ECONOMIC ASSESSMENT AND REQUIREMENTS OF PERMANENT RAISED BEDS IN WA.

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INTRODUCTION

Waterlogging has long been recognized as a major constraint to crop growth. Waterlogging in the South Western region of Western Australia (WA) is predominantly the result of perched water tables in duplex soils, caused by rainfall in excess to evapotranspiration limited percolation through the subsoil and lateral drainage. Surface drains have often been recommended to alleviate water logging however with little success due to poor lateral water movement. The concept of raised beds has been well established in irrigated agriculture (Tisdall and Hodgson, 1990). However, the application of raised beds to dryland agricultural area, notably waterlogged duplex soils has not been investigated. Raised beds provide short drainage pathways and reasonable hydraulic gradients. They improve lateral water movement, resulting in less water logging in the root environment, and increase in evapotranspiration and subsequent biomass accumulation.

In irrigated agriculture, raised beds are not an option but an essential feature of the irrigation layout of the farm, and exist by virtue of the necessity to introduce irrigation water along well defined pathways in conjunction with row cropping. Not so with the application of raised beds to dryland agriculture, particularly in the context of broadacre agriculture where the use of raised beds becomes an option available to farmers to deal with waterlogging. The economic impact of waterlogging is often assessed on the basis of intrafarm comparisons, between areas which are visually waterlogged and which are not. Given the fact that raised beds eliminate waterlogging (Bakker and Hamilton, 1998) an economic assessment of raised beds is required to be able to decide when raised beds are a viable and economic option to combat waterlogging. This paper describes the economic assessment of raised beds in WA based on the installation of raised beds in various locations in the SW corner of WA in two consecutive years.

ESTABLISHMENT COSTS

Surveys

The costs of establishment of raised beds is governed by the costs of the survey which, depending on the topography of the landscape, is generally done on a 50m x 50m grid basis and the contours plotted on a 20cm interval. It is not expected that for the application of raised beds in broadacre agriculture major earth moving or landlevelling will be carried out, but that the raised beds will be fitted in the landscape and that perhaps some losses will have to be accepted due to limited drainage opportunities. In some instances the topography of the landscape is such that surveys are not necessary at all.

Design

In a more complex landscape the orientation of the raised beds requires some elements of design in addition to the positioning and dimensioning of surface drains.

Soil Tests

The installation of raised beds on duplex soils has the potential to bring highly dispersible sub-soil to the surface. In that instance, soil tests should be carried out to determine the required amount of gypsum to be applied to the raised beds.

Installation costs

Catch drains and waterways are required to channel the runoff from the beds in a sustainable manner using conventional soil conservation considerations. The installation of the raised beds would, depending on the soil type, most likely require deep ripping and chissel ploughing to ensure sufficient loose top soil to form the beds and to incorporate any gypsum.

A summary of the establishment costs is presented in Table 1

Table 1. Establishment cost of raised beds.

Total costs, design, surveys and soil tests	**$50**	**/ha**
Installation		
Catch drains & waterways	$50	/ha
Raised beds	$60	/ha
Total installation costs	**$110**	**/ha**
Gypsum application @ 4t/ha	$100	/ha
Total establishment costs	**$260**	**/ha**
Total amortised establishment costs	**$20**	**/ha**

Maintenance Costs

Some degree of maintenance on a regular basis is required of the raised beds. The frequency depends on longevity of the raised beds which is related to whether the beds have been trampled on, the mobility of the gypsum and the longevity of the drains and waterways. A summary of the cost is presented in Table 2.

Table 2. Summary of the maintenance costs.

	Cost/ha	Frequency in years	Amortised Cost/ha
Gypsum application	$100	4 years	$28.86
Furrowing	$30	5 years	$7.12
Drains and waterways	$20	5 years	$4.75
Total annual maintenance cost per ha			**$40.73**

MACHINERY COSTS.

Raised beds are commonly established using customized tillage equipment. This is usually a tool bar equipped with furrowers (ripper shanks with furrower blades) and levelling blades. This equipment is readily available so straight purchasing and ownership costs can be calculated. To utilize the raised beds to their potential (i.e. zero traffic on the beds, all traffic confined to the furrows) some modifications of the seeder, spray unit and the harvester is required and some estimates of these costs are presented in Table 3. In all our costings an interest rate of 6% annually is assumed.

Table 3. Machinery and modification costs

Machinery and modifaciations	Current Value	Salvage value	Replacement Period	Amortised costs: Purchase Costs	Amortised costs: Ownership Costs
Purchase of new machinery					
Furrow bed former	$30,000	$2,500	20 years	$2,548	$1,800
Modification of existing machinery					
Seeder	$5,000	$0	15 years	$515	$300
Spray unit	$2,000	$0	10 years	$272	$120
Harvester	$10,000	$0	10 years	$1,359	$600
Total	**$47,000**			**$4,693**	**$2,820**
Total annual machinery costs					**$7,513**

CROPPING IMPLICATIONS OF RAISED BEDS

Waterlogging severely affects the yield and has implication for the choice of crops in the cropping program. The elimination of waterlogging will therefore increase the range of crops to be grown on previously waterlogged land. The crops in the our cropping program were not changed. In the cropping program we have assumed moderate increases in yield from the raised beds on all occasions, regardless whether it has been a dry or wet year (Bakker and Hamilton, 1998). A pasture phase has been included in our analyses but will not be presented here. Yields and farm-gate prices are highly variable from year to year and our figures are only indicative of what can be expected from the raised beds when an increase in yield is achieved. The expectancy of crop failure due to waterlogging before the introduction of the raised beds (i.e. 1 in 5 year heavy crop loss) can be introduced to suit ones own situation. In Table 4, the cropping program and assumed prices are presented.

Table 4. Cropping rotation, yield and prices before and after the installation of the raised beds.

Rotation before construction of raised beds							
Crops	**Yield /ha**	**Farm gate price**		**Returns /ha**	**Cropping Costs /ha**	**Net Return**	
Wheat	1.5 t	$180.0	/t	$270	$120	$150	/ha
Faba beans	0.5 t	$300.0	/t	$150	$140	$10	/ha
Wheat	0.8 t	$180.0	/t	$144	$120	$24	/ha
Canola	0.8 t	$300.0	/t	$225	$160	$65	/ha
Wheat	0.5 t	$180.0	/t	$90	$120	-$30	/ha
Average net return						**$44**	**/ha**
Rotation after construction of raised beds							
Crops	**Yield /ha**	**Farm gate price**		**Returns $/ha**	**Cropping Costs $/ha**	**Net Return**	
Wheat	2.0 t	$180.0	/t	$360	$120	$240	/ha
Faba beans	0.7 t	$300.0	/t	$210	$140	$70	/ha
Wheat	2.0 t	$180.0	/t	$360	$120	$240	/ha
Canola	1.5 t	$300.0	/t	$450	$160	$290	/ha
Wheat	3.5 t	$180.0	/t	$630	$120	$510	/ha
Average net return						**$270**	**/ha**

TOTAL BENEFITS

The total benefits of the raised beds are summarised in Table 5. The area worked after the raised beds are slightly less than before the raised beds due to the presence of drains. It is assumed that the furrows have been sown and that any yield reduction occurring in the furrows is included in the total yield of the raised beds. Increased land value and improved timeliness of operations are reflected in the increase in crop yield. Therefore, they are not to be included as separate benefits.

The value of conserved water is the cost of providing it from alternative sources.

The question of opportunistic irrigation is a difficult one and would require an investment analysis to determine the benefits of setting up the infrastructure to irrigate. However the lack of water is often not the main constraint to irrigating, it is the cost of storing and pumping water to where it is needed, and the relatively low benefits (compared to the cost).

Table 5. Benefits of the raised beds.

Area of crop before works	200	ha
Area of crop after works	195	ha
Rotation gross margin before works	$44	/ha
Rotation gross margin after works	$270	/ha
Value of conserved water	$0	
Opportunistic irrigation	$0	
Total revenue before works	$8,760	
Total revenue after works	$52,650	
Increase in revenue per ha raised beds	$257	

NET BENEFITS

The net benefits of the raised beds are summarized in Table 6. These benefits are obviously dependent on the area under raised beds. In Table 6, the area under raised beds is 195 ha compared to 200ha before raised beds (see Table 5).

Net benefits of raised beds		
Total costs and benefits		
Total amortised establishment costs	$20	/ha
Total annual maintenance cost	$41	/ha
Total annual machinery costs	$39	/ha
Total costs	**$100**	/ha
Total annual benefits	**$257**	/ha
Net benefits	**$158**	/ha

An assessment as to how costs and net benefit are related to the area under raised beds is presented in Figure 1. The base line data and assumptions used to derive that figure have been discussed in the above.

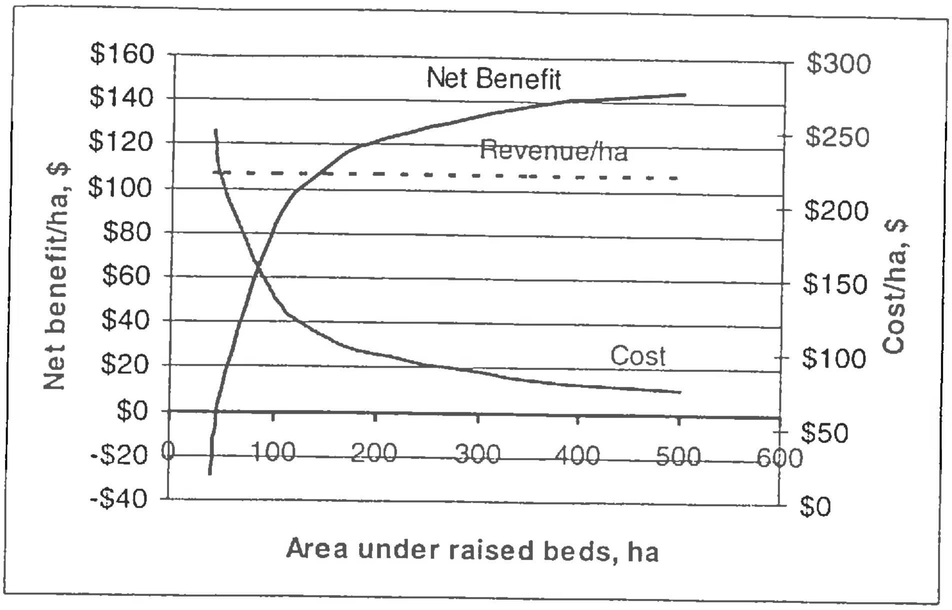

Figure 1. Net benefits and costs as a function of the area under raised beds for a full cropping program.

As one can see, the point of net return for areas under raised beds is about 50 ha. The maximum area to be worked by one implement and one machine during the window of opportunity has not been taken into account.

CONCLUSION

Based on the assumption used in our analysis it becomes quite clear that the purchase of the furrower/bedformer is by far the largest outlay associated with raised beds. However even for a relatively small area (50ha) under raised beds the investment is warranted. This area has to be enlarged when a pasture phase is introduced in the cropping program. Other factors which might influence the adoption of raised beds to alleviate waterlogging such as being locked into particular directions of cropping or problems in the pasture fase (i.e. rounding up sheep) are difficult to quantify. The extent of waterlogging is predominantly a function of rainfall and soil type and probabilities of degrees of waterlogging can therefore be predicted based on long term rainfall records. Probability simulations of waterlogging conditions, coupled to yield reductions due to waterlogging and the cost/benefit relationship can therefore become a tool to establish the economic viability of raised beds on waterlog prone land for individual farmers.

REFERENCES

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