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# Tillage options for productivity and profitability of food forage based production system in Indo Gangetic plains of India

**Mahendra Singh Pal**
G. B. Pant University of Agriculture and Technology, Pantnagar, India
Corresponding author e-mail: drmspal1@gmail.com

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## Introduction

Food – Forage based systems are the pre-requisite for sustainable rural development mainly as they provide support to small and marginal farmers by adjusting a substantial part of their land exclusively for forage production in grain crop based rotations (Kumar and Faruqui, 2009). In addition, the high cost of cultivation of intensive cropping systems is a major bottleneck in sustainable and profitable crop production. Presently, new innovations in tillage has revolutionized agriculture worldwide mainly due to reducing cost of cultivation, bulk density of soil and trafficabiltiy and also improving soil organic carbon resulting into high soil fertility. In addition, zero tillage provides extra benefit of time saving so that one short duration crop may be included in the crop rotation and increase cropping intensity. Therefore, the reduced tillage and zero tillage both have special attention among farming communities. Considering the increasing popularity about reduced and zero tillage, the present study was undertaken to assess the impact of tillage options in quality forage production in Indo-Gangetic plains of India Will the objectives.

1. To find out the suitable tillage options for forage production,
2. To study the effect of tillage options on productivity and profitability of forage production, and
3. To assess the impact of tillage options on soil fertility.

## Materials and Methods

The field experiment was carried out at Instructional Dairy Farm, G B pant University of Agriculture & Technology, Pantnagar (India) during 2009-10, 2010-11, 2012-13 and 2013-14 (4 years) to study the effect of different tillage options on production potential and sustainability of food-forage based crop sequence. The experimental site was silty loam with neutral soil reaction i.e soil pH 7.63, 0.86 % soil organic carbon and the available N, P and K were 283.56, 20.78 and 231.20 kg/ha, respectively. The experiment consisting of 8 treatments i.e. $T_1$, conventional tillage (3 cultivation-one disc harrow + 2 cultivator), $T_2$, 2 cultivation (1 disc harrow + 1 cultivator), $T_3$, 2 cultivation with rotavator, $T_4$, 1 cultivation with disc harrow, $T_5$,1 cultivation with rotavator, $T_6$, broadcast seed before 2 cultivation with rotavator, $T_7$, broadcast seed before one cultivation with rotavator and $T_8$, no cultivation (Zero tillage) was planted under RCBD with three 4 replications. The crop rotation 'Sorghum (Forage)-Wheat (Food)-Maize+Cowpea (Forage)' was grown with crop varieties *Pant Chari-5, PBW-343, African Tall and UPC-5286*, respectively. The green and dry forage yield of the system was calculated on the basis of converting grain yield to equivalent green and dry forage yield and then added to make the system productivity.

## Results and Discussion

The pooled green forage yield, dry forage yield, crude protein and net profit differed significantly with tillage options (Table.1). The green forage yield was recorded significantly highest under conventional tillage with 3 cultivation including one disc harrow + 2 cultivator followed by 2 cultivation with rotavator, however conventional tillage produced 9% higher green forage yield than 2 cultivation with

rotavator. The green forage yield remained significantly equal under 2 cultivations, one each from disc and cultivator and one cultivation with disc harrow. The green forage yield was recorded lower under broadcasting of seed in both conditions either after 2 or 1cultivation with rotatvator. Significantly lowest green forage yield was recorded under zero tillage. The average dry forage yield also followed the same trend with significantly highest value was found under conventional tillage followed by both treatments where 2 cultivations were made either with one disc harrow + one cultivator and 2 rotavator. The other tillage treatments produced lower values and significantly lowest value was noted under zero tillage. The highest dry forage yield was the result of higher green forage yield that was the outcome of better growth and development of crops. Chandrika *et al*., (2012) also reported higher productivity of food-forage based cropping systems.

The averge crude protein of the system was also recorded significantly highest in conventional tillage mainly because of greater growth and leaf:stem ratio followed by 2 cultivation with rotavator, 2 cultivation (one disc harrow+ one cultivator) and one cultivation with disc harrow. Again the lowest values were registered in zero tillage. The gross and net returns were observed significantly highest under conventional tillage with 8.1 and 10.6% greater values than folllowed treatment with 2 cultivations with rotavator. The 2 cultivations either with one disc harrow + one cultivator or cultivation with 2 rotavator were at par in both gross and net retunrs. The lowest gross and net returns were recorded under zero tillage.The B:C ratio was also significantly higher in conventional tillage with dic harrow and 2 cultivation with one.

The residual soil fertilty assessed after 4 years of experimenetation indicated that zero tillage was best tillage option that had significantly higher soil organic carbon and also available N, P and K values of soil (*Table.2*). The zero tillage also lowered down the soil pH compared to initial value. The soil organic carbon was found significamtly highest in zero tillage. The available N was also recorded significantly highest in zero tillage that remained at par to 2 cultivation with rotatvator. The available P was also recorded highest in zero tillage followed by 2 cultivation with rotatvotor, however it remained non significant among tillage options. The available K was also found significantly higher in zero tillage followed by 2 cultivation with rotatvator. Soil pH, electrical conductivity and bulk density were marginally reduced. However, available K status was slightly increased indicating that food-forage based system not only maintains soil fertility but improves over period of time (Kumar and Faruqui, 2009).

**Table 1:** Forage green yield equivalent, dry forage yield, gross and net return and B:C ratio as affected by different tillage options (pooled data).

| **Treatments** | **Forage Green yield Equivalent(q/ha)** | **Dry forage yield (q/ha)** | **Crude protein yield (q/ha)** | **Gross return (Rs./ha)** | **Net return (Rs./ha)** | **B:C ratio** |
|---|---|---|---|---|---|---|
| Conventional tillage (3 cultivation-one disc harrow + 2 cultivator ) | 2200 | 336.6 | 31.04 | 154282 | 109661 | 2.20 |
| 2 Cultivation(1 disc harrow + 1 cultivator) | 1985 | 321.1 | 28.50 | 141026 | 98054 | 2.02 |
| 2 cultivation with rotavator | 2000 | 321.1 | 29.29 | 142710 | 99144 | 2.01 |
| 1 cultivation with disc harrow | 1959 | 303.2 | 28.50 | 139807 | 97667 | 2.03 |
| 1 cultivation with rotavator | 1889 | 301.2 | 28.16 | 133712 | 91989 | 1.91 |
| Broadcast seed before 2 cultivation with rotatvator | 1891 | 304.10 | 27.81 | 134902 | 92402 | 1.95 |
| Broadcast seed before one cultivation with rotavator | 1803 | 296.3 | 27.15 | 128868 | 86523 | 1.85 |
| No cultivation (Zero tillage) | 1740 | 273.5 | 25.85 | 124535 | 83518 | 1.81 |
| S Em± | 28.99 | 3.27 | 0.29 | 1986.57 | 2338.95 | 0.041 |
| CD at 5% | 88 | 9.93 | 0.90 | 6025 | 7094 | 0.12 |

**Table 2:** Effect of tillage options on residual soil fertility status after 4 years of field experimentation

| **Treatments** | **Soil pH** | **Organic Carbon (%)** | **Available N (kg/ha)** | **Available $P_2O_5$ (kg/ha** | **Available $K_2O$ (kg/ha** |
|---|---|---|---|---|---|
| *Initial soil values* | 7.63 | 0.86 | 283.56 | 20.78 | 231.20 |
| Conventional tillage ( 3 cultivation-one disc harrow + 2 cultivator ) | 7.65 | 0.85 | 284.23 | 20.83 | 232.03 |
| 2 Cultivation(1 disc harrow + 1 cultivator) | 7.67 | 0.86 | 287.00 | 21.70 | 241.20 |
| 2 cultivation with Rotavator | 7.64 | 0.89 | 297.17 | 22.20 | 246.77 |
| 1 cultivation with disc harrow | 7.65 | 0.86 | 286.70 | 21.17 | 238.83 |
| 1 cultivation with Rotavator | 7.65 | 0.86 | 284.30 | 21.53 | 241.10 |
| Broadcast seed before 2 cultivation with rotavator | 7.68 | 0.87 | 291.83 | 21.67 | 241.07 |
| Broadcast Seed before one cultivation with rotavator | 7.63 | 0.87 | 294.93 | 22.17 | 243.80 |
| No cultivation (Zero tillage) | 7.60 | 0.92 | 301.20 | 22.50 | 250.33 |
| SEm± | - | 0.01 | 2.01 | 1.14 | 3.23 |
| CD at 5% | - | 0.03 | 6.10 | ns | 9.79 |

**Conclusion**

On the basis of above discussion, it is concluded that conventional tillage had signficantly higher green and dry forage yied, crude protien production and net returns followed closely by 2 cultivations with rotavator. In additon, cultivation with 2 rotavator had higher values of residual soil fertility. Therefore, cultivation with 2 rotavator is more beneficial for sustainable forage production. Hence, cultivation with 2 rotavator may be recommended for profitable green forage production in Indo-Gangetic plains of India

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