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# FORAGE QUALITY OF MAIZE AND LEGUMES AS MONOCULTURES AND MIXTURES AT DIFFERENT SEED RATIOS

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## ABSTRACT

Livestock is an important sector of agriculture, but good quality forage is one of the major limiting factors for the growth of this industry. Studies were conducted to compare the forage quality of maize and legumes sown in pure stand and in mixture in randomized complete blocks during 2005 and 2006 at the University of Agriculture Faisalabad, Pakistan. Maize (*Zea mays* L.) and three legumes [cluster bean (*Cyamopsis tetragonoloba*), cowpea (*Vigna unguiculata* (L.) Walp.), and sesbania (*Sesbania sesban*)] were sown at 100% the recommended seeding rate and in maize:legume mixtures at seed ratios (SR) of 75:25, 50:50 and 25:75. Crude protein (CP) and ether extractable fat (EEF) percentage of maize increased with the increase in seeding rate of legumes in all maize-legume mixtures over sole maize. Crude fibre (CF) percentage of forage maize was the maximum in sole maize. All monoculture legumes produced highest CP and EEF percentage than their mixtures with maize. Mixtures of maize-sesbania gave higher CP and EEF than maize-cowpea or maize-cluster bean at similar seed ratios, while cowpea sown alone or in mixture with maize had higher total ash than other legumes at same seed ratios. Farmers may grow maize+sesbania to get good quality forage.

**Key words:** Forage quality, maize, cowpea, cluster bean, sesbania, seed ratio

## INTRODUCTION

Cereals have higher yields than legumes, but they are considered poor in quality due to low protein content and essential amino acids (Ahmad, 2006; Eskandari *et al.,* 2009). Sowing legumes in mixture with cereals improves the quality of forage by increasing its protein content and reducing crude fibre content (Iqbal *et al*., 2006; Ayub *et al*., 2008). Legumes can improve the yield and quality of cereals by increasing the N availability for uptake (Giller, 2001) because legumes are the alternate of nitrogen fertilizers and protein supplements for improving dairy production (). Successful utilization of cereal-legume intercropping system depends on the selection of species with good associative ability (Mapiye *et al*., 2007).

The relative proportion of component crops in mixture is also an important factor in determining both forage yield and quality (Ayub *et al.*, 2004). However, the exclusion or inclusion of legumes at low seeding rate produces inferior quality forage (Ayub *et al.,* 2008), but maize forage quality can be improved by planting with a legume or addition the leaves of legumes in the fodder of maize at accurate ratio to improve the quality of diet of goats (Fasae *et al*., 2011).

In Pakistan, very little research work has been done to determine the forage quality of maize/legumes sown at different seeding ratios. The study was therefore be planned to evaluate the suitable maize-legume combination sown at compatible seed ratios for forage quality.

## MATERIALS AND METHODS

To compare quality of forage maize and legumes sown alone and in mixture at different seed ratios (SR), field experiments were conducted at the Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan, during 2005 and 2006. The experiments were conducted on different field each year in sandy clay loam. in complete block design with three replicates in a net plot size of 2.4m x 8.0m. Seed ratio treatments included, $SR_1$=100%+0% maize alone, $SR_2$=75% maize+25% cowpea, $SR_3$=50% maize+50% cowpea, $SR_4$=25% maize+75% cowpea, $SR_5$= 0%+100% cowpea alone, $SR_6$=75% maize+25% sesbania, $SR_7$=50% maize+50% sesbania, $SR_8$=25% maize+75% sesbania, $SR_9$=0%+100% sesbania alone, $SR_{10}$=75% maize+25% cluster bean, $SR_{11}$=50% maize+50% cluster bean, $SR_{12}$=25% maize+75% cluster bean, $SR_{13}$=0%+100% cluster bean alone.

Seed of all mixtures was combined by plot and sown on 20th July with a single-row hand drill in rows 30 cm apart, with 8 rows plot$^{-1}$, Fertilizers in the form of Urea and single super phosphate were applied @ 110-60 kg N-P ha$^{-1}$ each year. Three irrigations (first 21days, second 35days and third 50days after sowing) were given during both years. All agronomic practices were kept similar for all treatments.

All plots including (maize and associated legumes) were harvested manually at about 50% flower initiation by maize on 19th September in both years. A subsample of the harvested material retained for forage quality analysis. Determination of CP using the micro kjeldahl method (Jackson, 1962), crude fibre by the procedure defined by VanSoest *et al.* (1991). While the ether extractable fat and total ash were analyzed according to AOAC (1990).

Statistical analysis of data was done by using Fisher's analysis of variance technique and least significant difference test at 0.05 probability level was used to compare the treatment means (Steel *et al.,* 1997).

## RESULTS

**Effect of seed ratios on quality of forage maize:** Quality traits like crude protein, crude fibre, ether extractable fat and total ash percentage of forage maize were significantly influenced by seed ratios of different maize-legume mixtures during both the years (Table 1). The maximum crude protein was noted in $SR_{12}$ during both the years but did not differ significantly from $SR_4$ (25% maize+75% cowpea). Contrarily, the minimum CP was observed in $SR_1$ (sole maize) during both the years.

Year effect on crude fibre percentage of forage maize was significant and relatively more value of CF was recorded during 2nd year of study (Table 1). During both years, sole maize ($SR_1$) gave the maximum crude fibre percentage; however, the minimum CF percentage was given by $SR_{12}$.

The year impact on ether extractable fat (EEF) percentage was significant and it was higher during 2006 (Table 1). The EEF of maize was significantly affected by different seed ratios and maize-legume mixtures during both the years. The treatment $SR_{12}$ remaining at par with $SR_4$ and $SR_{11}$ gave the highest ether extractable fat percentage during both the years. The maize sown alone gave minimum EEF during both the years.

Total ash percentage of forage maize was also significantly affected by seed ratios of different maize-legume mixtures (Table 1). The seed ratio $SR_{12}$ gave the maximum total ash percentage during both the years however, it did not differ significantly from $SR_{11}$, $SR_4$ and $SR_3$ in the first year. While the seed ratio $SR_1$ remaining similar with $SR_6$ and $SR_7$ produced the minimum ash percentage in 2005. Similar trend regarding maximum and minimum ash percentage was observed during the second year.

**Effect of seed ratios on quality of forage legumes:** The year effect on CP of forage legumes was significant and higher value was noted during the year 2006 over 2005 (Table 2). Crude protein of legumes sown in mixtures with maize was significantly affected by different seed ratios during both the years (Table 2). The sesbania sown alone ($SR_9$) gave the highest CP percentage however, the minimum CP was noted in $SR_2$ (75% maize+25% cowpea) which was statistically similar with $SR_{10}$. The trend was almost similar in the second year.

Variation among the years for CF of forage legumes was significant (Table 2). The crude fibre percentage was higher during 2006. Crude fibre percentage of legumes differed significantly by seed ratios of maize-legume mixtures and $SR_{10}$ (75% maize+25% cluster bean) and $SR_9$ gave highest and lowest CF percentage, respectively during both the years.

Year impact on EEF percentage was also significant and relatively more EEF was recorded in 2006 (Table 2). The highest EEF was observed in $SR_9$ (sesbania alone) during both the years, whereas it was statistically similar with $SR_7$, $SR_8$ and $SR_{13}$, during 2006. While the lowest EEF was noted in $SR_2$ in both the years.

A significantly higher ash percentage of legumes was observed during 2006 (Table 2). Cowpea alone ($SR_5$) gave significantly higher ash contents than all legumes sown as sole and in mixtures during both years, however, it was statistically similar to $SR_3$ and $SR_4$ during 2006. Contrarily the minimum ash percentage was given by $SR_6$ (75% maize+25% sesbania) during both the years, however, it was statistically at par with $SR_7$ in the year 2006.

**Effect of seed ratios on quality of mixed (maize + legume) forage:** Crude protein percentage of mixed forage was significantly enhanced by seed ratios of different maize-legume mixtures during both years (Table 3). The mixture of maize with sesbania at seed ratio of 75:25, 50:50, 25:75 and 0:100 exhibited higher CP percentage than sole maize and either sown in mixture with cowpea or cluster bean at similar seed ratios. The lower CP percentage was noted in $SR_1$ during both the years.

Year impact on CF of mixed forage was significant yet lower during 2005 than 2006 (Table 3). Seed ratios significantly affected the CF percentage of maize-legume mixtures during both the years. During both years, higher CF was recorded for cluster bean alone ($SR_{13}$), and the minimum CF was given by $SR_9$ (sesbania alone). Significant variation among years on EEF percentage of mixed forage was noted but comparatively higher EEF observed in 2006 (Table 3). Sole sesbania ($SR_9$) showed significantly higher EEF in both years but statistically at par with $SR_{13}$ (cluster bean alone) in 2006. While, the lower EEF was noticed in maize alone ($SR_1$), during both the years. Total ash percentage of mixed forage differed significantly by seed ratios of different maize-legume mixtures during both the years (Table 3). Cowpea alone ($SR_5$) gave significantly higher ash percentage. In contrast, the lower ash percentage was observed in maize alone during both the years.

**Table 1: Effect of different seed ratios on quality parameters of forage maize**

| Treatments | Crude protein (%) | | Crude fibre (%) | | Ether extractable fat (%) | | Total ash (%) | |
|---|---|---|---|---|---|---|---|---|
| **Seed ratios** | **2005** | **2006** | **2005** | **2006** | **2005** | **2006** | **2005** | **2006** |
| **$SR_1$** | 8.62 $^{g}$ | 8.82 $^{g}$ | 30.82 $^{a}$ | 31.38 $^{a}$ | 1.27 $^{f}$ | 1.28 $^{e}$ | 8.45 $^{e}$ | 8.53 $^{f}$ |
| **$SR_2$** | 9.74 $^{d}$ | 9.80 $^{d}$ | 30.16 $^{d}$ | 31.20 $^{bc}$ | 1.30 $^{cd}$ | 1.32 $^{cd}$ | 8.76 $^{cd}$ | 8.80 $^{d}$ |
| **$SR_3$** | 9.93 $^{c}$ | 10.06 $^{b}$ | 30.10 $^{d}$ | 31.12 $^{c}$ | 1.31 $^{bc}$ | 1.33 $^{bcd}$ | 8.94 $^{ab}$ | 8.96 $^{c}$ |
| **$SR_4$** | 10.11 $^{ab}$ | 10.23 $^{a}$ | 29.96 $^{e}$ | 30.98 $^{d}$ | 1.32 $^{abc}$ | 1.34 $^{abc}$ | 9.09 $^{a}$ | 9.14 $^{b}$ |
| **$SR_5$** | - | - | - | - | - | - | - | - |
| **$SR_6$** | 9.40 $^{f}$ | 9.50 $^{f}$ | 30.40 $^{b}$ | 31.24 $^{b}$ | 1.29 $^{de}$ | 1.32 $^{d}$ | 8.46 $^{e}$ | 8.60 $^{e}$ |
| **$SR_7$** | 9.54 $^{e}$ | 9.62 $^{e}$ | 30.28 $^{c}$ | 31.16 $^{c}$ | 1.28 $^{ef}$ | 1.32 $^{cd}$ | 8.60 $^{de}$ | 8.75 $^{d}$ |
| **$SR_8$** | 9.85 $^{cd}$ | 9.80 $^{d}$ | 30.17$^{d}$ | 31.14 $^{c}$ | 1.28 $^{ef}$ | 1.32 $^{cd}$ | 8.82 $^{bc}$ | 8.98 $^{c}$ |
| **$SR_9$** | - | - | - | - | - | - | - | - |
| **$SR_{10}$** | 9.87 $^{cd}$ | 9.90 $^{c}$ | 30.10 $^{d}$ | 31.16 $^{c}$ | 1.31 $^{bc}$ | 1.34 $^{abc}$ | 8.86 $^{bc}$ | 8.98 $^{c}$ |
| **$SR_{11}$** | 9.98 bc | 10.12 $^{b}$ | 30.00 $^{e}$ | 31.00 $^{d}$ | 1.32 $^{ab}$ | 1.34 $^{ab}$ | 8.98 $^{ab}$ | 9.15$^{b}$ |
| **$SR_{12}$** | 10.15 $^{a}$ | 10.32 $^{a}$ | 29.92 $^{e}$ | 30.89 $^{e}$ | 1.33 $^{a}$ | 1.35 $^{a}$ | 9.10 $^{a}$ | 9.24 $^{a}$ |
| **$SR_{13}$** | - | - | - | - | - | - | - | - |
| **LSD (0.05)** | 0.13 | 0.09 | 0.09 | 0.08 | 0.02 | 0.02 | 0.16 | 0.05 |
| **Mean** | **9.72 NS** | **9.82** | **30.19 B** | **31.13 A** | **1.30 B** | **1.33 A** | **8.81 B** | **8.91 A** |

Means sharing different letters differ significantly at $P \leq 0.05$

NS = Non-significant

$SR_1$=100%+0% maize alone, $SR_2$=75% maize+25% cowpea, $SR_3$=50% maize+50% cowpea, $SR_4$=25% maize+75% cowpea, $SR_5$= 0%+100% cowpea alone, $SR_6$=75% maize+25% sesbania, $SR_7$=50% maize+50% sesbania, $SR_8$=25% maize+75% sesbania, $SR_9$=0%+100% sesbania alone, $SR_{10}$=75% maize+25% cluster bean, $SR_{11}$=50% maize+50% cluster bean, $SR_{12}$=25% maize+75% cluster bean, $SR_{13}$=0%+100% cluster bean alone

**Table 2: Effect of different seed ratios on quality parameters of forage legumes**

| Treatments | Crude protein (%) | | Crude fibre (%) | | Ether extractable fat (%) | | Total ash (%) | |
|---|---|---|---|---|---|---|---|---|
| **Seed ratios** | **2005** | **2006** | **2005** | **2006** | **2005** | **2006** | **2005** | **2006** |
| **$SR_1$** | - | - | - | - | - | - | - | - |
| **$SR_2$** | 18.96 $^{k}$ | 19.00 $^{k}$ | 27.32 $^{c}$ | 29.24 $^{e}$ | 1.73 $^{h}$ | 1.82 $^{g}$ | 11.34 $^{b}$ | 11.53 $^{b}$ |
| **$SR_3$** | 19.11 $^{ij}$ | 19.32 $^{j}$ | 27.27 $^{c}$ | 28.96 $^{f}$ | 1.78 $^{g}$ | 1.84 $^{fg}$ | 11.36 $^{b}$ | 11.55 $^{ab}$ |
| **$SR_4$** | 19.23 $^{i}$ | 19.45 $^{i}$ | 27.01 $^{cd}$ | 28.36 $^{g}$ | 1.79 $^{f}$ | 1.85 $^{efg}$ | 11.40 $^{b}$ | 11.64 $^{ab}$ |
| **$SR_5$** | 19.58 $^{g}$ | 20.04 $^{f}$ | 26.52 $^{d}$ | 27.96 $^{h}$ | 1.82 $^{e}$ | 1.87 $^{defg}$ | 11.51 $^{a}$ | 11.68 $^{a}$ |
| **$SR_6$** | 20.86 $^{d}$ | 21.16 $^{d}$ | 24.90 $^{e}$ | 25.12 $^{i}$ | 1.85 $^{d}$ | 1.90 $^{bcde}$ | 8.85 $^{h}$ | 9.01 $^{g}$ |
| **$SR_7$** | 21.54 $^{c}$ | 21.46 $^{c}$ | 24.52 $^{ef}$ | 25.00 $^{j}$ | 1.88 $^{c}$ | 1.93 $^{abc}$ | 8.98 $^{g}$ | 9.11 $^{fg}$ |
| **$SR_8$** | 21.92 $^{b}$ | 22.12 $^{b}$ | 24.43 $^{ef}$ | 24.84 $^{k}$ | 1.90 $^{b}$ | 1.94 $^{ab}$ | 9.14 $^{f}$ | 9.17 $^{f}$ |
| **$SR_9$** | 22.28 $^{a}$ | 22.34 $^{a}$ | 24.13 $^{f}$ | 24.45 $^{l}$ | 1.92 $^{a}$ | 1.96 $^{a}$ | 9.16 $^{f}$ | 9.23 $^{f}$ |
| **$SR_{10}$** | 19.02 $^{jk}$ | 19.45 $^{i}$ | 34.00 $^{a}$ | 34.52 $^{a}$ | 1.79 $^{fg}$ | 1.82 $^{g}$ | 10.08 $^{e}$ | 10.35 $^{e}$ |
| **$SR_{11}$** | 19.41 $^{h}$ | 19.52 $^{h}$ | 33.76 $^{ab}$ | 34.23 $^{b}$ | 1.82 $^{e}$ | 1.84 $^{fg}$ | 10.24 $^{d}$ | 10.56 $^{d}$ |
| **$SR_{12}$** | 19.89 $^{f}$ | 19.65 $^{g}$ | 33.59 $^{ab}$ | 34.00 $^{c}$ | 1.85 $^{d}$ | 1.88 $^{cdef}$ | 10.54 $^{c}$ | 10.76 $^{c}$ |
| **$SR_{13}$** | 20.06 $^{e}$ | 20.12 $^{e}$ | 33.15 $^{b}$ | 33.49 $^{d}$ | 1.86 $^{d}$ | 1.91 $^{abcd}$ | 10.63 $^{c}$ | 10.89 $^{c}$ |
| **LSD (0.05)** | 0.14 | 0.05 | 0.66 | 0.05 | 0.02 | 0.05 | 0.09 | 0.14 |
| **Mean** | **20.16 B** | **20.30 A** | **28.38 B** | **29.18 A** | **1.83 B** | **1.88 A** | **8.81 B** | **8.91 A** |

Means sharing different letters differ significantly at $P \leq 0.05$

NS = Non-significant

$SR_1$=100%+0% maize alone, $SR_2$=75% maize+25% cowpea, $SR_3$=50% maize+50% cowpea, $SR_4$=25% maize+75% cowpea, $SR_5$= 0%+100% cowpea alone, $SR_6$=75% maize+25% sesbania, $SR_7$=50% maize+50% sesbania, $SR_8$=25% maize+75% sesbania, $SR_9$=0%+100% sesbania alone, $SR_{10}$=75% maize+25% cluster bean, $SR_{11}$=50% maize+50% cluster bean, $SR_{12}$=25% maize+75% cluster bean, $SR_{13}$=0%+100% cluster bean alone

**Table 3: Effect of different seed ratios on quality parameters of mixed (maize+legume) forage**

| Treatments | Crude protein (%) | | Crude fibre (%) | | Ether extractable fat (%) | | Total ash (%) | |
|---|---|---|---|---|---|---|---|---|
| **Seed ratios** | **2005** | **2006** | **2005** | **2006** | **2005** | **2006** | **2005** | **2006** |
| **$SR_1$** | 8.62 $^{j}$ | 8.82 $^{i}$ | 30.82 $^{b}$ | 31.38 $^{bc}$ | 1.27 $^{j}$ | 1.28 $^{j}$ | 8.45 $^{h}$ | 8.53 $^{h}$ |
| **$SR_2$** | 10.96 $^{i}$ | 11.22 $^{h}$ | 29.54 $^{de}$ | 30.72 $^{d}$ | 1.36 $^{i}$ | 1.40 $^{i}$ | 9.19 $^{e}$ | 9.32 $^{ef}$ |
| **$SR_3$** | 12.07 $^{h}$ | 12.45 $^{g}$ | 29.32 $^{ef}$ | 30.42 $^{d}$ | 1.42 $^{h}$ | 1.46 $^{gh}$ | 9.65 $^{d}$ | 9.73 $^{d}$ |
| **$SR_4$** | 13.80 $^{f}$ | 14.04 $^{e}$ | 28.64 $^{fg}$ | 29.68 $^{e}$ | 1.50 $^{f}$ | 1.55 $^{e}$ | 10.10 $^{c}$ | 10.42 $^{c}$ |
| **$SR_5$** | 19.58 $^{c}$ | 20.04 $^{b}$ | 26.52 $^{hi}$ | 27.96 $^{g}$ | 1.82 $^{c}$ | 1.87 $^{b}$ | 11.51 $^{a}$ | 11.68 $^{a}$ |
| **$SR_6$** | 13.29 $^{g}$ | 13.52 $^{f}$ | 28.36 $^{g}$ | 29.11 $^{f}$ | 1.48 $^{g}$ | 1.52 $^{ef}$ | 8.74 $^{g}$ | 8.92 $^{g}$ |
| **$SR_7$** | 15.69 $^{e}$ | 15.82 $^{d}$ | 27.22 $^{h}$ | 27.89 $^{g}$ | 1.59 $^{e}$ | 1.64 $^{d}$ | 8.85 $^{fg}$ | 9.07 $^{fg}$ |
| **$SR_8$** | 17.98 $^{d}$ | 18.41 $^{c}$ | 26.14 $^{i}$ | 26.63 $^{h}$ | 1.70 $^{d}$ | 1.75 $^{c}$ | 9.05 $^{ef}$ | 9.15 $^{fg}$ |
| **$SR_9$** | 22.28 $^{a}$ | 22.34 $^{a}$ | 24.13 $^{j}$ | 24.45 $^{i}$ | 1.92 $^{a}$ | 1.96 $^{a}$ | 9.16 $^{e}$ | 9.23 $^{efg}$ |
| **$SR_{10}$** | 11.02 $^{i}$ | 11.38 $^{h}$ | 30.10 $^{cd}$ | 31.33 $^{c}$ | 1.37 $^{i}$ | 1.41 $^{hi}$ | 9.02 $^{ef}$ | 9.21 $^{fg}$ |
| **$SR_{11}$** | 12.20 $^{h}$ | 12.55 $^{g}$ | 30.29 $^{bc}$ | 31.53 $^{bc}$ | 1.42 $^{h}$ | 1.47 $^{fg}$ | 9.26 $^{e}$ | 9.59 $^{de}$ |
| **$SR_{12}$** | 14.10 $^{f}$ | 14.37 $^{e}$ | 30.82 $^{b}$ | 31.72 $^{b}$ | 1.51 $^{f}$ | 1.56 $^{e}$ | 9.57 $^{d}$ | 9.81 $^{d}$ |
| **$SR_{13}$** | 20.06 $^{b}$ | 20.12 $^{b}$ | 33.15 $^{a}$ | 33.49 $^{a}$ | 1.86 $^{b}$ | 1.91 $^{ab}$ | 10.63 $^{b}$ | 10.89 $^{b}$ |
| **LSD (0.05)** | 0.42 | 0.52 | 0.72 | 0.39 | 0.02 | 0.05 | 0.26 | 0.36 |
| **Mean** | **14.78 NS** | **15.01** | **28.85 B** | **29.72 A** | **1.55 B** | **1.60 A** | **9.48 NS** | **9.66** |

Means sharing different letters differ significantly at $P \leq 0.05$
NS = Non-significant
$SR_1$=100%+0% maize alone, $SR_2$=75% maize+25% cowpea, $SR_3$=50% maize+50% cowpea, $SR_4$=25% maize+75% cowpea, $SR_5$= 0%+100% cowpea alone, $SR_6$=75% maize+25% sesbania, $SR_7$=50% maize+50% sesbania, $SR_8$=25% maize+75% sesbania, $SR_9$=0%+100% sesbania alone, $SR_{10}$=75% maize+25% cluster bean, $SR_{11}$=50% maize+50% cluster bean, $SR_{12}$=25% maize+75% cluster bean, $SR_{13}$=0%+100% cluster bean alone.

## DISCUSSION

The quality traits (CP, CF and total ash) of maize were significantly improved by sowing it in mixture with legumes and all these parameters increased with increasing the seeding rate of legumes in the mixtures. This might be due to the transfer of fixed N by component legumes to the maize sown in mixture. Similar observations have been made by Dahmardeh *et al.* (2009) in sorghum-cowpea and maize-cowpea intercropping systems, respectively. The crude protein contents of maize may have improved by intercropping with legumes due to availability of more nitrogen fixed by the legumes. It may also be attributed that a large proportion of soil nitrogen was available to non legumes in the mixtures when compared to pure stands. The reason for having higher crude fibre percentage in sole maize can be attributed to less availability of nitrogen as compared to sown in mixtures with legumes. The transfer of fixed nitrogen by legumes to non legumes has been reported by Chu *et al*., (2004). Decrease in crude fibre content by nitrogen application has been reported in previous studies (Ayub *et al*., 2003). Similar observations have been made by Ibrahim *et al*. (2006) for maize-cowpea mixtures, and Dahmardeh *et al.* (2009) observed maximum acid detergent fibre in sole maize than intercropped with cowpea. The results are contradictory to those of Khandaker (1994) who reported that CF percentage of forage maize was not influenced significantly in mixed cropping with cowpea at different seed ratios. These contradictory results can be attributed to variation in genetic makeup of varieties, harvest timing, soil fertility status and prevailing climatic conditions, Variation of CF (maize) in years may be the favorable climatic conditions during the second year, which may result in statically more CF over 1$^{st}$ year. The improvement in EEF of forage maize with increasing seed rate of legumes might be due to the more growth and quality by the maize through the nitrogen contribution from the companion legumes in the mixture. These results confirm the findings of Sankaranarayanan *et al.* (2005) who stated that the intercropping of sorghum with legumes improved the nutritive value of fodders. Increase in total ash of forage maize by growing in mixture with legumes has been reported Ibrahim *et al.* (2006). In contrast, Ahmad (2006) reported non-significant effects of legumes intercropping on ash percentage of sorghum. These contradictory results may have been due to the variation in fertility status of soil or climatic conditions.

The CP of all legumes decreased with increasing seed rate of maize in mixture. These results confirm the findings of Eskandari *et al.* (2009). They also reported a significant reduction in CP percentage of cowpea when it was intercropped with corn. The legumes sown alone have lower CF percentage than their respective mixtures.

The variation in growth stage at harvest may have been the cause of these differences. Significant variation for EEF percentage among forage legumes has also been reported by Ahmad (2006) and Iqbal (2006). Results of total ash of legumes were quite similar with those of Ahmad (2006) who reported that cowpea gave significantly higher ash percentage than mung bean, cluster bean and sesbania. However, it was noticed that the EEF and total ash percentage of legumes increased with decreasing seed rate of maize in the mixture. Variation in quality traits among different legumes was probably due to differences in the genetic constitution (Ahmad, 2006).

Results regarding quality traits of mixed forage revealed that all maize-legume mixtures gave higher CP than maize sown alone. Sole legumes have high CP %age than their respective mixtures. The increase in CP %age of mixed forage with increase in seeding rate of legumes in mixture was due to the higher CP concentration of legumes. Legumes usually have 2 to 3 times more CP percentage than maize. These results confirm the findings of Ibrahim *et al.* (2006) and Ayub *et al.* (2004 and 2008) who reported the highest CP contents of sole legumes than cereal-legume mixtures and sole cereals. Increase in CP with increased seed rate of legume in the mixture has also been reported by Ahmad *et al.* (2007) and Ayub *et al.* (2008). Significantly higher CF values in maize-cluster bean mixtures than maize-cowpea and maize-sesbania mixtures may be due to the combined adventure of different crops having potential to give more CF (Table 1 and 2). These results confirm the findings of Ahmad (2006), while contrary to those of Ibrahim *et al*. (2006) who found higher CF in sole maize than maize-cowpea mixtures. These contradictory results can be attributed to species differences. Improvement in ether extractable fat percentage of mixed forage at higher legume densities was probably due to the more share of EEF comes from legumes which have higher EEF than sole maize (Table 1 and 2). Iqbal (2006) also reported higher fat percentage of maize-legume intercropping combination over sole forage maize. Mixtures of maize with sesbania have comparatively lower ash percentage than mixtures of maize + cowpea and maize + cluster bean (Table 3). These differences may be due to variation in rooting depth, lateral roots and rooting densities of the legumes or differences in growth rate of legumes, because root characters are strongly affected by the species (Paula and Pausas, 2011). Increase in ash contents with increased seed rate of legume in mixture with cereals has also reported by Ayub *et al.* (2004).

The quality parameters like CP, EEF and ash percentage increased while CF percentage decreased by growing maize in mixture with legumes. The increase in seeding rate of legume in mixtures improved the quality parameters. Transfer of fixed nitrogen by legumes to the non-legumes sown in combination has also been reported by Chu *et al.* (2004).

**Conclusion:** It can be concluded that mixed cropping is a beneficial technique to get good quality forage, and sesbania seems to be a suitable legume crop for growing in mixture with maize than cowpea and clusterbean at any seeding rate (75:25, 50:50 and 25:75) under Faisalabad conditions.

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