Permanent Raised Bed Cultivation Improves Nitrogen and Water Use in Rice-Wheat Cropping Systems of South Asia

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INTRODUCTION

Permanent raised bed cultivation for rice-wheat cropping systems in South Asia is a paradigm shift from the conventional practice of planting on flat land. Conventional practice involves substantial tillage and puddling of soil, thereby destroying soil aggregates and promoting soil organic matter degradation. Permanent beds employ a bed and furrow planting configuration that is maintained for all crops with only periodic reshaping.

Without tillage, beds allow soil aggregates to be rebuilt over time, provide deeper rooting, and better air/water relationships in the soil. Particularly attractive are the possibilities for reducing water inputs by furrow irrigation compared to flood irrigation, and improved fertilizer N recovery by banding nitrogen into the soil between two rows on a bed.

We present here the results from three experiment station trials comparing conventional and permanent bed cultivation in rice-wheat systems of Nepal and Bangladesh ongoing since 2001. Emphasis is on crop productivity trends, nitrogen use and irrigation inputs.

METHODS

Bangladesh Strip-split-split plot with 3 replications at Bangladesh Agricultural Research Institute (BARI) stations Nashipur (sandy loam soil) and Rajshahi (silty clay loam soil). Experiments followed a triple crop rice-wheat-mungbean rotation. The Rajshahi experiment was discontinued in 2003.

Main Plot: - Permanent beds (PB)
(15 cm high, 75 cm furrow to furrow - 2 rows/bed)
- Conventional flat (CF)

Sub-Plot: - Band placed nitrogen
- Broadcast nitrogen

Sub-sub Plot: - 50% recommended nitrogen
- 100% recommended nitrogen
- 150% recommended nitrogen

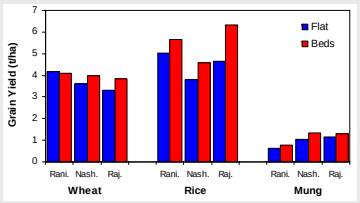
Nepal Started as RCB design with 4 replications at Nepal Agricultural Research Council (NARC) station Ranighat (silty loam soil) in a rice-wheat rotation. In 2002, mungbean was added to the system. Plots split to include straw mulch treatments in 2003.

Main Plot: - Permanent beds (PB)
(15 cm high, 65 cm furrow to furrow - 2 rows/bed)
- Conventional flat (CT)

Sub-Plot: - straw mulch @ 4 t ha^{-1}
- no mulch

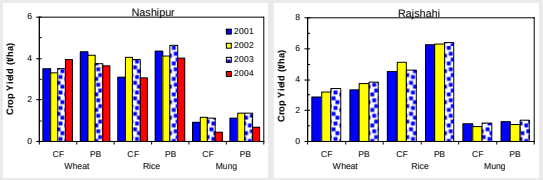
RESULTS

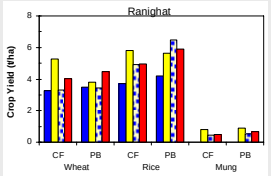
Crop Productivity



- On average PB outperformed CF for all crops with the exception of wheat at the Ranighat site.
- PB improved rice and mungbean productivity more than wheat. Mean yields were increased by 12-36% for rice, 16-26% for mung and -2-16% for wheat.

Yield Trends With Time





- Wheat yields on PB declined over time at Nashipur, unlike the flat plots, suggesting a negative influence on wheat yields with sustained PB practice.
- The wheat yield decline may be due to limited accessibility of applied nutrients concentrated near a drier soil surface on lighter textured soils.
- No negative crop yield trends for PB were observed at Ranighat or Rajshahi.

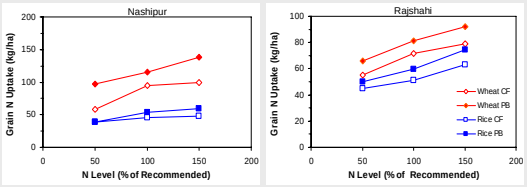
Mulch Effect On Yield

	Mean Yield 2003-2005 (t ha^{-1})		
	Wheat	Rice	Mung
CF	4.00	5.01	0.53
CF With Mulch	4.21	5.45	0.64
PB	4.31	5.90	0.62
PB With Mulch	4.47	6.39	0.77

- Straw mulch had a positive effect on yields of all crops at Ranighat but especially on rice. The response to mulch was similar with CF and PB.

Nitrogen Response

- The darker green rice plants on beds compared to those planted on the flat (background) suggests better nitrogen utilization in PB.



- Grain nitrogen uptake was higher on PB than CF at both sites for wheat, and at Rajshahi for rice.
- While grain yield responses to fertilizer N were higher with rice than wheat at both sites; grain N uptake in response to fertilizer N was higher with wheat.

Irrigation Inputs

Site	Crop	Beds	Flat	Change
Nashipur (L/15 m^2)	Wheat	728	923	-21%
	Rice	2092	2464	-15%
	Mung	320	430	-26%
Rajshahi (L/30m^2)	Wheat	3350	5410	-38%
	Rice	1108	1650	-33%
	Mung	1108	1650	-33%

- At Nashipur and Rajshahi, PB reduced irrigation inputs 21-38% in wheat, 15-33% in rice and 26-33% in mung relative to CF.

CONCLUSIONS

Permanent raised bed cultivation is an innovative practice for the rice-wheat system of South Asia. Beds increase crop productivity, improve N use and save irrigation water inputs relative to conventional practice. Additional cost savings in labor/land preparation, fertilizer and seed inputs are convincing farmers to adopt this technology in Bangladesh.

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