Evaluation of In-situ Moisture Conservation Practices for Sustainable Productivity of Major Crops in Vidarbha Region

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A B S T R A C T

Water stress periods are common in rainfed agriculture therefore the activities aimed at conserving the rainwater should be adopted for improving the productivity of dryland crops. The major crops in Vidarbha region of Maharashtra are cotton, soybean and sorghum. It was observed that the drought situation may arise during crop growth period which may result in partial failure of crops. It was therefore felt worthwhile to adopt the proper methods of in-situ moisture conservation so as to partially meet out the adverse effect of water stress in standing crop. The experiment was undertaken at the experimental field of AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The treatments adopted were T1 - Furrow opening (F), T2 - Crop residue mulch (M), T3 - Thinning (T), T4 - Combination of furrow opening, crop residue mulch and Thinning (FMT) and T5 - Control. The three major crops of Vidarbha region i.e. cotton (AKH-84635), soybean (JS-335) and sorghum (CSH-9) are considered for the study. The results regarding yields and soil moisture at different stages of crop growths since 2007-08 to 2010-11 were presented here. The economic evaluation of these practices has been done and is discussed in this paper.

Keywords
Productivity, Soil moisture, in-situ practices, Economics, Treatments.

Introduction

The success of dryland farming mainly depends on the evenly distributed rainfall during crop growing period. The root zone soil moisture is utilized for transpiration, when the rainfall becomes insufficient to meet the potential needs to transpiration. This causes depletion in soil moisture storage and a situation which may be designated as agricultural drought. Even after achieving the full irrigation potential, nearly 50% of the net cultivated dryland area will remain dependent on rainfall. In terms of crop groups, 77% of pulses, 66% of oilseeds and 45% of cereals are grown under rainfed conditions.

Therefore, a breakthrough in rainfed agriculture is an imperative for poverty alleviation, livelihood promotion and food security in India (Abrol, 2011). The most effective form of erosion control or prevention is to practice good land management techniques. Approaches to protect the top soil from splash effects of rainfall and sheet flow are best centered on good in-situ conservation practices (C. George Thomas, 2010). For any form of land use to be sustainable, production must be combined with conservation of resources. In Vidarbha region, about 89% land is under
Rainfed farming. The major crops are cotton, soybean and sorghum. Soil conservation is the only way to protect the productive lands. Rainfed farming plays an important role in agricultural economy of Vidarbha. It was observed that the drought situation may arise during crop growth period which may result in partial failure of crops. Drought situations caused due to aberrant weather and erratic rainfall has been routine crises in dryland agriculture. To cope up with such crunch, it is necessary to find out the possibilities to survive the crop under contingent conditions by using some of the simple methods of in-situ moisture conservation (Padmanabhan, 2008). It was therefore, felt worthwhile to adopt the proper methods of in-situ moisture conservation so as to partially meet out the adverse effect of water stress in standing crops. The positive effects of moisture conservation practices like ridges and furrows; in enhancing the plant height and yield attributes of sorghum, cowpea, bengalgram and sunflower have been observed (Somasundaram et al., 2000). In-situ moisture conservation practices viz., ridges and furrows + mulch, imparted beneficial effect on cluster bean for getting good growth and higher yields; which subsequently led to higher net returns and B: C ratio (Allolli et al., 2008). In order to study the effect of contingency in-situ moisture conservation measures on productivity and to find out suitable combination of in-situ moisture conservation measures to cope up with water stress in standing crops, the experiment was conducted on the experimental field during 2007-08 to 2010-11.

Results and Discussion

Based on the observations the results of yields and soil moisture were presented here. Accordingly, the GMR and NMR are calculated for each crop based on the existing market prices and discussed individually for each crop (Annual Reports 2008 to 2011).

Crop – Cotton

The productivity of cotton as influenced by different in-situ moisture conservation treatments (2007-08 to 2010-11) is presented in table 1. The total rainfall received during the crop growing period was 887.3mm as against the normal rainfall of 741.8mm. The in-situ moisture conservation treatments showed significant difference in seed cotton and stalk yield in cotton.

The highest seed cotton (2352kg ha\(^{-1}\)) yield was recorded in crop residue mulching treatment (T\(_2\)) and found at par with the treatment combination of furrow opening, mulching and thinning, T\(_4\) (2151kg ha\(^{-1}\)). However, the highest stalk yield (4372kg ha\(^{-1}\)) was recorded in treatment combination of furrow opening, mulching and thinning (T\(_4\)) and it was at par with crop residue mulching treatment (T\(_2\)). In pooled data of four seasons, seed cotton yield was found to be non-significant.
Economics of cotton cultivation

The data showing effect of various in-situ moisture conservation treatments on economics of cotton cultivation (pooled) is given in table 2. The highest gross monetary returns (Rs. 55025) was obtained in crop residue mulching treatment (T_2) and found at par with the treatment combination of furrow opening, mulching and thinning (T_4) and furrow opening treatment (T_1). The highest net monetary returns (Rs. 37391) and B: C ratio (2.73) was obtained in crop residue mulching treatment (T_2).

Soil moisture

The soil moisture at the depths of 0-15 and 15-30cm is given in table 3. The soil moisture status observed to be better in crop residue mulching treatment at early stages of crop growth followed by thinning and other treatments. However at the final stages of crop, the soil moisture content was observed maximum in the treatment of furrow opening followed by treatment combination of furrow opening, mulching and thinning.

Crop – Soybean

Productivity

The data on yield of soybean during 2007-08 to 2010-11 and pooled yields are given in table 4. The total rainfall received during the crop growing period was 807.3 mm as against the normal rainfall of 669.5mm.

The in-situ moisture conservation treatments showed no significant differences in grain and straw yield of soybean. In pooled data of four seasons, grain yield was found to be non-significant. Numerically highest grain yield (2513kg ha^{-1}) was recorded in crop residue mulching treatment (T_2) followed by thinning treatment (T_3) and highest straw yield (3678kg ha^{-1}) was recorded in control treatment (T_5) followed by crop residue mulching treatment (T_2).

Economics of soybean cultivation

The data showing effect of various in-situ moisture conservation treatments on economics of soybean cultivation (pooled) is given in table 5. The highest gross monetary returns (Rs. 55677) were obtained in crop residue mulching treatment (T_2) followed by thinning treatment (T_3). The highest net monetary returns (Rs. 38939) were obtained in thinning treatment (T_3) followed by crop residue mulching treatment (T_2). The highest B: C ratio (3.59) was obtained in control treatment (T_5).

Soil moisture

The soil moisture at the depths 0-15 and 15-30cm is given in table 6. The soil moisture status observed to be better in crop residue mulching treatment at early stages of crop growth followed by treatment combination of furrow opening, mulching and thinning and then by other treatments. However at the final stages of crop the soil moisture content was observed maximum in the treatment of furrow opening and treatment combination of furrow opening, mulching and thinning.

Crop – Sorghum

Productivity

The data of yield of sorghum during 2007-08 to 2010-11 and pooled yields are presented in table 7. The total rainfall received during the crop growing period was 847.8mm as against the normal rainfall of 689.5mm. Due to high intensity of rainfall distribution over the crop period, the in-situ moisture conservation treatments showed non-significant differences for grain and fodder yield of sorghum.
Table 1: Productivity of cotton as influenced by different in-situ moisture conservation treatments (2007-08 to 2010-11)

| Treatments | 2007-08 | 2008-09 | 2009-10 | 2010-11 | Pooled |
|------------|---------|---------|---------|---------|--------|
| T₁         | 2560    | 1308    | 1041    | 1916    | 1706   |
| T₂         | 2426    | 1254    | 1078    | 2352    | 1778   |
| T₃         | 2259    | 1130    | 1006    | 1919    | 1579   |
| T₄         | 2391    | 1193    | 1097    | 2151    | 1708   |
| T₅         | 2224    | 1109    | 998     | 1971    | 1576   |
| S. E. (m)  | 102     | 104     | 51      | 99      | 51     |
| C.D. at 5% | 287     | NS      | NS      | 307     | NS     |
| C.V. %     | 8.63    | 17.37   | 9.77    | 9.67    | 12.22  |

Table 2: Economics of cotton as influenced by different in-situ moisture conservation treatments (Pooled)

| Treatments | Yield (kg ha⁻¹) | GMR (Rs. ha⁻¹) | NMR (Rs. ha⁻¹) | B:C Ratio |
|------------|----------------|----------------|----------------|-----------|
| T₁         | 1706           | 4687           | 51275          | 33376     | 2.56    |
| T₂         | 1778           | 5015           | 55025          | 37391     | 2.73    |
| T₃         | 1579           | 4317           | 48103          | 30189     | 2.35    |
| T₄         | 1708           | 4679           | 52397          | 32561     | 2.31    |
| T₅         | 1576           | 4257           | 48216          | 30812     | 2.42    |
| S. E. (m)  | 51              | 119             | 1600           | 1600      | -       |
| C.D. at 5% | NS              | 368             | 4932           | NS        | -       |
| C.V. %     | 12.22           | 10.38           | 12.55          | 19.47     | -       |

Table 3: Soil moisture content (cm³/cm³) at different crop growth stages of cotton recorded at 0-15 and 0-30 cm depth

| Treatments | Depth (cm) | Vegetative growth | Soil moisture content (cm³/cm³) |
|------------|------------|-------------------|-------------------------------|
|            |            |                   | Flowering | Boll formation | Picking |
| T₁         | 0-15       | 33.86             | 36.73     | 33.42       | 30.13  |
|            | 15-30      | 35.28             | 41.27     | 37.93       | 36.09  |
| T₂         | 0-15       | 38.91             | 37.39     | 32.21       | 29.20  |
|            | 15-30      | 41.42             | 38.82     | 35.31       | 32.99  |
| T₃         | 0-15       | 35.54             | 38.17     | 33.10       | 30.22  |
|            | 15-30      | 38.89             | 41.16     | 35.57       | 32.92  |
| T₄         | 0-15       | 36.50             | 37.83     | 32.97       | 30.46  |
|            | 15-30      | 37.57             | 39.99     | 35.44       | 33.20  |
| T₅         | 0-15       | 32.21             | 34.66     | 29.22       | 26.47  |
|            | 15-30      | 33.88             | 36.61     | 34.92       | 32.06  |
Table.4 Productivity of soybean as influenced by different in-situ moisture conservation treatments (2007-08 to 2010-11)

| Treatments | 2007-08 | 2008-09 | 2009-10 | 2010-11 | Pooled |
|------------|---------|---------|---------|---------|--------|
| T<sub>1</sub> | 3231    | 2116    | 1471    | 2578    | 2349   |
| T<sub>2</sub> | 2893    | 2319    | 1748    | 3093    | 2513   |
| T<sub>3</sub> | 3028    | 2155    | 2069    | 2769    | 2505   |
| T<sub>4</sub> | 2941    | 2199    | 1831    | 2611    | 2396   |
| T<sub>5</sub> | 2884    | 2240    | 1812    | 2755    | 2423   |

S. E. (m) ±

| Treatments | 122     | 135     | 109     | 134     | 69     |
|------------|---------|---------|---------|---------|--------|

C.D. at 5% NS NS 336 NS NS

C.V. % 8.18 12.28 12.23 9.71 11.26

Table.5 Economics of soybean as influenced by different in-situ moisture conservation treatments (Pooled)

| Treatments | Yield (kg ha<sup>-1</sup>) | GMR (Rs. ha<sup>-1</sup>) | NMR (Rs. ha<sup>-1</sup>) | B:C |
|------------|-----------------------------|-----------------------------|-----------------------------|-----|
|            | Grain | Straw |                |                |       |
| T<sub>1</sub> | 2349  | 34.58 | 51798          | 36018          | 3.45  |
| T<sub>2</sub> | 25.13 | 36.29 | 55677          | 38466          | 3.40  |
| T<sub>3</sub> | 25.05 | 35.87 | 55405          | 38939          | 3.48  |
| T<sub>4</sub> | 23.96 | 35.84 | 53050          | 35022          | 3.14  |
| T<sub>5</sub> | 24.23 | 36.78 | 53722          | 38060          | 3.59  |

S. E. (m) ±

| Treatments | 0.69   | 1.04   | 1466           | 1466           | -     |
|------------|--------|--------|----------------|----------------|------|

C.D. at 5% NS NS NS NS NS

C.V. % 14.80 9.91 11.23 10.41 11.65

Market value of soybean grain @ Rs. 2183q<sup>-1</sup> and straw @ Rs. 50.00 q<sup>-1</sup>

Table.6 Soil moisture content (cm<sup>3</sup>/cm<sup>3</sup>) at different crop growth stages recorded At 0-15 and 0-30 cm depth

| Treatments | Depth (cm) | Soil moisture content (cm<sup>3</sup>/cm<sup>3</sup>) |
|------------|------------|-----------------------------------------------|
|            |            | Vegetative growth | Pod development | Harvesting |
| T<sub>1</sub> | 0-15       | 37.47             | 36.80           | 35.68      |
| T<sub>2</sub> | 0-15       | 39.68             | 39.39           | 37.96      |
| T<sub>3</sub> | 15-30      | 39.96             | 39.39           | 37.96      |
| T<sub>4</sub> | 0-15       | 38.74             | 39.23           | 32.64      |
| T<sub>5</sub> | 15-30      | 38.60             | 40.09           | 36.33      |
| T<sub>6</sub> | 0-15       | 39.96             | 33.05           | 34.94      |
| T<sub>7</sub> | 15-30      | 40.79             | 40.32           | 39.73      |
| T<sub>8</sub> | 0-15       | 35.78             | 31.91           | 26.33      |
| T<sub>9</sub> | 15-30      | 37.00             | 33.00           | 35.81      |
**Table 7** Productivity of sorghum as influenced by different *in-situ* moisture conservation treatments (2007-08 to 2010-11)

| Treatments | Grain yield (kg ha⁻¹) | 2007-08 | 2008-09 | 2009-10 | 2010-11 | Pooled |
|------------|-----------------------|---------|---------|---------|---------|--------|
| T₁         | 5324                  | 6034    | 4387    | 3138    | 4721    |
| T₂         | 5434                  | 6298    | 4327    | 3286    | 4836    |
| T₃         | 5173                  | 6373    | 4244    | 2881    | 4667    |
| T₄         | 5264                  | 6493    | 4595    | 3286    | 4909    |
| T₅         | 4818                  | 6019    | 4928    | 3318    | 4771    |
| S.E. (m) ± | 435                   | 274     | 251     | 613     | 183     |
| C.D. at 5% | NS                    | NS      | NS      | NS      | NS      |
| C.V. %     | 16.74                 | 8.80    | 11.15   | 11.96   | 15.32   |

**Fodder yield (kg ha⁻¹)**

| Treatments | Fodder yield (kg ha⁻¹) |
|------------|------------------------|
| T₁         | 13695                  |
| T₂         | 15432                  |
| T₃         | 12924                  |
| T₄         | 13310                  |
| T₅         | 13696                  |
| S.E. (m) + | 1124                   |
| C.D. at 5% | NS                     |
| C.V. %     | 16.28                  |

**Table 8** Economics of sorghum as influenced by different *in-situ* moisture conservation treatments (Pooled)

| Treatments | Yield (kg ha⁻¹) | GMR (Rs. ha⁻¹) | NMR (Rs. ha⁻¹) | B:C ratio |
|------------|----------------|----------------|----------------|-----------|
| Grain      | Fodder         |                |                |           |
| T₁         | 4721           | 10427          | 46761          | 29803     | 2.88     |
| T₂         | 4836           | 11195          | 48411          | 30126     | 2.80     |
| T₃         | 4667           | 10324          | 46187          | 29187     | 2.76     |
| T₄         | 4909           | 10900          | 48757          | 30234     | 2.68     |
| T₅         | 4771           | 10221          | 47214          | 31050     | 2.90     |
| S.E. (m) + | 183            | 279            | 1439           | 1439      | -        |
| C.D. at 5% | NS             | NS             | NS             | NS        | -        |
| C.V. %     | 15.32          | 10.51          | 12.13          | 20.49     | -        |

Market value (APMC, Akola) of sorghum grain @ Rs. 875q⁻¹ fodder @ Rs. 100q⁻¹

**Table 9** Soil moisture content (cm³/cm³) at different crop growth stages recorded at 0-15 and 0-30cm depth

| Treatments | Depth (cm) | Soil moisture content (cm³/cm³) |
|------------|------------|--------------------------------|
|            | Flag leaf  | Grain maturity | Harvesting |
| T₁         | 0-15       | 34.41           | 37.79      | 33.16     |
|            | 15-30      | 39.85           | 40.73      | 37.40     |
| T₂         | 0-15       | 37.36           | 38.17      | 32.28     |
|            | 15-30      | 41.65           | 40.08      | 36.44     |
| T₃         | 0-15       | 37.14           | 39.12      | 32.97     |
|            | 15-30      | 38.18           | 40.72      | 36.20     |
| T₄         | 0-15       | 37.71           | 33.02      | 34.52     |
|            | 15-30      | 41.82           | 40.88      | 37.54     |
| T₅         | 0-15       | 35.70           | 31.85      | 26.26     |
|            | 15-30      | 37.28           | 32.89      | 34.49     |
In pooled data of four seasons, grain and fodder yield were found to be non-significant. Numerically highest grain yield (4909Kg ha\(^{-1}\)) was recorded in treatment combination of furrow opening, mulching and thinning (T\(_4\)) followed by crop residue mulching treatment (T\(_2\)). Numerically highest fodder yield (11195 kg ha\(^{-1}\)) was recorded in crop residue mulching treatment (T\(_2\)).

**Economics of sorghum cultivation**

The data showing effect of various *in-situ* moisture conservation treatments on economics of sorghum cultivation (pooled) is given in table 8. The highest gross monetary returns (Rs. 48757) were obtained in treatment combination of furrow opening, mulching and thinning (T\(_4\)) followed by crop residue mulching treatment (T\(_2\)). The highest net monetary returns (Rs. 31050) were obtained in control treatment (T\(_5\)) followed by treatment combination of furrow opening, mulching and thinning (T\(_4\)). The highest B: C ratio (2.90) was obtained in control treatment (T\(_5\)).

**Soil moisture**

The soil moisture at the depths 0-15 and 15-30cm is given in table 9. The soil moisture status observed to be better in treatment combination of furrow opening, mulching and thinning at early stages of crop growth followed by crop residue mulching treatment and then by other treatments. However, at the final stages of crop the soil moisture content was observed maximum in the combination treatment of furrow opening, mulching and thinning followed by treatment of furrow opening.

For cotton crop, the highest gross monetary returns (Rs. 55025), net monetary returns (Rs. 37391) and B: C ratio (2.73) were obtained in crop residue mulching treatment (T\(_2\)). The soil moisture status observed to be better in crop residue mulching treatment (T\(_2\)) at vegetative growth stage of crop however at the boll formation stage the soil moisture content was observed maximum in the treatment of furrow opening (T\(_1\)).

For soybean crop, the highest gross monetary returns (Rs. 55677) were obtained in crop residue mulching treatment (T\(_2\)). The highest net monetary returns (Rs. 38939) were obtained in thinning treatment (T\(_3\)). The soil moisture status observed to be better in crop residue mulching treatment at vegetative growth stage of crop however at the pod development stage the soil moisture content was observed maximum in the thinning treatment.

For sorghum crop, the highest gross monetary returns (Rs. 48757) were obtained in treatment combination of furrow opening, mulching and thinning (T\(_4\)) followed by crop residue mulching treatment (T\(_2\)). The soil moisture status was better in treatment combination of furrow opening, mulching and thinning at flag leaf and grain maturity stage.

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