasons. Defoliation of new sprout may cause deterioration of coppicing capacity of the Karam tree.

Dabdabe (*Garuga pinnata*) produces higher biomass from Ashoj to Falgun and the fodder becomes more palatable in the same season. Feeding sprouts in Baishakh/Jastha may cause digestive disorder (diarrohoea). Defoliation of the fodder from Falgun-Baishakh and from Asar to Ashoj may cause plant mortality.

Likewise, Ginderi (*Premna integrifolia*) produces higher biomass from Bhadra to Poush and the fodder becomes more palatable from Ashoj to Mangsir. This fodder does not show adverse effect on animals while feeding on any seasons. But, defoliation from Jestha to Shravan may cause death of the tree.

Higher biomass retains in the Kharseto (*Ficus hispida*) tree from Shravan to Kartik and fodder becomes more palatable from Ashoj to Poush. This fodder also does not have adverse effect on animal health while feeding in any seasons, but defoliation from Baishakh to Bhadra may cause tree mortality.

Nimaro (*Ficus roxburghii*) produces higher biomass from Shravan to Magh and fodder becomes more palatable from Kartik to Magh. Feeding this fodder in Baishakh/Jestha has adverse effect on animal health and defoliation from Baishakh to Bhadra may heavily reduce the coppicing capacity.

Table 2 Months in which higher biomass retains in the fodder trees and the fodder becomes more palatable to the small ruminants

S/N	Fodder Tree	Months in which	
		Higher biomass in the fodder trees	The fodder becomes more palatable
1	Kavro	Baishakh-Asar	Chaitra-Jestha
2	Dumri	Shravan-Ashoj	Chaitra-Jestha
3	Bakaino	Baishakh-Kartik	Bhadra-Poush
4	Rai khanayo	Shravan-Magh	Ashoj-Baishakh
5	Khasre khanayo	Shravan-Magh	Ashoj-Baishakh
6	Musure/ Dhalne katus	Ashoj-Magh	Baishakh-Jestha and Bhadra-Poush
7	Dhayero	Shravan-Poush	Mangsir-Falgun
8	Pakhuri	Asar-Mangsir	Magh-Baishakh
9	Chuletro	Bhadra-Poush	Chaitra-Baishakh
10	Ipil-ipil	Baishakh-Asar	Ashoj-Jestha
11	Kimbu	Falgun-Jestha	Chaitra-Jestha
12	Sal	Bhadra-Poush	Baishakh-Ashoj
13	Chiple	Kartik-Magh	Poush-Chaitra
14	Pipal	Jestha-Ashoj	Chaitra-Jestha
15	Archal	Asar-Kartik	Asar-Kartik
16	Karam	Asar-Ashoj	Ashoj-Mangsir
17	Dabdabe	Ashoj-Falgun	Ashoj-Falgun
18	Ginderi	Bhadra-Poush	Ashoj-Mangsir

19	Kharseto	Shravan-Kartik	Ashoj-Poush
20	Nimaro	Shravan-Magh	Kartik-Magh
21	Badahar	Ashoj-Magh	Kartik-Falgun
22	Sajh	Shravan-Magh	Ashoj-Poush
23	Barro	Ashoj-Magh	Ashoj-Poush
24	Bhimal	Bhadra-Falgun	Shravan-Magh
25	Tanki	Bhadra-Falgun	Ashoj-Chaitra
26	Kutmiro	Mangsir-Chaitra	Mangsir-Falgun
27	Gayo	Ashoj-Poush	Magh-Falgun
28	Dudhilo	Shravan-Poush	Mangsir-Falgun
29	Panchpate	Bhadra-Magh	Mangsir-Falgun
30	Koiralo	Ashoj-Magh	Baishakh-Magh
31	Syalphusre	Bhadra-Kartik	Magh-Falgun

Badahar (*Artocarpus lakoocha*) produces higher biomass from Ashoj to Magh but the fodder becomes more palatable from Kartik to Falgun. It does not have any adverse effect on feeding in any months of the years but defoliation of fodder from Jestha to Ashoj may cause tree mortality.

Sajh (*Terminalia alata*) produces higher biomass from Shravan to Magh and fodder becomes more palatable from Ashoj to Poush. The fodder of Sajh from Jestha to Ashoj becomes extremely bitter and reduces voluntary intake while feeding to the animals. Defoliation from Baishakh to Shravan may reduce the coppicing capacity heavily.

Barro (*Terminalia belerica*) is another tree fodder used in the Western mid hills of Nepal. It produces higher biomass from Ashoj to Magh and fodder becomes more palatable in the similar season. Feeding Barro fodder from Chaitra to Ashoj may cause poisoning to the animals. The leaves of Barro contain some fractions of natural products, viz. terpeniods, saponin, alkaloids, coumarin, flavone, steroids, tannin and glycosides (Meena et. al. 2010). The fractions may be higher from Chaitra to Ashoj in this fodder and may cause poisoning. Defoliation of leaves of this fodder Chaitra to Kartik reduces the regrowth capacity of the fodder tree.

Higher biomass retains in the tree of Bhimal (*Grewia optiva*) from Bhadra to Falgun and the fodder becomes palatable from Shravan to Magh. Feeding of new sprouts to the animals sometimes results digestive complexities and frequent defoliation of new sprouts may cause tree mortality.

Similarly, Tanki (*Bauhinia purpurea*) produces higher biomass from Bhadra to Falgun and the fodder becomes more palatable from Ashoj to Chaitra. Feeding of higher volume of Tanki fodder in sprouting and flowering season (Ashoj-Kartik) may have digestive disorder in animals. On the other hand defoliation of this tree fodder from Asar-Kartik may cause plant mortality.

From Mangsir to Chaitra, higher biomass is produced by Kutmiro (*Litsea monopotela*) and the fodder becomes more palatable from Mangsir to Falgun. It has not adverse effect on animal health while feeding in any season of the year and defoliation of the fodder from Jestha to Kartik deteriorates the coppicing capacity.

In the case of Gayo (*Bridelia retusa*), higher biomass produced from Ashoj to Poush, but fodder becomes more palatable from Magh/Falgun. This fodder does not have adverse effect on animal health and tree health while feeding to animals in any season and defoliated in any season.

Higher biomass produced by Dhudhilo (*Ficus nemoralis*) from Shravan to Poush while the fodder becomes more palatable from Mangsir to Falgun. But, feeding Dudhilo in Baishakh/Jestha have adverse effect in animal health and defoliated from Baishakh to Bhadra may reduce coppicing capacity in the greater extents.

Panchpate/Kapase (*Sassuria* spp) fodder produces higher biomass from Bhadra to Magh and the fodder becomes more palatable from Mangsir to Falgun. Feeding this fodder to animals from Baishakh to Asar may cause bloat or tympani, and sometimes poisoning. Defoliation of fodder in the same time may cause tree mortality.

Likely, Koiralo (*Bauhinia veriegata*) produces higher biomass in the similar seasons from Ashoj to Magh, but becomes palatable only from Baishakh to Magh. Feeding Koiralo fodder in flowering stage (Baishakh/Jestha) reduces voluntary intake and may cause bloat to the animals too. In addition, defoliation of fodders from Baishakh to Mangsir deteriorates the coppicing capacity of the trees heavily.

Syal phusre (*Grewia tiliaefolia*) produces higher biomass from Bhadra to Kartik, although, the fodder becomes more palatable in Magh/Falgun. Feeding this fodder in Baishakh/Jestha may cause digestive disorder and defoliation from Baishakh to Mangsir may cause tree mortality.

In another study, Amatya (1990) had found similar results which support the result of the current study. The author stated the current practices of lopping seasons of different fodder trees in wide range in different regions, viz. low hills, mid hills and high hills. In low hills; Pakhuri (Mangsir to Chaitra), Pipal (Mangsir to Baishakh), Dabdabe (Ashoj to Baishakh), Bakaino (Baishakh to Asar), Barro (Falgun to Chaitra), Badahar (Ashoj to Falgun), Kavro (Magh to Jestha), Tanki (Kartik to Falgun), Koiralo (Kartik to Falgun) and Sal (Falgun to Jestha) were included. Similarly, the lopping cycle of Nimaro (Kartik to Poush), Rai Khanayo (Mangsir to Magh), Dhalne Katus (Chaitra to Jestha), Dhudhilo (Ashoj to Baishakh), Kutmiro (Mangsir to Falgun), Ginderi (Kartik to Magh), Khasre

Khanayo (Poush to Falgun) Gayo (Mangsir to Magh), Chuletro (Baishakh to Jestha) and Bhimal (Ashoj to Falgun) were stated for mid hills.

Table 3 The seasons which have adverse effects of feeding fodders on animal health and have adverse effect of defoliation on tree health

S /N	Fodder Tree	Adverse effect on animal health	Adverse effect on tree health
1	Kavro	Falgun- Chaitra	Asar-Falgun
2	Dumri	Falgun-Chaitra	Kartik-Mansir
3	Bakaino	No season for adverse effect	Asar-Bhadra
4	Rai khanayo	No season for adverse effect	Asar-Ashoj
5	Khasre khanayo	No season for adverse effect	Asar-Ashoj
6	Musure/ Dhalne katus	No season for adverse effect	Asar-Mangsir
7	Dhayero	No season for adverse effect	No season for adverse effect
8	Pakhuri	No season for adverse effect	Asar-Poush
9	Chuletro	No season for adverse effect	Asadh-Ashoj
10	Ipil-ipil	No season for adverse effect	No season for adverse effect
11	Kimbu	Magh-Falgun	Kartik-Poush
12	Sal	No season for adverse effect	Frequent defoliation
13	Chiple	No season for adverse effect	No season for adverse effect
14	Pipal	No season for adverse effect	No season for adverse effect
15	Archal	Sprouting season	Mansir-Chaitra
16	Karam	No season for adverse effect	Baishakh-Asar
17	Dabdabe	Baishakh-Jestha	Falgun-Baishakh and Asar-Ashoj
18	Ginderi	No season for adverse effect	Jestha-Shravan
19	Kharseto	No season for adverse effect	Baishakh –Bhadra
20	Nimaro	Baishakh-Jestha	Baishakh-Bhadra
21	Badahar	No season for adverse effect	Jestha-Ashoj
22	Sajh	Jestha-Ashoj	Baishakh-Shravan
23	Barro	Chaitra-Ashoj	Chaitra-Kartik
24	Bhimal	Chaitra-Jestha	Chaitra-Jestha
25	Tanki	Ashoj-Kartik	Asar-Kartik
26	Kutmiro	No season for adverse effect	Jestha-Kartik
27	Gayo	No season for adverse effect	No season for adverse effect
28	Dudhilo	Baishakh-Jestha	Baishakh-Bhadra
29	Panchpate	Baishakh-Asar	Baishakh-Asar
30	Koiralo	Baishakh-Jestha	Baishakh – Mangsir
31	Syalphusre	Baishakh-Jestha	Baishakh-Mangsir

Lopping cycle of Musure Katus (Mangsir to Falgun) and Kimbu (Poush to Ashoj) were described for high hills.

Foliage (biomass) productivity and fodder quality

Nutrient content varies with a single species and even within a single tree, depending upon eco zone, age, location of the leaves on the tree and maturity of the foliage (Shrestha and Tiwari, 1991).

Table 4 Productivity and nutrient contents of the tree fodders in the mid hills

SN	Fodder Tree	Yield (kg tree^{-1} year^{-1})	DM %	CP%	CF %	Lignin %	Adopted from
1	Kavro	150	32	12.1	NA	NA	Tiwari *et.al* (2005)
2	Dumri	70	30.5	10.9	13.8	15.8	Subba (1998), Tiwari *et.al* (2005)
3	Bakaino	45	36.0	25.3	14.0	5.8	Subba (1998), Tiwari *et.al* (2005)
4	Rai khanayo	55	35.0	12.4	16.4	NA	Subba (1998), Tiwari *et.al* (2005)
5	Khasre khanayo	75	38.2	10.6	18.5	17.5	Subba (1998), Tiwari *et.al* (2005)
6	Musure/ Dhalne katus	NA	43.9-49.9	8.4-14.2	NA	NA	Tiwari *et.al* (2005)
7	Dhayero	15	33.2	9.6	13.0	3.2	Subba (1998), Tiwari *et.al* (2005)
8	Pakhuri	120	32.0	24.3	25.9	4.3	Subba (1998), Tiwari *et.al* (2005)
9	Chuletro	35	23.0	15.8	19.0	18.3	Subba (1998), Tiwari *et.al* (2005)
10	Ipil-ipil	25	32.7	22.3	NA	NA	Tiwari *et.al* (2005)
11	Kimbu	25	25.9	20.2	17.8	4.2	Subba (1998), Tiwari *et.al* (2005)
12	Sal	95	26.2	10.3	18.9	12.8	Subba (1998), Tiwari *et.al* (2005)
13	Chiple	NA	28.9	18.7	NA	NA	Tiwari *et.al* (2005)
14	Pipal	80	33.9	13.9	NA	NA	Tiwari *et.al* (2005)
15	Archal	NA	13.5	18.6	13.4	6.7	Subba (1998), Tiwari *et.al* (2005)
16	Karam	NA	30.5	10.3	13.3	8.6	Subba (1998), Tiwari *et.al* (2005)
17	Dabdabe	65	33.9	13.7	15.4	8.7	Subba (1998), Tiwari *et.al* (2005)
18	Ginderi	70	22.2	18.1	25.5	8.9	Subba (1998), Tiwari *et.al* (2005)
19	Kharseto	20	21.2	16.6	17.9	NA	Subba (1998), Tiwari *et.al* (2005)
20	Nimaro	70	26.5	13.8	15.4	14.2	Subba (1998), Tiwari *et.al* (2005)
21	Badahar	95	31.2	15.8	19.8	8.9	Subba (1998), Tiwari *et.al* (2005)
22	Sajh	100	25.5	9.6	11.4	10.6	Subba (1998), Tiwari *et.al* (2005)
23	Barro	55	23.5	14.2	19.4	6.2	Subba (1998), Tiwari *et.al* (2005)
24	Bhimal	35-130	40.2	18.8	NA	NA	Tiwari *et.al* (2005), Pande (2007)
25	Tanki	45	35.9	19.8	31.6	NA	Subba (1998), Tiwari *et.al* (2005)
26	Kutmiro		30.2	16.8	21.7	23.1	Subba (1998), Tiwari *et.al* (2005)
27	Gayo	55	33.7	13.8	24.3	11.4	Subba (1998), Tiwari *et.al* (2005)
28	Dudhilo	65	28.5	13.6	14.3	18.2	Subba (1998), Tiwari *et.al* (2005)
29	Panchpate	80	27.0	11.6	26.5	20.1	Subba (1998), Tiwari *et.al* (2005)
30	Koiralo	45	36.2	14.7	31.6	NA	Subba (1998), Tiwari *et.al* (2005)
31	Syalphusre	80	43.5	15.6	24.5	21.2	Subba (1998), Tiwari *et.al* (2005)

CONCLUSION

The following calendar was prepared for the defoliation management of the tree fodders in mid hills of Nepal.

SN	Baishakh (April/May)	Jestha (/May/June)	Asar (June/July)	Shravan (July/August)	Bhadra (Aug/Sept)	Ash0j (Sept/Oct)	Kartik (Oct/Nov)	Mangsir (Nov/Dec)	Poush (Dec/Jan)	Magh (Jan/Feb)	Falgun (Feb/March)	Chaitra (March/Apr)
1	***Kavro (1)***											
2	***Dumri (1)***											
3	***Bakaino (1)***				***Bakaino (2)***							

4	*Rai Khanayo (1) or*					*Rai Khanayo (1)*						
5	*Khasre Khanayo (1)*					*Khasre Khanayo (1)*						
6	*Katus (1)*				*Katus (2)*							
7	*Dhayero (1)*								*Dhayenro (1)*			
8	*Pakhuri (1)*											*Pakhuri (1)*
9	*Chuletero (1)*						*Chuletro (2)*					*Chuletro (1)*
10	*Ipil-ipil (1)*			*Ipil-ipil (2)*			*Ipil-ipil (3)*					
11	*Kimbu (1)*			*Kimbu (2)*								*Kimbu (1)*
12	*Sal (1 or 2)*											
13		*Chiple (1)*						*Chiple (2)*				
14		*Pipal (1)*					*Pipal (2)*					
15		*Archal (1)*										
16			*Karam (1)*									
17				*Dabdabe (1)*								
18				*Ginderi (1)*								
19				*Kharseto (1)*								
20				*Nimaro (1)*								
21					*Badahar (1)*							
22					*Sajh (1)*							
23					*Barro (1)*							
24					*Bhimal (1)*							
25						*Tanki (1)*						
26						*Kutmiro (1)*						
27						*Gayo (1)*						
28						*Dudhilo (1)*						
29						*Panchpate (1)*						
30								*Koiralo (1)*				
31								*Syalfusre (1)*				

Numbers in parenthesis indicates the numbers of harvests per year

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RESEARCH NOTE

Insect Pest Status of Tomato and their Generic Pest Risk Analysis

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ABSTRACT

Attempts were made to carryout Pest Risk Analysis (PRA) of tomato commodity (with special focus to insect pests/mites) by employing its standard guidelines of identifying potential quarantine pest (PQP), extent of risk and mitigation measures under National Plant Quarantine Program (NPQP), Plant Protection Directorate (PPD), Hariharbhawan, Lalitpur in 2010. The study reported that a total of 211 Global insect pests were associated to tomato, among them, 52 insect pests were found in Nepal, all of which, 159 insects/mites were found of PQP. Based upon PRA of PQPs as well as pest status considerations with respect to insect pest occurrence, pathway association and pest establishment/economic consequences, a total of 33 insects/mites were found. Plant Quarantine Regulated Insect Pests (PQRP) in circumstances tomato commodity needs to import to Nepal from other parts of the world. The study also indicated that no additional declaration will be required for 126 pests to import tomato commodity to Nepal. Nepal being a member of WTO, the country needs to declare the prevailing pests status of crops which has been a major international concern.

Keywords: Pests, Risk, Quarantine, Analysis, Trade

INTRODUCTION

Tomato (*Solanum lycopersicon* L.) is one of the most commercially grown vegetable crops in plains (Terai) and hill of Nepal with an area coverage of 16416 ha, total production of 282481 metric tons and productivity of 17 ton/ha (Anonymous, 2011/12). The climatic diversity of the country permits year round production of tomato. In the hill, tomato can be successfully cultivated during spring and rainy season, and in the Terai, it is grown during winter season. The tomato fruit has great potential for sale in the regional, national and international markets. However, tomato production and productivity is becoming risky due to

attack of several insect pests, and also likely to enter, establish and spread of potential quarantine pest (insect pests) during trading practices. Nepal being a member of WTO, the country needs to declare the prevailing pests status of crops which has been a major international concern. This may be serious concern regarding trade promotion scenario among the member countries of WTO (Mahto, 2004).

In recent years, the trade of plants and plant products between countries has increased massively. The trading environment has been globalized. World Trade Organization (WTO) has sought to harmonize trading practices and regulations through a series of measures/agreements on Sanitary and Phytosanitary (SPS) measures. International Plant Protection Convention (IPPC) is one such framework, which develops a range of standards to harmonize the SPS measures imposed by trading partners. The countries, signatories to the IPPC are required to establish a National Plant Protection Organization (NPPO) to manage and regulate quarantine matters of concern for trade for their own country. The trading of plants and plant products around the world carries with it a risk of introduction of plant pests into new areas traded between the countries. The movement of people and commodities across borders brings along with them a certain probability (risk) of the introduction of pests that are harmful to agriculture. The process of estimating the possibility of negative consequences is termed as Pest Risk Analysis (PRA). PRA is the tool designed to scientifically analyze the risk and justify any quarantine SPS measures implemented by a country to another against any identified pest risks. IPPC has developed the International Standard for Phytosanitary Measures (ISPMs) on how to do PRA. According to IPPC, PRA is the process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any SPS measures to be taken against it (FAO, 1995; revised IPPC, 1997; ISPM No. 2, 2007). PRA is the only mechanism by which the importing country can justify any SPS measures taken against the exporting trading partner. With this all, generic PRA of tomato commodity carried out in 2010 with its standard guidelines; pest risk initiation to identify potential quarantine pest (PQP), pest risk assessment to identify extent of risk and pest risk management to identify mitigation measures. PRA specifically targeted to prepare a complete and extensive list of PQP (insect pests), analyze their risk of entry, spread, environmental damage, and risk management globally for import of tomato from outside into Nepal excluding insect pests present in Nepal.

MATERIALS AND METHOD

The PRA of tomato commodity was carried out under National Plant Quarantine Program, Plant Protection Directorate, Hariharbawan, Lalitpur in 2010. Three steps of PRA were employed.

The first step was pest risk initiation to identify potential quarantine pest (PQP). Insect pests or pests of tomato that are of quarantine concern were identified. These were PQP (insect pests) of tomato. List of PQP was developed avoiding all Nepal insect pests of tomato from the list of Global insect pests of tomato. The Global insect pests list of tomato was developed through the survey of Crop Pest Compendium (CPC) (2006). Nepal insect pests list of tomato was developed through literature and insect museum surveillance, survey of CPC (2006) and those reported in other relevant literatures for Nepal (hosts other than tomato and/or without any host). The PRA was done only for PQP.

The second step of PRA was pest risk assessment to identify extent of risk. In this process quarantine insect pests of tomato were categorized for quarantine insect pests. The probability of entry, establishment and spread of PQP was identified, the economic impact was assessed. The third step of PRA was pest risk management to identify mitigation measures. In this process cost effectiveness and feasibility of management, impact on trade, were analyzed.

The rating system for the pest risk assessment and pest risk management was High, Medium, Low and Negligible, respectively, with score of 4, 3, 2 and 1. In case no valid economic information available against insect pests; those are not processed for PRA and rated as Unknown. The guidelines for rating entry potential include rating Low i.e. the probability of entry is low given the combination of factors including the distribution of the insect pest source, management practices applied, low commodity volume, low probability of insect pest survival in transit, or low probability of contact with susceptible hosts given the intended use. The probability of entry is low but clearly possible given the expected combination of factors. Rating Medium i.e. pest entry into an area is likely given the combination of factors described above. Rating high i.e. pest entry is very likely or certain given the combination of factors described above. Rating negligible i.e. pest entry into an area has no chance given the combination of factors described above. Likewise, same rating scale was used, i.e. Negligible, Low, Medium, and High for establishment, spread, economic and environmental damage. The detail parameters and rating system are presented below.

Table 1 Parameters used for Pest Risk Assessment

Likelihood of entry	Rating	Summary notes
What level of risk do you consider the number of intended consignments to represent?		
What is the likelihood of the pest being associated with the pathway at origin?		
What is the likelihood of the pest surviving during transport?		

What is the likelihood of the pest surviving or evading existing pest management practices?		
Consider any previous interceptions. What level of risk do they represent?		
Consider any pathway destinations. What level of risk do they represent?		
What level of risk does the intended use of the commodity represent?		
SUMMARY		

Likelihood of establishment	Rating	Summary notes
What is the likelihood of suitable hosts being available?		
If transmitted by vectors, what is the likelihood of suitable hosts being available?		
How suitable is the environment?		
What is the likelihood that existing control measures for other pests are unable to provide adequate control?		
What level of risk does the biology of the pest represent?		
SUMMARY		

Likelihood of spread	Rating	Summary notes
How suitable is the natural and/or managed environment for the pest?		
if vectored, how likely are vectors to spread the pest in the PRA area?		
How likely is the pest to be transported with commodities or conveyances in the PRA area?		
What is the likelihood of the pest spreading to an area of higher economic importance than the area of introduction?		
What level of risk does the intended use of the commodity represent?		
What is the likelihood of natural enemies being unable to control spread of the pest?		
SUMMARY		

Likelihood of economic or environmental damage	Rating	Summary notes
What level of economic loss is associated with this pest in its existing geographical range?		
What is the level of potential economic loss to agriculture in the PRA area?		
What is the level of potential economic loss associated with non-agricultural factors?		
SUMMARY		

Table 2 Parameters for Pest Risk Management

Options for Consignments	Rating	Summary note

Inspection or testing		
Prohibition of the host		
Pre or post entry quarantine		
Conditions for preparing and packing		
Restriction on end use, distribution and periods of entry		
In-transit treatment		
Other specify		

Options to prevent or reduce infestation in the crop	Rating	Summary note
Treatment of crop, field or place of production		
Specially protected growing conditions		
Specified harvesting time		
Certification scheme		
Other specify		

Options to ensure that the production area is free from pest	Rating	Summary note
Sourcing from designated pest free areas		
Prohibition of commodities		
Phytosanitory certificate requirement		
Other specify in note		

RESULTS AND DISCUSSION

Survey of Crop Pest Compendium (CPC) (2006) reported 211 global insect pests (insect/mite) including Nepal insect pests. Survey of literature and insect museum, CPC (2006) and those reported in other relevant literatures for Nepal (hosts other than tomato and/or without any host) indicated 52 insect pests in Nepal. Among 52 insect pests, 20 were from the order Lepidoptera, 17 fromHemiptera (5 Heteroptera and 12 Homoptera), 6 from Diptera, 3 from Coleoptera, 4 from Thysanoptera and 2 from Orthoptera. The order Lepidoptera included cut worms, boll worms, fruit borers, loopers and moths (tuber moths, hawk moth, turnip moth, piercing moth and others). The Heteroptera included bugs, and the Homoptera included jassids, aphids, white fly, mealy bugs and scale insects. The order Diptera included fruit flies and loopers. The order Coleoptera included Epilachna beetles and store beetles. Thysanoptera order included thrips and the order Orthoptera included crickets. The details of Nepal insect pests are presented in Table 3.

Altogether, 159 Potential Quarantine Pest (PQP) were found. Among 159 PQP, 45 pests were from the insect order Hemiptera, 37 Lepidoptera, 26 Coleoptera, 20 Diptera, 10 Acarina, 9 Orthoptera, 8 Thysanoptera, 1 Hymenoptera and 3 others unidentified. Where, the order Hemiptera included 14 Family namely Coreidae (3), Pentatomidae (10), Aleyrodidae (6), Cicadellidae (11), Diaspididae (1), Tingidae (2), Pseudococcidae (5), Cixiidae (1), Cercopidae (1), Margarodidae (1), Rhopalidae (1), Aphididae (1), Membracidae (1) and Ortheziidae (1). The order Lepidoptera included 7 Family namely Sphingidae (3), Noctuidae (23),

Tortricidae (2), Crambidae (3), Arctidae (1), Gelechidae (3) and Pyralidae (2). The order Coleoptera included 10 Family namely Elateridae (4), Scarabaedae (3), Curculionidae (3), Lampyridae (1), Mycetophagidae (1), Chrysomellidae (9), Coccinellidae (2), Tenebrionidae (1), Nitidulidae (1) and Meloidae (1). The order Diptera included 4 Family namely Tephritidae (13), Cecidomyiidae (2), Anthomyiidae (1) and Agromyzidae (4). The order Orthoptera included Family Acrididae (4) and Gryllotalpidae (5). The order Thysanoptera included the Family Thripidae (8). The order Acarina included 4 Family; Eryophyidae (1), Penthaleidae (1), Tetranychidae (6) and Tarsonemidae (2). The order Hymenoptera included Formicidae (1) Family. There were 3 unknown species of insect pest.

PRA of the PQP of tomato indicated that 33 insect pests should be taken as Plant Quarantine Regulated Pests (PQRP) in circumstances tomato commodity needs to be imported to Nepal from other parts of the world. Besides, 126 insect pests required no additional declaration to import the commodity to Nepal. Among 33 PQRP, 11 pests belong to insect order Hemiptera with 5 families comprising of 1 Aphididae, 1 Margarodidae, 3 Aleyrodidae, 5 Pseudococcidae and 1 Diaspididae. They included aphid, mealy bug, whitefly and scale insects. Similarly, 13 pests belong to order Diptera with 2 families comprised of 11 Tephritidae and 2 Agromyzidae. They included fruit fly and leaf miner. As mentioned above, 2 pests belonged to order Lepidoptera with 2 families comprising of 1 Noctuidae and 1 Torticidae. They included looper and leaf roller. As preceding, 4 pests belonged to order Thysanoptera with 1 family Thripidae. They included thrips. And, 3 pests belonged to order Acarina with 3 families comprising of 1Eriophyidae, 1 Tarsonemidae and 1 Tetranychidae. They included mite.

Table 3 Nepal list of insect pest of tomato

SN	List of Nepal insect pests
1	Acherontia styx (small death's head hawkmoth) (CPC, 2006)
2	* Agrotis segetum (turnip moth), (CPC, 2006)
3	* Amrasca biguttula biguttula (Indian cotton jassid), (CPC, 2006)
4	* Aphis craccivora (groundnut aphid), (CPC, 2006)
5	* Aphis fabae (black bean aphid), (CPC, 2006)
6	* Aphis gossypii (cotton aphid), (CPC, 2006)
7	* Aspidiotus destructor (coconut scale), (CPC, 2006)
8	* Atherigona orientalis (pepper fruit fly), (CPC, 2006)
9	* Bactrocera cucurbitae (melon fly), (CPC, 2006)
10	* Bactrocera dorsalis species complex (Oriental fruit fly species complex), (CPC, 2006)
11	* Bemisia tabaci (tobacco whitefly), (CPC, 2006)
12	* Chromatomyia horticola (pea leaf miner), (CPC, 2006)
13	Chrysodeixis acuta (tomato semi-looper), (CPC, 2006)
14	* Epilachna vigintioctopunctata (hadda beetle), (CPC, 2006)
15	* Eudocima fullonia (fruit-piercing moth), (CPC, 2006)

16	* Hadula trifolii (clover cutworm), (CPC, 2006)
17	* Helicoverpa armigera (cotton bollworm), (CPC, 2006)
18	* Leucinodes orbonalis (eggplant fruit borer), (CPC, 2006)
19	* Liriomyza bryoniae (miner, tomato leaf), (CPC, 2006)
20	* Maconellicoccus hirsutus (pink hibiscus mealybug), (CPC, 2006)
21	* Myzus persicae (green peach aphid), (CPC, 2006)
22	* Nesidiocoris tenuis (tomato bug), (CPC, 2006)
23	* Nezara viridula (green stink bug), (CPC, 2006)
24	* Phthorimaea operculella (potato tuber moth), (CPC, 2006)
25	* Rhopalosiphum rufiabdominale (rice root aphid), (CPC, 2006)
26	* Spodoptera litura (taro caterpillar), (CPC, 2006)
27	* Agrotis ipsilon (Joshi & Manandhar, 2001)
28	* Achaea janata (Joshi & Manandhar, 2001)
29	* Aulacorthum solani (Joshi & Manandhar, 2001
30	* Brachycaudus helichrysi (Joshi & Manandhar, 2001)
31	* Peridroma saucia (Yoshimoto, 1992)
32	* Spodoptera exigua (Yoshimoto, 1992)
33	* Thrips palmi (Joshi & Manandhar, 2001)
34	* Trichoplusia ni (Yoshimoto, 1993)
35	* Xestia c-nigrum (Yoshimoto, 1992)
36	Scapteriscus (mole crickets) (Joshi & Manandhar, 2001)
37	* Acanthocoris scabrator (Joshi & Manandhar, 2001)
38	Anomis flava (Joshi & Manandhar, 2001)
39	Cavariella aegopodii (Joshi & Manandhar, 2001)
40	* Chrysodeixis chalcites (Joshi & Manandhar, 2001)
41	* Earias vittella (Joshi & Manandhar, 2001)
42	* Frankliniella intonsa (Joshi & Manandhar, 2001)
43	* Gryllotalpa gryllotalpa (Joshi & Manandhar, 2001)
44	* Icerya seychellarum (Joshi & Manandhar, 2001)
45	Microcephalothrips abdominalis (Joshi & Manandhar, 2001)
46	Phyllophaga (Joshi & Manandhar, 2001)
47	* Piezodorus hybneri (Joshi & Manandhar, 2001)
48	* Stegobium paniceum (Joshi & Manandhar, 2001)
49	* Thysanoplusia orichalcea (Joshi & Manandhar, 2001)
50	* Anastrepha suspensa (caribbean fruit fly) (Thapa, 1997)
51	* Chrysodeixis eriosoma (Thapa, 1997)
52	* Scirtothrips dorsalis (Thapa, 1997)

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Soil Fertility Evaluation under Community Forest and Upland Soil at Bhimeshwor Municipality, Dolakha

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ABSTRACT

A field investigation was conducted in 2008 from August to November to compare the status of soil fertility under community forest and upland soil in midhills area of Dolakha district. Field-level simple random sample survey was conducted in Bhimeshwor Municipality-6, Kiratichha of Dolakha district with 30 households. Soil fertility analysis showed that average organic matter content under pine forest was very low, and it was low in mixed forest and unfertile Bari land but it was medium in fertile Bari land and broad leaved forest. Similarly total Nitrogen percentage in the soil of pine forest was low but it was medium in mixed forest, broad leaved forest, fertile Bari land and unfertile Bari land. In the same way, P_2O_5 kg^{-1}ha was medium in pine forest, high in unfertile Bari land and very high in fertile Bari land, broad leaved forest and mixed forest, respectively. Similarly, the concentration of K_20 kg^{-1}ha was high in fertile Bari land and Pine forest but was medium in unfertile Bari land, mixed forest and broad leaved forest, respectively. The soil pH under the different types of soil revealed that the soil under Pine forest and mixed forest was strongly acidic, it was moderately acidic under broad leaved forest and unfertile Bari land but it was nearly neutral in the soil of fertile Bari land.

Key words: Soil pH, Nitrogen, Phosphorus, Potassium, Livelihood

INTRODUCTION

Soil is a dynamic natural body composed of mineral and organic solids, gases, liquids and living organisms which can serve as a medium for plant growth. It is the collection of natural bodies occupying parts of the earth's surface that is capable of supporting plant growth and that has properties resulting from the integrated effects of climate and living organisms acting upon parent material, as conditioned by topography over periods of time (Brady and Well, 2002). Soil fertility is concerned with the inherent capacity of soil to provide nutrients, in adequate amounts and in proper balance, for the growth of specified plants when other growth factors such as light, water and temperature, and the physical condition of the soil are favorable. It is an aspect of the soil-plant relationship that

is, plant growth with reference to plant nutrients available in soil (Biswas and Mukherjee, 1994). It depends upon a number of physico-chemical and biological properties of soil: texture, structure, pH, water holding capacity, porosity, soil organic matter, soil nutrients both (macro- and micro-nutrients), soil flora and fauna, etc. Soil productivity is basically an economic concept and signifies the capability of soil to produce specified plant or plant parts or a sequence of plants under well defined and specified systems of management inputs and environmental conditions.

Forests are the crucial component in the hill farming system and forests in general have a greater influence on soil conditions than most of the other plant ecosystem types. Moreover, different tree species can differ significantly in their influence on soil properties as well as on soil fertility. They can differ in quantity and quality of litter input to the soil and they also influence on the soil physical and chemical properties differently. The fertility status of the soil under the Community Forest (CF) including pine forest with and without any regeneration of another plant species, Pine forest with other vegetations and Forest consisting broad leaved plant species with in the periphery of equal elevation is different to that of soil under the agricultural land. It can be seen that the tree species under the dense pine forest are almost absent or very less. Present concerns of Nepal are the challenges of rural poverty and the conservation of natural resources and biodiversity according to the need of agro ecological situation. Only possible solution to this issue can be obtained by mobilizing people's participation to establish a practice for sustainable supply of the resources with building up carrying capacity of the nature. Community forestry can play crucial role in improving the fertility status of the soil as well as the crop productivity status along with the conservation of natural resources and biodiversity. It also empowers the people reducing the rural poverty strengthening the livelihood status of the people. Hence, soil fertility evaluation comparing forest floors under community forest and agricultural land is an indispensable part to step forward towards the organic agricultural system.

MATERIALS AND METHODS

The household survey was conducted at Bhimeshwor Municipality-6, Kiratichhap in Sitakunda Community Forest User Group (CFUG) of Dolakha. Simple random sampling technique was applied during household survey in 30 households out of the total 135 households. Altogether 16 soil samples were collected: 4 samples each from Pine forest, mixed forest, and broad leaved forest; and 2 samples each from fertile and unfertile bariland. Samples were collected in August 2008, and the values obtained from the experiment were pooled together so as to derive mean, which represented fertility status of the respective soil sample. The soil fertility status in different forest types and Bari land was analysed from the composite soil samples

and studied comparatively in the laboratory of Soil Science Division (SSD) of Nepal Agricultural Research Council (NARC), Khumaltar. The data obtained from questionnaire survey were analyzed using SPSS (version 12) and simple statistical analyses were carried out.

RESULTS AND DISCUSSION

Agricultural land holdings

Distribution of land was not uniform. In case of Bari lands, maximum ownership was 12.00 ropani and minimum 0.5 ropani. Similarly, maximum ownership in khet land was 18.00 ropani and minimum 0 ropani. Households with large area of fields thought that fields were not productive and FYM available were not enough. Table 12 shows that the average land holding of the farmers is 4.8 and 3.8 ropani khet and bariland respectively with multiple modes 0.00 and 1.00 respectively. The standard deviation of the khet land owned by the households was 4.4 and 2.7 with multiple modes 0 and 1 in khet land and Bari land, respectively (Table 1).

Table 1 Agricultural lands owned by HHs

Land type	Sum (in ropani)	in Ropani					
		Mean	Median	Mode	Minimum	Maximum	Standard deviation
Khet land	146	4.8	4	.00(a)	0	18	4.4
Bari land	114.5	3.8	4	1.00(a)	0.5	12	2.7

(a) Multiple modes exist. The smallest value is shown.

Cropping System and productivity status of the crops grown by the farmers

Farmers of the study area follow maize- millet-fallow cropping system in their Bari land but they grow rice-wheat in their low land. All the farmers used both organic as well as inorganic fertilizers in their farmland but the doses of application varied due to lack of technical knowledge. Crop productivity was also low due to some technical constraints like lack of knowledge to prepare and apply well decomposed organic manure, and higher dependency on inorganic fertilizers, lack of infrastructural facilities like irrigation, inadequate extension of improved varieties and technology to the farmers' level, and concept of agriculture as disguised employment. It was found that productivity status of wheat, millet, maize and rice was in increasing trend, i. e. 40 kg/ropani, 50 kg/ropani, 80 kg/ropani, 120 kg/ropani, respectively (Figure 1).

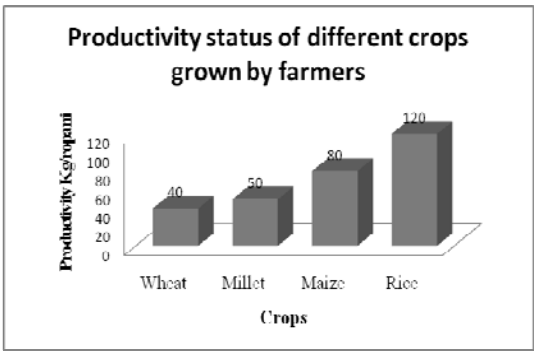

Figure 1 Productivity status of the different crops grown by the farmers

Impacts of community forest on livelihood

Community forestry related activities in the study area are gearing towards balanced and optimized social, economic and ecological benefits. Household survey and Focus Group discussion revealed that the farmers had experienced the reduction of burden for collecting fuel wood, fodder, grasses and timber (Uprety, 2000). They also raised their voice for increasing crop productivity after the formation of community forest but refused to provide full credit to the community forest because of dependency of crop productivity on integrated factors like use of chemical fertilizer, improved variety and other modern agronomic practices.

Soil fertility analysis

Soil fertility analysis revealed that fertility status was poor in pine forest, mixed forest and unfertile Bari land. It possesses almost similar type and fertile Bari land and broad leaved forest also possess similar type of soil fertility (Table 2).

Table 2 Summative evaluation of soil fertility under different soil types

Sample site	PH	OM (%)	TN (%)	P_2O_5 kg/ha	K_20 kg/ha	Soil texture
Pine forest	4.1 (Strongly acidic)	0.63 (Very Low)	0.04 (Very Low)	36.5 (Medium)	294 (High)	Clay loam (Heavy)
Mixed forest	4.4 (Strongly acidic)	1.24 (Low)	0.08 (Low)	287.8 (Very high)	277 (Medium)	Sandy loam (Light)
Broad leaved forest	4.7 (Moderately acidic)	1.86 (Low)	0.12 (Medium)	455.8 (Very high)	277 (Medium)	Loamy (Light)
Fertile bari land	6.6 (Nearly neutral)	1.79 (Low)	0.11 (Medium)	668.1 (Very high)	386 (High)	Sandy loam

						(Light)
Unfertile bari land	4.7 (Moderately acidic)	1.34 (Low)	0.09 (Low)	70.5 (High)	134 (Medium)	Loamy (Light)

Soil colour identification

It was found that the soil samples taken from different sites had different colour. The soil colour of the samples during dry and wet conditions was as given in Table 3.

Table 3 Identification of soil colour

Soil Samples	Hue-value/chroma	Soil Colour
Soil under Pine forest		
P1 dry condition	10 YR-6/8	Brownish yellow
P1 wet condition	10 YR-5/6	Yellowish brown
P2 dry condition	10 YR-6/8	Brownish yellow
P2 wet condition	10 YR-5/6	Yellowish brown
P3 dry condition	5 YR-6/6	Reddish yellow
P3 wet condition	5 YR-5/6	Yellowish red
P4 dry condition	10 YR-5/6	Yellowish brown
P4 wet condition	10 YR-5/6	Yellowish brown
Soil under Mixed forest		
M1dry condition	10 YR-7/2	Light grey
M1 wet condition	10 YR-5/1	grey
M2 dry condition	10 YR-6/3	Pale brown
M2 wet condition	10 YR-5/2	Grayish brown
M3 dry condition	10 YR-6/3	Pale brown
M3 wet condition	10 YR-5/3	Brown
M4 dry condition	10 YR-6/3	Pale brown
M4 wet condition	10 YR-4/2	Dark grayish brown
Soil under Broad leaved forest		
B1 dry condition	10 YR-6/8	Brownish yellow
B1 wet condition	10 YR-5/6	Yellowish brown
B2 dry condition	10 YR-4/4	Dark yellowish brown
B2 wet condition	10 YR-3/2	Very dark grayish brown
B3 dry condition	10 YR-6/3	Pale brown
B3 wet condition	10 YR-5/2	Grayish brown
B4 dry condition	10 YR-6/4	Light yellowish brown
B4 wet condition	10 YR-4/3	Dark brown
Soil under fertile bari land		
F1 dry condition	10 YR-6/2	Light brownish gray
F1 Wet condition	10 YR-4/1	Dark gray
F2 dry condition	10 YR-4/1	Dark gray
F2 Wet condition	10 YR-3/1	Very dark gray
Soil under unfertile bari land		
F3 dry condition	10 YR-6/2	Light yellowish brown
F3 Wet condition	10 YR-4/3	Dark brown
F4 dry condition	10 YR-6/3	Pale brown
F4 Wet condition	10 YR-4/3	Dark brown

Where, P_1, P_2, P_3, and P_4 are four samples from pine forest, B_1, B_2, B_3, and B_4 are the samples from Broad leaved forest, M_1, M_2, M_3, and M_4 are the samples from mixed forest. F_1, F_2 are the samples from fertile Bari land (on the basis of crop standing) and F_3, F_4 are the samples from unfertile Bari land.

Soil texture analysis

It was found that soil texture under the pine forest without regeneration of other vegetation was clay loam (heavy). Soil under the mixed forest and fertile Bari land was the sandy loam type, whereas, the soil texture under the Broad leaved forest and unfertile Bari land was loamy. However, the soil except under pine forest were categorized as light textured soil (Table 4).

Table 4 Soil texture analysis

Soil Sample	Sand (%)	Silt (%)	Clay (%)	Soil Texture	Soil type
Soil under pine forest	27.3	34.8	37.9	Clay loam	Heavy
Soil under Mixed forest	61.3	26.8	11.9	Sandy loam	Light
Soil under Broad leaved forest	47.3	40.8	11.9	Loamy	Light
Soil under Fertile bari land	59.3	30.8	9.9	Sandy loam	Light
Soil under unfertile bari land	47.3	28.8	23.9	Loamy	Light

CONCLUSION

The socio-economic background of the respondents was poor; however the protection, management and utilization of the community forest was satisfactory in the study area.

The soil fertility analysis revealed that the soil under Pine forest was mostly unfertile except in the case of Potassium because of strongly acidic soil with low organic matter content and total nitrogen, medium type in Phosphorus content and clay loam texture.

The soil fertility status under mixed forest tended to represent the soil of unfertile Bari land in the aspect of soil organic matter content (low) and total nitrogen (medium), however soil acidity was strong; the soil phosphorous level was very high. The acidity under unfertile Bari land was moderate and P_2O_5 Kg ha^{-1} was high. The texture of mixed forest soil was sandy loam but was loamy under unfertile Bari land.

Organic matter and total nitrogen content in broad leaved forest and fertile Bari land was of medium type with very high P_2O_5 content. Acidity was moderate in broad leaved forest and it was nearly neutral in fertile Bari land. The texture of soil under broad leaved forest was loamy, while under fertile Bari land it was sandy loam in nature.

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Towards Mitigating Climate Change Impact: Growth and Yield Performance of Okra under Drought and Hot Climatic Condition at Rajabas, Udayapur

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ABSTRACT

The field trial was carried out from last week of Chaitra, 2070 (March 2013) to Shrawan, 2070 (July 2013) on WOREC's Demonstration Farm at Baireni Eco Village, Udayapur. Three parallel plots, each plot of 28 sq. m., were laid out representing each a replication. A total of 150 plants were maintained in each plot with crop geometry of 30X45 cm. The chemical fertilizers (N: P: K @ 40:30:20 a.i. kg/ha) and manure (compost @ 15 t/ha) were applied as basal. Plantation was done by direct seeding method. Emergence, first mass flowering, and first mass pod formation were recorded. At the time of green pods harvesting, biometrical traits like plant height, green pod length, green pod diameter, and number of pods per plant, as well as pod yield per plant and per unit area were measured in 20 plants per replication. During the early growth period the okra plants tolerated drought while during flowering and fruiting stages the plants withstood heavy rainfall and high temperature. It has been revealed that even in such unfavourable conditio the yield of okra was as high as 22 kg per plot or 7,920 kg/hectare in one harvesting. Converting the pod yield into monetary value with 25 Rs per Kg of green pods, the gross income was worth NRs. 198,125 per ha. Being a plant with indeterminate flowering and fruiting, multiple harvesting is possible in okra without much input except labor cost for harvesting. That ensures more income than estimated for one harvesting. Farmers may generate only upto NRs 90,000 by growing paddy on the same area of land (1 hectare). It is thus evident that okra farming is a profitable business for small farmers in Baireni ecovillage in Udayapur during summer season in the rice-based cropping system.

Key words: Climate change, Drought, Ecovillage, Livelihoods, Inome generation

INTRODUCTION

Today agriculture has to address some serious environmental concens in the face of visible negative impacts of climate change globally (Rajbhandari and Bhatta 2009). Okra (*Abelmoschus esculentus*) is a proven warm season crop in dry and hot climatic conditions. It is considered as a traditional vegetable crop with high

commercial value. The immature, young pods (fruits) as well as young leaves and flowers of okra are edible parts. Okra leaves are considered good for cattle feed. The okra mucilage has medicinal value and industrial application. Okra has a high nutritional value; and grows quickly with high temperature. It is a proven crop component in dry and hot climatic condition. Okra seeds are regarded as good source of oil, protein and essential minerals. The nutritional value of 100 gram of edible portion of okra contains 1.9 g of protein, 0.2 g of fats, 6.4 g of carbohydrate, 0.7 g of minerals, 1.2 g of fiber, 8 g of Oxalic acid and 103 g of potassium (Gopalan et al. 2007). Thus it provides all the necessary sources of nutrients, which are often lacking in the diet of the people in developing countries. On the other hand, okra is free from fat and cholesterol, has very low amount of sodium, low in calorie, and good source of Vitamin A, Vitamin C, and Vitamin B6, and Riboflavin which is said to be very useful against chronic dysentery, genito-urinary disorders and curing ulcers (Nadkarni 1927). It is therefore considered a very important medicinal vegetable crop in tropical and subtropical climatic zones. In the context of climate change, there is a hypothesis that okra may play an important role to mitigate the impact of climate change in the subtropics. This simple trial was conducted in Udayapur, eastern part of Nepal, to verify that hypothesis from the perspective of resource poor farmer's livelihoods. In Udayapur, okra production is mainly limited to kitchen garden, giving comparatively little focus on its cultivation as compared to major cereal crops like rice and maize. Keeping in view the tolerance of okra to drought (high temperature) as well as water logging condition, Baireni Ecovillage and Utraitole Ecovillage in Triyuga Municipality of Udayapur were thought to be a pocket area of okra production.

MATERIALS AND METHODS

The cultivar (cv.) Pusa Sawani was selected for the trial. Among the several varieties of Okra, Pusa sawani is an improved and early maturing variety. It is very much popular among the farmers. The economic part, i.e. green pods are smooth, straight, dark green with an average length of 10.5 cm. The plants are tall, generally single steamed with early maturity.

The field trial was carried out from last week of Chaitra, 2070 (March 2013) to Shrawan, 2070 (July 2013) on WOREC's Demonstration Farm at Baireni-Rajabas, which is within the premises of Baireni Eco Village. Three plots were laid out parallelly each representing a replication. The area of each plot was 28 square meters. A total of 150 plants were maintained in each plot with crop geometry of 30X45 cm. The chemical fertilizers like Urea, DAP and micro-nutrients (Posan) and compost were applied as recommended for the crop. All required amount of fertilizer (N:P:K @ 40:30:20 kg/ha) and manure (compost @ 15 t/ha) was applied as basal.

Plantation was done by direct seeding method. Emergence (80% of the plant population in each plot), first mass flowering (80% of the plant population in each plot), and first mass pod formation (80% of the plant population in each plot) were recorded. At the time of harvesting green pods, the following biometrical traits were measured: plant height, green pod length, green pod diameter, and number of pods per plant, as well as pod yield per plant and per unit area. These traits were measured in 20 plants per replication, i.e. 60 plants.

RESULTS AND DISCUSSION

Climatic condition and phenology

The climatic condition in Baireni Rajabas during the cropping period was as shown in the Figure 1.

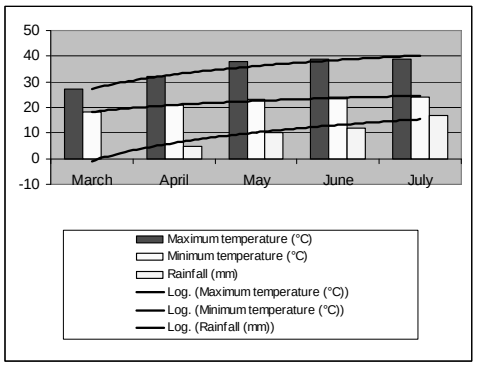

Figure 1 Climatic condition during cropping period, Udayapur

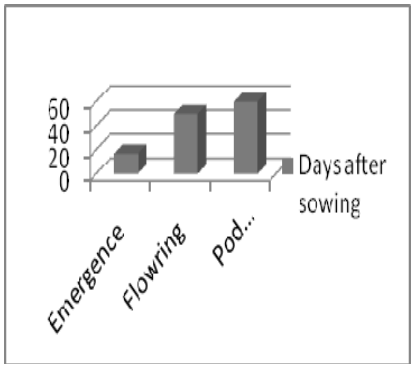

Figure 2 Phenology of Okra in DAS, Udayapur, 2013

There was no rainfall in the month of March, but from April it slowly started to rain. The temperature fluctuated from 18^0 to 32^0 C during March- April while in the months of May and June it ranged from 25 to 38^0 C. It is thus obvious that during the early growth period the okra plants had to tolerate drought while during flowering and fruiting stages the plants had to tolerate heavy rainfall and high temperature (Figure 1). The cultivar Pusa Sawani took 17 days after sowing (DAS) for emergence. It is a relatively longer time, which may be due to dry and compact soil condition. Mass flowering was recorded in 50 DAS; while the first mass pods formation or first green pod harvest was recorded on 60 DAS (Figure 2). Plants at various growth stages are presented in Figure 3 to 5.


Fig 3 Flowering


Fig 4 Pod formation stage


Fig 5 Mass pod formation stage

Yield and its components

The performance of Okra var. Pusa Sawani was very good in terms of growth, development and yield formation. Field data regarding yield and its components in okra has been summarized in Table 1.

Table 1 Yield and its components in okra cv. Pusa Sawani, Udayapur, 2013

S.N.	Parameters	Range	Mean Value
1	Plant height, cm	80…100	90
2	Green pod length, cm	7…15	11
3	Green pod diameter, cm	1.2…1.9	1.7
4	Number of pods per plant	10…25	17
5	Pod yield per plant, g	140…154	147
6	Pod yield per sq.m., g.	780…805	792
7	Pod yield per harvesting, kg/ha	7800…8050	7925
8	Gross income, NRs/ha	195,000…201,250	198,125

The average height of plants was 90 cm. This trial had shown that even in drought followed by high temperature and heavy rainfall, the yield of okra was as high as 22 kg per plot (792 g per sq m.) that is equivalent to 7,920 kg/hectare in one harvesting.

Converting the pod yield into monetary value with 25 Rs per Kg of green pods, the gross income would be worth NRs. 198,125 per ha. Being a plant with indeterminate flowering and fruiting, multiple harvesting is possible in okra without much input except labor cost for harvesting. That ensures more income that estimated for one harvesting. Farmers may generate only upto NRs 90,000 by growing paddy on the same area of land (1 hectare). It is thus evident that okra farming is a profitable business for small farmers in Baireni ecovillage in Udayapur during summer to monsoon period.

Incidences of insect pests like Mealy Bug, Leaf folder, Jassids were observed on this crop that had resulted in slight decline in yield, which was economically insignificat. The insect pests were managed by locally prepared botanical pesticides.

Table 2 Standard deviation and variability of yield and its components in okra cv. Pusa Sawani, Udayapur, 2013

S.N.	Parameters	STDEV	CV, %
1	Plant height, cm	14.14	15.71
2	Green pod length, cm	5.65	51.36*
3	Green pod diameter, cm	0.49	28.82*
4	Number of pods per plant	10.60	62.35*
5	Pod yield per plant, g	9.89	6.72
6	Pod yield per sq.m., g.	17.67	2.23

Standard Deviation (STDEV) and the variability (coefficent of variation, %) were computed in the yield and attributing traits (Table 2). The study revealed significant variability (CV higher than 20%) in green pod length (51.36%), green pod diameter (28.82%) and number of pods per plant (62.35) and medium (CV= 10-20%) in plant height (15.71%). The variability of pod yield per plant and per unit area was insignificant indicating more or less stable pod yields in the given agro-ecological conditions.

CONCLUSION

The trial revealed the possibility of growing okra in the ecovillages Baireni in Triyuga Municipality of Udayapur to mitigate the impact of climate change (drought followed by high temperature and afterwards heavy rainfall) simultaneously generating good income to secure livelihoods of the members of ecovillages.

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Ginger Farming: A Boon for Livelihood Improvement of Farmers in Gulmi

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ABSTRACT

The study was carried out in Herdineta, Digam, Kharjen and Huga VDCs of Gulmi district in 2011 to assess the impact of ginger production on household income of the local farmers. The findings included the response and primary data from100 ginger growers. Majority of farmers grew ginger in 1-3 ropani of land and harvested approximately 20-30 quintals of ginger which was marketed in fresh form and exported to various places of India namely Gorakhpur, Kanpur, Banaras, Delhi and Lucknow. Farmers were using local varieties (Nase and Bose) while some used Kapurkote. The major problems faced by the ginger growers were lack of technical knowledge and fluctuation of market price. Involvement of women was found instrumental in successful ginger production as they were engaged during plantation to intercultural operations. From ginger farming, majority of the farmers achieved double increment in their annual household income while few had increased their household income by three times. Consequently, with the extra money they earned, they were able to invest for higher education of their children, miscellaneous household expenses, and health.

Key words: Income generation, Livelihoods, Household income, Investment

INTRODUCTION

Ginger is the rhizome of underground modified stem of the plant *Zingiber officinale,* an herbaceous perennial. But it is cultivated commercially as annual crop. The ginger of commerce is the dry product of rhizome. India, China, Indonesia, Nigeria, the Philippines and Thailand are currently the main producers. In our context, where agriculture sector contributes 39% share of GDP, supporting 66% of economically active population (MoF 2005), ginger is regarded as the most important cash spices crop grown in the mid hill marginal and sub marginal lands. It has immense and major contribution to raise the socio economic status of the rural farmers to earn the foreign currency to the country and to decrease the environment degradation. The area and production especially in the ginger have been exponentially increasing year after year which indicate that there is the high

scope for the development of spices crop (Sharma 2002). Hence at present, India is only the major foreign market available for our produce. Import of spices has been steadily increasing, where as the export volume is almost stagnant. Production of ginger is mainly concentrated in the mid-hill region of the country, which is lacking in adequate transport facilities. Out of total 75 districts in the country, 12 districts share more than half of total area and production, which are identified as production pockets (ABSTRACO 2005). Five pocket districts having relatively better transportation network export major share of their produce to northern Indian cities, while remaining seven districts supply to the domestic market.

Nepalese ginger is superior in quality which is suitable for the production of dried ginger, oleoresins or essential oils. But due to the lack of ginger processing facilities within the country, the farmers have to sell their produce in the fresh form or traditionally dried form. The traditionally processed ginger comes to be inferior in quality than the mechanically processed one and as a result, proper value addition has not been attempted within the country. The choice of crop and farming methods should, therefore receive priority in participatory research and extension allocation (Rajbhandari & Bhatta 2008). Illam, Palpa, Nawalparasi, Salyan, Puthan, Kaski, Kavre, Arghakhanchi and Tanahu are the leading districts in ginger cultivation. The production of ginger during 2006/07 in Nepal 160576 mt, increased to 161171 MT during 2007/08. It is estimated that the production of ginger increased by 0.37 percent per year (MOAC 2007/08). Being a commodity which can be grown in the marginal and sub-marginal lands with the higher rate of productivity than cereals crops, it has become one of the lucrative business among the cash crops of Nepal. The value of ginger export has been increasing over the years and doubled in the last decade (Mercy crops 2009). Nepal ranks fourth in ginger production with share about 11.5% on total ginger produced in the world (Poudel 2009).

MATERIALS AND METHODS

Four Village Development Committees (VDC) of Gulmi district namely Hardineta, Kharjen, Digam and Huga were chosen for the study (Figure 1).

Figure 1 Map of Gulmi district showing research sites (VDCs)

Digam and Huga VDCs are identified as the pocket area for ginger production, whereas Hardineta and Kharjen are cultivating ginger in subsistence form. There is not any periodic document maintained in VDC or any other concerned agency about the ginger farmers. According to the technical assistance of Baletassar Agriculture Service Centre there are around 1750 to 1800 households involved in commercial ginger production. Within that area a lot of farmers produce ginger in small amount in their Bari land; and these farmers are moving toward commercial production.

A total of 100 farmers from these four VDC were randomly selected for the survey. Among the respondents, 25 were from Hardineta, 32 from Digam, 24 from Kharjen and 19 from Huga VDC. Sampling was carried out by simple random sampling method. The study was based on the primary data collected from field with the help of semi-structured questionnaire and published secondary information. The questionnaire was developed to gather the relevant information required to meet the specific objectives. Farmers were selected for interview using the questionnaire. SPSS (ver. 11.5) was used for the data processing and analysis.

RESULTS AND DISCUSSION

Majority of the respondents were self motivated (91%) for ginger farming, 6 percent were inspired by others while 3 percent of respondents were inspired by non government organizations (NGOs). In the study area, 76 percent of respondents were motivated for ginger farming for higher income while the rest chose ginger farming only due to good market. Majority of respondents (45%) were cultivating ginger for 5 years, 27 percent were cultivating ginger for more than 5 years, 15 percent have just started to cultivate for last 2 years and rest 13 percent were cultivating since 2-4 years.

Status of ginger farming in study area

In the study area, majority of the respondents (92%) had increased their land under ginger cultivation while the rest (8%) have not increased their land for ginger cultivation due to decreasing productivity and fluctuating market price (Figure 2).

Most of them (33%) had increased their land by more than three times (>300%) as compared to the initial period, 29 percent and 31 percent of respondents had increased their land 200 and 300 percent, respectively. Only 7 percent of the households reported that they have not increased the land area allocated for ginger cultivation.

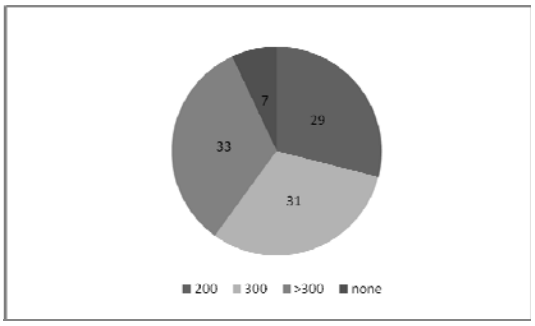

Figure 2 Distribution of households by land increment (%) for ginger production

Similarly 83 percent respondents had less than 2 ropani (1 ropani= 508.5 sq m) in the beginning and now they were cultivating ginger in 2 to 5 ropani. Respondents cultivating ginger between 5-10 ropani at present were 15 percent while those who were cultivating ginger in more than 10 ropani were 2 percent of the respondents. Due to lack of awareness and financial institutions none of the respondents in the study area had taken any loan for the ginger cultivation. Similarly, majority of the respondents were devoid of training (91%) and support (93%), while only 9 percent of the respondents had received training and 7 percent had received support regarding ginger cultivation

Change after ginger farming

As ginger is one of the important high value cash crops, 93 percent of the respondents in the study area responded that their income had significantly increased after ginger farming while 7 percent of them did not found any significant increase in their income (Figure 3).

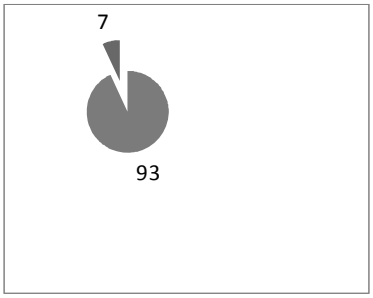

Figure 3 Distribution of households by increment in income from ginger farming

It is interesting to note that majority of the respondents (63%) had doubled their income from ginger farming. Twenty none percent had increased their income by 3 times while rest of them (8%) responded that their income had increased by more than 3 times (Figure 4).

Ginger growers in the study area, reported that ginger farming has increased their children's access to education; and their family member's access to food, health service, incidental expenses and saving. Farmers were able to generate more household income.

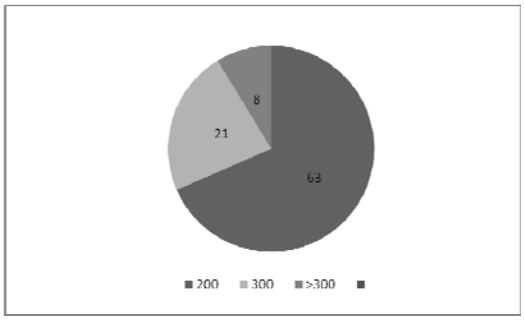

Figure 4 Distribution of households by the size of income growth from ginger farming

Local variety cultivated by the farmers has low productivity and higher incidence of rhizome rot and disease compared to improved variety. Farmers (64%) were using their own stock of local variety (Nase and Bose) whereas some farmers (36%) were using improved variety (Kapourkote).

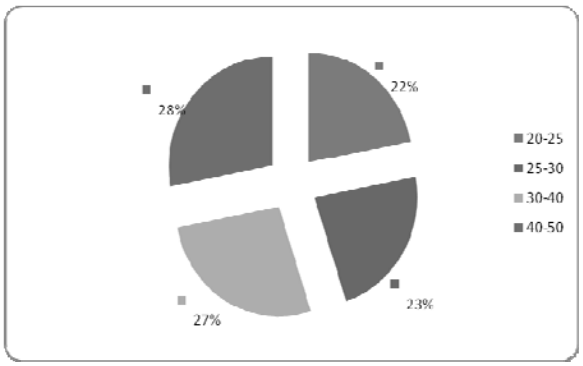

Figure 5 Compost used by farmers (in dokas) in study sites, Gulmi (1 doka= 10 kg)

In study area, most of the respondents were using compost as a prime source of nutrients (Figure 5). The maximum compost used in a ropani was 50 dokas where as the minimum was 20 dokas. Majority of respondents (40-50%) were using 40-50 dokas compost per ropani, 27 percent were using 30-40 dokas, 23 percent were using 25-30 dokas and 22 percent of respondents were using 20-25 dokas of compost per ropani for ginger cultivation.

Ginger marketing in the study area

Palpa is the nearest market where majority of the fresh ginger was sold by 60 percent of the respondents, 26 percent of them sold their produce in Butwal. Likewise, 12 percent of them sold it in local market which was further sold in India through two channels (Figure 6). Two percent of respondents sold their produce to India directly. Almost all the ginger produced in the study area was exported to India through middlemen. It was found that about 2 to 3 middle men were engaged to export ginger from Gulmi to India via Palpa and Butwal. A middle man in the village level collected ginger and sold them at Palpa (Dumre) and Butwal (Bhalbari). This ginger was again exported by the middle man to the Indian boarder to next middle man who finally would sell them to the Indian market and/or factories.

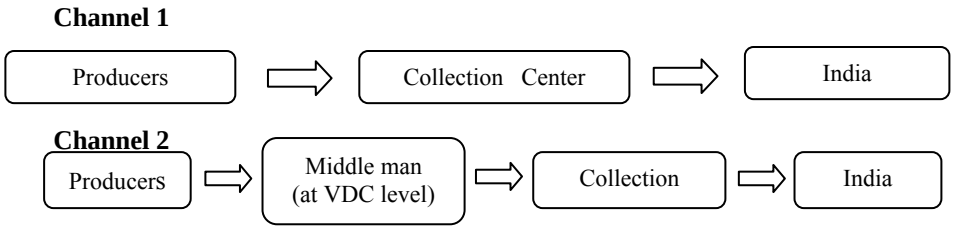

Figure 6 Channels of Nepalese ginger export to India

Most of the farmers get the price on the basis of existing market price. Trends showed that the price of ginger was high during offseason and low during normal season. The average price of ginger was Rs 25-30/kg during normal season and Rs 40-50/kg during offseason i.e. end of Mangsir to the time of plantation.

CONCLUSION

Ginger farming is increasing and becoming popular among the farmers of Gulmi district. Mostly the farmers of above 40 years age are engaged in ginger farming. Majority of farmers were cultivating ginger to make higher household income. Most of the ginger is sold to the middlemen. Farmers are neither getting cash in

hand nor appropriate price for their product. The fluctuation in market price was making ginger grower upset. Large quantity of ginger is produced in Huga and Digam VDCs but farming communities were not provided with any package of special program for the promotion of this crop in these VDCs. The involvement of women in on-farm activity is comparatively higher than male but their access to market is quite low so the male domination in marketing of ginger is obvious. The problems in production aspect were Rhizome rot, lack of improved varieties, technical skill, lack of irrigation and labor and knowledge on processing. Problems associated with marketing aspects were market within the district, low price of ginger, lack of market information and price fluctuation. For the sustainability and commercialization of ginger entrepreneurship in Gulmi district, both the technological as well as institutional innovations have become prerequisite.

ACKNOWLEDGEMENT

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An Assay of Rupa Lake Water from the Perspectives of Livelihoods

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ABSTRACT

This study was carried out in 2012-13 to analyze the water quality of Rupa Lake and assess for its use in fish farming and drinking. The physical and chemical analyses were conducted for a number of standard parameters. The water was found to be tasteless, colorless and odorless but less transparent. The result showed that the water had pH of 6.9, turbidity12 NTU, conductivity 4.8 µs/cm, dissolved oxygen 9.9 mg/L, total hardness (CO_3) 18 mg/L, temporary hardness (HCO_3) 40 mg/L, nitrogen 31 mg/L, Phosphorus 44 mg/L, and potassium 25 mg/L. The Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD) values in the water sample from Rupa Lake were 9.34 mg/L and 7.5 mg/L, respectively. It was found that the total dissolved solid is only 7.9 mg/L, which is very low as compared to WHO standard of 500 mg/L. Ammonia was found to be Nil. Fish farming at commercial level can be successfully done in the Lake as an optional enterprise for sustainable livelihoods of the inhabitants who are dependant on the Lake. Keeping in view the tremendous possibility of Rupa Lake Water as a source for drinking water to ever increasing town and cities, it has been recommended that microbiological test and relevant treatment is also necessary for making it suitable for drinking.

Key words: Conductivity, Chemical Oxygen Demand (COD), Biological Oxygen Demand (BOD), Total Dissolved Solids (TDS), Turbidity

INTRODUCTION

Search for fresh water sources for drinking and income generating purposes is on high gear globally. Being a rich country with fresh water resources, a search for such possibility is quite imperative in Nepal. We had identified Rupa Lake in Kaski district such a source for undertaking a multi-discioplinary reasrch. The research was primarily confined to analyze the water quality of Rupa Lake and assess for its use in fish farming and drinking purposes. Furthermore, importance of Rupa Lake wetland resources for the livelihoods of local people and impacts of climate change on the dimensions of livelihoods were also focused in the research.

Nepalese fish farming practice has subsistence nature. Now, it is increasing in professional and livelihood purpose to fulfill the demand of protein. A number of wild plants occurring in the wetland are also included in seasonal diets of local people. Obviously, wetland is the good source of proteinous and other food (vegetables) supplement. Paying due consideration on this reality, Rupa Co-operative is doing fish farming in Rupa Lake.

For drinking purpose, water should not be warm because in warm water the algae, fungi and other planktons may grow and develop. Drinking water should be colorless, odorless and tasteless (Clair et al. 2008). Colour in water may result from the presence of natural metallic ions, humus and peat materials, plankton, weeds and industrial wastes.

Water quality management is considered as one of the most important aspects for fish farming for many years, but less attention is paid to the management of bottom soil quality. However, there is increasing evidence that the condition of bottom soil and exchange between soil and water strongly influence water quality and thereby fish yield (Boyd 1995).The estimated production of fish in the Rupa Lake is 166,666 - 233,333 kg per year. As per Rupa Co-operative, the fish harvesting trend is declining (Rupa Cooperative- personal communication). Assay of the water quality of the lake is very important for fish and other purposes. Therefore, this study was done as a component of a bigger project to assay the Rupa Lake water through standard physical and chemical analysis (turbidity, conductivity, DO, COD, BOD, TDS, TSS and nutrients).

Chemical oxygen demand (COD) is a measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite. COD measurements are commonly made on samples of waste waters or of natural waters contaminated by domestic or industrial wastes. Chemical oxygen demand is measured as a standardized laboratory assay in which a closed water sample is incubated with a strong chemical oxidant under specific conditions of temperature and for a particular period of time. A commonly used oxidant in COD assays is potassium dichromate ($K_2Cr_2O_7$) which is used in combination with boiling sulfuric acid (H_2SO_4). Because this chemical oxidant is not specific to oxygen-consuming chemicals that are organic or inorganic, both of these sources of oxygen demand are measured in a COD assay (Clescerl et.al. 1998).

Chemical oxygen demand is related to biochemical oxygen demand (BOD), another standard test for assaying the oxygen-demanding strength of waste waters. However, biochemicaloxygen demand only measures the amount of oxygen consumed by microbial oxidation and is most relevant to waters rich in organic

matter. It is important to understand that COD and BOD do not necessarily measure the same types of oxygen consumption. For example, COD does not measure the oxygen-consuming potential associated with certain dissolved organic compounds such as acetate. However, acetate can be metabolized by microorganisms and would therefore be detected in an assay of BOD. In contrast, the oxygen-consuming potential of cellulose is not measured during a short-term BOD assay, but it is measured during a COD test.

Being a good solvent water picks up impurities easily. Pure water is tasteless, colorless, and odorless; and is often called the universal solvent. "Dissolved solids" refer to any minerals, salts, metals, cations or anions dissolved in water. Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, carbonates, bicarbonates, chlorides and sulfates) and some small amounts of organic matter (Oram 2000).

TDS in drinking-water originate from natural sources, sewage, urban run-off, industrial wastewater, and chemicals used in the water treatment process, and the nature of the piping or hardware used to convey the water, i.e., the plumbing. In the United States, elevated TDS has been due to natural environmental features such as: mineral springs, carbonate deposits, salt deposits, and sea water intrusion, but other sources may include: salts used for road de-icing, anti-skid materials, drinking water treatment chemicals, stormwater and agricultural runoff, and point/non-point wastewater discharges (Ibid). In general, the TDS concentration is the sum of the cations and anions in the water. Therefore, the TDS test provides a qualitative measure of the amount of dissolved ions, but does not show the nature or ion relationships. In addition, the test does not provide the insight into the specific water quality issues, such as: Elevated Hardness, Salty Taste, or Corrosiveness. Therefore, the TDS test is used as an indicator test to determine the general quality of the water. The sources of total dissolved solids can include all of the dissolved cations and anions (Ibid). An elevated total dissolved solids (TDS) concentration is not a health hazard. The TDS concentration is a secondary drinking water standard and therefore is regulated because it is more of an aesthetic rather than a health hazard (Oram 2000).

MATERIALS AND METHODS

Laboratory analysis of the water collected from Rupa Lake was done at Nepal Academy of Science and Technology (NAST).

1. Temperature

The temperature of water sample was noted by means of thermometric range 0- 100^0c. The temperature was 25^0c in summer whereas in winter it was 16^0c (Field Data from Rupa Co-operative).

2. Turbidity

The turbidity of the water sample was tested by HACH turbidity meter by using different standard solution of 0.61 NTU, 10 NTU and 100 NTU having different scales. Twenty five ml water sample was measured and placed in the sample cell and inverted the sample cell into the instrument covered with sample holder then read out the turbidity of the water sample. The turbidity of the water was found 6 NTU (Nepthlometric Turbidity Unit).

3. pH

pH of the water sample was carried out by immersing electrode in the water. The pH meter used was Elico pH meter (digital) and HANA pH meter.

4. Conductivity

By measuring the conductivity of water, we may obtain an indication of the level of dissolved solids in the water. HANA conductivity meter was used to test the conductivity of the given water sample. The unit of the conductivity of water was Siemens.

5. Dissolved Oxygen

Dissolved oxygen (DO) in water sample was tested by titration method by using different chemicals such as manganoussulphate, alkali iodide, azide, sulphuric acid and sodium thiosulphate. Starch solution was used as an indicator.

6. **Chemical Oxygen Demand**

Measurement of non biodegradable organics is usually done by the chemical oxygen demand (COD). The COD was tested by the titration method. Different chemicals were used such as N/20 sodium thiosulphate, potassium dichromate, potassium iodide, concentrated sulphuric acid and starch solution as an indicator.

Calculation

$$COD\ (mg/L) = 8 * c * (V_B - V_A)/V_S$$

Where,

V_S= Volume of water sample (50 ml)
C = Concentration of sodium thiosulphate (0.1M) N/20
V_A= Volume of distilled water (50 ml)
V_B = Volume in ml of titrant (Vol. of burette reading)
8 = Equivalent weight of oxygen

7. **Biological Oxygen Demand**

The amount of oxygen utilized during microbial utilization of organics is called biochemical oxygen demand (BOD). 300 ml of water sample was paced in an incubator at 20^0c for 5 days. Light must be excluded from the incubator to prevent algal growth that was produced oxygen in the bottle because the saturation calculation for oxygen in water at 20^0C is 9 mg/L.

After 5 days the water sample was tested by using 2 ml manganous sulphate, 2 ml alkali iodide azide; and 2 ml conc. sulphuric acid was titrated with N/80 sodium thiosulphate till pale yellow color. Then 2 ml of starch solution was added, the color of solution was changed into blue. Then titration was done until the blue color turned into colorless; and the volume of burette reading was noted.

8. Total Dissolved Solids

Total dissolved solid (TDS) was tested by gravimetric method. Total dissolved solid includes the addition of suspended solids and dissolved solids in the water sample. The given water sample was tested to dryness in a porcelain basin having 150 mm diameter. The 100 ml water sample was taken in a porcelain basin and kept about one and half hour at 103^0 C - 105^0 C. Then it was removed from the oven and placed in the desiccator to cool and it was weighed accurately. Same process was carried out for three times heating, cooling and weighing till concurrent reading.

9. Total Suspended Solids

Total suspended solid (TSS) in water may consist of inorganic and/or organic particles or immiscible liquids. The TSS was tested by gravimetric method involving the mass of the residues. TSS was tested by gravimetric method by evaporating a sample to dryness and weighing the residue. The residue was dryed at 105^0 C for 30 minutes; and it was left to cool for 15 minutes in desiccator. It was measured by weighing the residue. This process was carried out by heating, cooling and weighing for three times till the concurrent value was observed.

10. Nutrients:

a. Test for Nitrate

Nitrate cintent of the water was tested by UV spectrophotometer. The instrument was warmed up for 30 minutes and calibrated to test the nitrate in 220 nm. That nitrate sample (sodium nitrate) of different concentration 5 ppm, 10 ppm, 15 ppm and 20 ppm standard solution was made and calibrated it. After calibration the instrument was ready to test the water sample. The water sample was placed in the sample cell (cubet) and the reading was noted down.

b. Ammonia

Test for ammonia (NH_4) was similar to that of nitrate. The UV spectrophotometer was calibrated in 425 nm.

c. Potassium

Potassium was tested in the water sample by UV method.

d. Calcium

Calcium was tested by the photo-calorimeter method.

e. Carbonate and bicarbonate

Carbonate and bicarbonates were tested by titration method.

RESULTS AND DISCUSSION

Data obtained from analysis of the water sample collected from Rupa Lake are summarized in Table 1 and Table 2. It was found to be tasteless, colorless and odorless and not hard but less transparent. Obviously, it was good for fish farmin at commercial scale as an enterpriose to support the livelihoods of local people, who are more or less dependant on Rupa Lake.

The conductivity of water sample was found to be 3.3 µs/cm. by immersing the conductivity meter in 100 ml water sample and noted down the reading for three times for accuracy.

Turbidity in water of Rupa Lake was 6 against the WHO standard of 5. It may be caused by suspended matter such as clay, silt, and finally divided by organic and inorganic matter. Turbidity is an expression of optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample.

Measurement of pH is one of the most important and frequently used tests in water chemistry. Natural water usually have pH value ranging from 4 to 9, and most are slightly basic because of the presence of carbonates and bicarbonates of the alkali and alkaline earth metals. The pH valu of Rupa Lake water was found to be within the nationl and WHO guidelines, i.e. 7.56 (Table 1).

Table 1 Water quality of Rupa Lake, 2013

SN	Physico-chemical parameters	Unit	WHO guideline	National Drinking water quality standard	Value of Rupa Lake water	Methods used
1	Temperature	^{0}C	5.9		25	Immersing
2	Turbidity	NTU	5	5 (10)	6	Nephelometric method
3	pH		7 – 7.8	6.5 – 8.5*	7.56	Electrometric method
4	Electric Conductivity	µs/cm	-	1500	3.3	Platinum Electrode method
5	DO	mg/L	9	-	5.8 (summer) 9.0 (winter)	Titration method
6	COD	mg/ L	>50	-	9.34	Titration method
7	BOD	mg/ L	-		7.5	Titration method
8	TDS	mg/ L	500	1000	79	Gravimetric method
9	TSS	mg/ L	200	-	80	Gravimetric method

Values in parenthesis refers the acceptable values only when alternative is not available.

Dissolved oxygen (DO) was 5.8 mg/l in summer (25^0 C), which was lower as compared to WHO guideline. However, in winter (16^0 C) it was at par to the WHO guidelines, i.e. 9 mg/L. Obviuosly, amount of DO in water depended upon the temperature. COD and

BOD values in the water sample from Rupa Lake were also low, i.e. 9.34 mg/L and 7.5 mg/L, respectively (Table 1).

It was found that the total dissolved solid (TDS) was only 7.9 mg/L, which is very low as compared to WHO standard of 500 mg/L (Table 1). There is no Primary drinking water standard for TDS, but the Secondary standard for TDS is 500 mg/L (EPA, ref. www.water-research.net). It is important to keep in mind that water with a very lower TDS concentration may be corrosive; and corrosive water may leak toxic metals such as copper and lead from the household plumbing. This also means that trace metals could be present at levels that may pose a health risk (Oram, 2000).

Mineral composition of the water from Rupa Lake was analysed in terms of the following elements and compounds like nitrate, ammonia, potsssium, phosphorous, carbonate and bicarbonate (Table 2). Ammonia was not detected in the water sample. Contents of NO_3, K and P were 2.62 mg/L, 10 mg/L and 40 mg/L, respectively. The carbonate and bicarbonate content was found to be 14 and 34 mg/L, respectively. The carbonate content is less than WHO guidelines value.

Table 2 Mineral composition of the water of Rupa Lake, 2013

SN	Parameters	Unit	WHO guideline	National Drinking water quality standard	Value of Rupa Lake water	Methods used
1	NO_3	mg/L	10	50	2.62	U/V
2	NH_4	mg/L	0.5	1.5	0	U/V
3	K	mg/L	-	-	10.0	U/V
4	P	mg/L	-	-	40	U/V
5	Carbonate	mg/L	100	-	14	Titration
6	Bicarbonate	mg/L	-	-	34	Heating & titration

RECOMMENDATION

It is recommended to get the Rupa Lake water tested for microbilogical contamination prior to using it for drinking purpose or installing a community water treatment plant for local use and income generation toward livelihoods security of the local people.

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Perceptions of Veterinary Students and Veterinarians towards Veterinary Epidemiology and Public Health

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ABSTRACT

A cross sectional questionnaire survey was done among 105 veterinarians and 105 university veterinary students during March-May 2012 to evaluate their perceptions towards VE & PH in Nepal. The study reveled that though several modification have been made in the university curriculum for undergraduate veterinary studies, 32.86 percent opined that addition of courses on animal health & human welfare, emerging infectious diseases and food safety & security will enhance the graduate's skill in VE&PH. Similarly all veterinarians (100%) perceived the need of higher educational degree in VE&PH as well as need of more veterinary epidemiologists and public health specialist for jobs outside veterinary colleges in the country. Higher percentag (98%) of the veterinary students perceived that new veterinarians should have firm understanding of epidemiology.

Key words: Veterinary, Epidemiology, Public health, Curriculum

INTRODUCTION

Veterinary public health contributes to public health through the knowledge, skills and resources of veterinary science. This generally relates to the understanding, prevention and control of zoonotic diseases and food safety issues. The scope of veterinary public health is clearly multidisciplinary, involving not only veterinarians in public and private sectors, but also other health and agriculture professionals, communication experts and scientists as well as paraprofessionals. An interdisciplinary team approach to problem solving, research, control programmes and communication is essential for the improvement of human health in a significant and sustainable manner. Veterinary epidemiology is a holistic approach aimed at coordinating the use of various scientific disciplines and techniques during an investigation of disease or impaired productivity or even animal welfare.

Improvement and innovation in undergraduate teaching and learning requires understanding of student's perception of discipline context, content and relevance. This is particularly so for veterinary public health and epidemiology which, due to its population focus, can appear to veterinary undergraduates to be less relevant than other disciplines. At the same time, department of the government of any particular country is equally responsible for policies regarding the development of livestock sector. Until and unless the veterinary medical college students perceive VE&PH as an integral part of the national and personal liability, they will not be able to work in line with the government for attaining the national livestock development goal. Veterinary medical colleges in Nepal do not have a uniform syllabus and the values given to the core courses like medicine and surgery far exceeds the values given to para-clinical courses like VE&PH. This study was conducted to analyze the perceptions of veterinarians and university veterinary

students' towards veterinary public health and epidemiology in Nepalese context; and to compare the perception of university veterinary students at the commencement and conclusion of an epidemiology course.

METHODOLOGY

A cross sectional study design was used. There are three veterinary colleges in Nepal out of which one college has not yet produced any graduates. The Himalayan College of Agricultural Sciences and Technology, HICAST (Purbanchal University) and Institute of Agriculture and Animal Sciences, IAAS (Tribhuvan University) are the two colleges whose graduates are out in the field. The practicing veterinarians were randomly selected from various organizations such as Nepal Agriculture Research Council, Central Veterinary Laboratory, National Avian Laboratory, Department of Livestock Service, District Livestock Service Office and private veterinary clinics in two districts (Kathmandu & Chitwan). The list of veterinarians was obtained from Nepal Veterinary Association's Vet Directory. The list of students was obtained from respective veterinary colleges. The respondents were selected by simple random sampling method. Altogether 105 veterinarians and 105 veterinary students were selected. The sample sizes for this study by various institutions are as shown in Table 1.

Data were collected by using a pre structured questionnaire format. The interview format was pre-tested prior to administering to the actual respondents. Pre-testing was done at HICAST with four veterinarians and six veterinary students on 25th February 2012. Recommended adjustments were made on the interview schedule and were finalized. Veterinarians' and veterinary students' survey was carried out between 7th March to 21st May 2012. The information collected from the field was coded and entered into a computer. Separate data sets were created for responses to the veterinary student and veterinarian questionnaires. Descriptive statistics like mean, percentage and frequency were used to describe interest, experience, perception and knowledge towards VPH&E. Data entry and analysis was done using SPSS vs. 16 and Microsoft Excel vs. 7.

Table 1 Sample size distribution by institutes

Institute	Respondents		
	Vets with postgraduate or higher degree	Vets with undergraduate degree	Students of veterinary medical school
HICAST	6	15	57
NPI	2	2	0
IAAS	15	19	48
NARC	5	7	0
CVL	6	3	0
DLS	4	4	0
DLSO	1	4	0
NAL	2	1	0

Private Practice	3	6	0
Total	44	61	105

RESULTS AND DISCUSSION

Views on year of teaching VE&PH in university curriculum

Among 105 sampled veterinarians during the study 32.38 percent veterinarians expressed their view that the courses on VE&PH should be taught in fourth year of the study duration. However, around 26 percent veterinarians thought it is better to teach this subject in third year. The study revealed that only 0.95 percent veterinarian suggested the non-significance of the subjects in VE&PH (Figue 1).

Attitudes toward veterinary epidemiology and public health

The study revealed that 100 percent veterinarians strongly agreed with the notion that graduating veterinarians should be able to consider environment and other predisposing factors in addition to etiologic agents while diagnosing a disease. About 78 percent of them strongly agreed that graduating veterinarians should be aware about antimicrobial resistance to help them prescribe antimicrobials (Table 2).

On the other hand, ninety eight percent of the veterinary students perceived that new veterinarians should have better understanding of epidemiology. Similarly, 95 percent of the veterinary students agreed with the statement that knowledge in epidemiology and public health is important to perform necessary functions in the future. Only 24 percent of the student believed that we need more courses on VE&H at undergraduate level (Table 3).

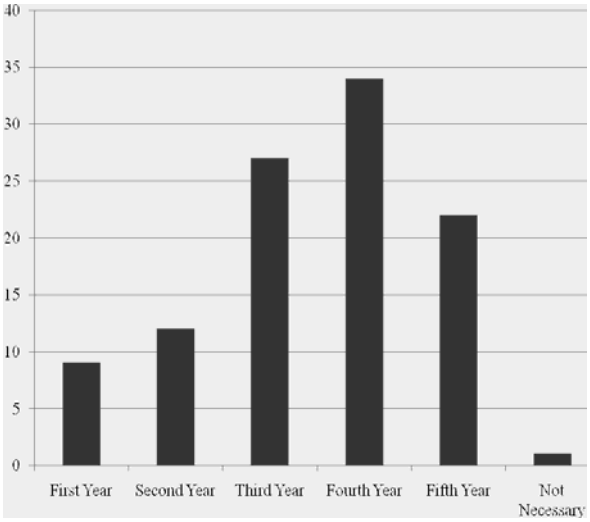

Figure 1 Number of vets suggesting the suitable study year for the courses on VE&PH

Table 2 Veterinarians with particular attitudes toward VE&PH (%)

Statements	SA	A	U	D	SD
Graduating veterinarians should have firm understanding of basic epidemiologic measures of diseases including incidence, prevalence, odds and risk ratios.	69.6	30.4			
Graduating veterinarians should be able to consider environment and other predisposing factors in addition to etiologic agents while diagnosing a disease.	84.8	15.2			
Graduating veterinarians in Nepal currently get enough understanding of epidemiology, public health and zoonoses to competently work in the field.		6.5	37	37	19.5
Graduating veterinarians should be aware about antimicrobial resistance to help them prescribe antimicrobials.	78.3	21.7			
Graduating veterinarians need a thorough knowledge of food hygiene to advise farmers to produce safe milk and meat.	69.6	30.4			
Veterinarians are the most influential people to train farmers about zoonotic and public health issues.	63	37			
Representation of veterinarians in national level public health programs is very low.	45.7	37	17.4		

Key: SA-Strongly Agree, A-Agree, U-Unsure, D-Disagree, SD-Strongly Disagree

This might be due to the reason that these days more and more students are either attracted for abroad studies after graduation or they are likely to prefer courses on small animal practice, medicine and clinics rather than food animal and herd health management.

Reports across the world also predict a shortage of veterinarians trained to address the future needs of public health (Fostgate 2008). The opportunities for VPH are boundless, but the challenge is to be able to apply the plethora of available research results and knowledge. What we will need is a new breed of veterinarians who will lead and provide us with a vision (Arambulo 2008).

Table 3 Necessity for betterment of VE&PH as perceived by vet students, %

Statements	Yes	No	Unsure
Knowledge in epidemiology is important to perform necessary functions by a veterinarian	95	3	2
Knowledge in public health is important to perform necessary functions by a veterinarian	95	3	2

I would go for higher degree in public health or epidemiology if I get an opportunity to study	65	16	19
New veterinarians should have firm understanding of epidemiology	98	2	
New veterinarians should have firm understanding of public health	89	11	10
New veterinarians should have understanding of food hygiene to advice clients for food safety issue	81	10	9
We need more courses in public health in BVSc&AH curriculum	24	62	14
We need more courses in epidemiology in BVSc&AH curriculum	27	62	14
We have enough veterinarians to teach public health in our veterinary college	40	25	35
We have enough veterinarians to teach epidemiology in our veterinary college	24	41	35
We need higher degree programs (MS, PhD etc.) in public health in Nepalese colleges.	57	9	34
We need higher degree programs (MS, PhD etc.) in epidemiology in Nepalese colleges	60	12	28
Higher degrees (MS, PhD etc.) in Nepalese colleges can address our needs better than that by foreign universities	58	21	21
We need more epidemiologists for the jobs outside the veterinary college (eg government, NGOs)	61	20	19
We need more public health experts for jobs outside veterinary college (eg government, NGOs)	60	12	28

The Association for Veterinary Epidemiology and Preventive Medicine (AVEPM) seeks to heighten awareness of issues in veterinary epidemiology and public health education among veterinary educators through various forums, symposia, and workshops. Key historical events, disease outbreaks, and individuals responsible for their control are reviewed and serve as a foundation for understanding the current and future efforts in veterinary public health. Animal medicine and veterinary public health have been intertwined since humans first began ministrations to their families and animals (Steele 2008). As seen in this study, 63 percent of the veterinarians and 60 percent of the veterinary students believed that veterinarians are the most influential people to train the farmers about zoonotic and public health issues. Similar reports have been made globally by various authors where they opine that veterinarians have a unique ability to bridge the fields of human and animal medicine and agriculture because of their education in comparative medicine. The veterinary profession deals not only with the animal as an individual but also with the herd health and zoonotics (Fostgate 2008, Kelly & Marshak 2007, Walsh et al 2003, Baker et al 2006, and Noah & Crowder 2002). Undergraduate and postgraduate training courses must promote a greater understanding of the importance of zoonoses and of how to investigate and control them. A good example has been seen at Auburn University, USA where they have been able to increase the students' exposure to the role of the veterinarian in public health and to develop a dual-degree DVM/MPH programs to augment their training in public practice (Wenzel et al 2008).

Though outside the scope of this report, some report suggest that around 20 percent of the students will change their career focus during their veterinary education (Becker 2003) so we can expect some subtle changes in the personal

career choice but the study still reveals that as 45.7 percent of the veterinarians and 73.3 percent of the veterinary students strongly agree in the notion of poor representation of the vets in national level public health programmes, we can expect more veterinary students choosing this line of career in future.

CONCLUSION

Both groups of the respondents, the veterinarians as well as the veterinary students, believed that the third and fourth year are the best time for including VE&PH in veterinary curriculum opf the college.

Most of the veterinary students perceived that knowledge in epidemiology and public health is important to perform necessary functions in the future.

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Prevalence of Campylobacter in Meat and Caecum of Broiler Poultry in Kathmandu Valley

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ABSTRACT

A total of 102 samples were collected for the isolation and identification of 3 different species of campylobacter viz. Campylobacter coli, Campylobacter lari, Campylobacter jejuni of which 52 were caecal samples and 50 were meat

samples. Out of 102 samples collected, the overall prevalence rate of Campylobacter spp. was 94.6 percent. Out of the total positive meat samples, C. coli, C. lari and C. jejuni were found to be 48.57%, 37.14%, and 5.71%, respectively. In case of the caecal samples, C. coli, C. lari and C. jejuni were found to be 48.83%, 37.20% and 11.62%, respectively.

Key words: Anaerobic organism, Infection, Contamination, Public health

INTRODUCTION

Campylobacter are spiral-shaped, Gram's negative, anaerobic organisms positive to catalase and oxidase. *C. jejuni* has a great zoonotic and public health significance. Freezing and drying reduces the number of campylobacter on raw meat. Birds infected with campylobacter may remain as carrier without becoming ill where as *campylobacteriosis* in human is accompanied by diarrhea, cramping, abdominal pain and fever. Contamination of broiler carcass possesses great risk for the pediatric human patients with *Campylobacter* infections (Paudyl 2009). Meat produced under unsanitary condition involving caecal contamination is likely to harbor *Campylobacter* (Humphrey et al 2007). Increasing rate of consumption of broiler meat is a positive sign for commercialization of poultry. Guided by vastly increasing demand of poultry meat, large number of poultry slaughter houses is functional in Kathmandu valley without proper scientific management and approach. Such unmanaged poultry meat production possesses a great public health hazard to the consumers of Kathmandu Valley.

MATERIALS AND METHODS

The present study was carried out at NARC, Khumaltar, Lalitpur. All the methodologies followed were as suggested by OIE. A total of 50 meat samples and 52 caecal samples were collected randomly from different slaughter houses and poultry dressing units of Kathmandu, Bhaktapur and Lalitpur districts. Autoclaved scissors, forceps and blades were used for sampling of caecum and meat. Samples were collected in sterilized 5x4 zipped plastic bags. Since the organisms are thermophilic, ice box were not used during the transportation.

For the processing of samples, 1 g of caecal content and 1 g of triturated meat were dipped in separate serum vials containing Preston enrichment broth along with Campylobacter supplement II (Butzler, FD 007-5VL). The serum vials were placed in an anaerobic jar containing gas packs; and were incubated for 48 hours at 42^0C. Following the incubation for 48 hrs the content of serum vials were streaked in a continuous fashion in Campylobacter selective agar prepared by using Blood Free Campylobacter Selective Agar Base and CAT selective supplement (FD 145). It was then again incubated at 42^0C for 48 hours

maintaining anaerobic condition.

Figure 1 Growth obtained in CCDA agar

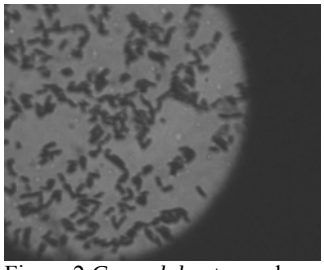

Figure 2 *Campylobacter* under 100 X magnification

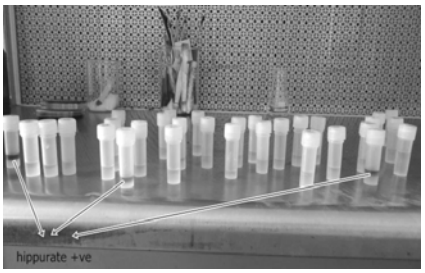

Figure 3 Hippurate hydrolysis Positive test

Colonies showing characteristic Campylobacter colonies were selected and for Gram's staining and were observed under 100X magnification

Biochemical tests were performed in the colonies obtained. Primary biochemical test conducted were catalase, oxidase, hippurate hydrolysis and indole acetate hydrolysis. Differentiation of various subspecies was based on the result obtained from hippurate hydrolysis and indole acetate hydrolysis tests. *C. jejuni* is positive to both the tests where as *C. coli* is positive to indole hydrolysis test only. *C. lari* is negative to both the tests.

The prevalence (P1) was measured as follows:

$$P1 = \frac{\text{Total number of Campylobacter cases observed}}{\text{Total number of caecal / meat samples analyzed}} \times 100$$

RESULTS AND DISCUSSION

Out of 102 samples the overall prevalence rate of *campylobacter* was 94.67

percent, which is supported by the statement of WHO that the reported incidence of *campylobacteriosis* in most developing countries has risen during the past 20 years, and specially since 1990 (WHO 2008).

Subspecies	Prevalence in meat, %	Prevalence in caecum, %	Overall prevalence, %
C. coli	48.57	48.83	48.70
C. lari	37.41	37.20	37.30
C. jejuni	5.71	11.62	8.67
Unclassified	8.50	2.30	5.40

Above 91 percent prevalence of *Campylobacter* in meat and 97 percent in caecum was found in this research, which differed with 38.26 percent prevalence in caecum as reported by Poudyl (2009) in a research conducted in Chitwan which may be due to the difference in poultry management system adopted in the areas where the study was conducted.

Prevalence of *C. coli, C. lari* and *C. jejuni* in meat samples were found to be 48.57 percent, 37.41 percent and 5.71 percent, respectively (Table 1). The findings differed from 2.85 percent (C. *coli*) and 11.12 percent (*C. jejuni*) as reported by (Singh et.al. 2009). The difference is obvious as the comparison involved two different countries with different epidemiological patterns for the diseases.

Prevalence of *C. coli, C.lari* and *C. jejuni* in caecum were observed to be 48.83 percent, 37.20 percent and 11.62 percent, respectively (Table 1). This report coincides with Saleha (2002) who reported prevalence of 73.2 percent, 26.8 percent for *C. jejuni,* and *C. coli,* respecitively. The greater prevalence of *C. jejuni* and *C. coli* in comparison to present report may be because the study was conducted at farm level.

In the People's Republic of China, Chen et al (2010) has reported 14 unclassified *Campylobacter* isolates among 275 positive isolates. However, none of the other authors have reported the findings of unclassified isolates, which in this study, was found to be 8.5 percent and 2.3 percent in meat and caecum, respectively (Table 1).

Table 1 Prevalence of various species of *Campylobacter*

CONLCUSION AND SUGGESTION

Higher prevalence of *Campylobacter* in meat samples suggests poor hygienic practice during the meat processing; and higher prevalence of *Campylobacter* in caecum suggests higher infection of chickens at farm level. Since the *Campylobacter* are already present in our flocks we need to take necessary

measures to control their colonization in the intestine. As far as applicable, other management tools and modified practices rather than antibiotics must be used to control *Campylobacter.*

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