Beds in bays increase profitability on rice farms

Rajinder Pal Singh & Geoff Beecher
NSW DPI, Yanco Agricultural Institute

in a rice hull

- An economic analysis was conducted to determine the financial benefits available to rice growers who use permanent lateral raised bed layouts (beds in bays)
- The results of a benefit cost analysis show that the adoption of beds in bays is potentially more profitable than adoption of several other irrigation designs for rice-based farming systems
- The analysis also suggests that beds in bays are viable in their own right from a financial perspective

An economic analysis was undertaken to measure the potential benefits and costs of converting existing irrigations layouts to 'beds in bays' in rice based farming systems.

This study arose from the field experiment at Coleambally Demonstration Farm on the performance of rice and other crops on lateral permanent raised beds, which has been progressively reported in this (pp 20–22) and previous Rice R&D editions of the *Farmers' Newsletter* (No.s 168, 171 and 174).

Potentially there are several financial benefits available to rice growers who use lateral permanent raised bed layouts. These include:

- increased returns from an individual crop/enterprise (non rice) due to increased in yield
- reduction in variable input costs
- reduction in production losses due to improved timeliness of operations
- water savings leading to a reduction in production costs and a source of additional income
- labour savings
- machinery cost savings
- shifts to cropping rotations with more profitable cropping options
- savings in overhead and operating costs.

A description of the economic analysis

Four existing field layouts currently being used by rice growers to grow different summer and winter crops were considered in the analysis. These were:

- non-landformed natural contour
- laser landformed natural contour
- laser landformed square contour
- laser landformed square contour alternating with raised beds.

There is no one crop sequence suited to every rice-based layout. The study identified a typical crop sequence from each of the selected irrigation layouts to allow a comparison of the financial performance of different crop sequences under different irrigation layouts. The details of the cropping sequences are given in Table 1. In the laser-landformed lateral permanent raised beds design, the study considered two rice phase lengths.

Benefit cost analysis & net present value

Within a benefit cost framework, the study estimated and compared the additional and foregone costs and benefits of changing the layouts to lateral permanent raised beds. The study considered financial values for all relevant inputs and outputs. The 'financial values' are the prices/benefits actually received by farmers for outputs or actually paid by them for inputs or losses.

An interest rate (discount rate) of 4%, commensurate with perceived risk, was used to convert future payments or receipts to present value.

The financial merit of adopting beds in bays was assessed using the net present value (NPV). Net present value is the difference between the present value of the costs associated with the investment and the present value of benefits accruing from it. The proposal is deemed to have a positive impact if NPV exceeds zero.

Gross margin analysis

The potential benefits and costs of adoption of permanent beds were established through gross margin analysis and crop sequence gross margin analysis. Gross margin is the gross return from a crop (yield x price) less the variable cost of production. The study used a *crop sequence* gross margin analysis to estimate the potential benefits of adopting lateral permanent raised beds over existing layouts over the long term, rather than gross margins for just one crop, as is customary with gross margin analysis.

Costs of some inputs or operations such as irrigation water, fertiliser and machinery operations are different under different field designs. Increase in yield or price also leads to increase in the cost of some variable inputs and operations such as harvesting costs, insurance and research levies. Therefore, the variable costs and returns of an individual crop/enterprise have been measured for different irrigation designs and cropping rotations separately. Standard gross margin analysis deals with only one crop.

Furthermore, selection of an enterprise is done not only on the basis of its profitability as an independent enterprise but also by its contribution to other enterprises or to a cropping system. To maintain the productive capacity and economic sustainability of a farm, the farmers grow certain crops that may not be profitable in their own right, but by improving soil fertility or reducing weeds/disease they help to increase yield of other crops grown in the rotation.

Improved field design offers opportunities to shift to a more profitable crop from an existing less profitable crop. This study first identified one typical rice-based cropping rotation from each selected field design. In a cropping sequence, different crops perform differently, depending upon their placement in a particular crop sequence. The crop sequence will affect yield or the amount of inputs required, eg fertilisers, chemicals or irrigation water. These relationships require analysis of the crop sequence budgets to allow comparisons of the performance of different crop sequences on different field designs to be made. Therefore, it is appropriate to compare the impact on crop sequence gross margin from the conversion of other designs to permanent raised lateral beds, rather than a single crop gross margin.

Developing gross margins for the study

The gross margins used in the analysis are based on NSW DPI farm budget handbooks (www.dpi.nde.gov.au). The information on crop yields, input use, number of irrigations and total water used to grow different crops on different layouts is based on the findings of the 'beds in bays' research project (Table 2).

Cost of developing lateral permanent raised beds

The costs of conversion to lateral permanent raised beds considered in the analysis include: initial cost of survey

Table 1: Details of the crops and crop sequences for selected irrigation field designs of the economic analysis

Irrigation layout design	Rotation analysed (legend for codes below)
I. Non landformed natural contour	RRRF(OW)WWPPP
II. Laser landformed natural contour	RRRF(OW)WWPPP
III. Laser landformed square contour	RRRF(OW)WWPPP
IV. Laser landformed square contour, alternating with permanent raised beds	RRRFS/BSF
Va. Laser landformed lateral permanent raised beds (zero-graded, bankless, terraced rice field irrigation design)	RRB/SB/S
Vb. Laser landformed lateral permanent raised beds (zero-graded, bankless, terraced rice field irrigation design)	RRRB/SB/S

Legend: R = rice, F = fallow, OW = opportunity wheat, W = wheat, B = barley, S = soybean

Table 2: Gross margins of each enterprise on a particular irrigation design, as determined from results of the 'beds in bays' research. The irrigation designs are described in Table 1.

Crop/enterprise	Gross margins ($/ha) based on irrigation design				
	I	II	III	IV	V
1st year rice	1738	1646	1880	1720	2012
2nd year rice	1507	1531	1739	1718	2009
3rd year rice	1528	1497	1704	1669	2009
Opportunity wheat (OW)	180	343	447	-	-
1st wheat	105	245	333	-	-
2nd wheat	57	159	232	-	-
1st barley	-	-	-	198	202
2nd barley	-	-	-	197	202
1st soybean	-	-	-	915	927
2nd soybean	-	-	-	784	927
1st pasture	162	229	229	-	-
2nd pasture	133	200	200	-	-
3rd pasture	64	101	101	-	-
Probability of OW	0.25	0.50	0.50	0.75	0.75

design, earthworks, landforming, capital costs and annual maintenance (reshaping) costs over the lifespan of the system. The machinery costs for preparing lateral permanent raised beds were rates charged by local contractors.

To estimate the costs involved in converting to lateral permanent raised beds, the study used three different types of fields under each layout based on the level/degree of slope and contortion of the field:

1. flat slope (greater than 1:2500)
2. medium slope (~1:1500)
3. steep slope (<1:750 and contorted).

The costs involved in constructing lateral permanent raised beds from different existing layouts with different degrees of slope were estimated in conjunction with a local irrigation surveyor and landforming contractor and during discussions with landholders. The analysis is based on the costs involved in constructing lateral permanent beds from different existing layouts on medium slope country (Table 3). The conversion costs were higher for more steeply sloped country and lower for flat country.

It was assumed that the life of the lateral permanent raised beds layout is 10 years and that reshaping of the beds is done every year.

Table 3: Cost of converting to lateral permanent raised beds from an existing layout

Existing field layout	Level of slope (medium)
Grazing field	$1,600
Non landformed natural contour	$1,469
Landformed natural contour	$1,417
Landformed square bays	$1,383

Benefits & costs of beds in bays

The results of the benefit cost analysis presented in Table 4 show that over the long term (30 years) the present value of the benefits from irrigation layouts Va and Vb were $34,029/ha and $35,951/ha, respectively.

The present value of benefits from layouts I, II and III were $15,350/ha, $16,628/ha and $19,307/ha respectively.

The present value of costs involved in converting to lateral permanent raised beds from layouts I and II were $2,976/ha and $2,922/ha respectively and $2,887/ha when converting from layouts III and IV.

Further, Table 4 shows that the conversion of a non landformed natural contour design (layout II) to a lateral permanent raised bed design (layout Vb) is more profitable than other conversions, with a net benefit of $17,626/ha over the long term.

The major reasons for a sharp increase in the net present value of benefits of converting to the lateral permanent raised beds over layouts I, II and III are:

- the saving of the cost of seedbed preparation when growing crops on beds in bays from year 2 to 10
- the shift to a cropping rotation with more profitable

Table 4: Present value of costs, benefits and net present value of benefits from lateral permanent raised beds over different existing layouts

Field layout	Present value of cost ($/ha)	Present value of benefits ($/ha)	Net present value of benefits ($/ha) Layout V (a)	Net present value of benefits ($/ha) Layout V (b)
I	2,976	15,350	15,704	17,626
II	2,922	16,628	14,425	16,347
III	2,887	19,307	11,746	13,669
IV	2,887	31,010	44	1,976
Sequence Va		34,029		1,966
Sequence Vb		35,951		-

Table 5: Sensitivity of results to changing values of selected parameters

Crop	Yield change	NPV of benefits of lateral permanent raised beds (Vb) over all other layouts: I	II	III	IV	V (a)
Default results [1]		17,626	16,347	13,669	1,976	1,966
Rice	10% decrease in yield	14,221	12,943	10,264	-1,438	1,355
Soybean	10% increase in yield	18,882	17,604	14,925	3,223	1,576
	10% decrease in yield	16,369	15,091	12,412	710	2,268
Barley	10% increase in yield	18,210	16,931	14,257	2,550	1,761
	10% decrease in yield	17,090	15,812	13,113	1,431	2,071
Discount rate used	7% real discount rate	10,506	9,676	7,779	338	1202
	10% real discount rate	7,482	6,899	5,442	33	994

[1]With rice yield @ 11 t/ha, soybean @ 3.3 t/ha, barley @ 5.5 t/ha and discount rate @ 4%

cropping options, ie moving from a low value wheat/ pasture after rice phase in layouts I, II and III to a more profitable double cropping sequence of soybean/barley
- a shorter phase of two years of non rice crops (double cropping of soybean/barley) on layouts IV, Va and Vb, compared with five years of wheat, annual pastures or short fallow phase in layouts I, II and III.

It is assumed that there were no yield losses on deep cut soil from landforming and there were no water savings from growing crops on beds in bays.

Sensitivity analysis

A sensitivity analysis was undertaken to show the effects on the net present value of financial benefits due to changes in yield of summer and winter crops grown on lateral permanent raised beds (Table 5). The following yield levels of rice, soybean and wheat were considered:

- 10% decline in rice yield on lateral permanent raised beds
- 10% increase and decline in soybean yield on lateral permanent raised beds
- 10% increase or decline of barley on lateral permanent raised beds
- 7% and 10% discount rate (interest rate).

The sensitivity analysis shows that the net present value of benefits are highly sensitive to change in the discount rate used in the analysis and a decline in rice yield, compared to any change in the yield of soybean and barley.

Potentially profitable

The results of the benefit cost analysis show that the adoption of beds in bays is potentially more profitable than the other selected designs for rice-based farming systems and the technology is viable from a financial perspective. The net present value of benefits are highly sensitive to a change in the discount rate used in the analysis and a decline in rice yield, compared with any change in the yield of soybeans and barley.

Any improvement in yield of growing crops on beds in bays would further increase the financial benefits from this technique, promoting its widespread adoption.

Acknowledgements

Mike Darnley Naylor and Laurie Barnhill for advice on layout design and earthmoving volumes and costs

RIRDC Project DAN-201A

Geoff Beecher
Research Agronomist
NSW DPI, Yanco Agricultural Institute
T: 02 6951 2611
E: geoff.beecher@dpi.nsw.gov.au

Further reading

HG Beecher, JA Thompson, BW Dunn, RP Singh and SK Mathews (2007). Using raised beds on rice farms- innovative rice based cropping systems. RIRDC Publication number 07/115.

Geoff Beecher, Brian Dunn, Shayne Mathews, John Thompson, Rajinder Pal Singh, Liz Humphreys, Jagadish Timsina, Keiran O'Keeffe & Daniel Johnston (2007). Permanent lateral beds for sustainable cropping systems on rice farms. IREC Farmers' Newsletter, *Rice R&D edition, No 174, Summer 2006–07, pp 4–8.*

Geoff Beecher, Brian Dunn, Shayne Mathews, John Thompson, Rajinder Pal Singh, Liz Humphreys, Jagadish Timsina, Keiran O'Keeffe & Daniel Johnston (2006). Permanent lateral beds for sustainable cropping systems on rice farms. IREC Farmers' Newsletter, *Rice R&D edition, No 171, Summer 2006, pp. 24–27.*

Mathews, S, Beecher G, Dunn B, Thompson J, Humphreys L, Johnston D (2005). Permanent beds for sustainable cropping systems. IREC Farmers' Newsletter, *Rice R&D edition, No 168, Summer 2005, pp.25–27.*

NSW Department of Primary Industries Farm Budget Handbooks - Southern NSW Irrigated summer and winter crops www.dpi.nsw.gov.au/econ/