

Impact of precise land levelling on pearl millet-based cropping systems

Y P Singh*, Sandeep S Tomar, Ravi Yadav, Ravi Gurjar and Deependra Sharma

Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, Madhya Pradesh 474 002

An impact study was carried out on selected locations of farmers' fields under the Farmer FIRST Programme in Morena district of Madhya Pradesh from 2017–22. The study interventions were land levelling through precision-based laser levelling (PLL) and traditional and levelling (TLL) under pearl millet-based winter (rabi) season crops, viz. wheat, mustard and chickpea. Compared with TLL, the PLL method enhanced the rainy (kharif) season pearl millet grain yield from 7.8–9.5% and winter season crops from 9.5–12.7%. Results indicated that pearl millet-based cropping systems establishment after PLL can be made more sustainable, productive, economically profitable and save Total Water User (TWU) in scarce groundwater or seasonal support canal irrigation systems.

Keywords: Cropping system, Economics, Precise levelling, Water productivity, Yield

DECLINING irrigation water availability and increasing productivity demand urgently require the quick adoption of scientific technologies for efficient water management. Water is a crucial factor in increasing agricultural production; its increasing scarcity has resulted in various innovative and efficient water management techniques. Farmers have traditionally levelled their fields because a flatter planting surface permits more efficient irrigation, saves labour and improves crop yield. Laser levelling improves the traditional process by using a laser guidance system to flatten fields to higher precision. This makes it possible to reduce irrigation time and use up to 25% less irrigation water as compared with traditionally levelled fields.

The farmers of Chambal region, Morena district of Madhya Pradesh irrigate the crops through border strips or flood irrigation and apply over-irrigation in undulated agricultural land. This resulted in excessive irrigation water use and nutrient losses, higher irrigation costs, poor water productivity, soil salinity or alkalinity and several biotic and abiotic stresses. These all contribute to reduced crop productivity while increasing the cost of cultivation and declining net profitability and environmental issues. The maximization of water productivity in scarce irrigation-water availability areas with efficient advanced irrigation methodology is required. The present impact study was conducted on precise and traditional land levelling on pearl millet-based cropping systems under the Farmer FIRST Programme project in scarce irrigation water available



Laser-assisted levelling

areas of Chambal region of Madhya Pradesh. The study objective was to improve the productivity of pearl millet-based cropping system, economics and water productivity in scarce water irrigation areas.

Precision levelling and execution

The impact study was based on two levelling methods- laser (light amplification by stimulated emission of radiation)-assisted precision land levelling (PLL) and traditional land levelling (TLL), with pearl millet (*Pennisetum glaucum*) based on three cropping systems- pearl millet-wheat (*Triticum aestivum*); pearl millet-mustard (*Brassica juncea*); pearl millet-chickpea (*Cicer arietinum*) cropping systems. As per the FFP project's general standards, demonstration plots were 4,000 m² in size.

A field study was carried out at selected farmer fields at Santa and Hadwansi adopted villages under the

Table 1. Impact of laser-guided precision land levelling on pearl millet-based cropping systems on yield and economics (pooled data of 5 years)

Cropping system	Levelling method	No. of farmers	Grain yield (tonnes/ha)		Stover yield (tonnes/ha)	Cost of production (thousand ₹/ha)	Net returns thousand ₹/ha)	B:C ratio
			Range	Mean				
Pearl millet-wheat	TLL	46	2.45–3.28	3.04	5.5	25.3	51.6	2.9
	PLL		2.65–3.75	3.35	6.1	26.2	62.1	3.2
	TLL	46	4.12–4.87	4.52	4.6	32.2	73.9	3.3
	PLL		4.38–5.26	4.95	5.2	30.3	82.4	3.7
Pearl millet-mustard	TLL	58	2.52–3.15	2.81	5.8	23.9	48.7	3.0
	PLL		2.76–3.30	3.03	6.3	23.4	56.1	3.5
	TLL	58	1.68–2.28	1.95	3.6	29.9	63.5	3.2
	PLL		1.89–2.36	2.18	4.2	28.5	75.2	3.8
Pearl millet-chickpea	TLL	24	2.73–3.34	3.17	6.2	24.9	57.1	2.6
	PLL		3.20–3.67	3.44	6.9	23.8	63.1	3.1
	TLL	24	1.31–1.82	1.58	1.8	28.1	53.5	2.9
	PLL		1.59–2.04	1.78	2.1	26.9	66.2	3.6

TLL-Traditional land levelling, PLL-Precise land levelling, B:C-Benefit cost ratio, Minimum seed support price in ₹ for the year 2016–17, 2017–18, 2019–20, 2020–21 and 2021–22 @14,250, 19,500, 20,000, 21,500 and 22,500/tonnes for pear millet, 17,350, 18,400, 19,257.690, 19,750 and 20,150/tonnes for wheat, 40,000, 42,000, 44,250, 46,500 and 50,500/tonnes for mustard and 44,000, 46,200, 48,750, 51,000 and 52,300/tonnes for chick pea; Average of 5 years for stover/ in local market @3,250, 4,500, 1,500 and 3,500/tonnes for pearl millet, wheat, mustard and chick pea, respectively.

Farmer FIRST Programme (FFP) project in the Morena district of Madhya Pradesh. The selected locations were sandy loam in texture and neutral to alkaline in nature. During the rainy (*kharif*) season crop pearl millet (var. hybrid) was grown and in the winter (*rabi*) season crops- wheat (var. RVW 4106), mustard (var. Giriraj), and chickpea (var. RVG 202) were grown. The Vishwa Vidyalyaya recommended agronomical packages of practices were followed for growing crops under study. Grain, straw yield, gross return, net returns (₹) and benefit-cost (B:C) ratio were calculated. Different economic indicators of inputs were calculated based on the minimum support price and existing market price. The total water use (TWU) was computed by the sum of irrigation water and effective rainfall between the sowing and harvesting of crops. The water productivity (WP) was calculated by seed yield (kg/ha) divided by TWU (m³ water/ha).

Impact on rainy (*kharif*) season crop

Results of PLL technology led to an improvement in grain yield of rainy season crops pearl millet from 7.8–10.2% and straw yield from 8.6–11.3% as compared with TLL (Table 1). The greater output of pearl millet was obtained when it was grown after chickpea, followed by wheat, and the lowest with mustard-based cropping systems. By the adoption of PLL practice, additional net savings of production cost was ₹500 to 1100/ha compared with total cultivation cost under TLL (₹23,900–25,300/ha) of pearl millet crop (Table 1). The maximum additional NRs are from pearl millet (₹10,500/ha) grown after wheat followed by mustard (₹7,400/ha) and least with chickpea (₹6,000/ha). The B:C ratio ranged from 3.1–3.5 with PLL, whereas 2.6–3.0 with TLL. The PLL technology improved crop stand and productivity,

resulting from higher net benefits and B:C ratio.

Impact on winter (*rabi*) season crops

Results indicated that PLL led to an improvement in grain yield of winter season crops (wheat, mustard, and chickpea) from 9.5–12.7% and straw yield from 13.0–16.7% as compared with TLL (Table 1). The PLL improved seed yield of chickpea was maximum (12.7%), followed by mustard (11.8%) and least with wheat (9.5%). Laser-assisted PLL has improved the input-use efficiency of water and nutrients, resulting in enhanced crop yields.

Under land levelling intervention, the lower average production cost of winter season crops grown after pearl millet were recorded with PLL due to savings in the price of irrigation water and labourers compared with TLL (Table 1). By the adoption of PLL practice, the net savings of production cost was from ₹1200 to 1900/ha as compared with the total cultivation cost were recorded under TLL (₹28,100 to 32,200/ha) of winter season crops. The maximum additional savings in cultivation cost were recorded in wheat (₹1,900/ha), followed by mustard (₹1,600/ha), and the least with chickpea (₹1,200/ha). The PLL technology had a maximum additional return of ₹18,700/ha with chickpea followed by ₹11,700/ha with mustard and lowest with wheat crop (₹8,500/ha) as compared with TLL. The PLL technology influences farming operations and productivity, resulting in higher NRs. The B:C ratio was higher with PLL (3.6–3.8) compared to TLL (2.9–3.3).

System productivity

The PLL method increased the pearl millet equivalent yield (PEY) of system productivity compared to TLL (Table 2). Results showed that the PLL method

Table 2. Effect of laser-guided precision land levelling on system-based pearl millet equivalent yield, economics and water balance

Interventions		PEY (tonne/ha)	Cultivation cost (thousand ₹/ha)	Net returns (thousand ₹/ha)	TWU (m ³ water/ha)	WP (kg seed/m ³ water)
Cropping system	Levelling method					
Pearl millet-wheat	TLL	7.42	58.1	124	8091	0.92
	PLL	8.16	55.7	144	7232	1.12
Average		7.79	56.9	134	7661	1.02
Pearl millet-mustard	TLL	7.29	53.7	112	6568	1.11
	PLL	8.04	52.0	131	6162	1.31
Average		7.66	52.9	121	6365	1.21
Pearl millet-chick pea	TLL	7.08	52.3	111	5934	1.19
	PLL	7.95	50.8	128	5601	1.42
Average		7.52	51.5	119	5767	1.30

TLL- Traditional land leveling, PLL- Precise land levelling, PEY- Pearl millet equivalent yield, TWU- Total water use, WP- Water productivity

increased PEY by 10.0–12.3% as compared to TLL. The PLL technology increased yield because of the uniform distribution of soil moisture for a longer time and increased soil physico-chemical properties. The PEY system productivity of the different cropping systems followed the order: pearl millet-wheat (7.79 t/ha) > pearl millet-mustard (7.66 t/ha) > pearl millet-chickpea (7.52 t/ha).

System economics

The system-based NRs were increased with PLL method compared with TLL (Table 2). The net cultivation cost savings increased from ₹1,500 to 2,400/ha of pearl millet-based cropping systems. Among the system, the maximum net savings of cultivation cost were with pearl millet-wheat (₹2,400/ha) followed by pearl millet-mustard (₹1,700/ha), pearl millet-chickpea (₹1,500/ha) as compared with total cultivation cost of TLL. The minimum production cost with PLL was mainly due to saving irrigation water and labour. Additional NRs of various systems with PLL were greater with pearl millet-wheat (₹20,000/ha) followed by pearl millet-mustard (₹1,9000/ha) and lowest with pearl millet-chickpea (₹1,7000/ha). The higher NRs were recorded with PLL system due to saving of cost in cultivation and higher yield.

Total water-use

The TWU for all three cropping systems was higher with TLL than PLL (Table 2). The savings of TWU

increased from 333 to 859 m³/ha with PLL as compared with TLL. The maximum protection of TWU with PLL was from pearl millet-wheat (859 m³/ha) followed by pearl millet-mustard (406 m³/ha) and pearl millet-chickpea (333 m³/ha). Among different cropping systems, pearl millet-wheat requires a higher amount of TWU (7661 m³/ha), followed by pearl millet-mustard (6365 m³/ha) and least with pearl millet-chickpea (5767 m³/ha).

Water productivity

The system-based water productivity (WP) was increased with PLL from 18.0–21.7% as compared to TLL (Table 2). The variations of WP due to the higher yield advantage of PLL were due to constant soil moisture availability which supports the concept of a better soil moisture environment. Overall higher WP of the system was recorded under pearl millet-chickpea (1.30 kg seed/m³ water) followed by pearl millet-mustard (1.21 kg seed/m³ water), and the lowest by pearl millet-wheat (1.02 kg seed/m³ water) cropping systems.

SUMMARY

The crop production under traditionally levelled fields is declining system productivity, profitability and water productivity over time. In these conditions, precise laser land levelling reformed soil properties and improved system productivity, economic profitability and water productivity of the pearl millet-based cropping system. The yield of crops, pearl millet equivalent yield, net returns and water productivity with precise land levelling were enhanced as compared with the traditional land levelling method. Like-wise, pearl millet equivalent yield, net returns and total water use were greater with pearl millet-wheat followed by pearl millet-mustard and lowest with pearl millet-chickpea under the study.



Mustard on levelled field at FFP field

*Corresponding author's e-mail: ypsinghkvk@gmail.com