Irrigated Cropping on Permanent Raised Beds in Southern New South Wales.

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Cropping with Raised Beds

Raised beds are a cropping system where the crop zone and the traffic lanes (wheel tracks) are distinctly separated. The flat-topped beds are constructed by moving soil from the traffic lanes to the crop zone. This raises the level of the cropped zone, leaving a furrow for the wheel traffic and for irrigation. Some of the advantages of raised beds are:

- the layout allows for improved surface and internal drainage of the cropped soil, reducing waterlogging in both winter and summer crops. More favourable root zone conditions assist plant growth as the greater depth of topsoil together with the close proximity of the furrows allows rapid re-aeration following irrigation or rainfall;

- wheel compaction is confined to the furrows;

- the range of crops is increased (less waterlogging, and can grow both summer and winter crops) and the grower can readily change crop sequences in order to obtain favourable market prices;

- the ability to operate a double cropping sequence combined with improved root zone conditions and the more timely conduct of cultural operations suggests improved financial returns are probable.

The raised bed system is rapidly gaining in popularity particularly on soil types where irrigation water moves readily from the furrow to the centre of the bed. These soils are usually clay soils that shrink and swell as moisture content changes i.e. cracks develop as the soil dries out.

The area of irrigated land in the Murrumbidgee and Murray Valleys cropped using the raised bed layout is estimated to approach 35,000 ha with virtually all of the maize and soybean production based on this layout.

Historical Background

In the mid 1970's, Martin Maynard of "Wooloondool Farms" Hay, changed his cropping system and began seeding winter crops directly into the previous summer crop beds. (Maynard *et al* 1991). New beds were still prepared for each summer crop, however, over time the system has evolved into one of cropping on permanent raised beds. With permanent bed farming a series of summer and winter crops can be grown in rotation without reforming the beds.

Timeliness of Operations

Under the conventional system the field was cultivated immediately after harvest to knock down the existing beds and prepare new beds for the next crop. Large tractors and heavy implements were used to plough, scarify, landplane and re-hill the field. These operations were often delayed or had to be repeated due to unsuitable weather conditions.

Due to pressure to get the next crop planted, the ground was often worked when it was too wet causing soil compaction and slicking. Alternatively, if worked too dry large clods resulted which then had to be broken down with additional cultivations to achieve a seed bed. In 40% of years the subsequent crop could not be planted because rain would delay ground preparation until it was too late to plant (Maynard *et al* 1991).

The permanent bed concept removes the need for all this ground preparation allowing immediate access to the field post harvest. Cultivation and/or reshaping of the beds is sometimes necessary before planting of the next crop, however the number of passes of machinery is dramatically reduced. By using the furrows as controlled traffic lanes the risk of compacting the soil on the beds by working after rain is negated.

Rotations

Crop rotation will play an important role. The establishment of an appropriate rotation to assist the control of weeds and diseases, and to maintain an appropriate nutritional balance of the soil is always important, even more so where the beds are permanent (Hutchins, 1987). Rotations are still evolving (Maynard and Muir, 1984; Maynard *et al*, 1991). If maize is involved it will usually be the first crop, as it is a high input crop that is less forgiving of inadequate management than most other crops that will be grown in southern NSW.

The likelihood of achieving a double cropping rotation is substantially increased with the permanent raised bed system. Success is dependent on timely sowing which is often affected by rainfall - too wet to harvest and/or plant.

It would seem unwise to double crop with consecutive legume crops. There is the potential for disease and weed buildup and loss of opportunity to benefit from N contribution from the legume crop.

Stubble Management

Experience with permanent beds has found that burning the stubble is often necessary to assist control of weeds and diseases and to reduce the quantity of trash (Maynard *et al*, 1991).

The stubble of irrigated winter cereal crops can be bulky (5-10 t/ha) and present significant impediment to the establishment of a succeeding double crop. Although summer crops can be successfully established into either slashed or standing cereal stubble by the use of a fluted disc coulter in front of the sowing tine, the most appropriate approach is to burn the stubble.

The stubble of winter legumes or oil seed crops has not been found to be disadvantageous to the planting of the following summer crop.

Investigations at Leeton Field Station (Thompson *et al,* 1989) showed that crops planted after burning or removing stubble consistently yielded more than where stubble had been retained or incorporated.

Economic Benefits?

McKenzie (1989) using Whole Farm Gross Margin analysis and Operating Profit analysis indicated favourable returns, especially from intensive double cropping where 10 crops were grown in 6 years.

A detailed economic analysis comparing a rotation on permanent beds has been described by Maynard *et al* (1991). The analysis, prepared from an actual case study, revealed a return to capital of 8.9% for permanent beds compared with 5.4% for the conventional system. The authors believed that the analysis was conservative in that more intensive rotations than used in their case study were possible with permanent beds.

Leeton Field Station Experiment

A permanent raised bed experiment was established in 1984 at the Leeton Field Station (lat. 34°28'S) in the Murrumbidgee Valley. The main objective was to ascertain any agronomic limitations to the system. Raised beds (1.5 m from furrow to furrow) were constructed in April and planted to wheat in the first week of June.

The following crop rotation, where all crops were direct drilled, was established.

1984 - wheat

84-85 - soybean, sunflower, maize, millet

1985 - wheat

85-86 - soybean, sunflower, maize, millet

1986 - wheat

86-87 - fallow

1987 - rapeseed

87-88 - soybeans, sunflower

1988 - barley

88-89 - soybean, sunflower

1989 - barley

89-90 - soybean, sunflower

1990 - wheat

The soil type was a grey semi-self mulching uniform textured clay (62%). The flat topped beds supported either 6 x 15 cm of winter crop or 2 x 65 cm rows of summer crop.

Plots were split for stubble management - burnt (removed if too wet to burn) or retained on the soil surface.

The following comments refer to the winter cereal/soybean rotation although other combinations responded similarly.

Grain yields from winter cereals ranged from 5-6 t/ha and soybeans achieved consistent yields of 3 t/ha. The yield of soybeans is encouraging especially as planting was delayed to late December (the preferred planting date is late November).

Retaining winter crop stubble usually reduced soybeans yield. On each occasion winter cereal yield was higher where soybean stubble was burnt - range 11-35%; average increase 21%.

Measurements of infiltration rate from the furrow, soil strength, soil water extraction patterns, bulk density and organic matter content were undertaken during the final 3 summer crop seasons. In spite of considerable effort, no significant differences were detected between the stubble management systems.

Provided plant establishment was not limiting to yield potential, there were no obvious agronomic limitations. A number of growers, particularly in the Murrumbidgee Valley, are now successfully double cropping relatively large areas on permanent raised beds. Yields have been as high or higher than those reported for the Leeton Field Station experiment.

Recommendations for Success

- Construct the raised beds on a field with an even slope - preferably after laser guided landforming
- Commence with a weed free seed bed
- Sow the first crop on time
- Adjust seeding rate to ensure an adequate plant stand
- Adopt a planned sowing "window" and do not be tempted to plant later - even if this means foregoing a cropping opportunity
- Minimise soil disturbance when direct drilling especially for the summer crop (apply the bulk of the fertiliser, other than N, to the winter crop)
- Burn or remove bulky stubbles

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