Survey of Agronomic Practices on

Thoroughbred
Horse Stud Farms

A Report for RIRDC by

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FOREWORD

This report investigates current agronomic practices on thoroughbred horse stud farms in eastern Australia to identify the scope for improvement in horse pasture management, and to assess the sustainability of such management, particularly in relation to reducing environmental degradation.

Issues such as bio-physical and human resource characteristics of properties, livestock composition, horse health, land degradation problems, and sources of pasture management expertise were surveyed and analysed to demonstrate what constitutes industry best practice and to identify the chief areas where improvements can be made.

This study forms part of RIRDC's Equine R&D program, which is assisting in developing the Australian horse industry and enhancing its export potential. We believe it will prove extremely useful to property owners, managers and others.

KEITH HYDE
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1. Summary

This project aimed to capture information on various aspects of agronomy, associated management practices and land degradation issues on Thoroughbred stud properties in eastern Australia. Some aspects of animal health which are liable to be influenced by agronomic practices were also investigated. Twelve properties were surveyed in each of the following regions: Darling Downs (Qld), Hunter Valley (NSW), Outer Sydney (NSW), Riverina/SW slopes (NSW) and Euroa district (Vic). On each property a detailed interview was conducted with the owner/manager and inspections made of paddocks representative of predetermined categories. The latter aspect of the study was influenced by widespread drought.

The survey revealed that stud properties varied widely in area, averaging from 136 ha in the Outer Sydney region to 1159 ha in the Hunter Valley. This difference in size was reflected in the numbers of horses present, for example in Outer Sydney the mean numbers of foals was 30 but in the Hunter Valley this value was 156. However, overall property area was not the only factor influencing horse numbers. The proportion of each individual stud which was used for horses varied from just 1.7 percent to 100 percent with the lowest regional averages being 61 percent in the Riverina SW slopes and to a high of 93 percent in the Euroa district. Other activities taking place on the properties included cropping and grazing of cattle and sheep. Supplementary feed was widely used in all regions but relatively high stocking rates seemed to be maintained in the Euroa district without particularly high levels of supplementation.

Paddocks were classified as "improved" if sown to a mixture of introduced grasses and legumes, "semi-improved" if introduced legumes had been sown into a native pasture, and "native" if none of the former had taken place, hence a mixture of native and self sown non-native, naturalised species were present. Improved pastures were the most
commonly recorded category of pasture being present on 51 of the 60 properties surveyed.

Common species in improved pastures included paspalum, perennial ryegrass, cocksfoot and lucerne. In contrast, semi-improved pastures were only present on seven properties indicating that when pasture improvement had taken place it had usually been to the full extent. Native pastures were found on properties in all five regions and but most frequently in the Darling Downs.

Soil acidity was worst in the Riverina/SW Slopes and Euroa districts, with a mean pH (calcium chloride test) lower than 6 in all pasture categories. The Darling Downs region had soil pH values closest to neutral.

The numbers of foals reported as being treated for developmental orthopaedic disease (DOD), expressed as a percent of the total numbers of foals, ranged from 7.3 percent in Outer Sydney to 20.1 percent in the Euroa district but marked intra-regional variability was greater than inter-regional trends.

Stud owners and managers were reportedly the major decision makers for pasture management and the majority of these relied upon experience as opposed to formal training or education. This suggests an opportunity to improve the quality of agronomic management by agricultural extension and education in appropriate non-conventional modes such as distance education and short courses in pasture management. Such initiatives would build on the considerable scope which is apparent from this survey to promote pastures as a major contributor to horse nutrition in Australia. Fifty of the sixty interviewees considered that the greatest benefit of pastures was either nutritional or economic favourability. Other reasons given, such as ground cover, exercise related or psychological well being of horses were rated most important by fewer respondents. Furthermore, on average, nine percent of the property budget
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was allocated to pasture management. Thus, provided that research results and other information on best practice are efficiently extended to the equine industry, there is great scope for adoption.

Longer term research needs identified by stud managers included development of pasture species with improved productivity and persistence considered to be of greatest importance.

2. Background

There is a paucity of published information on the role of pastures in horse nutrition in Australia (Kelleher, 1995), and the potential which may exist for lessening current reliance on supplementary feeding by greater use of pastures as is the case in New Zealand (Hunt, 1994). Indeed little is known about more general aspects of the agronomy of horse enterprises and the effects that such factors may have on pasture productivity, environmental sustainability and horse health.

Pasture management techniques developed overseas, relying heavily on hard feeds (Francis and Kimberley 1979), without making full use of pastures, have, in the past, been used as guidelines on Australian studs, aided by extrapolated research from other Australian industries, particularly cattle and sheep. This is inadequate for an industry which contributes so much to the Australian economy (Pilkington and Wilson 1993). A very different situation is reported in New Zealand where there is far greater reliance on pastures as a contributor towards the nutritional needs of horses (Hunt, 1994). Progress towards the New Zealand model is hampered by the dearth of reliable, applicable information and this was recognised by participants of the RIRDC workshop on pastures and horse nutrition, (RIRDC, 1995).

A number of problems are associated with the effects of horses on pastures such as the development of "horse sickness" (sensu Hunt, 1994), ungrazed areas due to poor manure and grazing management, and land degradation in such forms as bare ground, soil erosion and soil acidity. In addition, there may be adverse effects of the pasture on animals via inherent toxicity or contamination of various sown pasture species and weeds which may lead directly to, or subtly contribute to, ill health or poor reproductive performance in animals (Bryden, 1991; Kohnke, 1991a).

A particular problem in the Thoroughbred industry is wastage, a broad term which refers to that proportion of horses conceived which fail to eventually race. One form of wastage which is apparent on studs and for which this survey captured data, is developmental orthopaedic disease (DOD). Some factors which contribute to wastage, include biomechanical trauma, genetic predisposition, horse husbandry, nutritional and agronomic influences. The latter two factors in particular may be affected by the agronomic and broader management practices employed on the stud environment.
3. Objectives

The aim of this project was to identify current agronomic practices on Thoroughbred horse stud farms in eastern Australia and to analyse the importance of this "step", the plant sub-system (Fig. 1.), in the sustainability of the overall production system. For this exercise two outcomes were identified in the original research proposal:

- to identify scope for improvement in horse pasture management, and
- assess the sustainability of management practices with the primary aim of reducing environmental degradation/contamination.

To achieve these outcomes for agronomic factors there was a need to examine pasture management in the context of the broader production system. Accordingly data was also sought on the chief bio-physical characteristics of properties and broader management practices, livestock composition, horse health and land degradation problems. Attitudes were also canvassed from property owners/managers towards the role and importance of pastures, the sources of pasture management expertise and on what they perceived to be problems and research priorities.

Following data capture, information was compiled to provide a profile of Thoroughbred stud farms in eastern Australia and where appropriate this was done separately for five geographical regions. It was anticipated that this would show certain trends which may lead a clearer understanding of what constituted industry best practice and identify the chief areas where improvements could be made.
Figure 1. Agronomic factors in context - the Thoroughbred stud as an agricultural production system.
Findings which identify future research needs were to be communicated to relevant organisations and peers (by means of conferences, scientific articles and the reporting process). Results of immediate relevance and interest were to be communicated back to industry (by an advisory pamphlet and magazine articles).

4. Method

To reflect the wide geographical range of the Thoroughbred stud industry and to determine regional differences, five regions were surveyed: the Darling Downs, Hunter Valley, Outer Sydney, Riverina/South-West Slopes, and Euroa. These regions were delineated by broad similarities in topography, soil type and climate. Twelve Thoroughbred studs were chosen at random in each region from current Australian Bloodhorse Breeders listings (Australian Jockey Club personal communication). Properties were eligible for inclusion in the survey if they conducted Thoroughbred breeding operations. This did not require accommodation of a stallion, but did require accommodation of breeding mares.

Survey

The survey was conducted from February to April 1994, after approval from the University of Sydney Human Ethics Committee and the conduct of three local pilot surveys, which were used to refine the survey protocol. Confidentiality was ensured using a coding system for both region and property and subjects were free to withdraw from the survey at any time.

The survey consisted of an interview conducted during a visit to each property and an assessment of botanical composition, soil pH and soil texture examination of representative paddocks of each pasture category present. During the interview a comprehensive questionnaire was completed in consultation with the property
The questionnaire recorded information on property size, physical characteristics, management of crops, pastures and animal enterprises. Questions were composed of both open-ended and multiple-item scaling responses. A combination of both designs utilising multiple-item scaling with an open-ended "other" category, was used to gain the greatest precision in response and allow those who did not fit into the itemised categories to express a response. Questions and response categories were randomised to minimise item sequencing effects within the questionnaire as described by Belson (1986) and Judd et al. (1991). Responses were then coded numerically to allow computerised analyses of the data.

Representative paddocks suitable for botanical composition examination, soil pH and texture analyses were identified in consultation with the manager for the following three categories. Improved pastures, were defined as those sown to introduced grasses, such as phalaris (*Phalaris aquatica* L.), cocksfoot (*Dactylis glomerata* L.), perennial ryegrass (*Lolium perenne* L.) and/or lucerne (*Medicago sativa* L.). Semi-improved pastures, were those that had a legume component, such as subterranean clover (*Trifolium subterraneum* L.) or white clover (*T. repens* L.), introduced to a predominantly native grass pasture. Native pastures were those composed of native and/or naturalised species, without ever having had another pasture species introduced to the system, although some degree of self-sown introduced species may have been present. Other categories of paddock recognised were; promotional, typically located at the entrance to a property and managed for client impression rather than productivity, and working areas which accommodated non-grazing activities.

The botanical examination of paddocks containing improved, semi-improved and native pastures, where present, involved 150 observations taken over a zig zag transect avoiding anomalies such as stock camps and fencelines though disregarding
heterogeneity associated with typical horse grazing ethology. A modified point quadrat (5 points along a 30 cm line) was used to determine the relative frequencies of species, with first contacts recorded at 3-5 cm above ground level as described by Kemp and Dowling (1991).

During each botanical composition transect thirty 0-100 mm depth soil samples were taken using a 16 mm diameter corer. These were combined and subsequently ground, sieved and mixed in the laboratory and a pH test in 0.01 M CaCl$_2$ and soil texture test (McDonald et al. 1984), were performed. Plant specimens which could not be identified in the field were also returned to the laboratory for identification.

5. Results

5.1. Biophysical and Human Resources.
(Property area, age and pasture budget, Staffing and expertise, Rainfall and irrigation, Soil pH, Soil nutrient testing, Land Degradation.)

5.1.1 Property area, age and pasture budget.

Individual property area varied to a statistically significant extent with the largest regional mean being in the Hunter Valley (Table 1). The smallest regional mean property size was in Outer Sydney, averaging 136ha. The standard error of mean (SEM) values indicate that property size was most variable in the Hunter Valley and least variable in the Euroa region.

The area of each property normally used for horses followed a similar trend with Hunter Valley properties averaging 882ha for horses and those in the Outer Sydney region just 103ha. The ranked order of regions for total size was identical to the order
when ranked for area used for horses.

The area used for horses as a proportion of the total property area, differed significantly between regions with those in Riverina / SW Slopes less intensively used for horses (61 percent) than elsewhere (Table 1). Amongst other regions differences were less pronounced though the Euroa region was most intensively used for horses (93 percent).

Property age was greatest in the Hunter Valley, 35 years, whilst in Euroa the average property had only operated as a stud for just under 25 years (Table 1).
### Table 1. Reported area, age and proportion of budget allocated to pasture improvement (mean ± s.e.m and range in parentheses) of Thoroughbred horse studs surveyed in five regions of eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>Total Area (ha)</th>
<th>Horse Area + (ha)</th>
<th>Horse Proportion* (%)</th>
<th>Property Age* (years)</th>
<th>Budget Proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer</td>
<td>136.1 ± 31.9</td>
<td>102.9 ± 18.8</td>
<td>83.95 ± 5.67</td>
<td>21.1 ± 5.8</td>
<td>11.32 ± 3.28</td>
</tr>
<tr>
<td></td>
<td>(28.4-405.0)</td>
<td>(25.5-243.0)</td>
<td>(35.71-100.0)</td>
<td>(2.0-60.0)</td>
<td>(1.5-40.0)</td>
</tr>
<tr>
<td>Sydney</td>
<td>1159.0 ± 286.0</td>
<td>882.0 ± 235.0</td>
<td>81.61 ± 5.00</td>
<td>35.1 ± 10.3</td>
<td>8.68 ± 2.36</td>
</tr>
<tr>
<td></td>
<td>(7.0-2835.0)</td>
<td>(7.0-2693.0)</td>
<td>(49.61-100.0)</td>
<td>(6.0-125.0)</td>
<td>(0.0-25.0)</td>
</tr>
<tr>
<td>Hunter Valley</td>
<td>375.0 ± 127.0</td>
<td>231.2 ± 35.9</td>
<td>89.07 ± 7.66</td>
<td>27.75 ± 9.45</td>
<td>11.92 ± 2.18</td>
</tr>
<tr>
<td></td>
<td>(87.5-1620.0)</td>
<td>(87.5-428.3)</td>
<td>(17.50-100.0)</td>
<td>(8.0-120.0)</td>
<td>(1.00-25.00)</td>
</tr>
<tr>
<td>Darling Downs</td>
<td>720.0 ± 161</td>
<td>307.7 ± 72.3</td>
<td>61.50 ± 10.5</td>
<td>32.00 ± 6.90</td>
<td>10.65 ± 4.63</td>
</tr>
<tr>
<td></td>
<td>(16.0-1458.0)</td>
<td>(16.2-850.5)</td>
<td>(1.70-100.0)</td>
<td>(6.0-98.0)</td>
<td>(0.5-50.0)</td>
</tr>
<tr>
<td>Riverina/SW</td>
<td>160.9 ± 29.3</td>
<td>150.2 ± 29.2</td>
<td>92.56 ± 2.73</td>
<td>24.58 ± 5.31</td>
<td>3.67 ± 0.54</td>
</tr>
<tr>
<td></td>
<td>(21.5-344.3)</td>
<td>(21.5-344.3)</td>
<td>(75.00-100.0)</td>
<td>(4.0-75.0)</td>
<td>(1.0-6.0)</td>
</tr>
<tr>
<td>Euroa Slopes</td>
<td>450.62</td>
<td>318.89</td>
<td>-</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

L.S.D. (P = 0.05)

+ Other livestock species may also use this area in a rotational fashion.

# Values retransformed (arcsin). Values followed by the same letter not significantly different (P = 0.05).

* As a Thoroughbred stud.
The proportion of annual property budget reportedly allocated to pasture improvement was highest in the Outer Sydney, Darling Downs and Riverina SW Slopes regions (greater than 10 percent), and lowest in the Euroa district properties (3.7 percent) (Table 1). This level of budgetary allocation to pastures was considered to be a limiting factor in improving pastures by 9/12 managers in the Euroa district but by only five, or fewer, in other regions.

5.1.2 Staffing and expertise.

Staffing levels varied considerably both within and between regions. All regions had at least one property with just one or two staff but maximum numbers within regions varied from eight in the Euroa district to forty in the Hunter Valley (Table 2). Mean staff numbers differed significantly with between four and six staff employed in all regions except the Hunter Valley where the average was almost 17.

When considered from the perspective of those staff dedicated to farming/pasture management, properties in the Hunter Valley remained highest with a mean of almost four. Most other regions averaged between one and two though properties in the Euroa district had a relatively high value of 2.58.

The length of time for which individual managers had been in their post varied very widely from one to forty six years. However, the averages for different regions were fairly consistent, ranging from 14.5 years in both the Hunter Valley and Darling Downs regions down to just under eleven years in Outer Sydney.
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Table 2. Reported staffing characteristics (mean ± s.e.m. and range in parenthesis) of Thoroughbred horse studs surveyed in five regions of eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>Total Staff</th>
<th>Farming/Pasture Management Staff</th>
<th>Period in post for agronomic decision maker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Sydney</td>
<td>4.46 ± 1.11</td>
<td>1.92 ± 0.31</td>
<td>10.96 ± 2.40</td>
</tr>
<tr>
<td></td>
<td>(2 - 16)</td>
<td>(1 - 4)</td>
<td>(1.0 - 28.0)</td>
</tr>
<tr>
<td>Hunter Valley</td>
<td>16.83 ± 3.55</td>
<td>3.92 ± 0.85</td>
<td>14.50 ± 4.37</td>
</tr>
<tr>
<td></td>
<td>(1 - 40)</td>
<td>(1 - 10)</td>
<td>(1.0 - 46.0)</td>
</tr>
<tr>
<td>Darling Downs</td>
<td>4.25 ± 0.83</td>
<td>1.42 ± 0.23</td>
<td>14.50 ± 2.74</td>
</tr>
<tr>
<td></td>
<td>(2 - 12)</td>
<td>(0 - 3)</td>
<td>(4.0 - 37.0)</td>
</tr>
<tr>
<td>Riverina/SW Slopes</td>
<td>5.58 ± 1.31</td>
<td>1.33 ± 0.22</td>
<td>11.67 ± 2.17</td>
</tr>
<tr>
<td></td>
<td>(1 - 15)</td>
<td>(0 - 3)</td>
<td>(1.5 - 21.0)</td>
</tr>
<tr>
<td>Euroa</td>
<td>4.75 ± 0.58</td>
<td>2.58 ± 0.64</td>
<td>13.92 ± 3.61</td>
</tr>
<tr>
<td></td>
<td>(2 - 8)</td>
<td>(0 - 8)</td>
<td>(1.0 - 40.0)</td>
</tr>
<tr>
<td>L.S.D. (P = 0.05)</td>
<td>5.168</td>
<td>1.469</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

Experience gained from working on horse studs was the dominant source of expertise for persons making pasture related management decisions. This was augmented by advice from local agronomists in 18 cases, by a formal education in twelve cases and by experience gained in other agricultural industries in two cases.

5.1.3 Rainfall and irrigation

Properties in the Outer Sydney region reportedly received the highest annual rainfall (951 mm) which was significantly greater than for any other region. However, the high SEM is indicative of considerable variability within this region (Table 3). The Riverina/SW Slopes properties tended to receive the lowest rainfall (628 mm), though none of the other regions averaged greater than 730 mm.
The highest proportion of properties which reported not having access to irrigation water was in the Riverina/SW Slopes region (8/12). Properties in the Darling Downs and Euroa regions were also lacking irrigation water in approximately half the cases but 11/12 properties in both the Outer Sydney and Hunter Valley regions did have access to irrigation water.

The most common use for irrigation was for pastures (Table 3) and this practice was particularly common in the Hunter Valley and Outer Sydney regions. Other irrigation uses were only common in the Hunter Valley. Six of the properties in this region used irrigation for production of crops and five irrigated at least some areas for dust control using overhead sprinklers.

5.1.4 Soil pH. (calcium chloride test)

Soil pH varied considerably between regions with the Riverina/South-West Slopes regions tending to have the most acidic soils in both the improved and native pastures. The low standard error of mean (SEM) values for this region's mean pH values indicates that acid soils were a problem on the majority of properties (Table 4). The Darling Downs properties displayed the least acidic soils in both pasture types. Soil pH was slightly lower in native pastures than in improved pastures for all regions. The order of properties ranked for mean pH, was consistent between improved pastures and native pastures. Semi-improved pasture pH values tended to approximate the improved pasture pH in both the Hunter Valley and Riverina/SW slopes but are not presented for other regions due to the scarcity of this category of pasture.
Table 3. Reported annual rainfall (mean ± s.e.m. and range in parenthesis) and irrigation use on Thoroughbred horse studs surveyed in five regions of eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>Annual Rainfall (mm)</th>
<th>Number of Properties (of twelve) with/practising Access to Irrigation Water</th>
<th>Number of Properties (of twelve) with/practising Pasture Irrigation</th>
<th>Number of Properties (of twelve) with/practising Crop Irrigation</th>
<th>Number of Properties (of twelve) with/practising Dust Control Irrigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Sydney</td>
<td>951.1 ± 71.0 (685.8 - 1270.0)</td>
<td>11 8 1 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hunter Valley</td>
<td>651.9 ± 18.3 (584.2 - 762.0)</td>
<td>11 11 6 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Darling Downs</td>
<td>728.1 ± 22.0 (609.6 - 914.4)</td>
<td>7 6 3 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverina/SW</td>
<td>628.1 ± 24.2 (482.6 - 736.6)</td>
<td>4 0 1 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slopes</td>
<td>720.4 ± 50.3 (431.8 - 1016.0)</td>
<td>6 2 0 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Euroa</td>
<td>104.59 (P&lt;0.05)</td>
<td>- - -</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The median soil texture recorded for the most southerly region, Euroa, was sandy clay and in the most northerly region, Darling Downs, light clay dominated. In all other regions soils were predominantly loamy.
The level of awareness of soil acidity amongst managers varied quite markedly between regions. In the region with the worst acid soil problem, Riverina/ SW Slopes, though five managers had reported having acid soils, four managers did not know the general pH status of their property. In other regions the level of unawareness was either as high (Outer Sydney) or higher, being highest in the Darling Downs (Table 5).

Incidence of lime use (either as a topdressing or at sowing) was lowest in the Darling Downs Region and one property here reported applications of sulfur. Lime applications were much more common in the Euroa region. Use of ground limestone or dicalcium phosphate in horse rations was reported from at least half of the properties surveyed in each region and was most widely used in the Riverina/SW Slopes and Euroa regions.

5.1.5 Soil nutrient testing.

Soil testing for nutrient status was relatively uncommon but more regular in the Riverina/ SW Slopes region than elsewhere, reportedly being last conducted 34 months ago on average (Table 6). In the Darling Downs an average period of 72 months had elapsed since the last soil test had been conducted.

Most commonly reported nutrient deficiencies were (in declining order of frequency) phosphorus, nitrogen, calcium, molybdenum and potassium (Table 6). Such deficiencies were most prevalent in the Outer Sydney region and reportedly least prevalent in the Euroa district.
Table 4. Reported soil pH (mean ± s.e.m. and range in parentheses) and median soil texture of Thoroughbred horse studs surveyed in five regions of eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>Improved Pasture</th>
<th>Semi-Improved Pasture</th>
<th>Native Pasture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pH</td>
<td>Texture</td>
<td>pH</td>
</tr>
<tr>
<td>Outer</td>
<td>5.51 ± 0.118</td>
<td>fine sandy</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(4.82 - 6.07)</td>
<td>loam</td>
<td></td>
</tr>
<tr>
<td>Sydney</td>
<td>6.23 ± 0.116</td>
<td>silty clay</td>
<td>6.08 ± 0.342</td>
</tr>
<tr>
<td></td>
<td>(5.56 - 6.77)</td>
<td>loam</td>
<td>(5.46 - 6.98)</td>
</tr>
<tr>
<td>Hunter</td>
<td>6.68 ± 0.210</td>
<td>light clay</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(5.93 - 7.49)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valley</td>
<td>5.27 ± 0.095</td>
<td>fine sandy</td>
<td>5.71 ± 0.280</td>
</tr>
<tr>
<td></td>
<td>(4.88 - 5.65)</td>
<td>clay loam</td>
<td>(5.43 - 5.99)</td>
</tr>
<tr>
<td>Riverina/</td>
<td>5.41 ± 0.195</td>
<td>sandy clay</td>
<td>-</td>
</tr>
<tr>
<td>SW Slopes</td>
<td>(4.75 - 6.67)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 5. Reported dicalcium phosphate and lime use and general soil pH status of Thoroughbred horse studs surveyed in five regions of eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>DCP/ lime in ration</th>
<th>Lime use on pastures</th>
<th>Number of respondents per region (of twelve) reporting:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acid</td>
<td>Neutral</td>
<td>Alkaline</td>
</tr>
<tr>
<td>Outer Sydney</td>
<td>7</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Hunter Valley</td>
<td>8</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Darling Downs</td>
<td>6</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Riverina/SW Slopes</td>
<td>10</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Euroa</td>
<td>10</td>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

5.1.6 Land Degradation

Soil salinity was reported from only six properties, half of these being in the Riverina/SW Slopes region (Table 7). Generally the reported level of severity was low.

Tree decline ("dieback") was not reported from the Darling Downs but occurred in all other regions. In contrast, ringbarking of trees by livestock was most common in this region and occurred to some extent in all regions.

Loss of ground cover and soil erosion was reported from at least four properties in every region and was particularly common in the Darling Downs. Generally this phenomenon was most severe around feeders and water troughs. Fenceline pressure (loss of ground cover resulting from heavy traffic around paddock margins) was recorded separately and reported to be most intense in the Euroa region.
Table 6. Reported interval since last soil test (mean ± s.e.m. and range in parentheses) and nutrient deficiencies of Thoroughbred horse studs surveyed in five regions of eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>Interval since last soil test (months)</th>
<th>Phosphorus</th>
<th>Nitrogen</th>
<th>Calcium</th>
<th>Molybdenum</th>
<th>Potassium</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer</td>
<td>36.7 ±</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Sydney</td>
<td>12.70</td>
<td>(1 - 120)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hunter</td>
<td>53.5 ±</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Valley</td>
<td>15.60</td>
<td>(1 - 180)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Darling</td>
<td>72.4 ± 9.32</td>
<td>2</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Downs</td>
<td>(24 - 100)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverina/SW</td>
<td>33.9 ±</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>SW</td>
<td>11.70</td>
<td>(1 - 96)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slopes</td>
<td>48.7 ±</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Euroa</td>
<td>15.60</td>
<td>(12 - 120)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>15</td>
<td>12</td>
<td>8</td>
<td>4</td>
<td>3</td>
<td>16</td>
</tr>
</tbody>
</table>
Table 7. Reported land degradation phenomena of Thoroughbred horse studs surveyed in five regions of eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>Soil Salinity</th>
<th>Soil erosion</th>
<th>Fenceline pressure</th>
<th>Tree decline</th>
<th>Ring barking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Sydney</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Hunter Valley</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Darling Downs</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Riverina/ SW Slopes</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Euroa</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>

Relocation of feeders was widely practised in all regions and the chief reason for doing so was to minimise bare ground, pugging and erosion (Fig. 2). Feeders were relocated frequently in the majority of cases with 60 percent of properties moving at intervals shorter than a month (Fig. 3). In some cases the movement by horses was cited as significant in augmenting manual relocation. The longest interval reported between relocations was every one to two years on a property where feeders were semi-static concrete structures. Of those properties which did not move feeders, the use of static designs was the most common reason. Other reasons reported were convenience, lack of a need for relocation due to low stocking rates and the view that it was better to confine the damage associated with feeders rather than distribute it.
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Figure 2. Explanation given for moving or not moving feeders on Thoroughbred horse stud properties in eastern Australia.

Figure 3. Frequency of movement for feeders on Thoroughbred horse stud properties in eastern Australia.
Other practices employed to manage land degradation type problems included the use of tree guards which were widely used, by at least ten properties in every region (Table 8). Tree planting was also commonly practised, reported by at least eight properties in each region. Laneways were also found on the majority of properties.

Electric fencing was also widely employed, on at least half the properties surveyed in each region. Its use may also have been associated with land degradation problems or to minimise inter-paddock animal interaction and damage to rugs.

**Table 8. Reported land degradation related management practices of Thoroughbred horse studs surveyed in five regions of eastern Australia.**

<table>
<thead>
<tr>
<th>Region</th>
<th>Electric fencing</th>
<th>Tree guards</th>
<th>Tree planting</th>
<th>Laneways</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Sydney</td>
<td>9</td>
<td>11</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Hunter Valley</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Darling Downs</td>
<td>8</td>
<td>11</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Riverina/</td>
<td>9</td>
<td>10</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>SW Slopes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Euroa</td>
<td>6</td>
<td>10</td>
<td>8</td>
<td>12</td>
</tr>
</tbody>
</table>

**5.2. The Plant Sub-system.**

(Cropping and fodder conservation, Pasture types and botanical composition, Weeds, pests and diseases, Attitudinal factors.)

**5.2.1 Cropping and fodder conservation.**

Cropping was practised on at least half the properties in each region except Euroa.
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where no crops were reportedly grown. Cropping was most widely practised on properties on the Darling Downs (Table 9) where wheat, barley, lucerne, oats, sorghum and millet were grown (Table 10). Rotating crop and pasture phases was common amongst those properties which grew crops in the Riverina/ SW Slopes but less common elsewhere, particularly Outer Sydney. Over all regions the length of crop/pasture rotation ranged from five to nine years.

Table 9. Reported fodder conservation and cropping practices (mean ± s.e.m. and range in parentheses) of Thoroughbred horse studs surveyed in five regions of eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>Fodder Conservation</th>
<th>Cropping</th>
<th>Area under Crops (ha)</th>
<th>Rotating Crops with Pastures</th>
<th>Rotation Length (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Sydney</td>
<td>5</td>
<td>6</td>
<td>10.5 ± 5.99</td>
<td>1</td>
<td>9.0 NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0-70)</td>
<td></td>
<td>(9-9)</td>
</tr>
<tr>
<td>Hunter Valley</td>
<td>7</td>
<td>7</td>
<td>60.7 ± 41.90</td>
<td>4</td>
<td>6.2 ± 0.63</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0-500)</td>
<td></td>
<td>(5-8)</td>
</tr>
<tr>
<td>Darling Downs</td>
<td>7</td>
<td>9</td>
<td>154.7 ± 42.20</td>
<td>4</td>
<td>7.7 ± 0.88</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0-400)</td>
<td></td>
<td>(6-9)</td>
</tr>
<tr>
<td>Riverina/ SW Slopes</td>
<td>4</td>
<td>6</td>
<td>275.0 ± 162.00</td>
<td>6</td>
<td>6.3 ± 0.62</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0-1800)</td>
<td></td>
<td>(5-9)</td>
</tr>
<tr>
<td>Euroa</td>
<td>2</td>
<td>0</td>
<td>0 ± NA</td>
<td>0</td>
<td>- NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(NA)</td>
<td></td>
<td>(0-0)</td>
</tr>
</tbody>
</table>

Fodder conservation was most commonly practised in the Hunter Valley and Darling Downs regions (Table 9). Fodder conservation was most commonly viewed as a means of utilising extra feed during periods of high pasture productivity and maintaining year round feed availability whilst reducing cost of buying in supplementary feed. For those properties in these regions not conserving fodder, the most commonly reported reason
for not doing so was that it was not economically attractive. Many such properties did not own a mower hence were more reliant on contractors for fodder conservation.

Table 10. Reported crops grown on Thoroughbred horse studs surveyed in five regions of eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>Oats</th>
<th>Barley</th>
<th>Lucerne</th>
<th>Wheat</th>
<th>Sorghum</th>
<th>Millet</th>
<th>Lupins</th>
<th>Maize</th>
<th>Canary Grass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sydney</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hunter</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Valley</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Darling</td>
<td>7</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Downs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riverina/</td>
<td>6</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>SW Slopes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Euroa</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

5.2.2 Pasture types and botanical composition.

Most studs (51/60) had some improved pasture, many (25/60) also had native pasture, but there were few semi-improved pastures (7/60) (Table 11). In the Darling Downs, three properties relied solely on native pastures.

Botanical composition varied considerably between regions (Table 11). However, couch (*Cynodon dactylon* (L.) Pers.) was amongst the dominant pasture species in almost every region and pasture category. Perennial ryegrass (*Lolium perenne* L.) and
cocksfoot (*Dactylis glomerata* L.) were also dominant pasture species in improved pastures, as was lucerne (*Medicago sativa*) in semi-improved pastures, and paspalum (*Paspalum dilatatum* Poir.) and liverseed grass (*Urochloa panicoides* Beauv.) in native pastures.

### 5.2.3 Weeds, pests and diseases.

Over all regions, weeds were most common in the less improved pasture categories and dominant species included wireweed (*Polygonum aviculare* L.), bindweed (*Convolvulus erubescens* Sims), Yorkshire fog (*Holcus lanatus* L.) and skeleton weed (*Chondrilla juncea* L.). Couch (*Cynodon dactylon* L.) was also a common component of pastures in all regions but is less clearly definable as a weed in this context since it is readily grazed by horses.

Weed management strategies employed were, in descending order of importance: herbicide, slashing/mowing, manual removal/chipping, maintaining a vigorous pasture, tillage/cropping rotations, mixed species grazing, horse grazing management, biological control and burning. The frequency of use for these various techniques did not differ markedly between regions with the exception of manual removal/chipping which was relatively little used in the Riverina/SW Slopes region and tillage/cropping rotations which was not widely practised in the Euroa region (Table 12).

The success of weed management was reportedly greater for the Euroa region than elsewhere, where the consensus of opinion was successful/fairly successful control was being achieved (Table 12).

Plant disease was a relatively unimportant factor in the plant sub-system with rust of ryegrass (*Puccinia* sp) and of lucerne (*Uromyces striatus*) being cited as an occasional minor problem on just one property.
Pests, however, had reportedly required management on 28 properties and were considered "very severe in most years" in 11 cases (Fig. 4). Dominant pest species were earth mites (*Halotydeus destructor* (Tucker) and *Penthaeleus major* (Duges)) and aphids (*Theroaphis trifolii* (Monell), *Acyrthosiphon kondoi* Shinji and *A. pisum*). Pasture cockchafer (*Coleoptera Scarabeidae*) and an unidentified nematode were each cited as a problem on one property (Fig. 5).

Four properties reported having to control pests in all pasture categories but lucerne was the most commonly attacked crop (Fig. 6). Generally sowing and establishment were the growth stages most severely attacked by pests (Fig. 7), particularly earth mites.

Management techniques employed to combat plant pests included resistant cultivars and cutting but chemical control dominated, being employed in twenty two cases (Fig. 8).
Table 11. Pasture types and incidence of dominant species (mean ± s.e.m. and range in parenthesis) on Thoroughbred horse studs surveyed in five regions of eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>Improved pastures</th>
<th>Semi-improved pastures</th>
<th>Native pastures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Sydney</td>
<td>n = 12</td>
<td>n = 0</td>
<td>n = 3</td>
</tr>
<tr>
<td></td>
<td>49 ± 18% kikuyu</td>
<td></td>
<td>8 ± 6% couch</td>
</tr>
<tr>
<td></td>
<td>37 ± 14% paspalum</td>
<td></td>
<td>6 ± 4% paspalum</td>
</tr>
<tr>
<td></td>
<td>13 ± 6% perennial ryegrass</td>
<td></td>
<td>2 ± 2% kikuyu</td>
</tr>
<tr>
<td></td>
<td>22 ± 11% couch</td>
<td></td>
<td>1 ± 1% Rhodes grass</td>
</tr>
<tr>
<td></td>
<td>7 ± 4% cocksfoot</td>
<td></td>
<td>1 ± 1% summer grass</td>
</tr>
<tr>
<td>Hunter Valley</td>
<td>n = 11</td>
<td>n = 4</td>
<td>n = 6</td>
</tr>
<tr>
<td></td>
<td>26 ± 11% lucerne</td>
<td>10 ± 6% couch</td>
<td>26 ± 10% couch</td>
</tr>
<tr>
<td></td>
<td>19 ± 7% liverseed grass</td>
<td>6 ± 5% barnyard grass</td>
<td>3 ± 3% paspalum</td>
</tr>
<tr>
<td></td>
<td>18 ± 13% kikuyu</td>
<td>6 ± 6% summer grass</td>
<td>3 ± 3% pitted bluegrass</td>
</tr>
<tr>
<td></td>
<td>8 ± 5% couch</td>
<td>3 ± 1% liverseed grass</td>
<td>3 ± 2% liverseed grass</td>
</tr>
<tr>
<td></td>
<td>8 ± 5% summer grass</td>
<td>3 ± 2% Rhodes grass</td>
<td>3 ± 3% red natal grass</td>
</tr>
<tr>
<td>Darling Downs</td>
<td>n = 9</td>
<td>n = 0</td>
<td>n = 10</td>
</tr>
<tr>
<td></td>
<td>18 ±6% liverseed grass</td>
<td></td>
<td>26 ± 12% liverseed grass</td>
</tr>
<tr>
<td></td>
<td>17 ± 8% couch</td>
<td></td>
<td>12 ± 7% couch</td>
</tr>
<tr>
<td></td>
<td>10 ± 4% lucerne</td>
<td></td>
<td>11 ± 5% Queensland bluegrass</td>
</tr>
<tr>
<td></td>
<td>5 ± 5% paspalum</td>
<td></td>
<td>3 ± 3% barnyard grass</td>
</tr>
<tr>
<td></td>
<td>5 ± 5% prairie grass</td>
<td></td>
<td>3 ± 2% skeleton weed</td>
</tr>
<tr>
<td>Riverina/South-West Slopes</td>
<td>n = 8</td>
<td>n = 2</td>
<td>n = 3</td>
</tr>
<tr>
<td></td>
<td>20 ± 10% cocksfoot</td>
<td>7 ± 6% couch</td>
<td>13 ± 8% annual ryegrass</td>
</tr>
<tr>
<td></td>
<td>12 ± 7% phalaris</td>
<td>5 ± 5% lucerne</td>
<td>8 ± 5% Paterson's curse</td>
</tr>
<tr>
<td></td>
<td>11 ± 10% lucerne</td>
<td>4 ± 4% white clover</td>
<td>5 ± 3% couch</td>
</tr>
<tr>
<td></td>
<td>11 ±4% perennial ryegrass</td>
<td>2 ± 2% wallaby grass</td>
<td>4 ± 4% common barbgrass</td>
</tr>
<tr>
<td></td>
<td>10 ± 5% subterranean clover</td>
<td>1 ± 1% wireweed</td>
<td>3 ± 3% satintop grass</td>
</tr>
<tr>
<td>Euroa</td>
<td>n = 11</td>
<td>n = 1</td>
<td>n = 3</td>
</tr>
<tr>
<td></td>
<td>30 ± 9% perennial ryegrass</td>
<td>8 ± 8% couch</td>
<td>4 ± 4% couch</td>
</tr>
<tr>
<td></td>
<td>25 ± 11% couch</td>
<td>2 ± 2% subterranean</td>
<td>4 ± 4% prairie grass</td>
</tr>
<tr>
<td></td>
<td>22 ± 11% phalaris</td>
<td>clover</td>
<td>2 ± 2% Yorkshire fog</td>
</tr>
<tr>
<td></td>
<td>19 ± 6% cocksfoot</td>
<td>1 ± 1% phalaris</td>
<td>0.6 ± 0.6% subterranean clover</td>
</tr>
<tr>
<td></td>
<td>11 ± 6% white clover</td>
<td>1 ± 1% wireweed</td>
<td>0.5 ± 0.5% perennial ryegrass</td>
</tr>
</tbody>
</table>
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Table 12. Reported weed management practices and success (mean ± s.e.m. and range in parentheses) on Thoroughbred horse studs surveyed in five regions of eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>No of properties (of twelve) using</th>
<th>Herbicides</th>
<th>Slashing/Mowing</th>
<th>Manual Removal/Chipping</th>
<th>Pasture Vigour</th>
<th>Tillage/Crop Rotation</th>
<th>Mixed Livestock</th>
<th>Grazing Management</th>
<th>Biological Control</th>
<th>Fire</th>
<th>Weed Control Success*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Sydney</td>
<td></td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2.58 ± 0.336 (1-4)</td>
</tr>
<tr>
<td>Hunter Valley</td>
<td></td>
<td>11</td>
<td>10</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>2.50± 0.289 (1-4)</td>
</tr>
<tr>
<td>Darling Downs</td>
<td></td>
<td>12</td>
<td>7</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2.58 ± 0.336 (1-5)</td>
</tr>
<tr>
<td>Riverina/ SW Slopes</td>
<td></td>
<td>11</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>2.67 ± 0.414 (1-5)</td>
</tr>
<tr>
<td>Euroa</td>
<td></td>
<td>7</td>
<td>9</td>
<td>8</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2.00 ± 0.326 (1-5)</td>
</tr>
</tbody>
</table>

* Scale: 1 = Very successful, 2 = Successful, 3 = Fair, 4 = Unsuccessful, 5 = Very Unsuccessful.
Survey of Agronomic Practices on Thoroughbred Horse Stud Farms

Figure 4. Severity of plant protection problems on Thoroughbred horse studs surveyed in eastern Australia.

Figure 5. Dominant plant protection problems reported from Thoroughbred horse studs surveyed in eastern Australia.
Figure 6. Pasture/crop types requiring plant protection on Thoroughbred horse studs surveyed in eastern Australia.

Figure 7. Stage of growth of attacked by plant pests on Thoroughbred horse studs surveyed in eastern Australia.
5.2.4 Attitudinal factors.

There was a considerable level of recognition that pastures were an important component of the stud system. Most (46/60) believed that the greatest benefit from pastures was their contribution to horse nutrition. Other benefits identified were: psychological (horse "well being") (6/60), exercise related (1/60), ground cover (2/60) and economic (4/60). Of those that considered a factor other than economics as the greatest benefit of pastures, thirteen added that pastures were also economically desirable.

Most studs identified their principal area for pasture improvement as being an increase in the area on their property given over to improved pastures (25/60). However, many properties did not have any pasture plan in mind (24/60). Other areas for pasture improvement were identified as: more cleared land given over to pasture (5/60), greater weed eradication (3/60) and increased areas to irrigation (1/60) and cropping (1/60).
Characteristics of pasture plants which interviewees considered important for future
development to make pasture species better suited to horse pastures fell into four broad
aspects;

- better nutritional value,
- improved palatability,
- greater persistence (viz resistance to traffic, drought, waterlogging and frost) and,
- improved year round productivity.

For the latter there was a recognition that this may be achievable only by appropriate
combinations of improved species rather than one species alone. The majority of
responses included a combination of the above characteristics rather than one only.

5.3 The Animal Sub-system.
(Livestock composition, Supplementary feeding, Pregnancy rates, Developmental
orthopaedic disease)

5.3.1 Livestock composition

Regional mean numbers of horses carried by properties during the stud season ranged
from just over 100 in Outer Sydney to almost 450 in the Hunter Valley and these
regional differences were statistically significant (Table 13). Off-season horse
numbers also differed significantly and followed a similar trend except that numbers fell to a relatively small extent on properties on the Darling Downs where the second
highest average number of mares owned by the property was also reported.

The average number of foals reported per property was greatest in the Hunter Valley
which produced significantly more foals that any other region. The means for other
regions did not differ to a statistically significant extent but were highest in the Euroa district and lowest in the Outer Sydney region.

Over 1500 sheep were reported on average for properties in the Riverina/ SW Slopes but significantly less common in all other regions, particularly Outer Sydney. Cattle were relatively common on Hunter Valley properties and more common than sheep on Outer Sydney properties. Cattle were significantly less numerous in the Euroa district. Integration of horse grazing with other livestock by rotational grazing was reported on ten properties in each of three regions but only six in Outer Sydney and three in the Darling Downs. Horses were run in the same paddock at the same time as other livestock species less commonly but this was still reported by the majority of properties in both the Hunter Valley and the Riverina SW Slopes regions.

5.3.2 Supplementary Feeding.

Hay, mostly lucerne, was the supplementary feed generally used in greatest quantities, though lucerne chaff was also important, particularly in the Hunter Valley and Euroa districts (Table 14). Grain oats were also heavily used in these two areas. Total supplementary feed usage on a per property basis was significantly higher in the Hunter Valley than elsewhere though reliance on supplementary feed varied greatly between individual properties (Table 15). There was little variation in the amount of supplementary feed use between other regions. The intensity of use in the Hunter Valley was no longer reflected when supplementary feed was expressed on a per animal basis and region differences were no longer statistically significant.

Only one of the properties surveyed in the Hunter Valley did not take availability of herbage in paddocks into account when determining supplementary feed requirements. In other regions pasture was also considered on the majority of properties except in the Darling Downs where seven properties did not consider pastures.
Survey of Agronomic Practices on Thoroughbred Horse Stud Farms

Table 13. Reported livestock composition (mean ± s.e.m) of Thoroughbred horse studs surveyed in five regions of eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>Stud Season Horses</th>
<th>Off season Horses</th>
<th>Foals</th>
<th>Property Owned Mares</th>
<th>Cattle</th>
<th>Sheep</th>
<th>Rotational* Grazing</th>
<th>Mixed' Grazing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Sydney</td>
<td>106.6 ± 23.6</td>
<td>81.2 ± 13.9</td>
<td>30.0 ± 7.4</td>
<td>28.6 ± 5.7</td>
<td>53.9 ± 28.7</td>
<td>1.2 ± 1.2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Hunter Valley</td>
<td>446.1 ± 70.1</td>
<td>266.0 ± 50.9</td>
<td>156.0 ± 27.7</td>
<td>81.6 ± 23.1</td>
<td>454.0 ± 140.0</td>
<td>80.2 ± 74.6</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Darling</td>
<td>188.8 ± 38.9</td>
<td>112.1 ± 21.6</td>
<td>52.8 ± 7.8</td>
<td>34.5 ± 6.7</td>
<td>158.0 ± 101.0</td>
<td>125.0 ± 125.0</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Downs</td>
<td>171.7 ± 29.1</td>
<td>106.3 ± 18.9</td>
<td>52.7 ± 10.7</td>
<td>26.3 ± 7.3</td>
<td>156.7 ± 55.8</td>
<td>1542.0 ± 698.0</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Riverina/SW Slopes</td>
<td>233.3 ± 23.0</td>
<td>109.6 ± 9.74</td>
<td>74.0 ± 8.9</td>
<td>22.3 ± 3.3</td>
<td>12.1 ± 6.8</td>
<td>64.2 ± 42.9</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Euroa</td>
<td>116.13</td>
<td>77.31</td>
<td>41.61</td>
<td>32.97</td>
<td>233.92</td>
<td>907.05</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

L.S.D. (P = 0.05)

* Horses followed by cattle or sheep
+ Horses at same time as cattle or sheep
Table 14. Reported annual supplementary feed use by type (mean ± s.e.m. and range in parentheses) of Thoroughbred horse studs surveyed in five regions of eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>Hay (t)</th>
<th>Oats (grain) (t)</th>
<th>Lucerne Chaff (t)</th>
<th>Lucerne Pellets (t)</th>
<th>Wheat/Oats Chaff (t)</th>
<th>Other (t)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Sydney</td>
<td>99.5 ± 56.1</td>
<td>27.5 ± 15.3</td>
<td>1.9 ± 1.3</td>
<td>15.5 ± 13.6</td>
<td>0.8 ± 0.82</td>
<td>27.2 ± 8.0</td>
</tr>
<tr>
<td></td>
<td>(0-600)</td>
<td>(0-150)</td>
<td>(0-12)</td>
<td>(0-150)</td>
<td>(0-9)</td>
<td>(0-72)</td>
</tr>
<tr>
<td>Hunter Valley</td>
<td>193.8 ± 61.6</td>
<td>167.2 ± 42.6</td>
<td>39.9 ± 24.4</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>63.8 ± 25.2</td>
</tr>
<tr>
<td></td>
<td>(0-700)</td>
<td>(0-406)</td>
<td>(0-252)</td>
<td>(0-0)</td>
<td>(0-0)</td>
<td>(0-260)</td>
</tr>
<tr>
<td>Darling Downs</td>
<td>90.2 ± 46.4</td>
<td>64.7 ± 16.0</td>
<td>24.5 ± 16.3</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
<td>48.8 ± 32.4</td>
</tr>
<tr>
<td></td>
<td>(0-400)</td>
<td>(0-140)</td>
<td>(0-120)</td>
<td>(0-0)</td>
<td>(0-0)</td>
<td>(0-273)</td>
</tr>
<tr>
<td>Riverina/SW slopes</td>
<td>38.3 ± 11.6</td>
<td>134.7 ± 30.2</td>
<td>11.1 ± 5.93</td>
<td>0 ± 0</td>
<td>4.7 ± 4.67</td>
<td>25.9 ± 12.9</td>
</tr>
<tr>
<td></td>
<td>(0-110)</td>
<td>(0-365)</td>
<td>(0-64)</td>
<td>(0-0)</td>
<td>(0-56)</td>
<td>(0-137)</td>
</tr>
<tr>
<td>Euroa</td>
<td>61.9 ± 18.4</td>
<td>168.4 ± 27.1</td>
<td>45.4 ± 15.6</td>
<td>5.0 ± 3.6</td>
<td>5.4 ± 2.72</td>
<td>14.8 ± 5.42</td>
</tr>
<tr>
<td></td>
<td>(0-200)</td>
<td>(65 - 386)</td>
<td>(0-148)</td>
<td>(0-40)</td>
<td>(0-26)</td>
<td>(0-52)</td>
</tr>
</tbody>
</table>
Table 15. Reported annual supplementary feed use (mean ± s.e.m. and range in parentheses) and consideration of pastures in determining diets on Thoroughbred horse studs surveyed in five regions of eastern Australia

<table>
<thead>
<tr>
<th>Region</th>
<th>Total Supplementary Feed Use (t/year)</th>
<th>Annual Supplementary Feed Use (t/animal*)</th>
<th>Stocking Density (animals*/ha)</th>
<th>Number Properties (of twelve) considering pastures#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Sydney</td>
<td>172.4 ± 60.6 (6.2-660.0)</td>
<td>1.25 ± 0.279 (0.10-3.12)</td>
<td>1.18 ± 0.132 (0.66-2.08)</td>
<td>10</td>
</tr>
<tr>
<td>Hunter Valley</td>
<td>464.7 ± 83.3 (67.1-1134.0)</td>
<td>1.20 ± 0.262 (0.54-3.78)</td>
<td>1.43 ± 0.752 (0.23-9.64)</td>
<td>11</td>
</tr>
<tr>
<td>Darling Downs</td>
<td>228.1 ± 55.4 (32.0-510.0)</td>
<td>1.34 ± 0.218 (0.54-2.33)</td>
<td>0.91 ± 0.146 (0.28-1.78)</td>
<td>5</td>
</tr>
<tr>
<td>Riverina/ SW Slopes</td>
<td>214.6 ± 36.4 (52.0-474.5)</td>
<td>1.47 ± 0.231 (0.57-2.92)</td>
<td>1.14 ± 0.355 (0.17 - 4.18)</td>
<td>9</td>
</tr>
<tr>
<td>Euroa</td>
<td>301.0 ± 27.5 (170.8-515.4)</td>
<td>1.39 ± 0.114 (0.75-2.01)</td>
<td>2.41 ± 0.595 (0.60-7.94)</td>
<td>9</td>
</tr>
<tr>
<td>L.S.D. (P=0.05)</td>
<td>154.79</td>
<td>NS</td>
<td>NS</td>
<td></td>
</tr>
</tbody>
</table>

* (Stud season horse number x 0.33) + (off season horse number x 0.66) + foal number.
# in determining supplementary feed ration.

5.3.3 Pregnancy rates.

The proportions of mares reported to be pregnant at the end of each season ranged from 82 percent in the Riverina/ SW Slopes to 91 percent in Outer Sydney. However there was no statistically significant difference between regions. There was good (within 5 percent) agreement with the Australian Stud Book statistics for regional means except in the case of Euroa and Outer Sydney where reported rates were higher.
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Table 16. Comparison of reported pregnancy rates and Australian Stud Book records for Thoroughbred horse studs in five regions of eastern Australia (mean ± s.e.m.).

<table>
<thead>
<tr>
<th>Region</th>
<th>Australian Stud Book fertility (%±s.e.m.)</th>
<th>Reported fertility (%±s.e.m.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Sydney</td>
<td>80.40±4.94</td>
<td>91.00±2.51</td>
</tr>
<tr>
<td>Hunter Valley</td>
<td>86.76±1.05</td>
<td>84.32±2.67</td>
</tr>
<tr>
<td>Darling Downs</td>
<td>89.53±0.96</td>
<td>89.33±1.96</td>
</tr>
<tr>
<td>Riverina/SW Slopes</td>
<td>87.67±1.57</td>
<td>82.32±5.64</td>
</tr>
<tr>
<td>Euroa</td>
<td>83.71±1.37</td>
<td>90.17±0.65</td>
</tr>
<tr>
<td>P =</td>
<td></td>
<td>0.192 NS</td>
</tr>
</tbody>
</table>

5.3.4 Developmental orthopaedic disease.

Foals were reportedly treated by hoof trimming, corrective shoeing, confinement to stables, leg splints and surgery. Small numbers of foals were also destroyed. The incidence of all such intervention combined ranged as high as 62 percent on one particular property (Table 17) and exceeded twenty five percent of foals on ten properties. Regional means were far lower, ranging from seven percent in Outer Sydney to 20 percent in the Euroa district. Such regional differences were not, however, statistically significant.
Table 17. Reported treatment* levels of foals for developmental orthopaedic disease and similar problems (mean ± s.e.m. and range in parentheses) on Throughout horse studs surveyed in five regions of Eastern Australia.

<table>
<thead>
<tr>
<th>Region</th>
<th>Proportion of Foals Treated #(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Sydney</td>
<td>7.31 ± 1.72 (0 - 16)</td>
</tr>
<tr>
<td>Hunter Valley</td>
<td>15.89 ± 4.75 (0 - 62.0)</td>
</tr>
<tr>
<td>Darling Downs</td>
<td>11.51 ± 2.74 (0.0 - 33.3)</td>
</tr>
<tr>
<td>Riverina/SW Slopes</td>
<td>11.70 ± 4.47 (0.0 - 50.0)</td>
</tr>
<tr>
<td>Euroa</td>
<td>20.11 ± 2.91 (7.4 - 35.0)</td>
</tr>
<tr>
<td>P =</td>
<td>0.151 NS</td>
</tr>
</tbody>
</table>

* Total of: trimming, corrective shoeing, confinement to stable, leg splints, surgery, destruction.
# Retransformed means (from arcsin).

6. Discussion

Marked regional differences have been identified between Thoroughbred stud properties in eastern Australia. This was particularly evident in the most fundamental aspect of the system - the physical area of studs and the proportions being used for horses. The proportion used for stud was particularly high in the Euroa region and is accountable for by the fact that there was minimal integration of horses with other agricultural enterprises. No properties in this region reported cropping and only two were conserving fodder. Numbers of cattle carried were lower than elsewhere and only
the Outer Sydney area had fewer sheep.

The Riverina/SW slopes region properties represent a very different picture just over 60 percent of the area being allocated to the horse enterprise. These properties carried far higher numbers of other livestock species, sheep in particular. Cropping was also more important with half the properties cropping an average area of 275 ha.

Soil erosion and loss of ground cover appeared to be a significant problem in all five regions despite the widespread use of electric fencing and laneways. Three articulating strategies may help address this problem:

1) the development and implementation of a whole farm plans,
2) closer management of horse feeders, and
3) improved pasture vigour to reduce the incidence of bare ground subject to erosive forces (including "hoof action").

Whole farm planning is a now widely used approach for managing the biophysical environment of a property to improve the sustainability of production. Of the various tools it employs, the strategic retention and planting of trees and other perennial vegetation is the most applicable to the Thoroughbred stud environment. Plantings of shelter belts and windbreaks can help reduce lateral flow of both wind and water, two of the most important erosive forces, as well as being beneficial for animal well being. Benefits may also extend to other aspects of land degradation such as rising water tables, dryland salinity and rural tree decline, though such problems were not reported to be constituting a major immediate threat to properties in this survey. Only a minority reported soil salinity and tree decline. Tree planting was reported to be commonly practised in all regions so would be reducing the effect of such phenomena to some extent. However, property aesthetics is likely to be the major consideration in the planting pattern of these trees and it is likely that integrating aesthetics as a factor in a whole farm plan would help also to manage land degradation issues for long term sustainability.
Management of horse feeding devices (such as troughs and rubber tyres) was widely acknowledged in this survey as an important factor. The most commonly held view was that frequent movement of feeders was important in reducing the impact of concentrated traffic on pasture plants and so minimising subsequent soil erosion and compaction. However, this view was not unanimous. Some supported the use of non-mobile devices, the view being that it was better to confine rather than distribute traffic damage. Convenience was also given as a reason for not doing so. Though the validity of such views will be influenced by factors such as soil type, topography and stocking density it is the view of the authors that more frequent moving of feeders, before excessive degradation of pasture occurs, appears to be the best option for managing erosion. Permanent feeders create bare areas which increase in size each year and create dust over summer.

Pasture vigour is another factor which may affect the incidence of bare ground and subsequent soil erosion. Greater persistence, including resistance to traffic ("hoof action"), waterlogging, frost and drought was reported as a long term improvement considered desirable for horse pasture species. Such pasture swards would not only minimise this problem around feeders but also along fencelines and more generally throughout a paddock so reducing opportunity for weed establishment. However, reassessment of stocking rates may also be necessary to maintain ground cover, particularly in dryland situations.

Despite the importance of plants in maintaining ground cover and reducing soil erosion, pastures are also of more fundamental significance as the output of the plant sub-system which meets the nutritional needs, to a greater or lesser extent, of the animal sub-system. This role of pastures in horse nutrition was recognised by those interviewed in this survey with the majority considering the nutritional contribution as the greatest benefit of pastures. This is also reflected in the fact that improved pastures were found on most properties. Semi-improved pastures, in which an improved legume species had been added to an existing pasture, were relatively rare, indicating that where a given paddock had been considered worthy of improvement, this had occurred to the full extent. Native pastures remained important however, particularly on the Darling.
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Downs where ten properties possessed, and three relied solely on, such pastures. The most commonly cited longer term improvements desired for pasture species for horses were improved nutrition and palatability.

Regional differences in weed management strategies employed may be explained to some extent in relation to the other regional characteristics of the properties. Chipping and manual removal was particularly important in the Euroa region where the stud enterprise component was greatest in relation to other agricultural activities. This reduced the opportunity for weed control by cropping rotations, since no crops were grown. In the Riverina/SW Slopes chipping was relatively unimportant since alternative strategies were made possible by larger property size and integration of stud operations with other enterprises, cropping in particular.

Plant pest management on studs was heavily reliant on pesticides and this may constitute a long term challenge for the sustainability of current practices. This importance of chemical control was also reflected in the widespread use of herbicides for weed management in all regions. The widely acknowledged problems generally associated with intensive use of pesticides (e.g. resistance and pest resurgence, drift and environmental impact, cost and operator hazard) are increased in the case of stud operations by the risk of chronic or acute poisoning of animals with extraordinarily high unit values. Though reliance on chemical control for earth mites (one of the most important groups of plant pests identified by this survey) is to some degree justified by the relatively poor availability of non-chemical alternative techniques, there appears to be considerable scope for greater adoption of non-chemical strategies for management of lucerne aphids (the other major pest group) in a more integrated fashion.

Supplementary feeding has been shown to be widely practised with mean annual consumption per property exceeding 170 tonnes in all regions. The attempt to express supplementary feed reliance on a per animal basis must be treated with caution as a
result of the dynamic nature of animal numbers from property to property and the generic calculation of horse numbers used. These values do however indicate that reliance on supplementation was relatively consistent across regions. Stocking density was greater in the Euroa district yet use of supplementary feed on a per animal basis was not markedly greater than in other regions.

Regional differences in treatment rates for developmental orthopaedic disease of foals did not reach accepted levels of statistical significance and must be treated with caution. Furthermore, the relatively high levels of intervention reported from many properties will reflect different attitudes towards the need for treatment at a given level of clinical severity. Despite these reservations, the apparently high levels of intervention in the Euroa district may have some association in many individual cases with the high stocking densities reported.

Most properties employed at least one staff member whose duties were oriented around management of pastures and other farming operations though on many of the smaller studs this comprised just one aspect of their job description. The person identified as the agronomic decision maker had typically been in that post for an average of 10-15 years depending on region and this is important because experience gained "on the job" was cited as the single most important source of expertise in agronomy. Formal education, experience gained in other agricultural industries and advice from local agronomists (consultants or state departments of agriculture) was reportedly important in only the minority of instances.

We suggest that this reliance on "on the job" training is undesirable as it may serve to meet only short term needs (e.g. avoiding gross pasture decline) and obvious problems (e.g. ringbarking). Subtler or cryptic problems such as acid soils or poor soil fertility may go unchecked and so contribute to longer term problems. It may also slow the rate of adoption of improved pasture species and more productive cultivars.
Acid soils were found to be a particular problem in the Euroa and Riverina/ SW Slopes regions but were also likely to be sub-optimal on some properties in other regions also. Because a relatively large proportion of interviewees were unaware of the existence of this problem on their properties, liming was not being carried out to an adequate extent. Of those properties surveyed, less than half reported using lime as a topdressing or at sowing. Because liming is most likely to have been concentrated in improved pastures the pH values recorded from this category of pasture was at least as high as that recorded for native pastures. One additional factor which may have contributed to the fact that improved pastures were no more acidic than native ones is the widespread use of lime or di-calcium phosphate in the horse ration and subsequent excretion, predominantly in the urine, to the soil environment.

A similar problem was evident with the infrequent testing for soil nutrients. Properties in the Riverina/ SW Slopes region were testing soil most frequently, possibly because properties in this region had the largest areas under crops and used the relatively short average crop-pasture ley rotation period of 6.3 years. However, properties on the Darling Downs had the longest reported period since soil testing was last carried out, despite the fact that in this region the greatest proportion of properties practised cropping, a discrepancy not adequately explained by the longer rotation time of 7.7 years. This may reflect intrinsically higher levels of soil fertility in this district, hence a general assumption that testing is unnecessary.

Irrespective of these regional differences, the long periods which had generally elapsed since soil testing had been conducted indicate sub-optimal growing conditions for pasture plants are likely to prevail in many instances. This is particularly significant when considered in conjunction with the soil acidity common in some regions. This would make molybdenum, a nutrient particularly important for the nitrogen fixing legume component of pastures, unavailable.
7. Implications and Recommendations

This study has yielded results which provide a wide ranging overview of an important agricultural production system. A number of statistically significant differences have been observed between regions but more commonly the degree of variability within regions has exceeded the inter-regional variability.

These observations illustrate opportunities for better agricultural extension of agronomic expertise to the Thoroughbred industry. The production of a best practice manual for pasture management as discussed at the Rural Industries Research and Development Corporation, Equine Nutrition and Pastures for Horses Workshop (RIRDC, 1999), would meet the short term need for this. In the longer term however we consider that improved educational opportunities will be vital in allowing this industry to operate at maximum productivity in a sustainable fashion.

It is critical that education of those who enter the industry adopts an holistic approach which illustrates the importance of all aspects of the production system rather than just the horse component of the animal sub-system (Fig. 1).

To meet the educational needs of those already employed within the industry there is also a need to develop accessible products such as short continuing education (e.g. weekend) courses and others offered in distance education (i.e. correspondence) mode.

A number of issues which merit further action have been identified and to some extent the following recommendations have already been made using the forum of the Rural Industries Research and Development Corporation, Equine Nutrition and Pastures for Horses Workshop (RIRDC, 1995) at which two of the authors (G.M.G. & W.M.W.) were participants.
7.1. Extension of information on best practice for horse pasture management.

Responses to this survey have clearly indicated that there is a high degree of recognition that pastures are an important component of stud properties. Despite this there are some aspects of pasture agronomy which are being managed in a sub-optimal manner, soil nutrient testing and acidity in particular. Together these two themes indicate that there is a need for better agricultural extension of agronomic information to industry, and that if suitably packaged this information is likely to be well received and widely used so making a significant and rapid contribution to the viability of the industry.

Even without additional research much valuable technical and management information currently exists in various fragmented forms which could be compiled in a user friendly and horse oriented manner. One way of achieving this end would be the production of an Australian manual for horse pasture management as discussed at the RIRDC workshop (RIRDC, 1995). Such an extension tool could be inexpensive to produce provided it sought to convey basic principles and guide the reader on to further more detailed bulletins and fact sheets (where available) for specific topics. It should also provide some guidance on the development of whole farm plans and direct the reader on to existing sources of more detailed information. In this instance a particularly useful video/booklet package exists (Anon, 1990).

This initiative could be funded by the RIRDC and made available to the industry at a cost recovery price only.

There is also a need to match print based extension materials with other modes such as a research conference to be held periodically, possibly every two years and in conjunction with an existing conference program for a related subject. Such a forum could be used as a clearing house for recent research results and importantly allow the continuing flow of information (on needs) to researchers and administrators from industry.

Another complementary extension vehicle may employ modern information technology (I.T.) in such forms as interactive computer software 'expert system' packages, possibly CD ROM based. Such a medium is likely to be increasingly more widely used as more
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Farm offices use microcomputers. Associated with this I.T. phenomenon is the networking of machines for the exchange of information. This opens the possibility for bulletin board type Internet 'lists' for the posting of queries for rapid answer by other users.

7.1.1. Research to reduce reliance on supplementary feed.

The majority of properties in most regions did report considering availability of fresh herbage from pastures in determining supplementary feed requirements. However, there is scope for increasing the incidence of this practice and, by a combination of improved pasture productivity and a recognition of its nutritional content, reduce the reliance on supplementary feed.

This study has established the extent to which the Australian Thoroughbred stud industry is reliant on supplementary feed. On average horses were each fed 1.33t per annum which equates to 3.64kg per animal per day. This expensive input needs to be considered for reduction to minimise the cost of Thoroughbred production. Overseas work (e.g. Hunt, 1994) indicates that there is considerable scope for achieving this reduction. The fact that supplementary feeding of horses was not markedly greater in the Euroa region than elsewhere, despite the high stocking rates generally used in this area, suggests that closer examination of properties in this region may yield useful indications of how supplementary feeding may be reduced. This initiative should be complemented with the longer term goal of production of better information to studs on the formulation of diets incorporating the contribution of fresh herbage.
7.1.2. Field research to determine optimal pasture species, composition and management for Australian horse pastures.

There is a need to determine the nutritional content, palatability, persistence and associated problems (eg endophyte, oxalates) of currently available pasture species and cultivars under Australian conditions. Ideally grazing trials should be conducted in an ongoing fashion to gain information on newly released cultivars and on a number of sites representing the chief geographical regions in which the horse industry is concentrated. Where there is a subsequent need for location specific "fine tuning" of practice this may be accomplished by using state department of agriculture agronomists and or consultants able to interpret broader recommendations. The use of such individuals as nodes for information customisation and delivery will depend upon improving and maintaining their level of understanding of the nutritional requirements of horses and the management of pastures to meet these needs.

One particular aspect of the ongoing management of pastures which warrants further investigation is the need to determine the effect of widespread use of anthelmintics, such as ivermectin, in horses on the subsequent processing of manure by dung beetles. Effects have been reported by Wardhaugh and Rodriguez-Menendez (1989). As well as constituting effective natural enemies of parasites and pest fly larvae, dung beetles also aid in returning nutrients to the soil. Any adverse effect on dung beetles would also have ramification for property aesthetics.

7.1.3. Education initiatives.

As discussed above, extension initiatives may be able to meet the pragmatic short term needs of those currently employed within the industry. In the longer term however, there is a need to make available a number of educational products which would afford the opportunity to those within the industry to participate in more formal education. One such possibility is the conversion of course content offered to on campus Advanced Diploma of Horse Management students of Orange Agricultural College, The University of Sydney to print material. This process entails the production of "Study Guides" or modules which constitute the foundation for study by students
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studying off campus. These print materials are supported by other mechanisms such as residential schools, telephone conferences and video and audio materials. Various blocks of study can be undertaken ranging from small highly needs focussed modules covering specific competencies or larger units dealing more thoroughly with broader subjects. Students are able to undertake part time study at various levels of intensity to match their employment circumstances and other commitments.

A co-funded venture by the College and the RIRDC could make such educational package available to industry members in 2-3 years.

8. Intellectual Property

This report, and the thesis and conference papers detailed below, constitute the intellectual property arising from this project to date. No patents or licences have been granted or applied for at this time.


The use of interviews conducted during a visit allowed the establishment of a rapport to motivate the manager to answer the surveyor as fully as possible, and allowed extra clarification where necessary. Interviewing also allowed botanical composition to be assessed in representative pasture types and soil samples to be taken for subsequent pH and texture examination. Using a single interviewer/observer for visits to all sixty properties maximised comparability of results.

Open-ended questions, although allowing relative freedom of response, are often functions of many factors, such as the respondent's attitude, knowledge of the subject, education, general verbal fluency and communication style (Judd et al. 1991). Thus, multiple-item scaling, with a minimum of five categories, was the preferred method of responses wherever possible. This design also reduced complexity of the data set for subsequent analyses. Where open ended questions had to be used, replies were subsequently categorised to allow analysis.

The protocol used in the botanical composition examination was designed to allow an accurate estimation of herbage available to grazing animals. Thus, the modified point quadrat method was used, as it limited bias from tall, tussocky grasses, legumes and flowering stems, which are a common component of "horse sick" pastures, and ensured that short or stoloniferous species or those late in their phenological development, would be recorded (Kemp and Dowling 1991).

The timing of visits in this project was designed to avoid periods of peak activity (such as the stud season, harvesting and sowing operations) and by doing so maximise availability of key personnel for the interview which was the primary tool of data capture. However, surveying in mid-late summer, of districts predominantly drought declared, is likely to have underestimated the abundance of cool season, annual pasture species such as subterranean clover (*T. subteranneum*) and winter growing weeds e.g. capeweed (*Arctotheca calendula*) and many thistles. Consequently the pasture composition data presented constitutes only a single "snapshot" of the seasonally
dynamic balance of the various species within pastures which may change markedly over the course of a year, regardless of management practices. Despite this factor, the levels of perennial pasture species which were observed represent a relatively long term presence since these constitute a far more temporally robust component of the sward.

An additional factor which limits the extent to which any firm conclusions can be made from the pasture composition data is drought. The full extent of the drought during the survey period became apparent in October 1994 when 83% of New South Wales and 38% of Queensland were drought declared. Parts of these states had been drought affected for up to 4 years (National Farmers Federation 1994) making this the worst recorded drought in Australia's history (Barnett 1994). Areas of Victoria also experienced rainfall deficits, being well below average with some areas recording their driest April to July period on record (Zillman 1994). The growing severity of the drought in the period between project proposal and initiating data capture demanded a shift in the emphasis of the project towards being more heavily reliant on data captured via the questionnaire and away from field observations of factors likely to have been affected by drought.

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