RESEARCH FOR THE LIVESTOCK INDUSTRIES OF NORTHERN AUSTRALIA

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I. INTRODUCTION

A paper on the objectives and future direction of research for the livestock industries of northern Australia has to be a statement of personal beliefs. It is certainly impracticable, perhaps unwise, to try to reconcile the aims of the various organizations carrying out research in the region: the CSIRO, Queensland Department of Primary Industries (QDPI), Animal Industry and Agriculture Branch of the Department of the Northern Territory (DNT), other Government Departments, two Universities, and a number of companies. The growing collaboration between these bodies does not mean that they always think alike.

This paper begins by defining "northern Australia" and listing its resources and then discusses the outlook for sale of animal products from the region. The main body of the paper deals with existing research and future research priorities for the major livestock industries of the north, with particular emphasis on problems of the beef cattle industry.

II. NORTHERN AUSTRALIA

The southern boundary of northern Australia has been defined previously by various authors at 20°, 23.5°, and 30°S. Here, the Queensland-New South Wales border has been used. It is statistically convenient and as logical as any other dividing line. The whole of the Northern Territory has been included in northern Australia and the dividing line in Western Australia has been drawn at about 29°S, near Geraldton (see footnote to Table 1).

The region so defined can be subdivided into an arid zone, receiving less than about 500 mm average annual rainfall at the southern boundary and less than about 750 mm in the far north, and a humid zone. Within the humid zone there is a large area of land suitable for pastoral development. In Queensland alone it is estimated that about $660 \times 10^6$ ha are capable of supporting sown pastures, and about $14 \times 10^6$ ha are suitable for dryland farming (H.A. Nix, personal communication). Only about $2.8 \times 10^6$ ha were under effective sown pasture in 1972 (Anon. 1972d); about $2.1 \times 10^6$ ha were under crops. The Northern Territory and the relevant regions of Western Australia have a significant area judged suitable for sown pasture, but on Nix's criteria only about $0.4 \times 10^6$ ha are suitable for dryland cropping.

The reason for quoting these figures is to make the point that availability of suitable land is not a major factor in deciding the priorities of research for the pastoral industries of northern Australia, because there is so much undeveloped land throughout the humid zone. New land for cropping is more restricted. Most of the potential arable area (about 80% using Mix's figures) is in eastern Queensland, south of 20°, and the undeveloped part is mostly in the Fitzroy region.

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Beef cattle and sheep (for wool) account for most of the livestock in northern Australia (Table 1) and for a large portion of receipts from sale of animal products. The Bureau of Census and Statistics figures for the gross value of production in Queensland during 1971/72 were:

<table>
<thead>
<tr>
<th>Livestock</th>
<th>Value (x 10^6)</th>
</tr>
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<tbody>
<tr>
<td>Beef cattle</td>
<td>$203.5</td>
</tr>
<tr>
<td>Sheep</td>
<td>$67.2</td>
</tr>
<tr>
<td>Dairy cattle</td>
<td>$52.5</td>
</tr>
<tr>
<td>Pigs</td>
<td>$23.1</td>
</tr>
<tr>
<td>Poultry</td>
<td>$26.7</td>
</tr>
</tbody>
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In the Northern Territory, the value of beef production during 1971/72 was about $23 x 10^6, other forms of animal production being of minor importance. No separate figures are available for the value of livestock production in the north of Western Australia.

The gross value of production from the Queensland fishing industry in 1971/72 was $11.4 x 10^6 and from hunting $1.3 x 10^6. Comparable figures for the Northern Territory were $6.2 and 0.03 x 10^6.

| TABLE 1 |

Livestock numbers: Northern Australia
At March 31, 1972

<table>
<thead>
<tr>
<th>Western Australia (a)</th>
<th>Northern Territory (million)</th>
<th>Queensland (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef cattle</td>
<td>0.77</td>
<td>1.17</td>
</tr>
<tr>
<td>Dairy cattle</td>
<td>-(b)</td>
<td>-(b)</td>
</tr>
<tr>
<td>Sheep</td>
<td>4.74</td>
<td>-(b)</td>
</tr>
<tr>
<td>Pigs</td>
<td>0.02</td>
<td>-(b)</td>
</tr>
</tbody>
</table>

(a) Kimberley, Pilbara, North West, and Central Statistical Divisions, plus Chapman Valley, Greenough, Mullewa and Northampton local authority areas.

(b) Less than 10,000.

Source: Commonwealth Bureau of Census and Statistics.

III. OUTLOOK FOR SALE OF ANIMAL PRODUCTS

The outlook for sale of livestock products has been reviewed annually by officers of the Bureau of Agricultural Economics and others at National Agricultural Outlook Conferences. The main points from the 1973 Conference were:

Wool - Continued firm demand in the immediate future, but it is not yet reasonable to conclude that there has been a basic change in the long-term downward trend of wool prices.
Beef
- It appears that the market will remain firm throughout the 1970's.

Mutton
- Outlook relatively favourable in both the short and longer terms, although markedly higher prices for exports do not appear likely.

Lamb
- Scope for moderate increases in exports, but the Australian industry will remain highly dependent on the domestic market.

Pigmeat & Poultry Meat
- Will remain highly dependent on the domestic market, which may expand by population growth and further rises in per caput consumption.

Dairy Products
- The overall outlook on export markets is of limited opportunities, especially for butterfat products.

Eggs
- Unlikely that there will be any improvement in export markets.

Thus the best prospects are for the products of the main existing livestock industries in northern Australia, viz. beef cattle and sheep. Unfortunately, the "long term" of these forecasts is the late 1970's, whereas for research planners it is probably the late 1980's, because there may be a delay of up to 10 to 20 years between initiation of long-term applied research and first commercial application of the results. My guess is that the prospects remain unaltered for the 1980's, though competition from synthetics may be more damaging by then. There is also a possibility, hopefully remote, of meat consumption turning out to be a health hazard:

IV. A REVIEW OF EXISTING RESEARCH & FUTURE PRIORITIES

In this section, special attention is paid to the problems of the beef cattle industry, because of its current economic importance and favourable prospects for expansion. Mutton and wool also warrant attention, though economic value is not the only important criterion for assessing research priorities. The scope for innovation, which is determined by such factors as (a) the amount of relevant research that has already been done or is in progress, (b) the existence of suitable techniques for solving the problem(s), and (c) the size of possible improvements, is also very important.

The beef and dairy industries of northern Australia rate highly on scope for innovation, the sheep industry less highly, because of the large amount of relevant research being conducted in southern Australia and the fact that this industry is mostly on relatively "unimprovable", dry country, and the pig and poultry industries lower still, because the present trend towards adoption of closely-controlled intensive methods of production tends to eliminate regional research problems.

Research planners should also take account of the fallibility of market forecasts and devote some resources to alternative enterprises. One of the lessons of the recent rural crisis in southern Australia is that research on alternative crops or forms of animal production is too slow to be of any practical value if the work is delayed until the existing industry has collapsed.
Some important topics have been omitted entirely from this review, such as the role of research on processing and marketing of livestock products. Another omission is discussion of the choice between strictly-applied research objectives and more basic ones. The previous heavy emphasis in northern Australia on research with practical objectives has paid off in useful results. In remote parts of the region this emphasis should remain unaltered; elsewhere there must be a trend to more basic studies, if progress is to continue. The northern laboratories have made outstanding contributions to knowledge already, e.g. on adaptation of cattle at Rockhampton, on tropical legumes at Brisbane, and crop biology and environment at Katherine. Such work must continue, for, in contrast to the situation in southern Australia, there are no major laboratories yet in similar environments overseas that can be relied on for basic research.

There is also the question of the location of the research effort in northern Australia. Resources have been concentrated at the south-eastern and north-western extremities of the region, and in the Townsville-Cairns area, whereas the land in sub-coastal eastern Queensland, between about latitudes 20° (Bowen) and 24°S (Biloela), is probably under-researched in relation to its potential for crop and livestock development.

(a) Livestock improvement

The main aim of current research on beef cattle and merino sheep is to identify the causes underlying the ability of animals to cope with the special stresses of the northern Australian environment, such as heat, parasites and poor nutrition during the dry season. The need for such work is likely to increase with the current interest in importation of semen of new genotypes of cattle and the possible establishment of an offshore quarantine station.

Livestock breeding, because of its emotional associations, has great need of research to distinguish fact from fancy. Consequently there is a case for giving more attention to accurate measurements, under commercial conditions, of differences in growth and reproduction between and within breeds of cattle. Some such work is being done. The QDPI has experiments in progress on commercial properties to compare Africander x British crosses with Droughtmasters and Brafords (Anon. 1972a) and the QDPI, DNT and CSIRO are conducting breed comparisons on experiment stations (Anon. 1972a, 1972b, 1972c), but more should be done. The National Beef Recording Scheme is concerned only with measures that rank animals within a herd.

(b) Parasites and Diseases

Cattle tick is by far the most serious external parasite of livestock in the region. The annual cost in Queensland alone was estimated at $19 x 10^6 in 1959, and it would be much higher at current prices.

Although the emphasis in the short run is on chemical control of ticks, in which the chemical companies, CSIRO, and QDPI all have large research commitments, "the long-term prospects for chemical control of cattle tick are gloomy" (Anon. 1972a). The cost of finding new chemicals that will control multiresistant strains of ticks, and satisfy the standards set for chemical residues in foodstuffs, is very high.

Many research workers now favour tick-resistant cattle as the only feasible long-term solution to the problem. A recent Queensland survey (Bonney 1973) shows a relatively rapid increase in tick-resistant Bos indicus cattle since 1965, but only 31% of female cattle had a proportion of Brahman blood in 1970-71. No doubt this trend will continue, and the research priorities are already switching to problems associated with a tick-resistant
cattle population, such as its effect on incidence of tick fever (Anon. 1972b). In addition, tick resistance must be an even more important consideration in future research on improvement of cattle breeds.

Other external parasites, such as buffalo fly, and internal parasites (e.g., worms) require continuing attention from research workers, and one can predict increased emphasis on biological control, such as the attempt to control buffalo fly by release of exotic dung beetles.

With regard to infectious diseases of cattle, the main short-term priority is eradication of diseases such as tuberculosis and brucellosis that may prevent northern Australian beef from being exported to lucrative overseas markets (Muirhead 1973). Research is needed, as well as a large number of veterinary practitioners, but the highest priority must go to the task of keeping catastrophic exotic diseases such as foot and mouth out of Australia. Quarantine must become more difficult in northern Australia, with its long coastline and with increasing mobility of humans and livestock in Indonesia and New Guinea. The main impact on research priorities is through the Australia-wide need for effective methods of diagnosis and control if one of these exotic diseases does gain entry, and the need for scientists expert in dealing with these diseases.

(c) Feed Supply

Much research is already being done on improving the feed supply to grazing livestock in northern Australia and this type of research should be given a high priority in the future. Otherwise there is no way that the region will be able to benefit from expanding export markets for products such as meat. There are two lines of evidence indicating that cattle (and sheep) numbers in northern Australia are limited by feed. Firstly, numbers have increased very slowly for many years. In Queensland, for instance, cattle (beef and dairy) increased by only about $1.2 \times 10^6$ between 1921-30 and 1961-70 (Table 2); even in 1830-1900 there were about $5.5 \times 10^6$ cattle in the State. A good deal of conventional property development has taken place in Queensland and turnover has improved dramatically, but numbers have risen slowly, despite some increase in the area grazed. Cattle numbers in the Northern Territory show signs of becoming static, and the number in the Kimberley district was highest in 1917 (Kelly 1971).

TABLE 2
Changes in total numbers of beef and dairy cattle

<table>
<thead>
<tr>
<th>Decade</th>
<th>Northern Territory (million)</th>
<th>Queensland (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1921-30</td>
<td>0.78</td>
<td>6.08</td>
</tr>
<tr>
<td>1931-40</td>
<td>0.85</td>
<td>5.86</td>
</tr>
<tr>
<td>1941-50</td>
<td>0.98</td>
<td>6.29</td>
</tr>
<tr>
<td>1951-60</td>
<td>1.06</td>
<td>7.01</td>
</tr>
<tr>
<td>1961-70</td>
<td>1.11</td>
<td>7.25</td>
</tr>
</tbody>
</table>

Sources: The Beef Situation No. 15; Queensland Year Book No. 32
The second piece of evidence comes from observations and experiments on increased stocking rates. The main conclusion from them is that the northern cattlemen have set their stocking rates at a "safe" level where they can survive major droughts without disaster.

In the last three years cattle numbers in Queensland have risen sharply, reaching \(9.81 \times 10^6\) in March 1973. All the reasons are not yet clear, but the large areas of grass being sown on newly-cleared brisalow land (Anon. 1972d) certainly have played a significant part.

The role of various fields of research in increasing the feed supply for the northern livestock industries is considered below under the headings of range management, conventional property improvements, supplements, legume-based pastures, nitrogen-fertilized grass, and lot-feeding.

(i) Range Management - Throughout the arid zone of northern Australia, which feeds most of the sheep and some cattle, a high priority must be allocated to finding stable and conservative systems of range management. This type of research does little to lift the total feed supply above its original level; it is concerned more with restoring damaged native vegetation to its former level of productivity and then holding the line. Two particular problems are in special need of thorough study. One is the question of safe stocking rates and fair living areas, which need to be determined in the light of long-term probabilities and not short-term expediency. Heathcote (1964) has drawn attention to the administrative difficulties in controlling the use of inland holdings. The other is the question of strategy against drought. Graziers cannot afford to feed stock for survival; is it really in the national interest to let the animals take their chance?

There is a need also for range management research in parts of the humid zone of northern Australia, because there is no chance that all the native pasture there will be replaced by sown pasture in the near future.

(ii) Conventional Property Improvements - There is surprisingly little information on the quantitative effects of killing or removing trees on the carrying capacity of the major vegetation units in northern Australia, and this certainly warrants a higher priority in future research. Apart from consideration of conservation, the effect of clearing on the appearance of the countryside also deserves more attention than it gets. The potential effects of fencing and water improvements seem to be fairly small. Kelly (1971) has calculated that beef cattle numbers in the Kimberleys, the Northern Territory, and the Queensland Gulf Country could be increased by only 45, 39 and \(25\%\), respectively, if all the stations had adequate fences and watering points.

(iii) Nitrogen, Mineral and Energy Supplements - Recent research has shown useful responses to urea and molasses by cattle on native pasture during the dry season in north Queensland (Winks, Alexander and Lynch 1970; Winks, Laing, and Stokoe 1972), and there is evidence that the response is due to sulphur (in the molasses) as well as nitrogen (Playne, Siebert, and Edye 1973). Responses to phosphate supplement have been recorded in north Queensland and in the Northern Territory (Anon. 1972e). Responses to urea and molasses, or to phosphate, apparently have not been recorded in the field in southern Queensland, though response to sodium has been (Murphy and Plasto 1973).

There is considerable scope for further research to answer such questions as: how can one identify responsive situations; does the feeding of supplements increase carrying capacity or only turnover ("more cattle die in the meatworks instead of in the paddock"); and will the native pasture be able to tolerate heavier stocking (an ecological question that cannot be answered quickly).
(iv) Legume-based Pastures - These account for most of the existing pasture research in northern Australia. This country has pioneered the "domestication" of a number of herbaceous tropical legumes for use in sown pastures. Briefly the present position is that productive pasture mixtures are available for much of the humid zone in central and southern Queensland and for some areas of north Queensland (the wet tropical coast and Atherton Tableland). These mixtures have now been under realistic grazing for long enough (ten years or more) to indicate that they are persistent and profitable. But there have been important problems, some of which can be defined in terms of soils and topography. For instance, no herbaceous tropical legumes have been discovered that will persist on clay soils, including those of the important brigalow region, or on some low-lying soils along the Queensland coast. A different problem has arisen with Townsville stylo, which is well adapted to an area of about $40 \times 10^6$ ha of lighter-textured soils north of the tropic (Begg 1972). In both north Queensland and the Northern Territory heavily-grazed, superphosphate-fertilized pastures of Townsville stylo and native species have become dominated by annual grasses or broad-leafed weeds.

This is one of the problems that merits a high priority in future research. Is the dominance by annual grasses only a passing phase, caused by a larger input of available nitrogen, and can it be avoided by changes to management or use of a sown grass or perennial legume? In very broad terms, the aim of future pasture research in the north will be to find suitable sown pastures for areas that have none and to improve those we already have. The emphasis throughout must be on improvement of the existing very-extensive cattle industry, using 'cultivars that can be sown with a minimum of land preparation, that require modest quantities of fertilizer, that provide feed of adequate quality in the dry season and that persist indefinitely. Attainment of these objectives requires long-term ecological research, at the other end of the spectrum from the type that is appropriate where land is an important limiting factor.

The outlook for further progress with legume-based pastures is very favourable. The range of new legume introductions available for testing north of the Tropic, in genera such as Stylosanthes, Macroptilium (Phaseolus), and Centrosema, is far wider than the collection on hand in the 1950's, when J.G. Davies and others began work in the sub-tropics. Promising tropical grasses are available also. When the range of variation obtainable from overseas has been exploited there is undoubtedly further progress to be made by breeding and selection.

(v) Nitrogen-fertilized Grass - Sufficient work has been done with nitrogen-fertilized grass in Queensland to establish definitely that (a) very high levels of beef production per hectare, up to about twice those obtainable on the best legume-based pastures, are possible, and (b) its use is unprofitable in most beef-producing regions. In fact, the only place where nitrogen-fertilized grass is presently as profitable as legume-based pastures for year-round grazing is in the wetter districts of eastern coastal Queensland. There is also a case for opportunist use of nitrogen on grass in these districts (Henzell 1970).

Research on this topic would deserve a high priority in the future only if the price of nitrogen fertilizers was likely to fall. In fact, the price of synthetic nitrogen may rise, because the cost of the main feedstocks, natural gas and naphtha, is closely linked with the price of oil. Nevertheless, nitrogen fertilizers will continue to be widely used in tropical pasture research, because of their experimental advantages.

(vi) Lot-feeding - Dry-lot fattening of beef cattle has not been practised widely in Australia, chiefly because the profitability has seldom been high for long, and it is doubtful whether there is a strong case for much research
on this subject in the future. The published feeding standards can be applied directly (this may be the only place where standards from pen feeding do apply exactly). If research is needed, it’s likely to be in the evaluation of local feeds, e.g. Stewart (1970) has suggested a high priority be given to studies of high-yielding tropical crops. There could be a case also for research on integration of lot-feeding into pastoral systems, feeding only during drought (BAE 1969) or the dry season, to take cattle that are almost finished through to a marketable condition. The main research problem is to define the conditions under which high-energy supplements will complement, rather than substitute for, consumption of pasture forage.

Whatever changes may occur in the economics of lot-feeding, 'there is a strong case for northern Australia to continue to devote much of its research resources to improving the existing low-input systems of feeding cattle.

(d) Alternative Enterprises

The sheep and cattle industries of northern Australia will remain vulnerable, because of their dependence on export markets and the wide fluctuations of price and demand characteristic of those markets. Therefore it is necessary to consider the possibility of research on alternative enterprises. In the pastoral areas, i.e. in almost the entire region, it is very difficult to think of any serious alternatives to sheep or cattle. Sheep producing different types of wool, carpet wool for example, and different species of wild or domesticated animals yielding meat, e.g. buffaloes, are merely variations on the same theme. The most promising economic use of native animals is probably as an attractant for tourists. Another possible alternative is the production of pasture seeds for export.

In the areas suitable for dryland cropping, there are several alternatives warranting research, two of which are relevant to this paper. Firstly, there is the possibility of expanded production of high-energy, coarse grain crops such as sorghum. Some grain sorghum is already grown in central Queensland, as part of a flexible, livestock plus cropping, system of agriculture. If the season is dry or the market very poor, the grain sorghum is grazed; if the rains are satisfactory, the grain is harvested. Then there are a number of possible uses for the grain: (a) fed to dairy cows to overcome the lack of energy in tropical pastures (Stobbs 1971; Edgley & Tucker 1973), (b) fed to beef cattle in a drylot, (c) fed to pigs or poultry in Australia, or more likely, (d) exported for use in the pig and poultry industries of south-east Asia and Japan.

Secondly, there is the possibility of producing plant protein, from tropical oil seed crops or tropical grain legumes grown for protein per se. Again, there are various end uses for plant protein, all those listed for coarse grains above, as well as its use as a meat analogue or extender. Irrespective of whether the demand for meat remains high or not, research in northern Australia should be preparing for new export markets in cheaper blends of meat and plant protein.

(e) Economics

Economics is one of the obvious weaknesses of present-day agricultural research in northern Australia. In future, a higher priority should be given to inclusion of economic analysis in applied livestock production experiments, and the analyses need to be constructed and published in a form where they can be updated readily, knowing that costs and returns are bound to change with time.
In particular, economic analysis is dependent on the results of grazing trials. There is no other way of obtaining preliminary estimates of the profitability of innovations for the pastoral industries before they go into commercial practice. This argument for a larger component of economics in experimental design and analysis does not reduce the continuing need for economic surveys to show what the industry is now doing, such as the Bureau of Agricultural Economics industry surveys, and for specific studies to answer such questions as the relative profitability of conventional property improvements with and without sown pastures.

V. CONCLUSIONS

Informed guesses about future export markets for animal products from northern Australia suggest that the beef cattle and sheep industries, especially beef, have the best prospects. These industries require research on improvement of breeds, on control of parasites and diseases, and on increasing the feed supply. The latter is of particular importance, because there is evidence that cattle numbers on native pastures in northern Australia are already limited by feed supply, and that numbers can be increased by less than 50% by general adoption of fencing and water improvements. It is considered that legume-based sown pastures offer the best prospect for profitable increases in feed supply and that they warrant a higher priority in research than lot-feeding or the use of nitrogen-fertilized grass. Other topics suggested for further research are the effect of trees on pasture production, the role of nitrogen and mineral supplements, and studies of the profitability of various forms of property improvement. Attention is drawn to the need for research on sources of plant protein for use in cheaper blends with meat and on alternative enterprises to protect producers from the effect of a sudden slump in meat prices.
REFERENCES


