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Effects of corn-pea mixture and harvesting days on forage yield and quality

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The objective of this study was to assess the effect of mix-cropping, Yangtsepa corn variety with legume Sesbania, and single cropping on the forage yield and quality at 60-, 90-, and 120-days harvest. Randomized Complete Block Design (RCBD) with three replications was used as an experimental design. The corn and pea were line sown at 20 cm apart with a seed ratio of 50:50. The results showed higher corn forage yield (26.1 t/ha), and dry matter of 23.83% at 120-day harvest. The overall mean crude protein at 60 and 90-day harvest was significantly higher in the mixed than single cropping. The soil moisture and nitrogen corn crude fiber dry matter and stem yield increased with an increase in harvesting days. Soil N_2, corn DM, and ash were significantly higher ($p < 0.05$) in mixed cropping compared to single cropping in which the highest corn forage yield, corn DM, and soil N_2 were found at a 120-day harvest in mixed cropping. There was significantly higher overall mean CP content in mixed cropping than single cropping at 60- and 90-day harvests ($p < 0.05$) with the highest corn CP of 9.05% at 90-day harvest. Similarly, weed biomass was significantly lower ($p <.05$) in mixed than in the single cropping which proved that Sesbania competed with weeds for basic needs like light and nutrients for growth and yield. Thus, legumes with corn can be a comparatively better choice to reduce weeds, and improve soil nutrients, forage yield, and quality.

Key words: Crude fiber, crude protein, dry matter, forage yield, mixed cropping.

INTRODUCTION

Among livestock production systems, dairy farming is gaining momentum in Bhutan with a total cattle population of 303,250 which is 19.07% of the total livestock population and livestock products mainly include milk (83.57%), cheese (7.14%), butter (3.41%), beef (0.83%), Chugo (0.24%), and yak meat (0.22%) (Department of Livestock [DoL], 2017). However, over the years there was rapid development in livestock production in which 72% of the farmers across all agronomical ecological zones within the country have moved into a semi-commercial mode (5-15 cows) with the exception of marginal farmers constrained by inadequate resources despite their curiosity of escalating the farm (Tamang and Gyeltshen, 2015). Consequently, due to limited land and fodder resources in the country farmers have started to address fodder shortage by integrating forage production in field crops and horticulture system (Dorji et al., n.d.; Wangchuk and Tashi, 2008).

Increased livestock production leads to the

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manufacture of an abundant amount of better quality forage which is a pre-requisite for an effective and prolific livestock industry (Iqbal et al., 2006). Bhutan is a small mountainous country with only 8% of the country suitable for arable agriculture and 70% of the fodder needs are contributed by permanent grasslands, forest grazing, and grazing of the fallow land (Roder et al., 2001). Farmers with insufficient agricultural land and numerous cultivation practices are affected due to limited land in the country (Tamang and Gyeltshen, 2015). Killebrew and Wolff (2010) reported that for massive yield farmers around the world have progressively practiced single cropping with insufficient fertility and continuous deprivation of soil nutrients which resulted in a negative effect on soil quality and biodiversity. Increased livestock production leads to the manufacture of an abundant amount of better quality forage which is a pre-requisite for an effective and prolific livestock industry (Iqbal et al., 2006).

Intercropping maize with legume species especially Sesbania was found to have positive interaction in providing a higher yield and improving soil nutrient levels compared to other legumes which included cowpea and bean intercrops (Ibrahim et al., 2014). A scientific confirmation on intercropping would provide the most viable system of forage production for farmers, especially in a less arable and mountainous country like Bhutan. Therefore, this study was carried out with the objective to assess the effect of different harvesting days on forage yield and quality of corn, and to assess the effects of corn-pea mixture on forage yield, quality, and soil nutrient level.

MATERIALS AND METHODS

Study area

The field trial was initiated on the 8th of July 2019 at the College of Natural Resources (CNR) farm which is located at Tshokana, Barp Gewog, Lobesa under Punakha Dzongkhag, Bhutan. The latitude of the area ranged from 27°31' N to 27°40' Nand longitude of 89°45' E to 89° 57'E with the clayey red to brown soil located in the Walakha region at Lobesa along the Punatsangchu river bank (National Soil Services Centre of Bhutan [NSSC], 2003). The area as per Lhendup et al. (2009) is located at 1450 masl of altitude with 75.5% atmospheric humidity and 883 mm of precipitation annually. The annual mean temperature was 26.88°C in 2009 and 14.94°C in 2003 compared to the annual mean temperature of 12.68°C recorded in 1992 with the maximum annual mean rainfall of 70.82 mm recorded in 2002 and minimum of 44.77 mm in 2004 which showed that from 2004 onwards annual mean rainfall has been decreasing and it was only 50.94 mm in 2009 (Mukhia et al., 2011).

Experimental design

Randomized complete block design containing three replications was used as the experimental design (Iqbal et al., 2012; Mut et al., 2017) in an overall size of 10 m×12 m plot whereby spacing between replicates and plots were kept 2 and 0.5 m, respectively. There were 18 treatments arrangement of corn: legumes mix plot and corn as control plots (Banik et al., 2006), with the random and unbiased allocation of three harvesting days (HS) including HS1 (harvest at 60 days after sowing), HS2 (harvest at tasseling stage) and HS3 (harvest at 30 days after tasseling). The crops were harvested manually with a sickle (Contreras-Govea et al., 2009; Iqbal et al., 2006).

Land preparation and sowing

The corn (Yangtsepa) and legume (Sesbania) were sown at recommended seed ratio of 50:50 (Asangla and Gohain, 2016; Ayub et al., 2008; Ibrahim et al., 2014; Iqbal et al., 2006) with 65 kg/ha of rate of seeding. The maize seeds were sown 3 to 4 cm below the soil surface (Ayub et al., 2008). In both intercropping and single cropping, 20 cm space between the crops was found to be better compared to 30 cm spacing between the rows (Banik et al., 2006). Relay cropping was done whereby the corn seed was line sown at a distance of 20 cm between the plants and broadcasting of the Sesbania seed after 14 days. Fertilizer application of Single Super Phosphate (SSP) at the rate of 150 kg/acre as the basal dose was done for each plot. Weeding was done during the initial establishment of the plants and after each harvesting day. There was timely monitoring of pests and diseases of the plants and the field was watered based on its requirements. All the field practices were kept similar during the entire experimental period.

Data collection

Soil sample collection

The soil samples (300 g) were collected before planting and after each harvest using a different pattern of plus, multiplication, and zig-zag from the plot which was cleared of debris and weeds by soil auger. The soil samples dug from 15 to 20 cm (as root systems are mainly distributed at this soil depth) depth was combined, thoroughly mixed in a bucket, and air-dried in a ventilated room (Hauggaard-Nielsen et al., 2009), which was taken for Organic Matter (OM), pH, N_2, P and K analysis at CNR laboratory (Banik et al., 2006; Mthembu et al., 2017).

Plant height measurement

The height of the plant was measured using a measuring tape whereby 10 plants from each plot were selected randomly. The plant height was measured in centimeter (cm) from the base of the plant till the tip of leaf emerging node.

Plant density measurement

Frame size of 0.5 m×0.5 m was prepared which was thrown randomly by hands four times per plot. Thereafter, the plant numbers in each frame were counted manually by hand.

Species composition within plots

Bulk plants from four frames which were placed randomly by hand was cut and measured from each replicated 18 plots using a spring balance. After measuring the total biomass production of maize and pea in the mixture was separated whereby leaves and stems were weighed for each plot.

Leaf-to-stem ratio

There was manual hand separation of leaves and stems for maize

Table 1. Means of soil moisture (SM), organic matter (OM), and pH after different harvesting days and cropping types.

Soil sampling intervals	MC (%) N=18		OC (%) N=18		Ph (H_2O) N=18	
	SC	MC	SC	MC	SC	MC
60 days	1.01	1.21[a]	1.83	2.52[a]	6.76	6.78[a]
P Value						
90 days	1.21	1.28[a]	3.24	3.71[a]	5.6	6.43[a]
P Value						
120 days	1.76	1.28[a]	1.957	3.05[b]	6.39	6.49[b]
P Value						

Means within the same columns with different superscripts are significantly different at $p< 0.05$.
*Indicates $p< .05$, ns-non significant between single cropping (SC) and mixed cropping (MC)
Source: Statistical Package for Social Science (SPSS) version 23.0

only. The weight of forage leaves and stems was measured using spring balance to assess the leaf and stem ratio.

Dry matter yield

Bulked materials were thoroughly mixed and a representative sub-sample weighing not less than 400 g of forage leaves and stems was collected. The representative sub-samples weighing 400 g of forage leaves and stems were oven dried and dried samples were weighed by an electronic weighing balance.

Protein and fiber analysis

The oven-dried samples were analyzed for Crude Fiber (CF) and Crude Protein (CP) at CNR Laboratory, Punakha, Bhutan.

Soil laboratory analysis

Soil samples were analyzed before sowing and after each harvesting interval to determine the effect of intercropping and mono-cropping on soil nutrient status. Soil samples before treatment were collected on the 8th of July 2019. The soil samples were mixed thoroughly and the composite sample was taken from each of the plots. The composite samples were dried at room temperature in the CNR laboratory before soil analysis. The soil samples were collected after each harvesting stage. Then three composite samples from each treatment were taken for analysis.

Forage laboratory analysis

The chemical analysis of corn and pea were done in the College of Natural Resources laboratory. Nutrient analysis of the forages was done on crude protein (CP), ash, dry matter (DM) and crude fiber (CF).

Statistical analysis

All data analysis was performed using Statistical Package for Social Science (SPSS) version 23.0. Analysis of variance (ANOVA) tests was used to find the difference in means of forage yields of three harvesting stages. Bonferroni post hoc multiple comparison test was carried out to determine groups which are significantly different from other. A similar test was conducted to investigate the significant differences between soil nutrient content before and after each harvesting date. Two sample t-tests were conducted between intercrop and mono-crop on soil nutrients, forage yield, and weed biomass and forage nutrients.

RESULTS AND DISCUSSION

Effect of corn pea mixture and harvesting days on soil characteristics

The overall mean moisture content (MC) of the soil decreased by 0.86% and the pH of the soil was slightly neutral after harvest. There were no significant alterations ($p> 0.05$) in moisture content and organic matter percentage of the soil among three harvesting days (Table 2). Soil moisture was not significant at 60 Days After Planting (DAP); this was also similar to the findings of Eskandari and Ghanbari (2009) at 55 DAP. The lowest moisture content was found at 60 DAP and the highest was at 90 DAP. PH (H_2O) of the soil differed significantly ($p< 0.05$) among harvesting days with the exception between 60 and 90 DAP. Soil acidity increased with an increase in harvesting days though the soil was slightly neutral at 60 DAP compared to before sowing and soil organic matter increased with an increase in harvesting days. The highest organic matter was found in 120 DAP. No significant differences were found between single cropping and mixed cropping. The moisture content, organic matter and pH of the soil were comparatively higher in mixed cropping than in single cropping. However, no significant differences were found between single cropping (SC) and mixed cropping (MC) among harvesting days wherein a similar observation was found by Cong et al. (2014).

Table 2. Means of soil N_2, phosphorus (P), and potassium (K) after different harvesting days and between cropping types.

Soil sampling intervals	N (kg/ha)		P (mg/kg)		K (ppm)	
	N=18		N=18		N=18	
	SC	MC	SC	MC	SC	MC
60 days	122.77	282.67[a]	23.73	27.20[a]	182.33	194.33[a]
P Value	*		ns		ns	
90 days	187.18	342.68[a]	33.2	38.27[a]	183	185.67[a]
P Value	*		ns		ns	
120 days	362.36	430.92[a]	31.93	35.26[b]	170	178[b]
P Value	*		ns		ns	

Means within the same columns with different superscripts are significantly different at *p< 0.05.* *Indicates *p< 0.05*, ns-non significant between single cropping (SC) and mixed cropping (MC).
Source: Statistical Package for Social Science (SPSS) version 23.0

Table 3. Mean nutritive value of corn at different harvesting days and cropping types.

Harvesting intervals	DM (%)		Ash (%)		CP (%)		CF (%)	
	N=18		N=18		N=18		N=18	
	SC	MC	SC	MC	SC	MC	SC	MC
60 days	19.33	21.33[a]	7.66	9[a]	2.18	3.78[a]	12.67	13.03[a]
P Value	*		*		*		ns	
90 days	21	22.3[b]	9.33	10.33[b]	8.87	9.22[b]	16.33	16.33[b]
P Value	*		ns		ns		ns	
120 days	23	24.33[c]	10	10.67[b]	8.11	8.81[b]	18.5	19.5[c]
P Value	*		ns		*		ns	

Means within the same columns with different superscripts are significantly different at *p< 0.05.* *Indicates *p< .05*, ns-non significant between single cropping (SC) and mixed cropping (MC).
Source: Statistical Package for Social Science (SPSS) version 23.0

Although 120 DAP had shown significant differences against other harvesting days; there was no significant differences (*p> 0.05*) between 60 and 90 DAP (Hauggaard-Nielsen et al., 2001). The nitrogen content in the soil increased with the increase in harvesting days (60 < 90 < 120) (Table 3). The corn pea mixture significantly (*p< .05*) improved the nitrogen content in the soil whereby nitrogen content was higher in mixed cropping compared to single cropping which is in agreement with the results of Prasanthi (2012), Cong et al. (2014) and Dahmardeh et al. (2010) (Figure 1). The nitrogen content was higher in mixed cropping by 39.43% at 60 DAP, 29.35% at 90 DAP and 8.62% at 120 DAP which is 25.8% in average. Phosphorus content in the soil increased with increase in harvesting days. Significant difference (*p< 0.05*) in phosphorus content of the soil was shown by 60 DAP against two harvesting days but there was no significant differences (*p> 0.05*) between 60 and 90 DAP because of the increase in soil acidity at these harvesting days which have led to decrease in calcium and magnesium cation which are necessary for combination with phosphorus for absorption by roots (Hinsinger et al., 2003). Mixed cropping showed higher phosphorus content compared to single cropping which is similar to the findings of Dahmardeh et al. (2010) whereby the highest mean phosphorus content of 38.27 mg/kg was found in mixed cropping at 90 DAP. Potassium content in the soil decreased with increase in harvesting days. However, there were no significant difference in mean potassium and phosphorus content of the soil between single cropping and mixed cropping which is similar to the findings of Prasanthi (2012).

Effect of corn pea mixture and harvesting days on forage quality

The corn pea mixture and harvesting days affected the nutritive value of corn forage (Table 4). The dry matter (DM) percentage of the corn ranged from 20.33 to 23.83%. Harvesting days significantly (*p< 0.05*) affected the DM% of the corn. Dry matter increased with increase in harvesting days whereby highest dry matter was found at 120 DAP which is in line with the findings of Ayub et al.

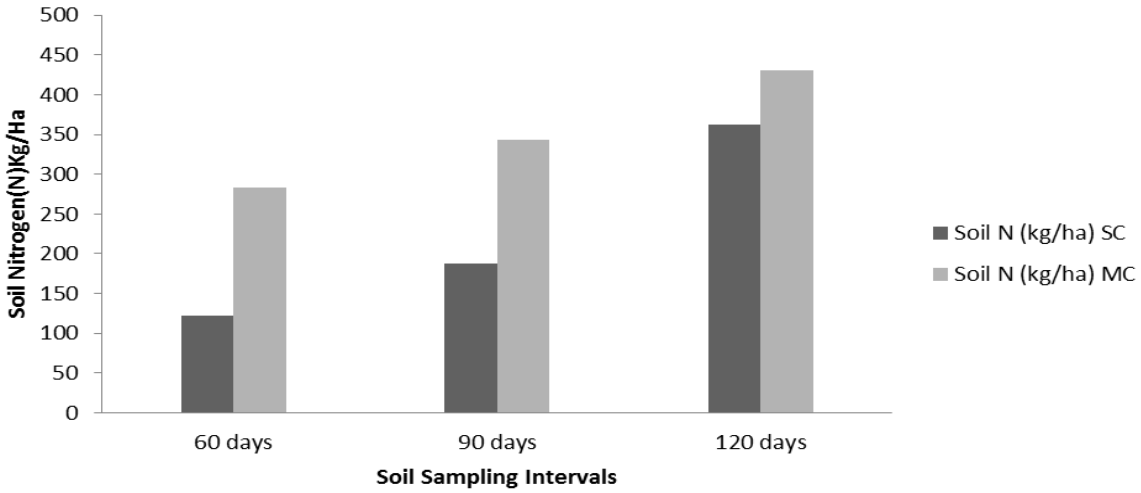

Figure 1. Significant difference between the means of soil nitrogen (N) after different harvesting days and between Single Cropping (SC) and Mixed Cropping (MC).
Source: Statistical Package for Social Science (SPSS) version 23.0

Table 4. The nutritive value of Sesbania (mean ± S.D at different harvesting days.

Harvesting intervals	DM (%)	Ash (%)	CP (%)	CF (%)
	N=18	N=18	N=18	N=18
60 days	19.5±0.29[a]	8.33±0.33[a]	3.26±0.10[a]	19±0.57[a]
90 days	22.5±0.29[b]	9.67±0.58[a,b]	20.48±0.72[b]	24.17±0.44[b]
120 days	23.83±0.6[b]	10.67±0.33[b]	21.30±0.58[b]	25.83±0.44[b]

Means within the same columns with different superscripts are significantly different at *p< 0.05.*
Source: Statistical Package for Social Science (SPSS) version 23.0

(2008). Significant difference (*p< 0.05*) was found between single cropping and mixed cropping whereby dry matter percentage was higher in mixed cropping than single cropping which is similar to the findings of Ibrahim et al. (2012) and Javanmard et al. (2009) (Figure 2). The highest difference in dry matter of 5.16% compared to single cropping was found at 60 DAP. Similarly, ash percentage increased with increase in harvesting days. Ash percentage is not significantly different (*p>0.05*) between 90 and 120 DAP but ash percentage at 60 DAP is significantly different against other two treatments. Although there was significantly (*p<0.05*) higher ash percentage in mixed cropping compared to single cropping at 60 DAP which is again similar to the findings of Ibrahim et al. (2012) and Javanmard et al. (2009) but it was vice versa in the other two DAP.

The overall mean CP content of the corn ranged between 2.98 and 8.46%. CP content was highest at 120 DAP which is in agreement with the findings of Ayub et al. (2008) who reported the increase till final date. CP content at 60 DAP is significantly (*p< 0.05*) different against two treatments but no significant difference was found between 90 and 120 DAP. CP content was significantly higher in mixed cropping than single cropping at 60 and 120 DAP which is in line with the findings of Ibrahim et al. (2012), Eskandari and Ghanbari (2009), Mthembu et al. (2017) and Javanmard et al. (2009) which could be due to the presence of symbiotic nitrogen fixation by the legume whereas no significant (*p> 0.05*) difference was found between the two at 90DAP. The highest CP content of 9.22% was found in mixed cropping at 90 DAP. The decrease in crude protein content after 60 DAP with increase in harvesting days were in line with the results of Dahmardeh et al. (2009).

The overall mean crude fiber percentage ranged between 12.85 and 19%. Harvesting days significantly (*p< 0.05*) affected the CF% of the corn whereby CF% increased with increase in harvesting days due to increase in nitrogen fixation by legumes with increase in harvesting days. However, no significant difference in CF% between single cropping and mixed cropping among harvesting days might be due to the less availability of soil nitrogen content in single cropping which increased at par with soil fertility, mixed cropping, variation in genetic make-up of plant, time of harvest and climatic circumstances (Ibrahim et al., 2012).

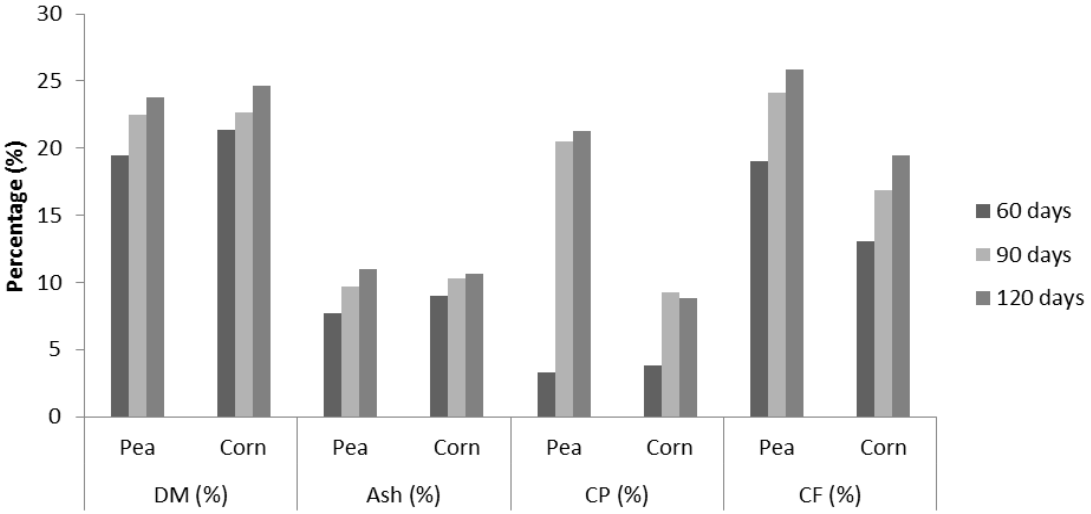

Figure 2. Figure showing the comparative nutritive value of the corn-pea mixed cropping at different harvesting days.
Source: Statistical Package for Social Science (SPSS) version 23.0

Table 5. Comparison of corn forage yield, plant numbers, and height at different harvesting days and cropping types.

Harvesting intervals	Forage Yield (t/ha)		Plants (Nos.)		Height (m)	
	N=18		N=18		N=18	
	SC	MC	SC	MC	SC	MC
60 days	18.87	25.77[a]	7.33	8.42[a]	0.64	0.61[a]
P Value	*		ns		ns	
90 days	21.18	29.01[a]	4.67	7.5[a]	0.72	0.73[a]
P Value	*		ns		ns	
120 days	29.57	22.57[a]	7	7.08[a]	0.9	0.94[b]
P Value	ns		ns		ns	

Means within the same columns with different superscripts are significantly different at $p< 0.05$.
*Indicates $p< .05$, ns-non significant between single cropping (SC) and mixed cropping (MC).
Source: Statistical Package for Social Science (SPSS) version 23.0

The nutritive value of pea increased with increase in harvesting days (Table 5). The overall mean range of pea dry matter was 19.5 to 23.83%, ash 8.33 to 10.67%, crude protein 3.26 to 21.30% and crude fiber 7.67 to 11%. Dry matter, ash and crude fiber at 60 DAP are significantly different against other two treatments but no significant difference ($p> 0.05$) was found between the 90 and 120 DAP. Ash percentage is significantly ($p< 0.05$) different between 60 and 120 DAP but it was vice versa in other comparisons.

There were significant differences ($p< 0.05$) in ash, dry matter, and crude fiber content between corn and pea on different harvesting days (Table 6). There were high dry matter and low crude fiber content in corn compared to pea which is in contrast to the findings of Ayub et al. (2008) might be due to difference in plant species, different fertility of the soil, and climatic circumstances. Ash percentage was higher in corn at 60 and 90 DAP but it was the opposite at 120 DAP. CP content was significantly ($p< 0.05$) higher in peas at 90 and 120 DAP which is in line with the findings of Ibrahim et al. (2012) as legumes usually have higher CP content but are not significant at 60 DAP.

Effect of corn pea mixture and harvesting days on forage growth and yield

No significant difference ($p> 0.05$) was observed in corn forage yield and corn plant numbers among the

Table 7. Means of corn stem yield, leaf yield, and weed biomass at different harvesting days and cropping types.

Harvesting intervals	Stem yield (t/ha)		Leaf yield (t/ha)		Weed (t/ha)	
	N=18		N=18		N=18	
	SC	MC	SC	MC	SC	MC
60 days	10.29	14.50[a]	8.57	11.27[a]	2.52	1.16
P value	*		*		*	
90 days	10.29	15.55[a]	10.88	13.45[b]	2.87	1.30
P value	*		*		*	
120 days	18.91	11.68[a]	10.66	10.88[b]	2.46	0.99
P value	*		ns		*	

Means within the same columns with different superscripts are significantly different at $p< .05$ except in weed biomass. *Indicates $p< .05$, ns-non significant between single cropping (SC) and mixed cropping (MC)
Source: Statistical Package for Social Science (SPSS) version 23.0

harvesting days. Plant height increased in mixed cropping compared to single cropping which agrees with the findings of Mut et al. (2017) but statistically, there was no significant difference in corn plant numbers and corn height between the two (Table 6). The highest corn forage yield was observed at 120 DAP with 26.1±2.43% in line with Ayub et al. (2008) who mentioned that harvest after 75 days gave maximum yield. The overall mean forage yield was lower than the findings in cowpea by Dahmardeh et al. (2009) and Asangla and Gohain (2016) but higher than the finding of Iqbal et al. (2006). Forage yield increased with increase in harvesting days. Forage yield was higher in mixed cropping compared to single cropping at 60 and 90 DAP which is similar to the findings of Ayub et al. (2008) but it was non-significant at 120 DAP. Lowest corn plant number of 6.08 was observed at 90 DAP. Plant height of corn ranged between 0.62 and 0.92 m. Corn height increased with increase in harvesting days but there was no significant difference between 60 and 90 DAP.

There was no significant ($p> 0.05$) difference in pea forage yield, plant numbers, and plant height among harvesting days (Table 6). This indicated that plant density or plant number did not affect the soil nitrogen fixation and forage yield despite the type of field or plot (Matusso et al., 2014). Pea forage yield and height increased with an increase in harvesting days. Pea forage yield ranged between 5.47 and 13.42 t/ha and plant height between 0.76 and 0.98 m. Plant number was highest 9.17 ± 1.20% at 90 DAP and lowest at 6.08 ± 0.83% at 60 DAP.

There was significantly ($p< 0.05$) higher corn stem yield and low weed biomass in mixed cropping than in single cropping, however, no significant difference was observed in the corn stem yield among harvesting days (Table 7). Stem yield increased with an increase in harvesting days which ranged between 12.4 and 15.3 t/ha. This increase in stem yield could be due to the maturity of the plant and the increase in fiber content of the plant. There was no significant difference in leaf yield between 90 and 120 DAP but corn leaf yield at 60 DAP showed a significant difference against the other two treatments. Leaf yield was highest with 12.17 ± 0.61% at 90 DAP. There was significantly higher weed biomass at single cropping than mixed cropping which is in line with the findings of Matusso et al. (2014) that reported, leguminous plants competed with weeds for basic needs like light and nutrients for growth and yield in mixed cropping (Hauggaard-Nielsen et al., 2001). There was no significant ($p> 0.05$) difference in plant numbers and height between corn and pea among harvesting days (Table 8). Though there was a significant ($p< 0.05$) difference in forage yield between pea and corn at 60 and 90 DAP but it was non-significant at 120 DAP.

Forage yield was higher in corn compared to peas but plant height was higher in peas than corn which showed a depressing effect of Sesbania on corn height (Ibrahim et al., 2014). Plant number was higher in corn at 60 DAP but it was higher in peas on the other two harvesting days.

Conclusion

Corn pea mixture sown at 20 cm space and three harvesting days had a significant effect on forage yield, quality, and soil nutrients. Soil nitrogen was significantly better in all three stages of harvest in mixed cropping than in single cropping resulting in higher corn yield because leguminous plants compete with weeds for basic needs like sunlight and nutrients for growth. Thus, to get better forage yield and quality corn forage, farmers should

Table 8. Comparison of forage yield, plant numbers, and plant height of the corn and pea mixed cropping at different harvesting days.

Harvesting intervals	Forage yield (t/ha)		Plants (Nos.)		Height (m)	
	N=18		N=18		N=18	
	Pea	Corn	Pea	Corn	Pea	Corn
60 days	5.47	25.77	6.08	8.42	0.76	0.62
P Value	*		ns		ns	
90 days	7.49	29.00	9.17	7.5	0.86	0.73
P Value	*		ns		ns	
120 days	13.41	22.57	8.38	7.08	0.96	0.95
P Value	ns		ns		ns	

*Indicates *p<0.05*, ns-non significant between pea and corn.
Source: Statistical Package for Social Science (SPSS) version 23.0

adopt mixed tillage.

Recommendations

A similar study with other legumes (especially cowpea, barseem, peanut and beans) and Bhutan's native maize varieties especially TaloDasum (TD), Arun-2 (A-2) and Gelephu White (GW) is recommended. A similar study with different forages especially fodder oat of Bhutan, stampede, Swede, sorghum, sugarcane and fodder grass species is recommended. A similar comparative study with or without nitrogen fertilization before sowing is also recommended.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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