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# Productivity and quality attributes of maize varieties (*Zea mays* L.)

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**Abstract**

Productivity and profitability of maize grown under different use patterns for fodder baby corn, green cobs and grain were evaluated during 2009 and 2010. The experiment was laid out in Randomized Block Design with three replications in the plot size of 3 x 3m. Three varieties each for different use pattern of maize *viz*., fodder type, baby corn, green cob and grain maize were investigated for yield parameters, biochemical traits and production economics. The maize varieties for fodder resulted in maximum fodder yield (up to 429.62 q/h), crude protein (up to 11.96%) and *in vitro* dry matter digestibility. The maize green fodder equivalent yield varied significantly from 181.8 to 1281.3 and 228.5 to 1136.6 q/ha, during 2009-10, respectively. The quality traits of the green fodder of baby corn varieties and green cob varieties were comparable to the varieties grown solely for the fodder purpose. The gross returns also varied significantly from 18,180.67 to 1, 28,128.30 and 22,845.00 to 1, 13,660.33 Rs/ha, during the year 2009 and 2010 respectively. The results of the study revealed that the cultivation of dual-purpose maize varieties was more economic than the cultivation of varieties for a single purpose.

**Keywords:** Fodder, Maize productivity, Maize use patterns, Production economics, Quality attributes

## Introduction

Maize is one of the most potential cereals grown globally, and ranked third after wheat and rice in total food-grain production. In India as maize production and consumption has been rising consistently, the consumption pattern also is changing. In the past it was mainly confined to food in India but now it is being used largely for the feed purpose (60%) mainly due to significant shift in its usage in last five to six years (Sai Kumar *et al*., 2012). Nowadays, maize is often grown in crop livestock farming systems where maize stover makes a crucial contribution to livestock feeding (Thorne *et al.,* 2002). Increasing demand for fodder, shortage of arable land and water together with shrinking and deteriorating common property resources is further increasing the demand for maize as a food-feed crop. It is envisaged to encourage the cultivation of dual purpose maize genotypes that provide good green fodder/ stover quantitatively and qualitatively besides other food items (Desta *et al.* 2000).

The adoptability of maize variety is necessarily governed by its economic viability, profitable production, better feed quality and practical feasibility. The economic returns are higher in dual purpose maize varieties as compared to one grown for the single use. Therefore, the identification of the maize varieties with higher economic returns demands considerable attention. Maize varieties giving profitable production can be exploited to improve the economic status of poor maize growers. Keeping in mind the immense maize growing potential of the state, the present investigation was undertaken to assess maize varieties grown under different use patterns for their yield, biochemical attributes and economic viability so as to find out proper recommendations for particular use pattern giving maximum economic returns.

## Materials and Methods

The field experiment was conducted during the months of June 2009 and 2010 at the Research Farm of CSK HPKV, Palampur, Himachal Pradesh, India, which lies between $30^0$ 12ô40" North latitude and $75^0$ 14ô55" to $79^0$ 04ô22" East longitude. The soil condition was clay loam with pH 5.5. The crop was raised only under rain fed conditions. The experiment was laid out in randomized block design with three replications in a plot size of 3 x 3 $m^2$. Three varieties each for fodder type, baby corn, green cob and grain maize were investigated for yield, biochemical and economical parameters (Table 1). Crop plantation was done on June 10, 2009 and June 12, 2010 at the rate of 60 kg/ha, 40 kg/ha, 20 kg/ha and 20 kg/ha for fodder maize, baby corn, green cob and grain maize, respectively. The spacing pattern for fodder maize was 40 x 15 cm while that for baby corn, green cob and grain

maize was 50 x 20 cm. Fertilizers (N:P:K) were applied at the rate of 90:60:40 kg/ha, 150:60:40 kg/ha, 120:80:50 kg/ha and 120:80:50 kg/ha for fodder maize, baby corn, green cob and grain maize, respectively. The weeds from the crop were removed manually after 30 and 60 days after sowing. Recommended agronomic practices were adopted for successful cultivation and harvesting. The data were analyzed for fodder/stover yield, baby corn yield, green cob yield, grain yield, dry matter content and dry matter yield. Estimation of quality parameters *viz*., crude protein, crude fibre and ash content was done according to the standard methods (AOAC, 1970). *In vitro* dry matter digestibility (IVDMD %) was estimated following the procedure given by Tilley and Terry (1963). The economics of different maize types (net returns and benefit: cost ratio) was worked out with the cost of cultivation and gross returns. The cost of cultivation was calculated by standard method involving all the inputs. The maize fodder equivalent yield (q/ha) was calculated as ýyield of corn x price / price of fodderô Gross returns (Rs/ha) were calculated as ÎMaize green fodder equivalent yield x 100ô The net returns were calculated as the difference between gross returns and cost of cultivation. The data was statistically analyzed by the method given by Panse and Sukhatme (1985).

**Results and Discussion**

***Yield attributes:*** The fodder/stover yield varied significantly from 34.81 to 429.62 and 51.84 to 411.07 q/ha in 2009 and 2010 respectively (Table 1) in maize varieties grown under different use patterns. The varieties of fodder type gave maximum fodder yield followed by baby corn type and green cob type. Baby corn, green cob and grain yield varied significantly in different varieties from 22.32 to 24.81, 49.26 to 58.89 and 19.25 to 28.51 q/ha, respectively for the year 2009. During 2010, variation in the yield of baby corn, green cob and grain was also observed from 24.44 to 26.29, 39.99 to 52.58 and 15.92 to 19.99 q/ha, respectively. Masood *et al*. (2012) observed increase in fodder and grain yield with the increase in seed rate. Shanti *et al*. (2012) also reported highest green fodder yields in African Tall grown for the fodder purpose only.

***Quality attributes:*** The quality of the forage for livestock is important. Determination of dry matter in feed is important to ensure that animals are receiving proper amount of nutrients through their diet. During 2009, the dry matter per cent of various maize varieties under different use patterns varied significantly from 15.36 to 76.23 percent (Table 2). The fodder dry matter per cent of all the grain maize varieties namely, Girija, Bajaura Sweet Corn and Early Composite was significantly higher than the varieties of other types. Fodder dry matter yield (q/ha) was maximum for the maize varieties of fodder type *viz*., African Tall (65.84) and Chadhiar local (69.28) followed by VL-Makka-42 (60.72) and VL-Baby Corn-1 (62.24) varieties of baby corn type. The lowest dry matter yield was observed in the varieties for grain maize. During 2010, the dry matter content among various maize varieties grown under different use patterns varied significantly from 15.50 to 75.80 per cent (Table 2). The dry matter per cent of all the grain maize varieties was higher than other varieties. Dry matter yield (q/ha) of baby corn maize varieties *viz.,* VL-Baby Corn-1 (84.29), VL-Makka-42 (74.69) and VL-78 (61.36) was maximum followed by fodder type maize varieties *viz.,* J-1006 (74.60) and African Tall (61.05). The lowest dry matter yield (q/ha) was exhibited by Early Composite variety (39.35) of grain maize. The results suggest that cultivation of varieties for the baby corn are more beneficial as in addition to green fodder, they also yield baby corns which are of high economic value.

Crude protein content of the fodder of different maize varieties varied from 8.16 to 11.96 per cent during 2009. During 2010, crude protein varied significantly from 7.00 to 11.37 per cent among maize varieties grown under different use patterns. During both years, the crude protein content of maize varieties of fodder type namely, J-1006, Chadhiar Local and African Tall and two varieties of baby corn type namely, VL-78 and VL-Makka-42 was significantly higher than other varieties. Shanti *et al*. (2012) reported highest crude protein content in the forage of maize varieties grown for baby corn purpose.

Crude fibre which consists of cellulose, hemi-cellulose and lignin, is an important constituent of food in animal nutrition. During 2009, the crude fibre content of the fodder of maize varieties investigated under different use patterns varied significantly from 24.80 to 34.50 per cent. The crude fibre content was significantly higher in maize varieties of grain maize type *viz,,* Girija, Early Composite and Bajaura Sweet Corn followed by Him-129 and VL-Makka-42 for green cob. During 2009, the crude fibre content varied significantly from 24.27 to 35.03 per cent. The crude fibre content of varieties of grain maize type was significantly higher than other varieties, which could be attributed to the plant maturity due to delayed harvest of the cobs in grain maize varieties. Masood *et al*. (2012) observed that the crude fibre percentage was mainly influenced by growth stage and harvesting time.

## *Quality of Maize varieties*

**Table 1.** Fodder/stover, baby corn, green cob and grain yield from maize varieties

| Varieties | Use pattern of variety | Yield (q/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Fodder/stover | | Baby corn | | Green cob | | Grain | |
| | | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 |
| African Tall | Fodder | 429.62 | 373.94 | - | - | - | - | - | - |
| J-1006 | Fodder | 429.62 | 411.07 | - | - | - | - | - | - |
| Chadhiar local | Fodder | 411.11 | 340.71 | - | - | - | - | - | - |
| VL-78 | Baby Corn | 274.07 | 337.00 | 22.32 | 25.17 | - | - | - | - |
| VL-Makka-42 | Baby Corn | 292.59 | 344.41 | 22.59 | 26.29 | - | - | - | - |
| VL-Baby Corn-1 | Baby Corn | 288.88 | 337.00 | 24.81 | 24.44 | - | - | - | - |
| Girija | Green Cob | 229.63 | 185.17 | - | - | 49.26 | 39.99 | - | - |
| Him-129 | Green Cob | 218.52 | 218.50 | - | - | 58.89 | 52.58 | - | - |
| Early Composite | Green Cob | 225.92 | 199.98 | - | - | 54.44 | 43.33 | - | - |
| Girija | Grain Maize | 34.81 | 69.27 | - | - | - | - | 28.51 | 15.92 |
| Bajaura Sweet Corn | Grain Maize | 41.48 | 78.14 | - | - | - | - | 19.25 | 18.51 |
| Early Composite | Grain Maize | 45.92 | 51.84 | - | - | - | - | 20.00 | 19.99 |
| G.M | Fodder | 243.5 | 245.58 | 23.24 | 25.30 | 54.19 | 45.30 | 22.50 | 18.14 |

**Table 2.** Fodder yield and quality attributes of maize varieties

| Varieties | Fodder yield | | | | Quality attributes | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dry matter (%) | | Dry matter yield (q/ha) | | Crude protein (%) | | Crude fibre (%) | | Ash content (%) | | IVDMD (%) | |
| | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 |
| African Tall | 15.36 | 16.32 | 65.84 | 61.05 | 11.37 | 10.79 | 24.80 | 24.27 | 6.00 | 5.10 | 57.80 | 56.00 |
| J-1006 | 15.76 | 18.13 | 67.70 | 74.60 | 11.96 | 11.08 | 27.33 | 27.93 | 6.07 | 5.73 | 57.20 | 54.80 |
| Chadhiar local | 16.93 | 15.50 | 69.28 | 52.64 | 11.66 | 11.37 | 25.47 | 27.40 | 5.63 | 6.00 | 55.80 | 53.80 |
| VL-78 | 17.75 | 18.20 | 48.73 | 61.36 | 11.08 | 10.31 | 30.63 | 28.53 | 4.63 | 5.13 | 55.00 | 54.80 |
| VL-Makka-42 | 20.74 | 21.77 | 60.72 | 74.69 | 10.50 | 10.50 | 31.43 | 29.97 | 6.67 | 6.00 | 54.80 | 51.80 |
| VL-Baby Corn-1 | 21.50 | 25.00 | 62.24 | 84.29 | 9.91 | 9.91 | 29.47 | 29.09 | 7.77 | 7.23 | 54.40 | 53.40 |
| Girija | 26.20 | 22.57 | 60.17 | 41.68 | 10.21 | 10.21 | 30.63 | 30.17 | 7.63 | 7.17 | 54.00 | 56.20 |
| Him-129 | 27.06 | 23.10 | 59.31 | 50.38 | 10.04 | 8.75 | 31.63 | 30.13 | 7.33 | 6.97 | 53.40 | 54.20 |
| Early Composite | 25.13 | 21.53 | 56.87 | 43.18 | 8.75 | 8.75 | 30.67 | 29.70 | 7.50 | 7.40 | 53.00 | 54.00 |
| Girija | 72.75 | 73.48 | 25.27 | 51.04 | 8.46 | 7.87 | 34.50 | 35.03 | 6.73 | 6.37 | 49.00 | 52.20 |
| Bajaura Sweet Corn | 73.11 | 73.03 | 30.36 | 57.06 | 8.16 | 7.29 | 33.33 | 34.73 | 6.97 | 6.77 | 49.00 | 54.20 |
| Early Composite | 76.23 | 75.80 | 35.00 | 39.35 | 8.16 | 7.00 | 34.00 | 34.35 | 7.23 | 7.47 | 49.80 | 51.80 |
| G.M | 34.04 | 33.70 | 53.46 | 57.61 | 10.02 | 9.49 | 30.33 | 30.11 | 6.68 | 6.44 | 53.60 | 53.90 |
| CD at 5% | 2.96 | 3.07 | 12.40 | 11.33 | 0.73 | 0.64 | 2.75 | 0.96 | 0.75 | 0.35 | ð ð - | ð ð - |
| CV % | 5.14 | 5.38 | 13.70 | 11.62 | 4.31 | 3.97 | 5.35 | 1.88 | 6.61 | 3.22 | ð ð - | ð ð - |
| SE (m) ± | 1.01 | 1.05 | 4.23 | 3.86 | 0.25 | 0.22 | 0.94 | 0.33 | 0.25 | 0.12 | ð ð - | ð ð - |

Ash content, which represents the total mineral content varied significantly from 4.63 to 7.77 per cent during 2009 in the fodder of maize varieties grown under different use patterns. Significantly high ash content was observed in VL-Baby Corn-1, Girija, Him-129, Early Composite (Green Cob type), Early Composite (Green maize type) and Bajaura Sweet Corn. During *kharif* 2010, the ash content varied significantly from 5.10 to 7.47 per cent among maize varieties grown under different use patterns. Ash content was maximum in Early Composite (Grain maize and Green cob type) followed by VL-Baby Corn-1 and Girija.

*In vitro* dry matter digestibility (IVDMD) of maize varieties grown under different use patterns ranged significantly from 49.00 to 57.80 per cent and 51.80 to 56.20 per cent during *kharif* 2009 and 2010, respectively. During both the years, all the varieties of fodder type exhibited maximum IVDMD followed by the varieties of baby corn and green cob due to their early harvest as compared with the later.

**Table 3.** Production economics of maize varieties

| Varieties | Maize green fodder equivalent yield (q/ha) | | Gross returns (Rs/ha) | | Cost of cultivation (Rs/ha) | |
|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2009 | 2010 | 2009 | 2010 |
| African Tall | 429.62 | 373.94 | 42,962.33 | 37,393.67 | 18,463.00 | 18,463.00 |
| J-1006 | 429.62 | 411.07 | 42,962.33 | 41,107.00 | 18,463.00 | 18,463.00 |
| Chadhiar local | 411.11 | 340.71 | 41,110.67 | 34,070.67 | 18,463.00 | 18,463.00 |
| VL-78 | 1,166.73 | 973.80 | 1,16,006.66 | 97,380.33 | 24,461.00 | 24,461.00 |
| VL-Makka-42 | 1,196.18 | 1,084.81 | 1,19,618.66 | 108,481.00 | 24,461.00 | 24,461.00 |
| VL-Baby Corn-1 | 1,281.28 | 1,136.60 | 1,28,128.30 | 1,13,660.33 | 24,461.00 | 24,461.00 |
| Girija | 722.19 | 585.10 | 72,219.33 | 58,510.00 | 21,301.00 | 21,301.00 |
| Him-129 | 807.38 | 744.33 | 80,738.33 | 74,433.00 | 21,301.00 | 21,301.00 |
| Early Composite | 770.39 | 633.25 | 77,039.00 | 63,324.67 | 21,301.00 | 21,301.00 |
| Girija | 181.81 | 228.45 | 18,180.67 | 22,845.00 | 23,006.00 | 23,006.00 |
| Bajaura Sweet Corn | 196.99 | 263.24 | 19,698.67 | 26,323.67 | 23,006.00 | 23,006.00 |
| Early Composite | 208.85 | 251.74 | 20,885.33 | 25,174.33 | 23,006.00 | 23,006.00 |
| G.M | 650.18 | 585.59 | 64,962.53 | 58,558.64 | 21807.75 | 21807.75 |
| CD at 5% | 104.91 | 77.23 | 10,543.40 | 7,722.33 | ð ð - | ð ð - |
| CV % | 9.53 | 7.79 | 9.59 | 7.79 | ð ð - | ð ð - |
| SE (m) ± | 35.77 | 26.33 | 3,595.26 | 2,633.29 | ð ð - | ð ð - |

| Varieties | Net returns (Rs/ha) | | Benefit: cost ratio | |
|---|---|---|---|---|
| | 2009 | 2010 | 2009 | 2010 |
| African Tall | 24,499.00 | 18,930.67 | 1.33 | 1.03 |
| J-1006 | 24,499.00 | 22,644.00 | 1.33 | 1.23 |
| Chadhiar local | 22,648.00 | 15,607.67 | 1.23 | 0.85 |
| VL-78 | 91,545.00 | 72,919.33 | 3.73 | 2.98 |
| VL-Makka-42 | 95,157.00 | 84,020.00 | 3.88 | 3.43 |
| VL-Baby Corn-1 | 1,03,667.30 | 89,199.33 | 4.24 | 3.65 |
| Girija | 50,918.00 | 37,209.00 | 2.39 | 1.75 |
| Him-129 | 59,437.00 | 53,132.00 | 2.79 | 2.49 |
| Early Composite | 55,738.00 | 42,023.67 | 2.61 | 1.97 |
| Girija | -4,825.00 | -161.00 | -0.21 | -0.01 |
| Bajaura Sweet Corn | -3,307.00 | 3,317.67 | -0.14 | 0.14 |
| Early Composite | -2,120.00 | 2,168.33 | -0.09 | 0.09 |
| G.M | 43,154.80 | 36,750.89 | 1.93 | 1.63 |
| CD at 5% | 10,543.10 | 7,722.51 | 0.50 | 0.33 |
| CV % | 14.43 | 12.41 | 15.23 | 11.85 |
| SE (m) ± | 3,595.18 | 2,633.36 | 0.17 | 0.11 |

***Production economics:*** The maize green fodder equivalent yield varied significantly from 181.81 to 1281.28 and 228.45 to 1136.60 q/ha (Table 3), respectively. During both the years, the values were significantly higher for the varieties of baby corn and green cob types. Maize green fodder equivalent yield was least for the varieties of grain maize type. This might be due to the lowest stover yield (q/ha) from maize grown for seed purposes.

The gross returns varied significantly from 18,181 to 1, 28,128 and 22,845 to 1,13,660 Rs/ha, respectively. During both the years, the varieties of baby corn and green cob types accounted for significantly higher gross returns than those of fodder type which could be attributed to the dual products (cobs and fodder) from the baby corn and green cob varieties. Shanti *et al*. (2012) reported high gross returns, net returns and B:C ratio in baby corn compared to maize grown in other use patterns. Gross returns from grain maize varieties were the lowest. The cost of cultivation of baby corn varieties was the highest followed by the varieties of grain maize. However, the fodder type varieties involved the least cost of cultivation.

The highest net returns were obtained from the varieties of baby corn type followed by those of green cob type. Though the cost of cultivation was the highest for the varieties of baby corn type yet they gave the maximum net returns as these varieties accounted for the highest maize green fodder equivalent yield. The net returns from the three varieties of grain maize type were deficit due to higher cost of cultivation and the least maize green fodder equivalent yield. Benefit-cost (B:C) ratio ranged between ñ0.21 and 4.24 for *kharif* 2009 and between -0.01 and 3.65 for *kharif* 2010. B:C ratio was maximum for baby corn varieties followed by green cob varieties.

The mean values of two years data revealed that the highest monetary return and benefit: cost ratio was observed for maize varieties of baby corn type followed by green cob and fodder type in that order. The maize varieties grown for grain purpose exhibited least value for monetary return and benefit-cost ratio. Earlier workers have also reported that baby corn is a profitable crop, making possible a diversification of production, aggregation of value and increased income (Pandey *et al.,* 2002; Silva *et al*., 2006). According to Desta *et al*. (2000) the cultivation of multiple purpose maize genotypes should be encouraged that provide good fodder/stover besides other food items. Muthukumar *et al.* (2005) and Das *et al*. (2008) reported the baby corn as a potential crop which can improve the economic status of poor farmers and help to boost agriculture in India. Baby corn can provide more nutrition per unit area for marginal and small farmers and green fodder for animals at a more affordable cost. In addition to high nutritional value as human food, another benefit of baby corn consists of utilizing husk, silk, and stover as green herbage for feeding ruminants which gives an additional income to the growers (Aekatasanawan, 2001; Ramachandrappa *et al*., 2004).

Based on the results, it can be concluded that the cultivation of multi-purpose maize varieties is economically more viable and profitable than the cultivation of varieties solely for fodder purpose. The quality traits of the fodder of baby corn and green cob varieties were just comparable to the fodder type varieties. The economic viability study revealed that baby corn varieties followed by green cob varieties were the most suitable types for cultivation.

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