Production potentials of promising oat (*Avena sativa*) varieties in combination with legumes at farmers' field condition

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ABSTRACT

Winter fodder scarcity is one of the major problems in feeding management for ruminants in Nepal. Some of the improved fodders are introduced at farmers' level but appropriate technology is not yet established. Moreover there is a risk of fluctuation in the production potential of such fodder due to climatic variability across the location. Three trials were conducted across the three locations of Chitwan, Gorkha and Tanahu district of Nepal to estimate production potentials of two varieties of fodder oats (Avena sativa)in combination with field pea (Pisum sativum) and vetch (Visia sativa) . Six treatments were used; each replicated for four times in a RCBD. Fresh herbage mass and dried weight was estimated along with number of tiller per plant and determination of major chemical constituents. Findings revealed that highest dried matter yield (t/ha) was obtained in Gorkha and Chitwan district (7.0 t/ha) that varied significantly (P<0.001) with respect to the location whereas treatment differences remained statistically similar indicating similar performance of the varieties across the location. Likewise, except %CP there was significant variation in the % content of EE, ADF, NDF and ADL among the sites/location whereas such variation was statistically similar for treatment combination that fairly suggest the differences in quality of fodder as per their productive performance. Findings clearly suggests the need to consider niche specific variation while promoting improved cultivation practices of oats in combination with promising forage legumes. This could equally be linked to the climatic parameters such as total rainfall received, while making efforts in improvement in the quantity herbage harvest.

Keywords:, Vetch, field pea, Dried Weight, herbage mass, forage legumes,

INTRODUCTION

Winter feed deficit is one of the critical problems related to ruminant production in Nepal whereas quality feeding management considering leguminous as well as non-leguminous fodder cultivation (Upreti and Shrestha, 2006; Upreti and Upreti, 2013) is grossly lacking. Oats are considered most important cereal fodder crop grown in Nepal during the winter season. Oats are quick growing, palatable, succulent and nutritious (Suttie and

Reynolds, 2004) and form an excellent combination when fed along with other winter season grasses such as berseem, lucerne, pea, and vetch. They have many uses: a cereal, a feed grain (to feed horses, sheep and poultry), green or conserved fodder. In Nepal, fodder oats have been under testing since 1970s, but the two cultivars Kent and Swan were distributed to relatively large numbers of farmers, especially after 1980s. Usually oat is an erect annual with a fairly good tillering habit. It attains a height of 1-2 m. The panicles are lax and effuse. The inflorescence may be equilateral or unilateral. The main axis and lateral branches end in a single apical spikelet. The grain is long and slender or spindle shaped and usually covered with fine hair at the upper end. The leaves may have a length of 25 cm and more. Roots are fibrous (Relwani, 1979).

In spite of its advantages to grow as winter fodder- farmers have not been cultivating oats widely due to several factors associated with it. This necessitate establishing demonstration block of promising winter fodder cultivation at the farmers' field so that demonstration effect of cultivation practices and dry matter yield potential of fodder, such as oats (Relwani, 1979; Suttie and Reynolds, 2004), would help farmers in convincing towards opt of these practices. Better nutrition through low cost fodders would help farmers in reducing per unit milk production and way out the path towards their ability in adapting harsh condition that may prevail due to alteration in climatic parameters that are associated with feeding management in Nepal. Accordingly a field trial was conducted in three research sites of Gorkha, Tanahu and Chitwan with the objective to establish demonstration unit at farmers' field by using promising fodder oats and legumes, and to demonstrate cultivation practices and fodder yield potentials in terms of dry matter and chemical composition.

MATERIALS AND METHODS

Experimental site and duration

The field experiments were conducted at Farmers' field condition in three districts, viz: Gorkha, Tanahun and Chitwan during November 2012 to March 2013. Palungtar, Gorkha district is situated approximately 148 kilometer North of Dumre Bazar-lies in the Kathmandu-Pokhara Highway. Dulegauda, Tanahun district lies about 28 km west to Pokhara and represent inner flat plain valleys with the foot hills towards the North. Chanauli-Gunjanagar of Chitwan district represent sub-tropical inner Terai region of southern part of central part Nepal, situated between 83°48’ to 84°45’ east longitude to 27°21’ to 27°46’ north latitude, and is 228 meter above sea level.

Design: Randomized Complete Block Design; each treatment replicated for 4 times. Each treatment was sown using 6 meter square of area. All together there were 24 experimental units, each with 3× 2 meter square area.

Treatments:

a. Oats variety Kamadhenu (a)
b. Oats variety Netra (b)
c. Oats 'a' + winter vetch in combination
d. Oats 'a' + field pea in combination

e. Oats 'b' + winter vetch in combination
f. Oats 'b' + field pea in combination

Seed rate: Seed rate was used as -oats: @90 kg/ha; vetch @8-10 kg per ha in mixture with oats; pea-@30 kg per ha in mixture with oats was used.

Fertilizer: Organic manure was applied as @10 t Farm Yard Manure/ha. Nitrogen and phosphorus fertilizers were applied @120:40 kg/ha considering a double cut crop (80 kg nitrogen as basal and 40 kg nitrogen for top dressing after the first cut). Accordingly, DAP 52 g +Urea 84 g per plot of $6m^2$ was applied as basal dose, and urea was applied as 24 g per plot as top dressing.

Seeds were sown during first week of November (after rice harvest). Spacing was maintained as: Row to row: 25 cm; legumes in between rows in a continued fashion

Climate

The experiment sites lies in the subtropical humid climate zone of Nepal. The mean monthly meteorological data (maximum and minimum temperature and total rainfall) covering the experimental period was taken from the daily record of National Maize Research Program (NMRP) at Rampur, located about 300 m away from experimental site for Chitwan Chanauli site whereas similar information was obtained from Weather Station at Khairanitar, Tanahun as a nearby weather station for Gorkha and Tanahun site. Temperature and total rainfall during the experiment period has been illustrated in Figure 1.

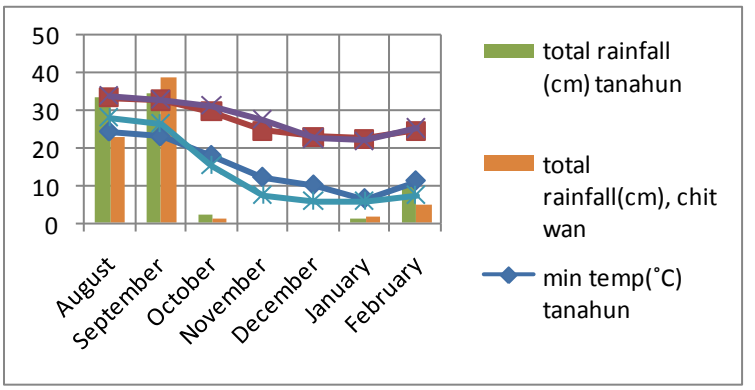

Figure 1. Rainfall (in cm) and temperature (Celsius) at around the research site, 2012/13

RESULTS AND DISCUSSION

Physico-chemical properties of soil

The chemical properties of experimental sites revealed that soil pH varied as per site. pH in the Chitwan was low which denotes the strongly acidic (5-5.5 strongly acidic) condition of soil whereas it was slightly alkali in the case of Tanahun and Gorkha. The

available organic matter % was medium in all sites so as the N content. On the other hand available phosphorus and potash in all the sites was medium to high. Available phosphorus was relatively low in the Tanahun whereas it was higher in the case of Tanahun followed by in the Gorkha (Table1).

Table1.The Physico-chemical characteristics of soil (0-15cm) at the experimental site in 2012

Site	pH	OM%	N%	P_2O_5 (Kg/ha)#	K_2O (Kg/ha)#	Physical properties			Remarks
Chitwan						% Sand	% Silt	% Clay	
	5.5	2.86	0.12	347.5	493.9	47	42.5	10.5	Loam
Tanahun	7.8	2	0.1	80.08	117.1	17	68.5	14.5	Silt Loam
Gorkha	8	2.6	0.12	268.9	126.2	17	70.5	12.5	Silt Loam

Note: # denotes available phosphorus and potash

Fresh and dried fodder yield

Table (2) presents fresh and respective dried yield of the treatments. Trends of fresh fodder yield (t/ha) was such that it increased from first to second harvest in general. Fresh fodder yield in Tanahun was the lowest whereas treatments variation was non-significant ($P>0.05$) whether they be mixed with vetch or peas or grown as oats alone (Table 2). Variation in fresh fodder yield could be attributed to the several factors including rainfall that was higher during September in Chitwan compared to the Tanahun and Gorkha. % OM and available P_2O_5 content in the Chitwan was also higher compared to the rest of the sites (Table 1). MOAC-DLS (2065/66BS) reported that general fresh yield of oats could be 30-50 t/ha that the results of this experiments matches well to the value reported. Pariyar (2002) had reported that results from the leasehold district in Nepal had yielded 25-31 t/ha of fresh herbage mass of oats grown in combination with vetch and pea. Findings from this experiment revealed possibility of further increment in the fresh yield to the value reported by Pariyar (2002) that could be varied as per district and local sites.

The trend in dried yield of treatments considering district variation was similar to that of fresh herbage mass yield (Table 2). Accordingly total dried yield of fodder varied significantly ($P<0.01$) to the districts whereas treatment combination remained statistically similar. Highest total dried yield was for Gorkha and Chitwan (7.6 t/ha) followed by Tanahun. In terms of treatments as well Netra (6.4 t/ha) alone or in combination with vetch had highest dried yield but the statistically it was similar ($P>0.05$) to the other treatments (Table 2). Detail of fresh weight of fodder as well as respective dried weight as per districts for different harvests has been presented in Table (3) and (4).

Table2. Fresh fodder yield and corresponding Dried yield by location and specie combination

Factors	Fresh fodder wt. (t ha^{-1})				Dried wt. (t ha^{-1})			
	I harvest	II harvest	III harvest	Total fresh fodder	I harvest	II harvest	III harvest	Total dried fodder
Locations								
Chitwan	13.92	27.29	-	41.41	1.91	5.12	-	7.03
Gorkha	10.79	12.96	17.67	41.42	2.07	2.07	3.53	7.68
Tanahun	17.38	10.71	-	28.08	2.08	1.65	-	3.73
F-prob	<0.001	<0.001	-	<0.01	NS	<0.001	-	<0.001
LSD	2.22	5.49	-	6.00	0.31	0.66	-	0.91
Species combinations								
Kamdhenu	12.42	18.75	17.54	37.00	1.79	3.11	3.34	6.01
Netra	13.29	18.67	17.54	37.79	1.95	3.23	3.66	6.41
Kamdhenu+Vetch	13.67	16.33	17.91	36.00	1.99	2.93	3.45	6.07
Kamdhenu+Pea	14.08	16.83	18.64	37.25	2.04	3..04	3.78	6.35
Netra+vetch	15.62	16.83	17.18	38.12	2.19	2.76	3.59	6.15
Netra+Pea	15.08	15.50	17.18	36.25	2.18	2.59	3.34	5.87
F-Prob	NS	NS	NS	NS	NS	NS	NS	NS
LSD	2.21	3.34	2.33	4.04	0.33	0.66	0.53	0.77

Table 3. Treatments combination and fresh weight of fodders, t ha^{-1}, using Split plot design

Factors	Chitwan			Gorkha				Tanahun		
Treatments	I Harvest	II Harvest	Total	I Harvest	II Harvest	III Harvest	Total	I Harvest	II Harvest	Total
Kamdhenu	12.38	31.25	43.62	9..00	11.75	17.50	38.25	15.88	13.25	29.12
Netra	14.00	30.50	44.50	10.50	13.00	17.50	41.00	15.38	12.50	27.87
Kamdhenu+Vetch	10.75	28.00	38.75	11.75	13.00	18.00	42.75	18.50	8.00	26.50
Kamdhenu+Pea	12.75	27.50	40.25	11.50	14.00	19.00	44.50	18.00	9.00	27.00
Netra+Vetch	17.38	25.25	42.62	11.50	13.50	17.00	42.00	18.00	11.75	29.75
Netra+Pea	16.25	24.25	40.50	10.50	12.50	17.00	40.00	18.50	9.75	28.25

First harvest: The interaction effects were not significant ($p>0.05$) with SEM=1.35, LSD=3.95, %CV= 19.2

Second harvest: The interaction effects were not significant ($p>0.05$) with SEM=2.44, LSD=7.08, %CV= 23.

Third harvest: The interaction effects were not significant ($p>0.05$) with SEM=1.34, LSD=4.04, %CV= 6.6

Total fresh biomass: The interaction effects were not significant ($p>0.05$) with SEM=2.84, LSD=8.17, %CV= 13.3

There was a visible difference in dried weight of different treatments of oats in combination with peas and vetch (Figure 2). Accordingly all the treatments had higher yield in Chitwan followed by in Gorkha and Tanahun. Lower yield of treatments in Tanahun was due to short cropping period in Tanahun where only two cuts was possible as farmers had to continue with other food crops after second harvest. Nevertheless the oat variety 'Netra' had relatively better performance than the other (Figure 2).

Table 4. Treatments combination and dried weight of fodders, t ha^{-1}, using Split plot design

Factors	Chitwan			Gorkha				Tanahun		
Treatments	I Harvest	II Harvest	Total	I Harvest	II Harvest	III Harvest	Total	I Harvest	II Harvest	Total
Kamdhenu	1.82	5.44	7.25	1.74	1.83	3.36	6.92	1.82	2.05	3.87
Netra	1.99	5.68	7.76	1.99	2.06	3.68	7.74	1.86	1.95	3..81
Kamdhenu+ Vetch	1.51	5.57	7.09	2.25	2.02	3.43	7.71	2.22	1.19	3.41
Kamdhenu+ Pea	1.74	5.11	6.85	2.14	2.45	3.84	8.43	2.23	1.56	3.79
Netra+Vetch	2.29	4.66	6.95	2.17	2.02	3.60	7.79	2.10	1.62	3.72
Netra+Pea	2.12	4.23	6.35	2.17	2.05	3.29	7.51	2.25	1.52	3.76

First harvest: The interaction effects were not significant ($p>0.05$) with SEM=1.35, LSD=3.95, %CV= 19.2

Second harvest: The interaction effects were not significant ($p>0.05$) with SEM=2.44, LSD=7.08, %CV= 23.

Third harvest: The interaction effects were not significant ($p>0.05$) with SEM=1.34, LSD=4.04, %CV= 6.6

Total fresh biomass: The interaction effects were not significant ($p>0.05$) with SEM=2.84, LSD=8.17, %CV= 13.3

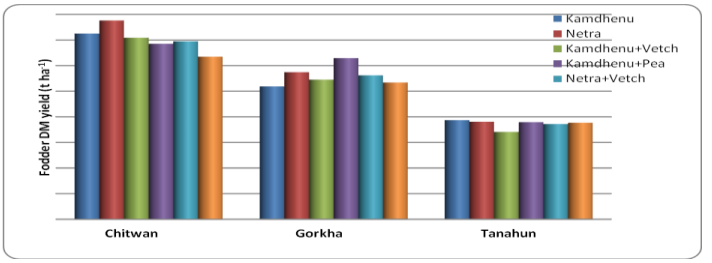

Figure 2. Fodder dry matter yield of different treatments in different locations

Chemical constituents

The nutrient composition of fodders at second harvest is presented in Tables 5 and 6. Dry matter content of fodder at Gorkha was significantly higher compared to Tanahun and Chitwan ($p<0.001$). There was no significant difference in crude protein (CP) content in all the three sites testes. Upreti and Upreti (2013) reported the CP value of oats in general as of 11.6%, whereas in this experiment the values in all the three sites tested was 5.9%. It could be due to its late stage of harvest.

Table 5. Chemical constituents as per treatments at second harvest

Factors	% chemical constituents							
	DM	CP	EE	T Ash	Ca	NDF	ADF	ADL
Locations								
Chitwan	93.06	5.70	3.10	13.18	0.80	64.87	52.22	7.06
Gorkha	95.91	5.97	4.58	10.92	0.89	66.33	55.90	12.14
Tanahun	95.28	5.03	3.15	13.59	0.99	53.64	41.53	5.03
F-prob	<0.001	NS	<0.001	<0.001	NS	<0.001	<0.001	<0.01
LSD	0.40	1.50	0.36	0.82	0.22	2.30	3.03	2.73
Species combinations								
Kamdhenu	94.52	5.44	3.60	12.28	0.78	61.32	49.24	6.47
Netra	94.59	4.46	3.72	12.53	1.06	63.33	53.04	10.57
Kamdhenu+Vetch	94.81	5.42	3.91	13.24	0.85	58.54	46.58	7.70
Kamdhenu+Pea	94.50	6.06	3.73	12.79	0.94	61.58	50.02	8.64
Netra+vetch	94.87	6.95	3.47	12.33	0.84	62.52	51.82	8.67
Netra+Pea	95.21	5.08	3.22	12.21	0.93	62.37	48.59	6.40
F-Prob	NS	<0.001	NS	NS	NS	NS	NS	NS
LSD	0.88	1.03	0.50	1.19	0.29	3.53	5.13	4.39

The ether extract (EE) content varied significantly from site to site ($p<0.001$) so as the total ash, NDF, ADF and ADL. There was no difference in Ca content amongst the three sites (Table 5). NDF, ADF and ADL values were similar to the values reported by Upreti and Upreti (2013) with slighter higher values in this experiment. ADL content in Gorkha was slightly higher than the other sites and also to the values reported by Upreti and Upreti (2013). ADL content in Gorkha could have been attributed to the lower rainfall in the sites and also due to relatively dryness in the site. These values as per treatment combination, however, were not statistically significant ($p>0.05$), except CP content whereas CP content of treatments varied statistically ($p<0.05$) and it was highest for Netra plus vetch (Table 5). Detail of % chemical constituents as per treatments combination and sites has been presented in Tables 6 (a, b).

Table 6a. Nutrient composition at second harvest (CP, EE, T Ash and Ca)

Fodder species/Locations	CP			EE			T Ash			Ca		
	Cht	Gkh	Tan	Cht	Gkh	Tan	Cht	Gkh	Tan	Cht	Gkh	Tan
Kamdhenu	2.94	7.82	5.55	2.74	4.82	3.26	12.82	11.74	12.29	0.81	0.91	0.62
Netra	3.01	5.94	4.44	3.26	5.22	2.69	13.18	9.69	14.72	0.98	1.14	1.06
Kamdhenu+Vetch	6.68	5.44	4.14	3.22	5.30	3.22	13.51	12.55	13.65	0.89	1.09	0.57
Kamdhenu+Pea	6.99	6.50	4.70	2.96	5.23	3.00	12.95	10.48	14.93	0.89	0.86	1.07
Netra+Vetch	7.53	6.84	6.47	3.18	3.61	3.62	13.85	10.55	12.61	0.56	0.67	1.28
Netra+Pea	7.03	4.31	4.90	3.27	3.29	3.09	12.80	10.50	13.32	0.68	0.72	1.39

Note: CP: The interaction effects were significant ($p<0.001$); SEM=0.72, LSD=2.07, %CV= 22.5

EE: The interaction effects were significant ($p<0.001$); SEM=0.31, LSD=0.87, %CV= 16.9

T Ash: The interaction effects were not significant ($p>0.05$); SEM=0.70, LSD=1.99, %CV= 11.5

Ca: The interaction effects were significant ($p<0.05$) SEM=0.17, LSD=0.49, %CV= 28.9

Table 6b. Chemical composition of major nutrients at second harvest (NDF, ADF and ADL)

Fodder species/Locations	NDF			ADF			ADL		
	Cht	Gkh	Tan	Cht	Gkh	Tan	Cht	Gkh	Tan
Kamdhenu	64.77	63.79	55.40	50.72	55.84	41.16	6.38	8.04	4.99
Netra	66.05	69.99	53.96	52.57	60.59	45.97	6.26	21.27	4.20
Kamdhenu+Vetch	62.98	61.91	50.70	49.82	49.94	39.99	6.02	13.19	3.89
Kamdhenu+Pea	65.27	65.28	54.19	56.19	50.82	43.06	6.45	12.08	7.40
Netra+Vetch	65.55	68.75	53.27	51.05	63.21	41.20	10.32	10.81	4.78
Netra+Pea	64.60	68.23	53.30	52.98	55.00	37.79	6.91	7.42	4.86

Note: NDF content: The interaction effects were not significant ($p>0.05$); SEM=2.07, LSD=5.87, %CV= 7.0; ADF: The interaction effects were not significant ($p>0.05$); SEM=2.98, LSD=8.46, %CV= 12.5;
ADL content: The interaction effects were not significant ($p>0.05$); SEM=2.56, LSD=7.27, %CV= 26.1

CONCLUSIONS

There is a need to consider niche specific variation while promoting improved cultivation practices of oats in combination with promising forage legumes. This could equally be linked to the climatic parameters such as total rainfall received while making efforts in improvement in the quantity herbage harvest.

The findings revealed lesser variation of the popular oats varieties - Netra and Kamadhenu whereas role of legumes was minimal in contributing to the total herbage mass. This fairly suggests the need to explore better performing legume species to be suited with oats in combination.
There were differences in quality of fodder in relation to the major chemical constituents that varied according to the sites. This also emphasizes the need to consider proper harvesting management to address the particular production scenario of a locality.

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