MEAT & LIVESTOCK AUSTRALIA

An Economic Assessment of the Value of the NPICC Pasture Species Database

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AN ECONOMIC ASSESSMENT OF THE VALUE OF THE NPICC PASTURE SPECIES DATABASE

FINAL REPORT TO THE NATIONAL PASTURE IMPROVEMENT COORDINATING COMMITTEE

B.W. BOOTLE

Bootle Agricultural & Economic Consulting

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AN ECONOMIC ASSESSMENT OF THE VALUE OF THE NPICC PASTURE SPECIES DATABASE

EXECUTIVE SUMMARY

The aim of this project was to analyse the value and possible uses of the NPICC pasture database. The project developed methodology capable of analysing the economic value of the NPICC database. The methodology was demonstrated using sub. clover as an example pasture species. Three Victorian regions in which sub. clover is present were chosen to demonstrate the effects of aggregating farm-level results to regional, State and National results.

The project was conducted in three stages. The first stage was the analysis of example regions in which sub. clover pasture was used. In each region, a number of livestock and crop gross margin budgets were compiled. Three regions were chosen, primarily based on availability of data. The North Central region was divided in two because of differences in farm types in the northern and southern halves of the region and the third region was the South Western region. Gross margin budgets for crops, pastures and livestock enterprises were developed for each region. The results of these are presented in Appendices 1 and 2.

The second stage of the analysis involved defining and constructing a linear programming model of a representative farm for each region based on the gross margin budgets developed in Stage 1. The model was then tested and a base level solution for each representative farm identified, these results are presented in Tables 1, 3 and 5. A number of scenarios were then modeled, including hypothetical changes in management and pasture productivity. The differences between the values returned in the base model and the values returned from the alternative scenarios indicated the value of that change to the representative farm. The percentage changes between the base model and results of each of the alternative scenarios are presented in Tables 2, 4 and 6.

The third stage of the analysis was to aggregate the results of Stage 2 to determine the regional impact of the alternative scenarios modeled. The results of this are presented in Tables 7, 9 and 11. In summary, an increase in the annual feed production of sub. clover by 5% (assuming a full 5% improvement in DSE production) led to an additional net farm income in the Northern half of the North Central Region of $4.5 million, in the Southern half of the North Central Region of $4.1 million and in the South West Region of $4.8 million. This was assuming 100% adoption of the new pasture species and immediate re-sowing of all sub.clover.

An assumption was made that a hypothetical new technology increased production of sub. clover by 5% and that this increase in production led to a 5% improvement in available feed. It is recognised that in reality considerably less than 5% in available feed would result from a 5% increase in production, however this assumption was made to simplify the analysis. It was also recognised that adoption of any new technology occurs over time and is seldom 100%. To account for this a range of adoption rates were analysed using a Net Present Value (NPV) analysis over ten years. The results of this are presented in Tables 8, 10 and 12. In summary, using an adoption rate of 10% and an increase in the production of sub. clover of 5%, the NPV

of additional net farm income over ten years in the Northern half of the North Central Region was $17.6 million, in the Southern half of the North Central Region was $15.9 million and in the South West Region was $18.9 million.

CONCLUSION

In conclusion, a number of simplifying assumptions were used in this analysis to expedite the development of the methodology, and this should be recognised when looking at any of the net benefits generated. However, the methodology developed and suggested in this analysis could be used to analyse any pasture type; locally, across a state, or nationally. The importance of this approach therefore, **is not the figures** generated for the sub. clover example, as these are recognised to be unrealistically high due to the simplifying assumptions used, **but the methodology** developed demonstrated that an improvement in pasture feed production **does not** result in a **proportionate** increase in the amount of livestock carried. Nor does it result in a proportionate increase in net farm returns.

Possible Improvements in Methodology

As mentioned above, a number of simplifying assumptions were made in this analysis and to conduct a more accurate analysis of any pasture species these assumptions would need some additional attention. The improvements that could be made with regard to this include:

1. Additional information on the timing of pasture feed production. This could be achieved using growth curves for pasture types identified in the NRICC database, rather than complicating the database with monthly pasture production figures.
2. More accurate estimates of improvements in available feed achieved from any given increase in pasture production (i.e. when you run a 5% increase in dry matter production through GrazFeed for example, you do not get a 5% increase in DSE production).
3. Assume partial adoption of the technology rather than total adoption at an on-farm level and regional level. On-farm, the technology improvement would be assumed to occur as pastures were re-sown, for example in Region 1, new pasture would be sown over the 5 years of the pasture phase. At a regional level, this may be adopted at a rate of 10%. Thus every year 10 percent of farms would begin year one of a five year pasture phase.
4. The use of an industry level analysis to determine price response to changes in supply of livestock products. The type of analysis would need to be complex as a number of products were being produced by the livestock enterprises, such as wool, mutton, lamb and beef.

Possible Uses of the NPICC Pasture Database

From an economic context there are a number of potential uses for a continually updated national pasture species database. The first would be to analyse the investment decisions made in allocating funding to pasture research. The second would be to use the methodology in allocating funding to research in production, marketing, or processing.

AN ECONOMIC ASSESSMENT OF THE VALUE OF THE NPICC PASTURE SPECIES DATABASE

1. PROJECT OVERVIEW

The principle aim of this project was to analyse the value and possible uses of a national comprehensive pasture species database. A single pasture type was modeled to illustrate the type of information that can be gleaned from an economic analysis such as this. The pasture type agreed on was sub. clover. The method used to analyse the pasture species was to use gross margin budgets to create representative farms of some example regions in Victoria. The representative farms were then modeled in a linear programming framework to determine the response from hypothetical changes in feed production levels in the sub. clover pasture. The result from the linear programming model was a change in enterprise combination that corresponded in a change in net farm income. The change in net farm income was then aggregated into a regional response from the change in pasture productivity.

2. METHODOLOGY

The project was conducted in three stages. The first stage was the analysis of some example regions in which sub. clover pasture was used. In each region, a number of livestock and crop gross margin budgets were compiled. The second stage of the analysis was the use of these budgets to construct representative whole-farm linear programming models for each of the three regions analysed. Once a representative farm was constructed and tested, a base level of performance was identified. Changes to the sub. clover pasture could then be modeled.

A number of scenarios were modeled, including hypothetical changes in management and pasture productivity. It should be noted that for the changes in pasture productivity, two hypothetical new technologies were modeled. These technologies increased production of sub. clover by 5% and 20%, and this was assumed to have led to a 5% and 20% improvement respectively in available feed. It is recognised that in reality considerably less than 100% in available feed would result from any increase in production. However, this assumption was made to simplify the analysis. For arguments sake, one could assume the 5% improvement in available feed resulted from a 30% increase in pasture production and the 20% improvement in available feed resulted from a 120% increase in pasture production. Ultimately the figures are only hypothetical and intended to demonstrate the application of the methodology, not a real analysis of technical improvement in sub. clover .

The third stage of the analysis was to use the results of stage two, that is, changes in net farm income, to determine the regional impact of the various changes modeled.

3. THE FIRST STAGE - DEFINITION OF KEY REGIONS AND COMPILATION OF GROSS MARGIN BUDGETS

3.1 Region 1 - Southern Half of the North Central Region of Victoria

The initial region analysed was the Southern half of the North Central region of Victoria. This region was chosen because it is a mixed enterprise farming region that uses sub. clover pastures. The type of enterprises conducted in the this region include; wheat, barley, lupins, field peas, oats, canola, chick peas, merino sheep, first cross sheep, and beef cattle. The pasture types identified in the NPICC pasture database were divided into five types, 1. sub. clover, 2. lucerne, 3. grass based pasture (rye grass etc.), 4. temporary pasture and 5. unimproved pasture.

A number of gross margin budgets were developed for the typical farm in this region. Cereal and winter crop budgets were adapted from Kennelly 1995, livestock budgets were developed using the Sheep Cents and Cattle Cash gross margin budget programs and pasture budgets were developed using MS Excel. Gross margin budgets are presented in Appendix 1.

The gross margins for the crops and pastures identified in Region 1 were as follows:

Crop/Pasture	GM ($/Ha)[1]
1. Wheat	161
2. Barley	189
3. Oats (for grain only)	275
4. Triticale	168
5. Field Peas	182
6. Lupins	137
7. Canola	506
8. Forage Oats (fully grazed)	-143
9. Sub. Clover Undersown[2]	-19.70
10. Sub. Clover Undersown[3]	-28.98
11. Lucerne Undersown	-29.48
12. Grass Pasture	-45.45
13. Temporary Pasture (volunteer pasture)	0
14. Unimproved Native Pasture	0

[1] A negative figure indicates the enterprise was an intermediate enterprise that produces a product that was utilised elsewhere in the farm model. E.g. Pasture costs money to produce and on its own returns none, however when combined with a livestock enterprise it can be profitable.

[2] Sub. clover undersown 1 refers to the current level of production as identified in the NRIC database. I.e. for Bet Bet a DSE rating of 4.1 per hectare.

[3] Sub. Clover Undersown 2 refers to the potential level of production as identified in the NRIC database. I.e. for Bet Bet a DSE rating of 6.2 per hectare.

The gross margins identified for the livestock enterprises were as follows:

Enterprise	GM per DSE ($/DSE)
1. Beef Cattle selling yearlings	22.83
2. Beef Cattle selling to local trade	16.65
3. Merino Wethers	19.76
4. Dorset Cross Merino Lamb	12.92
5. Prime Lamb Production	13.77
6. Self-replacing Merino Flock	14.44

The above gross margins were used to construct a 'representative' or 'typical' farm. This farm was modeled using standard linear programming techniques, such as those explained in Dent, Harrison and Woodford (1986). The linear programming approach enables a more thorough analysis of resource utilisation, substitution and interaction that was unavailable through simple gross margin analysis.

3.2 Region 2 - Northern Half of the North Central Region of Victoria

The typical mixes of farm enterprises in this region include: wheat, barley, triticale, lupins, field peas, oats, canola, chick peas, prime lambs, beef cattle and short-term agistment of dairy cattle. The pasture types identified were divided into the same five types identified in Region 1, these were: 1. sub. clover, 2. lucerne, 3. grass based pasture (rye grass etc.), 4. temporary pasture and 5. unimproved pasture.

As in Region 1, gross margin budgets were developed for the typical farm in this region. Cereal and winter crop budgets were adapted from Kennelly (1995), livestock budgets were developed using the Sheep Cents and Cattle Cash gross margin budget programs and pasture budgets were developed using MS Excel. Agistment rates were determined using the Cattle Cash model to calculate the energy consumption required by the two classes of agistment cattle. A cow live weight of 550 kilograms was assumed. A dry cow used 9.03 LSM (livestock months of feed[4]), while a gestating cow during the three months prior to calving, used an average of 11.74 LSM. The budgets developed for this region are presented in Appendix 1.

Gross margins for Region 2 crops and pastures were as follows:

Crop/Pasture	GM ($/Ha)
1. Wheat	161
2. Barley	189

[4] One livestock month (LSM) is equivalent to 1/12 of a 50 kilograms Dry Sheep Equivalent (DSE). See Bootle (1993).

3. Oats for Grain only	275
4. Triticale	168
5. Field Peas	182
6. Lupins	137
7. Chickpeas	79
8. Canola	506
9. Forage Oats	-143
10. Sub. Clover Undersown[5]	-19.70
11. Sub. Clover Undersown[6]	-28.98
12. Lucerne Undersown	-29.48
13. Composite Grass/Sub. Pasture	-45.45
14. Temporary Pasture (volunteer pasture)	0
15. Unimproved Native Pasture	0
16. Other Grass Pasture	0

The gross margins identified for Region 2 livestock enterprises are summerised below, a complete listing of the gross margins is included in Appendix 1.

Enterprise	GM per DSE ($/DSE)
1. Beef Cattle selling yearlings	22.83
2. Beef Cattle selling to local trade	16.65
3. Prime Lamb Production	13.77
4. Agistment of Dairy Cattle (gestating)	3.25 per week
5. Agistment of Dairy Cattle (dry)	2.50 per week

3.3 Region 3 - The South West Region of Victoria

Information concerning the South West region of Victoria was provided by Andrew Patterson, Regional Farm Management Economist at Hamilton. The main enterprises conducted in this region include self-replacing wool sheep, merino wethers, prime lambs, beef cattle enterprises selling weaner heifers and producing vealers, weaners, steers and bullocks, pasture hay, oats, barley and wheat.

Gross margins for this region were adapted from Patterson (1995). These are presented in Appendix 2. The pasture budgets are the same as for the North Central Region and are presented in Appendix 1. The pasture production figures used come from the NPICC pasture database for Ararat.

[5] This refers to the current level of production as identified in the NRIC database. I.e. for Huntley A DSE rating of 3 per hectare.

[6] This refers to the potential level of production as identified in the NRIC database. I.e. for Huntley A DSE of 5 per hectare.

Gross margins for Region 3 crops and pastures are presented in detail in Appendix 2, they are summerised below.

Crop/Pasture	GM ($/Ha)
1. Wheat	209
2. Barley	172
3. Oats for Grain only	165
4. Forage Oats	9.48
5. Sub. Clover Undersown[7]	-19.70
6. Composite Grass & Clover Pastures	-45.45
7. Temporary Pasture (volunteer pasture)	0
8. Unimproved Native Pasture (not fertilised)	0
9. Unimproved Native Pasture (fertilised)	-9.40

The gross margins identified for Region 3 livestock enterprises, can be viewed in Appendix 2, and are summerised below.

Enterprise	GM per DSE ($/DSE)
1. Self-replacing 19 Micron Merino Flock	20.71
2. Prime Lamb Producing Flock	18.47
3. 19 Micron Merino Wether Flock	17.31
4. Beef Cattle selling males & females as weaners	17.27
5. Beef Cattle selling males as vealers & females as weaners	19.52
6. Beef Cattle selling males @ 18 Months & females as weaners	19.38
7. Beef Cattle selling males @ 30 Months & females as weaners	17.69

4. THE SECOND STAGE - WHOLE-FARM LINEAR PROGRAMMING MODELS

4.1 Region 1 - Southern Half of the North Central Region of Victoria

Assumptions

The linear programming model's activity mix was a reflection of the enterprise mix derived the first stage of this analysis. The representative farm was assumed to be 800 hectares (A. Kennelly, pers. com.). Of which 711.11 hectares was arable and 88.89

[7] This refers to the current level of production as identified in the NRIC database. I.e. for Ararat a DSE rating of 8 per hectare.

hectares was non arable. Non improved pasture (native pasture) was assumed to be the only pasture enterprise using the non arable land.

A pasture to crop rotation of 5 to 4 was assumed. The farm was also assumed to have in place a crop rotation that consisted of canola, cereal, grain legume, cereal then pasture (A. Kennelly, pers. com.). This in effect meant that the area of crop was 50% cereal, 25% canola and 25% grain legume. Pasture was also constrained by a rotation that ensured that the amount of pure lucerne pasture was no greater than 50% of total pasture area. This was an artificial constraint to force the farm model to be more representative of the 'typical farm'. A constraint on the number of merino wethers that could be run was included to keep the farm more representative. This constraint limited the number of merino wethers to 50% of the number of ewes of any other breed.

The initial run of the whole farm model included enforced pasture percentages (based on the NPICC database) of: sub. clover, 20%, lucerne, 10%, composite grass and clover based pasture, 11%, temporary pasture, 39% and unimproved pasture, 20%. Carrying capacity estimates for each pasture type also came from the NPICC database.

A simplifying assumption was made throughout this analysis, that composite pastures (i.e. those with two or more species one of which included sub. clover) were not sub. clover for the purposes of this analysis, but were included as "grass based pasture". This was assumed because no information was available of the true percentage composition of these composite pastures. The composite pastures were not optimal in the "no pasture constraints" runs of the linear programming models and therefore this assumption did not influence the results of the analysis.

Linear Programming Model

The initial run of the linear programming model resulted in the farm returning a net of $131,428 from an optimised enterprise mix which included: 177.8 hectares of barley, 88.9 hectares of field peas, 88.9 hectares of canola, 88.9 hectares of sub. clover, 44.5 hectares of lucerne, 48.9 hectares of grass based pasture, 173.3 hectares of temporary pasture (e.g. volunteer species such as: annual ryegrass, barley grass, etc.), 88.9 hectares of unimproved native pasture, 36 cow yearling-producing herd, 230 ewe merino self-replacing flock and 115 merino wethers. This data is summerised in Table 1 below.

Once the 'base' whole farm model was solved, a number of alternate scenarios could be proposed and solved and then related back to the 'base' or each other. The scenarios analysed are outlined below:

1. Remove Pasture Constraints

Remove the enforced pasture percentages, allowing optimum pasture combination (note that a rotation of 1:1 lucerne to other pasture types was enforced).

2. Sub. Clover to NPICC Database Optimum

As for scenario 1 but improve the sub. clover pasture's feed production to its NPICC database optimum. The difference between the first sub. clover pasture and the new NPICC optimum sub. clover pasture is outlined in the pasture gross margin budgets in Appendix 1. The difference was essentially an increased level of management and inputs costing an additional $9.28 per hectare.

3. Sub. Clover Feed Production Increased by 5%

As for scenario 2 but add a new sub. clover that has a 5% higher DSE production for the same input costs in scenario 2.

4. Sub. Clover Feed Production Increased by 20%

As for scenario 3 but add another sub. clover that has a 20% higher DSE production for the same costs.

The results of the linear programming model optimisations are presented in Table 1. Table 1 contains net farm returns in dollars and production levels for each of the optimal enterprises. A zero result indicates the enterprise was not included in the optimal solution. For example, grass based pasture was included in the 'base' model solution at a level of 48.89 hectares. However, in the second model where enforced pasture levels were removed the grass based pasture drops out of the optimal solution.

Table 1 - Region 1 Linear Programming Model Results

	Original Whole-farm Model	Remove Pasture Constraints	Sub Clover to NRIC Database Optimum	Sub Clover Production Increased by 5%	Sub Clover Production Increased by 20%
Net Return to Farm	$131,428	$139,636	$143,598	$144,410	$146,985
Barley	177.775	177.775	177.775	177.775	177.775
Field Peas	88.8875	88.8875	88.8875	88.8875	88.8875
Canola	88.8875	88.8875	88.8875	88.8875	88.8875
Sub Clover	88.89	177.78	177.78	177.78	355.56
Lucerne	44.45	177.78	177.78	177.78	0
Grass Based Pasture	48.89	0	0	0	0
Temporary Pasture	173.33	0	0	0	0
Unimproved Pasture	88.89	88.89	88.89	88.89	88.89
Yearlings	36	31	29	29	28
Merino SR Ewe Flock	230	500	628	647	704
Merino Wethers	115	250	314	323	352

Table 2 below, contains the percentage changes in net farm returns and activity levels resulting from the hypothetical technology changes in the above four scenarios. The change in the column entitled "Change from Scenario 1", was the percentage difference in model results from the base model to the results generated in Scenario 1. The relaxation of the pasture constraints led to the farm running a more profitable mixture of pasture types. This in turn led to a higher number of sheep being carried, a lower number of cattle being carried and an overall increase in net farm returns of 6.25 percent.

Changes in scenarios 2,3 and 4 are presented in terms of percentage increases over Scenario 1, not over the base model. This was so the change in pasture productivity could be analysed separately from the change in management technology that could have led to Scenario 1. Scenario 2, an improvement in the feed production of sub.

clover to the NPICC database optimum, led to an overall increase in net farm returns of 2.84 percent. This increase resulted in a change in the level of activities run on the farm. The number of cattle run declined by 6.5 percent while the number of self-replacing merinos run increased by 25.6 percent and the number of merino wethers also increased by 25.6 percent. In Scenario 3 a similar result was observed. A 5 percent increase in pasture feed production over the level of pasture feed production in Scenario 2, led to net farm returns increasing by 3.42 percent over the results from Scenario 1. Cattle numbers stayed the same as in Scenario 2 but sheep numbers increased by 29.4 percent.

The final scenario analysed the result of a 20 percent increase in pasture feed production as a result of a hypothetical new technology. The increase over the results generated in Scenario 1 was a 5.26 percent increase in net farm returns. This increase in net farm returns resulted from a change in the optimum combination of farm enterprises. The area of pasture, while remaining constant due to rotation constraints, resulted in a complete substitution of lucerne pasture with sub. clover pasture. A change like this may not be totally realistic, but illustrates the fact that, in this scenario, the sub. clover pasture was more productive than the lucerne pasture. Livestock numbers also changed, cattle numbers declined by 9.7 percent while sheep numbers increased by 40.8 percent.

An observation that can be made here was that a 5, 10 and 20 percent increase in pasture feed production, resulted in a 2.84, 3.42 and 5.26 percent increase in net farm returns. This increase was a result of a change in the optimum combination of livestock enterprises. That is, a decrease in the number of cattle run by 6.5, 6.5 and 9.7 percent and an increase in the number of sheep by 25.6, 29.4 and 40.8 percent.

Table 2 - Percentage changes in the Representative Farm Results for Region 1

	Change from Scenario 1	Change from Scenario 2	Change from Scenario 3	Change from Scenario 4
Net Return to Farm	6.25%	2.84%	3.42%	5.26%
Area Cropped	0%	0%	0%	0%
Area of Pasture	0%	0%	0%	0%
Sub Clover	100%	0%	0%	100%
Lucerne	300%	0%	0%	-100%
Grass Based Pasture	-100%	NA	NA	NA
Temporary Pasture	-100%	NA	NA	NA
Unimproved Pasture	0%	0%	0%	0%
Yearlings	-13.9%	-6.5%	-6.5%	-9.7%
Merino SR Ewe Flock	117.4%	25.6%	29.4%	40.8%
Merino Wethers	117.4%	25.6%	29.2%	40.8%

In monetary terms the changes in net farm returns can be identified in Table 1. That is for Scenario 1, hypothetically a change in management, an increase of $8,208. For Scenario 2, again hypothetically, a change in management, an increase of $3,962. For Scenarios 3 and 4 , hypothetical changes in technology, increases over Scenario 1 of $4,774 and $7,349 respectively.

4.2 Region 2 - Northern Half of the North Central Region of Victoria

Assumptions

The representative farm was again assumed to be 800 hectares. Of which 720 was arable and 80 was non arable. Native pasture was assumed to be using the non arable land. Cropping was assumed to be 40% of total farm area (A. Kennelly, pers. com.).

The initial run of the whole farm model included enforced pasture percentages of: sub. clover - 19%, lucerne - 10%, composite grass and clover based pasture - 40%, temporary grass pasture - 15%, other grass pasture - 6% and unimproved pasture - 10%. The pasture percentages were those identified in the NPICC database. Carrying capacity estimates for each pasture type came from the NPICC database. As in Region 1, where two or more pasture types were aggregated, average carrying capacity figures were calculated. Agistment of dairy cattle was an activity carried out in the northern half of the North Central Region. This activity was enforced in the model to the equivalent level of 50 dry cows for a period of three months (i.e. 150 cow month equivalents).

Linear Programming Model

The 'base' run of the linear programming model for this region resulted in the farm returning a net of $111,851 from an optimised enterprise mix which included: 144 hectares of barley, 72 hectares of field peas, 72 hectares of canola, 91.2 hectares of sub. clover, 48 hectares of lucerne, 192 hectares of composite grass and sub. clover pasture, 80 hectares of native pasture, 28.8 hectares of other grass pasture, 72 hectares of temporary pasture, 38 cow yearling-producing herd, 523 ewe 1st cross lamb flock and 150 cow months of agistment of dry dairy cows.

The same number of scenarios were then analysed as for Region 1, these were,

1. Remove enforced pasture percentages, allow change to optimum pasture combination. Note that in order to keep the farm model representative, the area of lucerne pasture has to be less than or equal to the area of sub. clover pasture.

2. As for scenario 1 but also improve sub. clover to its NPICC database's "carrying capacity potential".

3. As for scenario 2 but add a new sub. clover that has a 5% higher DSE production for the same costs.

4. As for scenario 3 but add another sub. clover that has a 20% higher DSE production for the same costs.

Each of the above scenarios can be considered a change in technology. The source of the change was not important, what was important was the result in the optimised level of farm activities and the consequent change in net farm returns. Scenario 1 for example could be the result of a change in management technology due to, for example, better extension of pasture research or the release of a new herbicide. The result of the change was that the farmer altered the farms' pasture improvement program. The results of these model optimisations are presented in Table 3, below.

Table 3 - Region 2 Linear Programming Model Results

	Original Whole-farm Model	Remove Pasture Constraints	Sub Clover to NRIC Database Optimum	Sub Clover Production Increased by 5%	Sub Clover Production Increased by 20%
Net Return to Farm	$111,851	$116,302	$119,917	$120,619	$122,726
Barley	144	144	144	144	144
Field Peas	72	72	72	72	72
Canola	72	72	72	72	72
Sub Clover	91.2	216	216	216	216
Lucerne	48	216	216	216	216
Composite Grass/Sub	192	0	0	0	0
Other Grass Pasture	28.8	0	0	0	0
Temporary Pasture	72	0	0	0	0
Unimproved Pasture	80	80	80	80	80
Yearlings	38	36	34	34	33
1st Cross Lamb Prodn	523	626	803	825	892
Agist Dairy Cattle	150	150	150	150	150

In monetary terms the changes in net farm returns can be identified in Table 3. That is for Scenario 1, hypothetically a change in management, an increase of $4,451. For Scenario 2, again hypothetically, a change in management, an increase of $3,615. For Scenarios 3 and 4 , hypothetical changes in technology, increases over Scenario 1 of $4,317 and $6,424 respectively.

Table 4 - Percentage changes in the Representative Farm Results for Region 2

	Change from Scenario 1	Change from Scenario 2	Change from Scenario 3	Change from Scenario 4
Net Return to Farm	3.98%	3.11%	3.71%	5.52%
Area Cropped	0%	0%	0%	0%
Area of Pasture	0%	0%	0%	0%
Sub Clover	137%	0%	0%	0%
Lucerne	350%	0%	0%	0%
Composite Grass/Sub	-100%	0%	0%	0%
Other Grass Pasture	-100%	0%	0%	0%
Temporary Pasture	-100%	0%	0%	0%
Unimproved Pasture	0%	0%	0%	0%
Yearlings	-5.3%	-5.6%	-5.6%	-8.3%
1st Cross Lamb Prodn	19.7%	28%	31.8%	42.5%
Agist Dairy Cattle	0%	0%	0%	0%

In percentage terms, Table 4, contains the percentage changes in net farm returns and enterprise levels from changes in the whole farm model in the Northern half of the North Central Region of Victoria. As for Table 2, the changes for Scenario 1 are with respect to the base model, while for Scenarios 2,3 and 4 the changes are with respect to the results of the whole farm model presented in Scenario 1.

For Scenario 1 the relaxation in pasture level constraints, representing a change in management, lead to an improvement in 3.98 percent in net farm returns, brought about by changes in the levels of pastures, a reduction in the number of cattle and an increase in the number of 1st cross ewe carried.

Scenarios 2, 3 and 4 lead to 3.11, 3.71 and 5.52 percent increases in net farm returns, brought about by altering the optimum combination of livestock enterprises due to additional pasture production. The number of cattle run declines by 5.6, 5.6 and 8.3 percent respectively for Scenarios 2, 3 and 4. While the number of 1st cross ewes run increases by 28, 31.8 and 42.5 percent respectively for scenarios 2, 3 and 4.

4.3 Region 3 - The South Western Region of Victoria

Assumptions

The average farm size identified in the South West Victorian Monitor Farm Project (Patterson 1995) was 849 hectares. On the typical farm, the main enterprises were sheep, beef cattle and cropping. The average area cropped was 52 hectares, non arable land, was used for native pastures and averaged 183 hectares. The remaining arable land was utilised by pasture. In the NPICC pasture database the percentages of different pasture types were; sub. clover pasture 10.9% or 87 hectares, composite grass and sub. clover pasture 36.5% or 291 hectares, temporary grass pasture 29.6% or 236 hectares, unimproved native pasture 11.3% or 90 hectares and fertilised native pasture 11.7% or 93 hectares.

As for Regions 1 and 2, pasture carrying capacity estimates came from the NPICC pasture database. The pasture database however only had figures for the current carrying capacity for the Ararat Region, not the estimates of the potential carrying capacity as was available for Regions 1 and 2. This resulted in the linear programming analysis having one scenario less analysed than in the Regions 1 and 2.

The linear programming model of the representative farm in the South West region included a number of constraints and rotations. The first, the area of cropping and pasture was restricted to the areas mentioned above. Beef cattle, merino sheep and prime lambs were constrained to represent the enterprise mix identified in Patterson (1995). Beef cattle numbers were constrained be greater than or equal to 56 breeding cows. No limit was placed on the sheep enterprise selected in the optimal model.

Linear Programming Model

An initial run of the linear programming model resulted in the farm returning a net farm income of $94,044 from an optimised enterprise mix which included: 52 hectares of wheat, 87 hectares of sub. clover, 291 hectares of composite grass & sub. clover, 236 hectares of temporary grass based pasture, 90 hectares of unimproved native pasture, 93 hectares of fertilised native pasture, 56 cow breeding herd selling weaner heifers and vealer steers, and 1,409 ewe 19 micron self-replacing flock. This data is summerised in Table 5 below.

In monetary terms the changes in net farm returns can be identified in Table 5. That is for Scenario 1, hypothetically a change in management, an increase of $14,659. For Scenarios 2 and 3 , hypothetical changes in technology, increases over Scenario 1 of $3,388 and $13,553 respectively.

Table 5 - Region 3 Linear Programming Model Results

	Original Whole-farm Model	Remove Pasture Constraints	Sub Clover Production Increased by 5%	Sub Clover Production Increased by 20%
Net Return to Farm	$94,044	$108,703	$112,091	$122,256
Wheat	52	52	52	52
Sub Clover	87	409.33	409.33	409.33
Composite Grass/Sub	291	204.67	204.67	204.67
Temporary Pasture	236	0	0	0
Unimproved Pasture	90	0	0	0
Unimproved Fertilised	93	183	183	183
Vealer Production	56	56	56	56
19 Micron Merino Ewe	1409	1716	1774	1948

Table 6 contains the percentage changes resulting from the three scenarios outlined above. The removal of pasture constraints resulted in a 15.59% increase in net farm returns due to changes in the enterprise mix including a 370% increase in sub. clover pasture and a 97% increase in fertilised native pasture. The result of these changes in pasture resulted in an increase in merino ewe numbers by 21.79%. Scenario two and three resulted in an increase in net farm returns of 3.12 and 12.47 percent respectively. This increase in net farm returns resulted from an increase in the number of merino ewes carried by 3.38 and 13.52 percent respectively from an increase in sub. clover feed production of 5 and 20 % respectively.

Table 6 - Percentage changes in the Representative Farm Results for Region 3

	Change from Scenario 1	Change from Scenario 2	Change from Scenario 3
Net Return to Farm	15.59%	3.12%	12.47%
Wheat	0%	0%	0%
Sub Clover	370%	0%	0%
Composite Grass/Sub	-30%	0%	0%
Temporary Pasture	-100%	0%	0%
Unimproved Pasture	-100%	0%	0%
Unimproved Fertilised	97%	0%	0%
Vealer Production	0%	0%	0%
19 Micron Merino Ewe	21.79%	3.38%	13.52%

5. THE THIRD STAGE - AGGREGATION OF REGIONAL FARM MODELS

Due to the unavailability of the ABS data for the Victorian statistical regions except on a user pays basis, this section has not been completed to the standard possible.

Instead some assumptions of regional areas had to be made. This does limit the application of the results from the regional aggregation of the whole farm models. However, the methodology was considered more important than the actual results.

5.1 Region 1 - Southern Half of the North Central Region of Victoria

According to Kennelly (1995) the area in the North Central Region is approximately 1.5 million hectares. This would make the south of the region approximately 750,000 hectares. Using this area, the representative farm results can be aggregated to give an indication of the regional net farm returns. This can be achieved because the representative farm was an average farm not an actual case study, therefore the aggregation for the region can give meaningful results. Table 7 contains the results of a simple aggregation of changes in net farm income from each of the hypothetical technology changes modeled in section 4 of this analysis. Note that the results here were assuming 100% adoption of the technology, and that the figures presented in Table 7 are annual figures.

Table 7 - Annual Increase in Regional Income with 100 % Adoption ($ Million)

Removal of Pasture Constraints	Increase Production to NPICC Optimum	Increase Production by 5%	Increase Production by 20%
$7.7	$3.7	$4.5	$6.9

The figures presented in Table 7 illustrate the removal of pasture constraints, or a hypothetical change in management, resulted in the greatest single improvement in annual regional net farm income of $7.7 million. A 5% improvement in sub. clover pasture feed production, assuming 100 percent adoption, resulted in a $4.5 million improvement in regional net farm income.

Table 8 - Ten Year Regional Net Present Value of Technology ($ Million)

Rate of Adoption	Removal of Pasture Constraints	Increase Prodn to NPICC Optimum	Increase Production by 5%	Increase Production by 20%
1%	3	1.4	1.8	2.7
2%	6	2.9	3.5	5.4
5%	15.1	7.3	8.8	13.6
10%	30.3	14.6	17.6	27.1
20%	45.4	21.9	26.4	40.7
50%	55.6	26.9	32.4	50

A valid criticism of the results presented in Table 7 would be that it is unlikely that any new technology would be adopted in one year. Technology usually filters through the farm sector, there are initiators, early adopters, followers, stragglers and non adopters. Think of the rate of adoption of a new cereal grain variety, seed growers are the first to adopt the variety, then progressive farmers, then in time a majority of farmers adopt the variety, but not just the one variety. Often farmers continue with trusted varieties until the new is proven. Even then, in most cases a new variety is never fully adopted.

What was required therefore was a method of analysing different rates of adoption and analysing the additional returns generated in terms of today's money. The economic tool for achieving this is called net present value (NPV). NPV presents a stream of cashflows in today's dollar terms taking account of inflation. Inflation was accounted for by applying a discount rate. The discount rate assumed in this analysis was 5%.

Table 8 contains the results of the NPV analysis for Region 1. The figures presented in Table 8, in millions of dollars, are the additional NPV resulting from the adoption of the technology at the indicated regional adoption rate.

5.2 Region 2 - Northern Half of the North Central Region of Victoria

The Northern Half of the North Central Region, by deduction also contains approximately 750,00 hectares also. Using the same process described in 5.1, the results of the annual aggregation of each of the technologies is presented in Table 9. The figures presented in Table 9 illustrate the effects of a 100 percent adoption of the various technologies, as explained above. The greatest increase in regional net farm income came from a 20% improvement in the feed production of sub clover pasture.

Table 9 - Annual Increase in Regional Income with 100 % Adoption ($ Million)

Removal of Pasture Constraints	Increase Production to NPICC Optimum	Increase Production by 5%	Increase Production by 20%
$4.2	$3.4	$4.1	$6.0

Table 10 contains the results of the ten year adoption analysis, as explained in 5.1. As expected, as adoption rate increases, the additional regional net farm income becomes greater.

Table 10 - Ten Year Regional Net Present Value of Technology ($ Million)

Rate of Adoption	Removal of Pasture Constraints	Increase Prodn to NPICC Optimum	Increase Production by 5%	Increase Production by 20%
1%	1.6	1.3	1.6	2.4
2%	3.3	2.7	3.2	4.7
5%	8.2	6.7	8.0	11.9
10%	16.4	13.3	15.9	23.7
20%	24.6	20.0	23.9	35.6
50%	30.2	24.6	29.3	43.6

Looking at a 5% increase in the feed production of sub. clover, a 1% annual adoption rate results in a NPV of additional regional net farm income, over ten years, of $1.6 million. Likewise, for a 20% increase in sub. clover feed production, with an adoption rate of 10%, the NPV of additional regional net farm income was $23.7 million.

5.3 Region 3 - South West Region of Victoria

As explained in 5.1, the results of a 100% adoption of the three hypothetical technology changes are presented in Table 11. There are only three scenarios analysed due to incomplete data in the NPICC pasture database. The result of a 5% increase in sub. clover feed production is shown in Table 11 to be an annual increase of regional net farm income of $4.8 million.

Table 11 - Annual Increase in Regional Income with 100 % Adoption ($ Million)

Removal of Pasture Constraints	Increase Production to NPICC Optimum	Increase Production by 5%	Increase Production by 20%
$20.7	NA	$4.8	$19.2

Table 12 contains the results of the NPV analysis of varying levels of technology adoption in the South West region. A 5% increase in sub. clover feed production, adopted at an annual rate of 10%, can be seen in Table 12 to have resulted in an additional $18.9 million dollars.

Table 12 - Ten Year Regional Net Present Value of Technology ($ Million)

Rate of Adoption	Removal of Pasture Constraints	Increase Production to NPICC Optimum	Increase Production by 5%	Increase Production by 20%
1%	8.2	NA	1.9	7.5
2%	16.3	NA	3.8	15.1
5%	40.8	NA	9.4	37.7
10%	81.6	NA	18.9	75.4
20%	122.4	NA	28.2	113.1
50%	150.1	NA	34.7	138.8

5.4 Aggregation of the Regional Models

If, for example sub. clover was only grown in the above three regions in Victoria it would be possible to aggregate the data to get an indication of the State impact of any of the above hypothetical changes in technology. For example, if research indicated that a new sub. clover pasture variety that increased feed production by 5%, would be likely to be adopted at an annual rate of 10%. Then the additional State net farm income[8], over ten years, presented in today's dollars would be: $17.6 million from Region 1, $15.9 million from region 2 and $18.9 million from region 3, a total of $52.4 million.

6. CONCLUSION

In conclusion, a number of simplifying assumptions were used in this analysis to expedite the development of the methodology, and this should be recognised when looking at any of the net benefits generated. However, the methodology developed and suggested in this analysis could be used to analyse any pasture type; locally, across a state, or nationally. The importance of this approach therefore, **is not the figures** generated for the sub. clover example, as these are recognised to be unrealistically high due to the simplifying assumptions used, **but the methodology** developed demonstrated that an improvement in pasture feed production **does not** result in a **proportionate** increase in the amount of livestock carried. Nor does it result in a proportionate increase in net farm returns.

6.1 Possible Improvement to the Methodology

As mentioned above, a number of simplifying assumptions were made in this analysis and to conduct a more accurate analysis of any pasture species these assumptions would need some additional attention. The improvements that could be made with regard to this include:

1. Additional information on the timing of pasture feed production. This could be achieved using growth curves for pasture types identified in the NRICC database, rather than complicating the database with monthly pasture production figures.
2. More accurate estimates of improvements in available feed achieved from any given increase in pasture production (i.e. when you run a 5% increase in dry matter production through GrazFeed for example, you do not get a 5% increase in DSE production).
3. Assume partial adoption of the technology rather than total adoption at an on-farm level and regional level. On-farm, the technology improvement would be assumed to occur as pastures were re-sown, for example in Region 1, new pasture would be sown over the 5 years of the pasture phase. At a regional level, this may be adopted at a rate of 10%. Thus every year 10 percent of farms would begin year one of a five year pasture upgrade to the new technology, consequently there would be a significant delay in the complete adoption of any new technology. In modeling this adoption it would be necessary to discount the cashflow of the new technology.
4. The use of an industry level analysis to determine price response to changes in supply of livestock products. The type of analysis would need to be complex as a number of products were being produced by the livestock enterprises, such as wool, mutton, lamb and beef.

[8] Assuming that there were no market level impacts from the additional livestock production that resulted from the technology change.

6.2 Areas to Improve in the NPICC Pasture Database

From an economic analysis context, the amount of pasture production on a monthly or seasonal basis is more meaningful than one annual figure. This would give a better indication of the timing of pasture production which is critical in accurate linear programming of a representative farm. It would also enable the modeling of technology change to be handled in a more sophisticated manner. For example a new technology may increase the quantity of pasture produced in winter, not total production, the final results may differ markedly. An increase in winter feed production for example may benefit prime lamb production and not beef cattle. Therefore the number of prime lambs that would be chosen in the optimal solution, and the increase in net farm income may be completely different to the optimal solution generated from annual figures.

General data errors fall into two categories; first, incomplete data, often missing DSE rating information, or as in the above analysis, only partially complete DSE rating information. Second, incorrect data, discrepancies between data tables seem to be common, particularly the pasture code number.

6.3 Possible Uses of the NPICC Pasture Database

From an economic context there are a number of potential uses for a continually updated national pasture species database. The first, and possibly most important, would be in analysing the investment decisions that have to be made in allocating funding to pasture research. For example, three research proposals, each into different pastures, competing for funding require a total budget of $1.5 million. The sum available for research in this area is $750,000. How are the research dollars to be allocated? A simple two or three region analysis like the one presented above would give a good indication of the likely net returns and the funds could be allocated accordingly.

Second, on a higher level of research funding, the decision to allocate research to production, marketing, or processing could also be answered using a slightly more sophisticated analysis to the one presented above.

7. REFERENCES

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8. Appendix 1 - Gross Margin Budgets for the North Central Region

9. Appendix 2 - Gross Margin Budgets for the South West Region