The Economics of saltland agronomy

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The Economics of Saltland Agronomy

John S. Salerian
Clive Malcolm
Eddie Pol

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Disclaimer

The contents of this report were based on the best available information at the time of publication. It is based in part on various assumptions and predictions. Conditions may change over time and conclusions should be interpreted in the light of the latest information available.

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# Table of Contents

1. Summary .................................................................................................................. 1
2. Introduction ............................................................................................................... 2
2. Part I Maya Catchment Study ................................................................................... 4
   2.1 Representative Farm Models ............................................................................ 4
   2.2 Feed Value of Saltbush ..................................................................................... 5
   2.3 Scenarios .......................................................................................................... 8
      2.3.1 Scenario 1 – No Salinity ............................................................................. 8
      2.3.2 Scenario 2 – Salinity ................................................................................... 8
      2.3.3 Scenario 3 – Saltbush ................................................................................ 8
   2.4 RFM Results ...................................................................................................... 9
   2.4 Maximum Establishment Cost ......................................................................... 19
PART II....................................................................................................................... 22
   2.6 The Representative Farm Model ..................................................................... 22
   2.7 Feed Value of Bluebush .................................................................................. 23
   2.8 Scenarios ........................................................................................................ 25
      2.8.1 Scenario 1. Pre-salinity............................................................................ 25
      2.8.2 Scenario 2. Alternative Dry Matter Production Levels ............................. 25
      2.8.3 Scenario 3. Alternative Metabolizable Energy Concentrations ................ 25
   2.9 RFM Results .................................................................................................... 25
   2.10 Maximum Establishment Cost ......................................................................... 32
3. Conclusion .............................................................................................................. 33
4. References ............................................................................................................. 34
Summary

A bioeconomic model (MIDAS), based on the linear programming technique, is used to estimate the potential economic benefits of saltland agronomy and its role in the farm system. The results show that saltland agronomy is potentially profitable in the wheatbelt region of Western Australia. The profitability of saltland agronomy is sensitive to levels of dry matter production and metabolisable energy concentration of plants. The profitability of saltland agronomy also depends upon farm size, relative area of soil types and salinity, and relative commodity process. To obtain the profits from saltland agronomy, livestock numbers are increased, less land is cropped, more pasture is grown, and grain feeding of sheep is reduced.
1. Introduction

Soil salinity is one of the major forms of land degradation occurring in Western Australia. It is estimated (ABS, 1984) that 1.84 percent of cleared farm land in the wheatbelt is affected by soil salinity. Soil salinity does not occur on all farms. In 1984, 35 percent of farmers claimed to have land which is salt-affected. This means that on average 5.2 percent of their cleared land is salt-affected. In addition there is variability between regions. Shires such as Brookton, Wagin, Cunderdin, Tammin and Wongan-Ballidu have over 60 percent of their farmers claiming to have salt-affected land. This is above the State average of 35 percent, which suggests that while salinity may not appear to be significant on a State average, it may be important to individual farmers and regions.

Solutions to the salinity problem are being researched in two areas: the first aims to prevent or reverse the salinity problem, and the second aims to develop farming systems which are financially viable on salt-affected land. The latter involves planting salt-tolerant shrubs and grasses on salt-affected land, which is grazed by sheep. A preliminary estimate of the economic potential of saltland agronomy is evaluated in this report.

The objectives of this report are:

1. to illustrate how bioeconomic models can be applied to analyse soil conservation problems;

2. to estimate the potential economic benefits of growing saltbush on salt-affected land;

3. to identify how saltland agronomy can be integrated into the farm system.

These objectives are achieved by using MIDAS in conjunction with capital budgeting methods. MIDAS (Model of an Integrated Dryland Agricultural System) is a static linear programming model of a wheat-sheep farm, developed by the Marketing and Economics Branch of the WA Department of Agriculture. The farm system described by MIDAS contains:

- alternative rotations for several soil types;
- alternative flock structures;
- rotation interactions;
- livestock – rotation interactions;
- alternative machinery options;
- alternative livestock feeding options;
- nitrogen response functions for cereal crops

This report consists of two parts: Part I relates to analyses of three farmers in the Maya catchments, near Perenjori. Three Representative Farm Models (FRM's) are used to
evaluate the economic potential of saltland agronomy for farms situated in the top, middle and bottom of the catchment. A RFM is a version of the MIDAS model which has been modified to represent more accurately the areas and soil types occurring on actual farms. In Part 1, the north-eastern wheatbelt version of MIDAS is used because Maya is in this region.

In Part II, the eastern wheatbelt version of MIDAS is used to formulate a RFM of a farm in the Narembeen Shire. This farm has a larger proportion of salt-affected land. In addition, the sensitivity of the results to the level of dry matter production and the energy concentration of saltbush are evaluated.
2. Part I Maya Catchment Study

2.1 Representative Farm Models

This study aims to evaluate the potential economic benefits to farmers of establishing saltbush on salt-affected land. This potential is likely to be affected by the area of soil types and salinity, because the relative productivities of cereals, pastures and lupins change with soil type. To concentrate on these factors, many of the parameters of each RFM are set to those of an average Morowa-Mullewa farm as described in the basic Morawa-Mullewa MIDAS model. No attempt is made to restrict farming practices, machinery, indebtedness or personal preferences to those of individual farmers in the Maya catchment. The models determine which farm systems maximize post-tax profit. Farmers may not be adopting profit maximising farm plans for a variety of reasons, which are not discussed. If the RFM are specifically based on individual farmers, rather than an average farm, then the results may be constrained by particular circumstances on the individual farms, rather than an average farm, then the results may be constrained by particular circumstances on the individual farm and make these less applicable to farms in general.

The basic RFM used in this study is the Agricultural Economics and Marketing Division’s Morowa-Mullewa MIDAS model. The Morowa-Mullewa model was modified to make it representative of farms in the Maya catchments by:

1. deleting a soil type (medium land);
2. adjusting commodity prices;
3. adjusting the area of land in each soil type;
4. adjusting the total area of land;
5. introducing salt-affected land;
6. introducing saltbush growing option;
7. introducing monthly saltbush grazing options.

Each RFM has a total farm area of 1943 hectares, which corresponds to the area of a farm on which the saltland agronomy trials are being conducted (Pol and Malcolm, 1985). This assumption is made to remove the effect of farm size from the analysis.

The three RFMs correspond to three positions in the catchments. The proportions of various soil types on each RFM are based on farm maps produced by the farmers in the catchments (Nash, pers. comm., 1986). The maps provided have anomalies and the areas are regarded only as approximate. The area of each soil type and the area of salt-affected land for each RFM under each scenario are shown in Table 1.

RFM1 corresponds to a farm at the top of the catchments and is characterized by a relatively small area of heavy and salt-affected land. RFM2 corresponds to a farm midway down the catchments and has an intermediate proportion of heavy and salt-
affected land. RFM2 corresponds to a farm at the bottom of the catchments and has the highest proportion of heavy and salt-affected land.

Table 1: Area of each soil types and salt-affected land in each RFM under two situations: no salinity and salinity

<table>
<thead>
<tr>
<th>Soil Type and salt-affected land (ha)</th>
<th>Poor Light</th>
<th>Good Light</th>
<th>Heavy</th>
<th>Salt-affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>RFM1 (Low Salinity)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Salinity</td>
<td>797</td>
<td>797</td>
<td>349</td>
<td></td>
</tr>
<tr>
<td>Salinity</td>
<td>797</td>
<td>797</td>
<td>251</td>
<td>98</td>
</tr>
<tr>
<td>RFM2 (Intermed. Salinity)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Salinity</td>
<td>600</td>
<td>600</td>
<td>743</td>
<td></td>
</tr>
<tr>
<td>Salinity</td>
<td>600</td>
<td>600</td>
<td>533</td>
<td>210</td>
</tr>
<tr>
<td>RFM3 (High Salinity)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Salinity</td>
<td>476</td>
<td>476</td>
<td>991</td>
<td></td>
</tr>
<tr>
<td>Salinity</td>
<td>476</td>
<td>476</td>
<td>711</td>
<td>280</td>
</tr>
</tbody>
</table>

2.2 Feed Value of Saltbush

In order to use representative whole farm mathematical programming models to determine how saltland agronomy can be integrated into the farm system, it is necessary to determine the feed value of saltbush. In this study the species of saltbush is assumed to be Atriplex undulata, which has a digestibility of approximately 52.5 per cent (Malcolm, per. comm.. 1985).

The digestibility and metabolisable energy concentration of a variety of salt-tolerant plants are shown in Table 2. The percent digestibility values are obtained from analysis by the Ruminant Feed Stuff Laboratory in Bunbury (Malcolm, pers. comm.. 1985).
Table 2: Metabolisable energy concentration of salt-tolerant plants.

<table>
<thead>
<tr>
<th>Plants</th>
<th>Percent Digestibility</th>
<th>Metabolizable Energy (MJ/kg) Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halosarcia</td>
<td>75.8</td>
<td>11.1</td>
</tr>
<tr>
<td>M breuofolia</td>
<td>68.3</td>
<td>9.94</td>
</tr>
<tr>
<td>M. breuofolia</td>
<td>60.5</td>
<td>8.71</td>
</tr>
<tr>
<td>A. paludosa</td>
<td>66.3</td>
<td>9.63</td>
</tr>
<tr>
<td>A. undulata</td>
<td>55.6</td>
<td>7.95</td>
</tr>
<tr>
<td>A. undulata</td>
<td>49.4</td>
<td>6.98</td>
</tr>
<tr>
<td>A. amnicola</td>
<td>60.1</td>
<td>8.66</td>
</tr>
<tr>
<td>A. amnicola</td>
<td>59.2</td>
<td>8.51</td>
</tr>
</tbody>
</table>

The Metabolisable Energy Concentration is derived from the percent digestibility as follows:

1. \[ \text{MEC (MJ/kg)} = 0.1568 \times \text{percent digestibility} - 0.768 \]

(Ministry of Agriculture, Fisheries and Food, 1984)

The MEC of A. undulata is approximately 7.5 MJ/kg (averages of values in Table 2). A. undulata has a higher MEC than crop stubble. The MEC of crop stubble varies between the grain, leaf and stem components. The MEC of these components are 7.3, 6.6, and 4.9 MJ/kg respectively. The MEC of A. undulata is lower than annual winter pasture which has an MEC of 11.4 MJ/kg.

To include A. undulata in the RFM, Dry-Matter (DM) and Metabolizable Energy (ME) production per hectare are required.

The estimate of ME production of 7404 MJ/ha (see Table 3) is derived from data obtained from grazing trials (Pol and Malcolm, 1985) conducted on a property in the Maya catchments, using the following relationship (Rickards and Passmore, 1977).

2. \[ \text{ME (MJ/ha)} = \left(\frac{(0.39 + 0.19 \times LW + 0.1305 \times LWC + 0.0102 \times LWC^2)}{31} \right) \times GD \times \text{NS} / A \times 252 \]
where:

$LW =$ initial liveweight of sheep in kg;

$LWC =$ the change in sheep liveweight in kg;

$GD =$ the number of days that sheep grazed the saltbush;

$NS =$ the number of sheep grazing the saltbush;

$A =$ the area of saltbush grazed;

Table 3: Data to calculate metabolisable energy and dry-matter production.

<table>
<thead>
<tr>
<th>Saltbush species</th>
<th>Sheep livewt kg</th>
<th>Sheep livewt kg</th>
<th>Grazing days</th>
<th>Sheep number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. undulata</td>
<td>53.3</td>
<td>-0.2</td>
<td>41</td>
<td>20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Saltbush species</th>
<th>Area ha</th>
<th>Metabolizable energy MJ/ha</th>
<th>Dry matter intake kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. undulata</td>
<td>0.899</td>
<td>7404.1</td>
<td>0.8646</td>
</tr>
</tbody>
</table>

The DM consumed by the sheep of 992 kg/ha is given by:

$$\text{(3) DM (kg/ha)} = \frac{\text{ME (MJ/ha)}}{\text{MEC (MJ/kg)}}$$

The average daily DM Intake (DMI) of the sheep grazing the saltbush is given by:

$$\text{(4) DMI (kg/day)} = \frac{\text{DM} \times A}{\text{NS} \times \text{GD}}$$

$$= 991.9 \times 0.899 / 20 / 4$$

$$= 1.08 \text{ kg/day}$$

This is 25 per cent higher than the theoretical value (Rickards and Passmore, 1977) of daily DMI which is given by:

$$\text{(5) DMI (kg/day)} = \frac{(5.69 \times \text{MEC} + 0.307 \times \text{LW} - 15) \times \text{LW}^{0.75}}{1000}$$

$$= ((5.69 \times 7.464 + 0.307 \times 40.5 - 15) \times 40.5^{0.75}) / 1000$$

$$= 0.86 \text{ kg/day}$$
Further research is needed to verify the ME and DM production of saltbush. The ME and DM values used in this study are based on one observation involving only a small area and few sheep. In addition further information is required on the sustainable levels of ME and DM production from saltbush over a number of years. The sensitivity of the economics of saltland agronomy to the energy concentration and dry matter production of saltland are evaluated in Part 2 of this report. In this study, it is assumed that A. undulata produces 991.9 kg/ha of DM and 7404 MJ/ha in each year once it is established.

2.3 Scenarios

Each RFM is optimize for three scenarios. These are described below.

2.3.1 Scenario 1 – No Salinity

The optimization of this model provides an estimate of potential post-tax farm income if secondary salinity had never occurred. This is required to identify:

the costs of salinity to farms in various positions in the catchment;

the relative profitability of farms in various positions in the catchment in the absence of secondary salinity;

2.3.2 Scenario 2 – Salinity

In this scenario it is assumed that 28 percent of heavy land becomes salt-affected. This estimate is based on the local farm soil maps and the area of salinity on each farm (Nas, pers. comm. 1986).

Salt-affected land is assumed to be completely unproductive under current farming systems. Salinity causes a loss of heavy land from production. Each RFM is optimized, assuming that farm size is reduced by the area of heavy land suffering from salinity.

The solution to this scenario provides an estimate of potential post-tax income in the presence of salinity, and comparison with scenario 1 provides an estimate of the cost of salinity.

The solution to this scenario provides an estimate of potential post-tax income in the presence of salinity, and comparison with scenario 1 provides an estimate of the cost of salinity.

2.3.3 Scenario 3 – Saltbush

In this scenario it is assumed that A. undulata is established on salt-affected land. It provides DM and ME according to the specification in section 2. The saltbush is available for grazing on a monthly basis at any time of the year. Each RFM is a static
model of the annual farm system. That is, the farm system chosen is in equilibrium and repeats itself year after year.

Optimisation of this model determines whether or not saltbush has economic potential. There are no annual costs or establishment costs for saltland agronomy activities. Any increases in annual farm post-tax profit, once saltbush is established, are used to determine how much the farm business can afford to spend on establishing saltbush, using capital budgeting methods. The reasons for this approach are:

It is assumed that once established, there are no variable costs associated with maintained saltbush;

The establishment costs are fixed cost, and the level of these costs depends on the characteristics of the site;

To include a capital cost in an annual farm model requires the conversion of the capital cost into an equivalent annual value using capital budgeting methods. The equivalent annual value of the capital cost is sensitive to the length of the planning horizon and the discount rate used. The choices of planning horizon and discount rates can be arbitrary within an acceptable range.

2.4. **RFM Results**

The annual post-tax net farm income, assuming the farm has three partners sharing profits are shown in Figure 1. Net farm income is defined as the post-tax farm business profits less $14,300 for living expenses by the business owners. There are assumed no repayments on land purchases in the RFM's. Any repayments would need to be funded out of net farm income. The absolute differences in net farm income are equivalent to the absolute differences in post-tax farm profits.

There are differences in profitability between farms situated in different parts of the catchment, reflecting the relative profitability of soil types. The profitabilities of good light and, to a lesser extent, poor light land are higher than for heavy land.
Salinity reduces farm profits because it renders land unproductive. Its effect on farm profitability is not linearly related to the area of the farm which is salt-affected. Salinity reduces profits of RFM1 by 1547 dollars and the area of salinity is 98 hectares; RFM2 incurs a decrease in profit of 4125 dollars and the area of salt-affected land is 210 hectares; RFM3 loses $5556 and the area of salt-affected land 280 hectares.

The losses in post-tax farm profits per hectare for RFM1, RFM2 and RFM3 are 15.79, 19.64 and 19.84 $/ha respectively. The reason for this is the interaction between the total area cropped and machinery size. Salinity causes a reduction in the area of land cropped. However, it is not possible to reduce the fixed cost of machinery in proportion to the reduction in area cropped. Consequently, within a range for a given farm size and mix of soil types, the greater the area of salinity, the higher the machinery cost component of cropping.

The introduction of saltbush into the farm system partially restores the productivity of salt-affected land. This results in a level of profitability in between the no-salinity and salinity situations.

In comparison with the post-salinity scenario, the establishment of saltbush on salt-affected land increases farm profitability of RFM1 by $663; FRM2 by $1732; and RFM3 by $2616. The increases in profits are not linearly related to the area of saltbush. The additional profits per hectare of saltbush for RFM1, RFM2 and RFM3 are 6.7, 8.2 and 9.3 $/ha respectively. This is caused by the interaction in the farm system between machinery size, crop area, pasture area, the relative crop and pasture productivities of soil types, area of salt bush, and sheep numbers. These are explained in more detail below.
The optimal solutions of the RFM's show how saltland agronomy is integrated into the farm system. The annual land use plans for RFM1, RFM2 and RFM3 under each scenario are shown in Figures 2, 3 and 4.

For each RFM, the rotations on poor and good light land are constant across all scenarios. The optimal rotation on these soil types for all RFM’s is cereal-lupin. The cereal on good light land is triticale and the cereal on good light land is wheat. The presence of salinity or the establishment of saltbush on salt-affected land does not change the land use of these two soil types. This may not necessarily be the case if other parameters in the model are changed (e.g. relative commodity prices).

In Figures 2, 3 and 4, the following abbreviations are used:

PLLUP: lupins grown on poor light land
PLTR: triticales grown on poor light land
GLLUP: lupins grown on good light land
GLWH: wheat grown on good light land
HWH: wheat grown on heavy land
HPAS: pasture grown on heavy land

For each RFM, the optimal rotation on heavy land under the pre-salt and post-salt scenarios are the same. The optimal rotation is pasture-pasture-wheat-wheat. In a static model, this means that for each hectare selected in this rotation, 0.25 of a ha is in the first pasture following two wheat crops; 0.25 ha is in the second pasture following two what crops; 0.25 ha is in the first wheat crop following two years of pasture, and 0.25 ha is in the second wheat crop following two years of pasture.

Under the post-salt scenario, the area of heavy land is reduced to reflect the amount of heavy land which turn saline. Salinity reduces the area of wheat grown, the area of pasture and the number of sheep.
FIGURE 2: Land use for RFM1 (Top) under each scenario

FIGURE 3: Land use for RFM2 (Middle) under each scenario
The establishment of saltbush on salt-affected heavy land changes the optimal rotation on heavy land for each RFM. For RFM1 and RFM2, the rotation is pasture-pasture-pasture-wheat. Saltbush is used as a limited substitute for grain feeding and early grazing of winter pasture. It is profitable not only to reduce grain feeding, but also to increase the area of pasture on heavy land and to crop less wheat, and increase the number of sheep carried on the farm.

In the case of RFM3 with the largest area of heavy and salt-affected land, it is profitable to have even more winter pasture on heavy land and less wheat. The rotation on heavy land is a combination of continuous pasture and pasture-pasture-pasture-wheat. The reason for this difference between RFM1 and RFM2, and RFM3, is that RFM3 crops less land. With less crop being grown on RFM3, it is profitable to use a tractor powered harvester rather than a self-propelled harvester.

The total sheep numbers (measured in DSE's) on each RFM under each scenario are shown in Figure 5. The total DSE's on each RFM are lower in the post-salinity scenario compared with the pre-salinity scenario. This is the result of less pasture land being available due to the loss of heavy land to salinity.

The total DSE's on each RFM are highest under scenario 3. On all RFM's, it is most profitable when growing saltbush on salt-affected land to carry more sheep than before salinity occurred. The optimal solutions of the RFM's under each scenario indicate how the optimal farm system changes under each scenario.

The optimal utilisation of saltbush for each RFM is shown in Figure 6. The RFM's exhibit similar trends in the grazing of saltbush during the year. Most of the available saltbush
is grazed during the months of April, May, June and July, accounting for 69, 68 and 84 per cent of available area on RFM1, RFM2 and RFM 3 respectively. For all RFM's, there is excess feed available during summer due to the high proportion of farm being cropped. This results in an alternate solution for grazing saltbush during November-March, which means that the level of saltbush grazed in November-March represents excess levels.

---

**FIGURE 5:** Total number of sheep for each RFM under each scenario.
The sources of livestock feed for each RFM under each scenario throughout the year are shown in Table 4. The feed sources under the pre-salinity and post-salinity scenarios for each RFM are essentially the same. The levels of feed are reduced, reflecting the smaller number of sheep being carried after salinity occurs. Sheep are fed on grain and cereal stubble in April, and are fed grain, cereal stubble and pasture in May. From June to October sheep are fed pasture, and from November to March sheep are fed lupin and cereal stubbles.

Under the saltbush scenario, grain and cereal stubbles are replaced with saltbush as the feed source in April. In May, grain and cereal stubbles are replaced with saltbush. During June-October, more pasture is fed under the saltbush scenario, then under the pre- and post-salinity scenarios. This reflects the larger number of sheep being carried under the saltbush scenario.

There is a greater utilisation of crop stubbles during the summer period, November to March, under the saltbush scenario. Saltbush provides feed predominantly during the April-July period. This enables more sheep to be carried and the cost and amount of supplementary grain feeding during autumn to be reduced. The net result of this is an increase in post-tax farm profits.

The quantities of grain sold for each RFM, under each scenario, are shown in Table 5. The quantity of wheat firsts sold declines for each RFM, moving from pre-salinity to saltbush scenarios. This reflects firstly the decline in the area of heavy land cropped due to the presence of salinity. Secondly, under saltbush, less heavy land is cropped to wheat, resulting in less wheat sold.
More wheat seconds are sold under the saltbush scenario, because they are not used to feed livestock.

Triticale grain sales increase because, firstly, in the post-salinity scenario the lower sheep numbers require less grain feeding. Secondly, in the saltbush scenario, saltbush alleviates the need to feed triticale, allowing more triticale to be sold.

For each RFM, lupin sales are constant under all scenarios.
Table 4: Sources of livestock feed for each RFM, under each scenario

<table>
<thead>
<tr>
<th></th>
<th>RFM1</th>
<th>RFM2</th>
<th>RFM3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Salt</td>
<td>Post-Salt</td>
<td>Salt Bush</td>
</tr>
<tr>
<td>WHT2APR</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>TRITAPR</td>
<td>14</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>CERSTBAPR</td>
<td>4</td>
<td>10</td>
<td>36</td>
</tr>
<tr>
<td>SBUSHAPR</td>
<td>22</td>
<td>48</td>
<td>78</td>
</tr>
<tr>
<td>WHT2MAY</td>
<td>4</td>
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<td>TRITMAY</td>
<td>17</td>
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<td>CERSTBMAY</td>
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<td>PASTMAY</td>
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<tr>
<td>PASTOCT</td>
<td>56</td>
<td>40</td>
<td>101</td>
</tr>
<tr>
<td>LUPSTBNV-MR</td>
<td>20</td>
<td>43</td>
<td>6</td>
</tr>
<tr>
<td>CERSTBNV-MR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBUSHNV-MR</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4 continued

Key to Table 4

- **WHT2APR** = Wheat seconds fed in April
- **TRITAPR** = Triticale fed in April
- **CERSTAPR** = Cereal stubble grazed in April
- **SBUSHAPR** = Saltbush grazed in April
- **WHT2MAY** = Wheat seconds fed in May
- **TRITMAY** = Triticale fed in May
- **CERSTBMAY** = Cereal stubble grazed in May
- **SBUSHMAY** = Saltbush grazed in May
- **PASTMAY** = Annual pasture grazed in May
- **SBUSHJUN** = Saltbush grazed in June
- **PASTJUN** = Annual pasture grazed in June
- **SBUSHJUL** = Saltbush grazed in July
- **PASTJUL** = Annual pasture grazed in July
- **SBUSHAUG** = Saltbush grazed in August
- **PATAUG** = Annual pasture grazed in August
- **SBUSHSEP** = Saltbush grazed in September
- **PASTSEPT** = Annual pasture grazed in September
- **SBUSHOCT** = Saltbush grazed in October
- **PASTOCT** = Annual pasture grazed in October
- **LUPSTBNV-MR** = Lupin stubble grazed during November to March
- **CERSTBNV-MR** = Cereal stubble grazed during November to March
- **SBUSHNV-MR** = Saltbush grazed during November to March
Table 5: Grain sales for each RFM under each scenario

<table>
<thead>
<tr>
<th></th>
<th>RFM1</th>
<th>RFM2</th>
<th>RFM3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-Salt</td>
<td>Post-Salt</td>
<td>Salt Bush</td>
</tr>
<tr>
<td>SELLWHT</td>
<td>562</td>
<td>522</td>
<td>470</td>
</tr>
<tr>
<td>SELLWHT2</td>
<td>1</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>SELLTRIT</td>
<td>313</td>
<td>313</td>
<td>313</td>
</tr>
<tr>
<td>SELLUP</td>
<td>701</td>
<td>701</td>
<td>701</td>
</tr>
</tbody>
</table>

Key to Table 5

SELLWHT = Wheat firsts sold
SELLWHT2 = Wheat seconds sold
SELLTRIT = Triticale sold
SELLUP = Lupins sold

2.4 Maximum Establishment Cost

The increase in annual post-tax profits between the post-salinity and saltbush scenarios can be used to determine a maximum level of expenditure. In this section, the maximum economic level of establishment cost is determined for each RFM.

The factors considered in determining the maximum establishment cost are the:

1. increase in post-tax annual profits over the planning horizon;
2. increase in asset value of the farm at the end of the planning horizon, reflecting the farm’s higher income earning potential;
3. tax deductibility of capital expenditure on saltbush establishment;
4. marginal taxation rate;
5. rate of real discount.

The maximum establishment cost is the level of capital expenditure which is exactly equal to the discounted sum of the benefits resulting from the establishment of saltbush.

It is assumed that saltbush cannot be utilized until it is two years old. There are therefore no increases in post-tax profits until year three of the analysis. The capital
expenditure on saltbush is fully tax deductible. In year one, taxable income is reduced by the amount of expenditure on saltbush establishment. This reduces the amount of tax paid in year two on the analysis, providing the farm business with a benefit. This benefit depends upon the level of expenditure and the farm business’ level of taxable income.

As estimate of the increase in the discounted asset value of the farm is given by summing the discounted increases in annual post-tax profit increases from year three to the end of the planning period.

The present value (PV) of profit increases and the increase in asset value of the farm is therefore the sum from year three to infinity of the discounted annual post-tax increases in profits. This is given by;

(6) PV (profit + asset value increases)

\[ \text{tax benefit} \times (1 + \text{rate of discount})^{-2} \]

The Maximum Establishment Cost (MC) is equal to the sum of equations (6) and (7). Equation (7) is a function of the MC. In order to determine the MC, the above information is formulated into a linear programming problem and solved using GAMS/MINOS (Kendrick and Meeraus 1985, and Murtagh and Saunders 1983).

The general linear programming model formulated is given by:

(8) \[ \text{Maximise: } MC \]

Subject to:

(9) \[ MC - 6 \sum_{t=1}^{T} TD_t (1 + R)^{-2} = \frac{API}{(R^*(1+R))^{-2}} \]

(10) \[ MC + 6 \sum_{t=1}^{T} TD_t < 0 \]

(11) \[ TD_t < TDUB_t \quad t = 1, 6. \]

where MC = maximum establishment cost

TD_t = amount of tax deduction at each marginal tax rate, t.

R = real discount rate

API = annual post-tax profit increase

TDUB = amount of tax being paid at each marginal rate, t, before tax deduction.

R, API and TDUB are predetermined and only MC and TD_t are variables to be optimized. LP models are formulated for each RFM and are solved for at three different real rates of discount.
Equation (9) ensures that the MC is equal to the PV of tax benefits, profit increases and asset appreciation. Equation (10) ensures that tax deductions are equal to expenditure on saltbush establishment (MC). Equation (11) ensures that tax deductions at each marginal tax rate do not exceed the level of taxation being paid at each tax rate.

The MC for each RFM for three alternative discount rates are shown in Table 6.

The MC (or break-even establishment cost) declines as the real rate of discount increases. The higher the real rate of interest, the smaller the capital expenditure which can be supported by the post-tax profit increases from the establishment of saltbush. The current real rate of interest is approximately 10 per cent.

Table 6: Maximum establish cost of saltbush for each RFM for three real rates of discount.

<table>
<thead>
<tr>
<th>RFM1</th>
<th>RFM2</th>
<th>RFM3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real discount MC ($)</td>
<td>17,893</td>
<td>42,742</td>
</tr>
<tr>
<td>Rate: 5% MC/ha ($/ha)</td>
<td>183</td>
<td>204</td>
</tr>
</tbody>
</table>

| Real discount MC ($) | 8,596 | 20,550 | 30,139 |
| Rate: 5% MC/ha ($/ha) | 88 | 98 | 108 |

| Real discount MC ($) | 5,519 | 12,861 | 18,951 |
| Rate: 5% MC/ha ($/ha) | 56 | 61 | 68 |

The MC per hectare increases the higher the proportion of the farm that is salt-affected. At real rates of interest of 10 per cent, RFM1, with the smallest proportion of saltland, can only afford to spend 88 $/ha. In comparison, RFM2 and RFM3, with intermediate and high proportions of saltland, can afford to spend 98 and 108 $/ha respectively. This is because the economic benefits of saltbush in the form of annual post-tax profit increases are not linearly related to the proportion of the land area which is salt-affected.

Current seeding costs are approximately $50/ha. This leaves approximately 38, 48 and 58 $/ha for RFM1, RFM2 and RFM3 to spend on fencing and water supplies.
PART II

2.6 The Representative Farm Model

The results in Part I show that growing saltbush on salt-affected land is potentially profitable, and that profits appear to be non-linearly related to the proportion of the farm area which is salt-affected. Following the results obtained in Part I, it was decided to evaluate the economic potential of saltland agronomy for a situation where the proportion of salt-affected land is higher than that found in the Maya catchment. In addition, results obtained in Part I are subject to given assumptions relating to the Metabolizable Energy Concentration (MEC) of saltbush and the Dry Matter (DM) production of saltbush. It is also decided to test how sensitive the economic potential of saltland agronomy is to such assumptions.

In the second part of this report, the objective are to:

1. determine the potential economic benefits of growing saltbush on this salt-affected land;
2. identify how saltbush is optimally integrated into the farm system;
3. determine the sensitivity of the potential economic benefits of growing saltbush to the given assumptions on MEC and DM production of saltbush.

To achieve these objectives, a Representative Farm Model (RFM) is formulated using data from a farm in the Narambeen Shire. This farm is small with a total land area of 1209 hectares. Using an enlarged aerial photograph, information obtained from the farmer and local district advisory officers from the Department of Agriculture, the land uses for each soil type are derived. These are shown in Table 7.

In this study, the RFM is derived from the eastern wheatbelt version of MIDAS because the farm data are obtained from the region to which the eastern wheatbelt is applicable. The basic model is modified to make it represent the farm chosen. The modifications include:

Table 7: Area of land use and soil type for the representative farm

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Light-med.</th>
<th>Duplex</th>
<th>Heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop and pasture</td>
<td>174.0</td>
<td>60.2</td>
<td>462.2</td>
</tr>
<tr>
<td>Small isolated salt scalds</td>
<td>21.2</td>
<td>5.1</td>
<td>15.1</td>
</tr>
<tr>
<td>Large continuous saltland</td>
<td></td>
<td></td>
<td>225.0</td>
</tr>
<tr>
<td>Saltland suitable for barley</td>
<td></td>
<td>68.9</td>
<td></td>
</tr>
<tr>
<td>Total (1208.9)</td>
<td>2.8</td>
<td>38.3</td>
<td>136.1</td>
</tr>
</tbody>
</table>

|                              | 198.0      | 397.5  | 613.4 |
1. adjusting commodities prices;
2. deleting unnecessary soil types;
3. adjusting overhead expenditure to reflect more realistically those of the RF chosen. This is a smaller farm than the average eastern wheatbelt farm;
4. adjusting the areas of each soil type suitable for agricultural purposes;
5. adding activities related to the growing of saltbush and its grazing by sheep.

The RFM has a total of 1032 ha of arable land, of which 335 ha (32 per cent) is salt-affected. There is a single large salt affected area across the center of the farm occurring on the duplex soil type. This large salt affected area is contained within four paddocks. The entire area of these paddocks is salt-affected, although part of the area (68.9 ha) can be used to grow barley.

The numerous other technical and biological parameters are set to those of the standard eastern wheatbelt model.

### 2.7 Feed Value of Bluebush

Feed value data used were derived from grazing trails on a property near Tammin (Broun, 1986) and unpublished data from Ward (1986). The species of salt-tolerant shrub grazed on the property at Tammin is Maireana brevifolia (bluebush). The ME/ha obtained from sheep grazing bluebush is calculated using equation (2) in section 2 of Part I of this report. In this grazing trial, between 603 and 1636 ewe weaners are grazed on a 25 ha site for 34 to 28 days. A sample of 93 are weighed. The sample of 93 ewes grazed an average area of 1.54 ha for a period of 34 days. At the beginning of the trial, the sample man weight is 32.74 kg/hd and at the end of the period, the mean weight is 27.61 kg/hd.

The monthly (31 day) weight loss per ewe is 4.681 kg. applying these data equation (2) calculates the energy consumed per hectare to be 6531 MJ. This is less than the energy being obtained from the grazing of saltbush at Maya, used in Part I of this report.

In order to calculate the dry matter consumed per hectare, it is necessary to calculate the MEC of bluebush. In this study, a slightly different and more recent equation is used to estimate MEC from percent in-vitro digestibility (Falconer, 1986) from that used in Part I of this report (see equation (1) in section 2). In this case MEC is given by:

\[
\text{(12) MEC (MJ/kg) = 0.1568*percent digestibility} \times \text{8 0.98 - 0.768.}
\]

Dry matter consumed per hectare is calculated by dividing the energy consumed per hectare by the energy concentration of bluebush. There is some uncertainty regarding the digestibility (and therefore MEC) of the parts salt-tolerant shrubs consumed by sheep. This in turn affects the estimates of dry matter consumed by sheep.
Analyses indicate that the in-vitro digestibility of bluebush is between 67 and 49 per cent (Ward 1986) with a mean of 56.5. The metabolisable energy concentration and dry matter production consumed in the Tammin grazing trial for three values of digestibility are shown in Table 8.

The values in Table 8 assume that the energy obtained by sheep from bluebush is 6531 MJ/ha. As the digestibility declines, the estimates of metabolisable energy concentration and dry matter production decline and rise respectively. The estimated dry matter intake in Table 8 is given by

Table 8: Metabolisable energy concentration, dry matter production, estimated dry matter intake and theoretical dry matter intake for three levels of in-vitro digestibility of *M. brevifolia*

<table>
<thead>
<tr>
<th>In-vitro digestibility %</th>
<th>64</th>
<th>56.5</th>
<th>49</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolisable energy concentration (MJ/kg)</td>
<td>9.07</td>
<td>7.91</td>
<td>6.76</td>
</tr>
<tr>
<td>Dry matter production (kg/ha)</td>
<td>720</td>
<td>825</td>
<td>966</td>
</tr>
<tr>
<td>Estimated dry matter intake (kg/hd/day)</td>
<td>0.35</td>
<td>0.40</td>
<td>0.47</td>
</tr>
<tr>
<td>Theoretical dry matter intake (kg/hd/day)</td>
<td>0.64</td>
<td>0.55</td>
<td>0.46</td>
</tr>
</tbody>
</table>

(13) Estimated dry matter intake (kg/hd/day)  

= dry matter production (kg/ha)*hectares/number of sheep/days

Theoretical dry matter intake is given by equation (5) in section 2, Part I. The theoretical and estimated dry matter intakes are similar only for the lowest digestibility assumption. This poses two possibilities:

1. the metabolisable energy concentration of the bluebush consumed in the Tammin grazing trial is approximately 6.76 MJ/kg;

2. the theoretical equation relating dry matter intake to metabolisable energy concentration and live body weight is inappropriate for bluebush.

Further research is required to resolve these questions.
2.8 Scenarios

The RFM is formulated for three scenarios:

2.8.1 Scenario 1. Pre-salinity

The model is optimized to provide an estimate of optimal farm net income and the farm system before salinity developed.

2.8.2 Scenario 2. Alternative Dry Matter Production Levels

In this scenario, bluebush can be established on the large continuous salt-affected area, which consists of four paddocks. The possible options included are:

1. growing bluebush on the entire area of the four paddocks (225 + 68.9 ha);
2. excluding bluebush from parts of the paddocks so that barley can be grown. The areas suitable for barley are not partitioned off, so that bluebush in three of the paddocks can only be grazed at the times when barley stubble is grazed;
3. as in 2, except that the areas suitable for barley crop are partitioned off, enabling bluebush to be grazed at any time during the year.

Bluebush is assumed to have a digestibility of 56.5 per cent. A bluebush standard is assumed to have a metabolisable energy concentration of 7.91 MJ/kg and dry matter production of 825 kg/ha. The RFM is solved for this standard and then solved for dry matter production levels of 0, 20, 40, 60, 80 and 120 per cent of the standard level. The energy concentration is held constant. This enables the sensitivity of the economics of saltland agronomy to levels of dry matter production to be estimated.

2.8.3 Scenario 3. Alternative Metabolizable Energy Concentrations

In this scenario, the digestibility of bluebush is set at two levels, 64 and 49 per cent. Using the Tammin grazing trial data, the dry matter production for these two levels of digestibility are estimated to be 720 and 966 kg/ha respectively, as shown in Table 8. This enables the sensitivity of the economics of saltland agronomy to the metabolisable energy concentration.

2.9 RFM Results

Net post-tax farm income for each scenario is shown in Figure 7. Scenarios 0.0, 0.2, 0.4, 0.6, 0.8, and 1.2 represent the level of bluebush dry matter production as a proportion of the standard (STD). Scenarios L and H represent the scenarios with bluebush energy concentrations lower and higher than the standard. The PS scenario represents the situation before salinity occurred.

The representative farm used in this study is almost too small to be viable. If salinity is not present, the farm business has surplus income of
$4313. If all the salt-affected land is unproductive, the business incurs a shortfall in income of $9529, which is unviable in the long run. At the extreme, assuming salt-affected land is completely unproductive, salinity costs the farm business $13,572 ($40/ha of salt-affected land) in increases, farm profits increase, and post-tax net farm income becomes positive at the standard level of production, and increases further as farm income is $1077. Growing bluebush increases annual farm profits by $10,336 (or $35 per hectare of bluebush). However, even with bluebush the farm business is making $3236 less profit compared with the pre-salinity scenario. The economic benefits are sensitive to the level of dry matter productivity of bluebush.

The economic benefits of bluebush are also sensitive to the assumptions made on the digestibility of bluebush. As the digestibility of bluebush increases, the metabolisable energy concentration increases, estimated dry matter production declines, and post-tax farm income increases. Figure 8 shows the total livestock numbers on the RF for alternative scenarios.
Except for dry matter production levels equal to or less than 60 per cent of the standard, growing bluebush increases the optimal number of sheep carried compared with the pre-salinity scenario. As the energy concentration of bluebush increases, the estimated dry matter production falls, as shown in Table 8 in section 7. The total energy per hectare from bluebush is unchanged. The fall in dry matter production compensates for the increase in energy concentration. As the energy concentration increases the optimal number of sheep declines, while profit increases. As the energy concentration of bluebush increases, it is increasingly used to substitute for grain feeding. Under the high energy concentration scenario, no grain is fed (Figure 9).

This can occur because the energy concentration of bluebush is high enough to satisfy the sheep energy requirement at any time of the year.

In the varying productivity scenario, the energy concentration of bluebush is not high enough to meet the sheep requirement during early lactation.
Consequently grain feeding is reduced, but cannot be eliminated altogether. In Figure 9, as the productivity of bluebush initially increases, the level of grain feeding declines. Bluebush is grazed initially in June and July. This eliminates the need to feed barley in July, allows the earlier grazing of pastures in May (less detriment in May and June as shown in Table 10), reducing the amount of wheat fed in May. Then as the productivity of bluebush is increased, bluebush is grazed over a wider period from April to August.

At the same time, sheep numbers are increased and the grain fed during the months of April, May and June is eliminated. However, grain feeding in July cannot be eliminated. The total grain fed in July eventually rises as sheep numbers increase.

In addition, as the productivity of bluebush increases, the cereal and lupin stubbles are utilised earlier. Grazing of cereal stubbles in May is eliminated and there is more intensive grazing of stubbles during the months of December, January, February, March and April.

The patterns of bluebush grazing, for dry matter productivity scenarios in excess of 40 per cent of the standard and for all energy concentration scenarios (see Figures 10 and 11), are similar to those obtained in the study in Part I of this report.

The optimal land use plans under all scenarios are shown in Table 10. The optimal rotation on each soil type does not respond to changes in assumptions relating to dry matter production or the energy concentration of bluebush. The optimal rotation on the medium and duplex soil types is wheat-wheat-lupins. The optimal rotation on the heavy...
solid type is pasture-pasture-pasture-wheat. This rotation is modified when bluebush dry matter production is zero or at 20 percent of the standard. In these cases, the optimal rotation on the heavy land is a combination of pasture-pasture-pasture-wheat and pasture-wheat-pasture-wheat. The optimal utilization of bluebush on salt-affected land requires more pasture to allow an increase in sheep numbers. This is a similar result to those obtained in Part I of this report.

In this study, three options are allowed for the establishment of bluebush. Two of these options allowed for part of the salt-affected area to be used to grow barley. In all scenarios, except when bluebush is completely unproductive, barley is not selected. It is more profitable to grow bluebush on the entire area of the four salt-affected paddocks.

Figure 10: Bluebush grazing under alternative dry matter production scenarios.
Figure 11: Bluebush grazing under alternative metabolisable energy concentration scenarios
Table 9: Land utilization under alternative scenarios

<table>
<thead>
<tr>
<th>Land use</th>
<th>0.0</th>
<th>0.2</th>
<th>0.4</th>
<th>0.6</th>
<th>0.8</th>
<th>Scenario</th>
<th>1.2</th>
<th>L</th>
<th>STD</th>
<th>H</th>
<th>Pre-salinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium – wheat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>STD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- pasture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>STD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duplex – wheat</td>
<td>40</td>
<td>40</td>
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<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>239</td>
</tr>
<tr>
<td>- lupin</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>120</td>
</tr>
<tr>
<td>- bluebush</td>
<td>0</td>
<td>294</td>
<td>294</td>
<td>294</td>
<td>294</td>
<td>294</td>
<td>294</td>
<td>294</td>
<td>294</td>
<td>294</td>
<td>0</td>
</tr>
<tr>
<td>- barley</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>STD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- pasture</td>
<td>295</td>
<td>302</td>
<td>247</td>
<td>347</td>
<td>347</td>
<td>347</td>
<td>347</td>
<td>347</td>
<td>347</td>
<td>347</td>
<td>358</td>
</tr>
</tbody>
</table>

Table 10: Deferment of pasture grazing under alternative scenarios

<table>
<thead>
<tr>
<th>Deferment period</th>
<th>0.0</th>
<th>0.2</th>
<th>0.4</th>
<th>0.6</th>
<th>0.8</th>
<th>Scenario</th>
<th>1.2</th>
<th>L</th>
<th>STD</th>
<th>H</th>
<th>Pre-salinity</th>
</tr>
</thead>
<tbody>
<tr>
<td>May-Jun (t)</td>
<td>45</td>
<td>4</td>
<td>19</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>37</td>
<td>76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jun-Jul (t)</td>
<td>14</td>
<td>4</td>
<td>13</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>8</td>
<td>22</td>
<td>39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug-Sep (t)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>STD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sep – Oct (t)</td>
<td>68</td>
<td>71</td>
<td>2</td>
<td>80</td>
<td>64</td>
<td>50</td>
<td>38</td>
<td>41</td>
<td>50</td>
<td>54</td>
<td>82</td>
</tr>
<tr>
<td>Oct-Nov (t)</td>
<td>2</td>
<td>87</td>
<td>2</td>
<td>16</td>
<td>24</td>
<td>5</td>
<td>9</td>
<td>24</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct-Mar (t)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>STD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct-Apr (t)</td>
<td>58</td>
<td>65</td>
<td>81</td>
<td>70</td>
<td>30</td>
<td>8</td>
<td>71</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.10 Maximum Establishment Cost

The amount of capital spent on bluebush establishment, which is economically justifiable, is calculated using the method outlined in section 5 of Part I of this report.

The maximum establishment cost for three real rates of discount are shown in Table 11.

Table 11: Maximum establishment cost of bluebush for three real rates of discount

<table>
<thead>
<tr>
<th>Real rate of discount</th>
<th>5</th>
<th>10</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum establish. cost ($)</td>
<td>196,876</td>
<td>93,963</td>
<td>59,918</td>
</tr>
<tr>
<td>Maximum establish cost/ha ($/ha)</td>
<td>669</td>
<td>319</td>
<td>209</td>
</tr>
</tbody>
</table>

The gains in post-tax profit are assumed to be the difference between the zero dry matter production and the standard scenarios. This assumes that salt-affected land is completely unproductive and that the farm size is reduced by the area of salt affected land. At current real rates of discount of approximately 10 per cent an expenditure of $319/ha is justified.

This level is higher than obtained for the RFMs in part I of this report. The reason is that the stocking rate of the Narambeen RFM is higher than those in the Maya catchment. Under the assumption that salt-affected land is unproductive, the Narembeen farm is carrying 1520 DSE’s of sheep with 295 ha or pasture (see figure 8 and Table 11).

In contrast, RFM3 (Part I of this report) under the equivalent scenario carries 1356 DSE’s with 355 ha of pasture (see Figures 2 and 5). The Narembeen RFM achieves this higher stocking rate by feeding more grain. The Narembeen RFM feeds 81 tonnes of grain (Figure 9) compared with only 14 tonnes by RFM3 (Table 4). Saltland agronomy allows grain feeding to be reduced. The Narembeen RFM is able to reduce grain feeding substantially (from 81 to 20 tonnes). RFM3 reduces grain feeding by only 14 tonnes. The Narembeen RFM reduces grain feeding by approximately four times that of RFM3. This explains the relatively large gains in profit achieved by the Narembeen RFM compared with those in the Maya catchment.

The wheat prices used in this study are lower than those used in Part I of this study, which lowers the opportunity cost of feeding wheat to sheep.
3. Conclusion

Saltland agronomy has economic potential. The benefits depend upon the absolute size of the farm, the proportion of soil types, the area of salt affected land and the soil type on which it occurs, and relative prices of sheep and grains. At a real rate of discount of 10 per cent, the analysis indicates that expenditures ranging from $88-$319/ha are economically justifiable.

The economic benefits of saltland agronomy are derived by increasing sheep numbers, reducing grain feeding, and cropping less on soil types which have the lowest opportunity cost for growing pastures.

The economic benefits of saltland agronomy are sensitive to assumptions relating to dry matter production and metabolise energy concentration. Future research work should be directed towards providing more accurate data on the levels of dry matter production and metabolisable energy concentration and the long-term sustainable levels of dry matter production.

The results of this report cannot be generalized to all farms. The RFM indicated how saltland agronomy my be integrated into the farm system. However, the economic benefits vary between farms. Individual farmers adopting saltland agronomy need to prepare farm plans and budget based on how saltland agronomy is to be integrated into their farm system.
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