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Conservation agriculture- plus for resource conservation and enhancing productivity of sloping crop lands of Himalaya

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INTRODUCTION

❖Frequent occurrence of extreme rainfall events (>80-100 mm hr^{-1}) is predicted under changing climate scenario of Indian Himalayan Region (IHR) and recent estimates indicate that nearly 39% area of IHR has a potential soil erosion rate of more than 40 Mg ha^{-1} yr^{-1}, which is much higher than the specified soil loss tolerance limit of 10 Mg ha^{-1} y^{-1}.

❖India loses about 13.4 Mt food grains, worth US $2.5 billion (2008-09) due to soil erosion by water in rainfed areas.

❖ Rainfed maize (rainy season crop; mid June-mid September)-wheat (winter season crop; mid-November to April) is a dominant cropping system of north-western Himalayan states.

❖Several studies indicated that even after following all the three practices of conservation agriculture (FAO, 2012), runoff and soil loss values in maize crop growing on sloping crop lands were in higher range than the maize crop growing in mild sloped or flat lands (Singh et al., 2019).

❖This was resulted into insufficient available soil moisture for the post rainy season crops in the region.

❖So, in this context there are wide research and technology gaps, where the present study may provide the solution/technology for small land holders of the IHR or somewhere else in the same conditions.

METHODOLOGY

❖An experiment was conducted on the rainfed maize crops on a 4% sloping crop land during rainy season of 2015 and 2016 at the Research Farm, Selakui of the ICAR- Indian Institute of Soil and Water Conservation Dehradun, Uttarakhand, India (30° 20' 40" N latitude, 77°52'12" E longitude) at 516 m above mean sea level.

❖The field experiments were conducted on the zero tilled maize crops (in between the 15 cm long stubbles of previous wheat crop) planted in rainy seasons with following six treatment combinations:

T_1 – Zero tilled maize (ZTM)

T_2 – T_1 + cowpea as vegetative filter on 1 m vertical interval (ZTM+C)

T_3 – T_1 + grass weed as vegetative filter on 1 m vertical interval (ZTM+GW);

T_4 – T_1 + maize straw geo-textile on 1 m vertical interval (ZTM+MSGT)

T_5 – T_1 + *Arundo donax* (Rag-weed) geo-textile on 1 m vertical interval (ZTM+ADGT)

T_6 – T_1 + coir geo- textile on 1 m vertical interval (ZTM+CGT)

Replications: 4 Design: RBD Slope: 4%

One treatment plot size: 100x20 m^2

RESULTS

Table 1. Resource conservation and productivity of maize as influenced by different treatments

Treatments	Runoff (%)	Soil loss (t ha^{-1})	Maize grain yield (kg ha^{-1})	Soil moisture (%) at the end of rainy season		
				0-15 cm	15-30 cm	30-45 cm
T_1 – ZTM	24.4	18.8	2329	10.83	14.80	17.56
T_2 – ZTM+C	19.5	13.4	2387	11.14	15.15	17.70
T_3 – ZTM+GW	17.0	12.0	2295	11.81	15.29	15.91
T_4 – ZTM+MSGT	8.4	3.9	2727	13.19	18.16	18.20
T_5 – ZTM+ADGT	5.9	1.3	2963	14.49	17.98	20.23
T_6 – ZTM+CGT	11.4	8.6	2631	13.34	16.77	19.07
LSD (p<0.05)	-	-	424.5	3.04	3.16	3.55

❖Among all the treatments, the highest runoff (24.4%) and soil loss (18.8 t ha^{-1}) was recorded in the zero-tilled maize crop (ZTM) in which no extra protection for water erosion (geo-textiles or vegetative filters) were provided (only conservation agriculture).

❖However, it was less than the conventionally tilled maize crops (37.5% and 26.8 t ha^{-1}, respectively) as reported in the previous long-term studies (Sharma *et al.*, 2017) from the same plots. Whereas, the minimum runoff (5.9%) and soil loss (1.3 t ha^{-1}) was recorded in T_5: ZTM+ADGT followed by T_4: ZTM+MSGT (8.4% and 3.9 t ha^{-1}, respectively) (Table 1).

❖ Synthetic geo-textiles like coir-geo-textile (T_6: ZTM+CGT) produced 93% higher runoff which resulted into loss of 7.3 t ha^{-1} higher soil loss than T_5: ZTM+ADGT.

❖Vegetative filters of cowpea (T_2: ZTM+C) and grass-weed (T_3: ZTM+GW) produced 25 and 43% less runoff, respectively, which conserved 5.3 and 6.8 t ha^{-1} higher soil from erosion than ZTM but they were less efficient than geo-textiles with zero tillage (conservation agriculture plus).

❖Significantly, the highest maize grain yield (2963 kg ha^{-1}) was recorded in T_5: ZTM+ADGT which was 27% higher than maize crop raised without geo-textiles (T_1- ZTM).

CONCLUSION

Conservation agriculture practices along with geo-textiles (conservation agriculture plus) are more efficient in terms of resource conservation and productivity enhancement than only conservation agriculture practices (minimum soil disturbance, soil residue cover and diversified crop rotation) on a 4% land slope of IHR. If harvested correctly, these resources are readily available and can be used in the long-run.

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