# PRIORITIES IN PASTURE RESEARCH IN THE CLARENCE RIVER BASIN

R. C. DUNCAN*

## 1. INTRODUCTION

In 1965 a research team was established at the Agricultural Research Station, Grafton (New South Wales Department of Agriculture) to investigate possibilities for pasture improvement in the beef areas of the Clarence River Basin. The team is an interdisciplinary venture which brings together research workers in agronomy, animal husbandry, and agricultural economics.

Part of the agricultural economist's role in this co-operative venture must be to give direction in the allocation of research priorities, paying due regard to the most critical problems facing the farmer. An attempt is made herein to decide on the most critical problems facing the beef producer in the study area and to indicate priorities for research into improved pastures.

## 2. CHOICES FACING THE PASTURE RESEARCHER

### WHICH SOIL TYPE?

Faced with limited resources, the research team's first important decision was on which of the several soil types in the Clarence River Basin to concentrate the agrostological work. It was decided to concentrate on the two largest *soil-association* units in the Basin. A soil-association unit is an area in which the soils are derived from the same parent material. A full range of topographical features occurs within each unit, as well as a range of soil groups and a range of soil-moisture/drainage relationships. Obviously, it is hoped that there will be quite high spill-over effects to other soil-association units.

### PASTURES OR FORAGE CROPS?

The beef industry in the area, largely store breeding, is based on native pastures with extremely low levels of phosphorus and protein. Feed supplies throughout the year fluctuate widely from a summer flush to dormancy in winter. Normally the situation is aggravated by lack of rain in spring.

It became obvious that a decision would have to be made on the place of forage crops in the research programme. Should some attention be given at this stage to forage crops with which to fill in the gaps in the feed supply, or should all resources be given over to the development of legume-based pasture systems to lift year-round productivity? It was decided to carry out a linear programming study with its main aim being to see what place forage crops had in the existing farming situation.

* Economics Research Officer, Grafton Agricultural Research Station.

The research on which this paper is based is being financed by a grant from the Australian Meat Research Committee, whose support the author gratefully acknowledges.

## 3. THE LINEAR PROGRAMMING STUDY

The study was based on the use of the *representative farm* concept. It was felt that this approach would be worthwhile for the purpose in mind because of the fairly homogeneous climatic environment throughout the study area The assumption implied is that while soil types may differ between farms, the more important resource limitations such as feed supply at different periods of the year will be similar from farm to farm.

A linear programming solution can be used to suggest the allocation of research priorities on the basis of the limiting restrictions to production.[1] Restrictions can be divided into two categories—physical and non-physical, a distinction which has implications for research. Physical restrictions may include water supply, diseases and pests, and feed supply at particular periods of the year. Non-physical restrictions may arise in terms of labour supply, credit availability, cost and price uncertainty, and institutional restrictions such as tenure and grazing rights. The former category is the concern of technical research. Both categories are the concern of economic enquiry. The possibility of complementarity between the different categories of restrictions should not be ignored. For example, encouraging results with pasture research could lead to improved credit availability.

Programming results can be used to formulate policy decisions on research into overcoming physical and non-physical resource supply restraints, or they may directly indicate institutional changes to clear bottlenecks such as credit restrictions. Alternatively, it might be seen that changes in one or more technical coefficients in the matrix could lead to the relaxation of resource restrictions. Heady states that "generally, the important types of research making for these changes include improved breeding, stocking management, wintering methods, age combinations, and other practices with animals that allow greater gains from given forage supplies."[2] Obviously, the coefficients which will be of most interest will be those relating to the limiting restrictions.

With the existing levels of nutrition in the native pastures it seems clear that no amount of juggling with animal management practices will enable the industry, in effect, to lift itself up by its own bootstraps. The injection of purchased inputs such as seed and fertilizer is essential if productivity is to increase. It can therefore be stated at the outset that pasture research must receive priority over animal husbandry research if the two are competitive for funds.

### The Programming Matrix

The physical data for the linear programme were supplied in part by an economic survey of the study area in 1965.[3] Two representative farm situations were synthesized for consideration. The modal holding

[1] E. O. Heady, "Economic Concepts in Directing and Designing Research for Programming Use of Range Resources", *Journal of Farm Economics*, Vol. 38, No. 5, (December 1956), pp. 1604–16.

[2] *ibid.*, pp. 1608–9.

[3] R. C. Duncan, *Report on an Economic Survey of the Beef Cattle Industry in the North Coast area of New South Wales*, (Division of Marketing and Agricultural Economics, N.S.W. Department of Agriculture, Miscellaneous Bulletin No. 2, November, 1967).

size classification for beef production in the area, 1,000 to 1,999 acres, was represented by Farm A of 1,500 acres. The second most common holding size classification 2,000 to 4,999 acres, was represented by Farm B of 3,500 acres. The basic programming matrix for Farm A and Farm B is shown in Table 1. A brief description of the matrix is given in the following paragraph, but the full details of assumptions for the restraints and activities and the enterprise budgets are described elsewhere.[4]

The programmed representative farm situation was limited in scope to the extent that the only beef-producing activities considered were store-breeding enterprises. These constitute the principal form of beef production in the area. Unfortunately, consideration of cattle-fattening enterprises was made impossible by the complete lack of data on this type of activity.

Vetch growing was included as the activity to test the place of forage crops. Some preliminary work has been done with this crop at Grafton Agricultural Research Station. The results of this work and the results of work done at Wollongbar Agricultural Research Station[5] provided a reasonable set of assumptions for the activity budget. Other forage species could not be included at this stage because of the lack of technical data.

An activity for buying lucerne hay was included as a yardstick for the vetch activity. Only four landholders interviewed during the survey (out of sixty-three) regularly purchased lucerne hay as a drought provision (whether for the seasonal winter/spring drought, or for a long-term drought). Only two of the sample landholders grew vetches as supplementary feed for beef cattle.

We pass now to a consideration of the generated farm plans and to a comparison of these plans with actual farm organization as seen from the survey data.

## 4. THE OPTIMAL FARM PLANS

Optimal farm plans for the two assumed resource situations are presented in Table 2. Apart from a scale effect there is no substantial difference between the solution for Farm A (1,500 acres) and Farm B (3,500 acres).

The 2-year store enterprise ($P_4$) was selected. However, the final plans are not particularly stable with respect to changes in the gross margins of activities $P_2$, $P_3$, or $P_4$. A fall of \$0.24 in the gross margin for activity $P_4$ would lead to its replacement by $P_3$. Essentially there would be little difference in gross profit whether activity $P_2$, $P_3$, or $P_4$ was the operative enterprise.

[4] R. C. Duncan, *Allocation of Research Priorities: Directing Research into Problems of the Beef Industry in the Clarence River Basin*, (University of New England, Armidale: Unpublished M.Ag.Ec. thesis, 1966).

[5] See J. M. Holder, F. G. Swain, and R. L. Colman, "The Use of Sod Sown Vetch (*Vicia sativa*) as a Supplement by Dairy Cows on the Far North Coast of New South Wales", *Australian Journal of Experimental Agriculture and Animal Husbandry*, Vol. 3, No. 9, (May 1963), pp. 153–9.

TABLE 1

*Input-Output Matrix for Assumed Representative Farms*

| Resources | Unit | *b*-column: Resource Situation A* | *b*-column: Resource Situation B† | Activities | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | $P_1$ | $P_2$ | $P_3$ | $P_4$ | $P_5$ |
| | | | | Weaner Store Enterprise | Yearling Store Enterprise | 18 months Store Enterprise | 2 year Store Enterprise | $X_1$ Native Pasture |
| Z—C | $ | 0 | 0 | −18.82 | −27.27 | −33.80 | −35.57 | 0 |
| $X_1$ Cropping Land .. .. .. | acres | 75 | 70 | .. | .. | .. | .. | 1.0 |
| $X_2$ Cleared Grazing Land .. .. | acres | 225 | 280 | .. | .. | .. | .. | .. |
| $X_3$ Uncleared Grazing Land .. | acres | 1,200 | 3,150 | .. | .. | .. | .. | .. |
| $X_4$ January-March Feed .. .. | DCM | 0 | 0 | 6.267 | 6.267 | 7.371 | 7.371 | −3.0 |
| $X_5$ April-June Feed .. .. .. | DCM | 0 | 0 | 3.891 | 4.737 | 4.737 | 5.841 | −1.32 |
| $X_6$ July-September Feed .. .. | DCM | 0 | 0 | 4.476 | 5.304 | 5.304 | 6.408 | −0.66 |
| $X_7$ October-December Feed .. | DCM | 0 | 0 | 5.187 | 5.187 | 6.291 | 6.291 | −1.98 |

* Representative Farm A of 1,500 acres.
† Representative Farm B of 3,500 acres.

TABLE 1—*Continued*

*Input-Output Matrix for Assumed Representative Farms*—Continued

| Resources | Unit | Activities | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | $P_6$ | $P_7$ | $P_8$ | $P_9$ | $P_{10}$ | $P_{11}$ | $P_{12}$ |
| | | $X_2$ Native Pasture | $X_3$ Native Pasture | $P_7$ T'fer 1 | $P_7$ T'fer 2 | Forest Lease | Buying Lucerne Hay | Growing Vetches |
| Z—C | $ | 0 | 0 | 0 | 0 | 0.10 | 8.04 | 21.65 |
| $X_1$ Cropping Land | acres | .. | .. | .. | .. | .. | .. | 1.0 |
| $X_2$ Cleared Grazing Land | acres | 1.0 | .. | .. | .. | .. | .. | .. |
| $X_3$ Uncleared Grazing Land | acres | .. | 1.0 | .. | .. | .. | .. | .. |
| $X_4$ January-March Feed | DCM | −0.75 | −0.42 | 0.42 | 0.42 | .. | .. | −3.0 |
| $X_5$ April-June Feed | DCM | −0.12 | −0.09 | −0.31 | .. | −0.09 | .. | .. |
| $X_6$ July-September Feed | DCM | −0.24 | −0.21 | .. | −0.21 | −0.06 | −1.0 | −2.0 |
| $X_7$ October-December Feed | DCM | −0.60 | −0.24 | .. | .. | .. | .. | −1.98 |

TABLE 2

*Optimal Plans for Assumed Basic Resource Situations—Representative Farms A and B*

| | Unit | Level | |
|---|---|---|---|
| | | Farm A | Farm B |
| ACTIVITIES | | | |
| $P_4$ 2-Year Store Enterprise | cows | 91 | 169 |
| $P_5$ Cropping Land, Native Pasture | acres | 75 | 70 |
| $P_6$ Cleared Grazing Land, Native Pasture | acres | 225 | 280 |
| $P_7$ Uncleared Grazing Land, Native Pasture | acres | 1,200 | 3,150 |
| $P_8$ Native Pasture Transfer 1 | acres | 204 | 783 |
| $P_9$ Native Pasture Transfer 2 | acres | 339 | 403 |
| $P_{10}$ Forest Lease | acres | 2,592 | 3,715 |
| Gross Profit | $ | 2,972 | 5,637 |
| MARGINAL VALUE PRODUCTS | | | |
| $X_1$ Cropping Land | $/acre | 10.06 | 10.06 |
| $X_2$ Cleared Grazing Land | $/acre | 2.86 | 2.86 |
| $X_3$ Uncleared Grazing Land | $/acre | 1.31 | 1.31 |
| $X_4$ January-March Feed | $/D.C.M. | 0.41 | 0.41 |
| $X_5$ April-June Feed | $/D.C.M. | 0.56 | 0.56 |
| $X_6$ July-September Feed | $/D.C.M. | 0.83 | 0.83 |
| $X_7$ October-December Feed | $/D.C.M. | 3.81 | 3.81 |
| OPPORTUNITY COSTS | | | |
| $P_1$ Weaner Store Enterprise | $/cow | 9.40 | 9.40 |
| $P_2$ Yearling Store Enterprise | $/cow | 2.11 | 2.11 |
| $P_3$ 18-Months Store Enterprise | $/cow | 0.24 | 0.24 |
| $P_{11}$ Buying Lucerne Hay | $/D.C.M. | 7.21 | 7.21 |
| $P_{12}$ Growing Vetches | $/D.C.M. | 8.78 | 8.78 |

The weaner-store enterprise ($P_1$) has the high opportunity cost of $9.40. From the survey results it was apparent that a large proportion of stores sold in the area are sold as weaners. Consequently, the assumptions made in the weaner-store enterprise budget were closely examined. The results of this examination are discussed later.

There was no restriction placed on the area of forest lease in the programming solution. Seeing that forest leases were allowed to supply feed only in the autumn and winter periods, this meant that feed in the October-December period became the limiting factor on the area of forest lease. This limitation is reflected in the higher marginal value product for October-December feed.

Eight of the 63 landholders interviewed in the survey lease forest reserves ranging in size from 2,000 to 15,000 acres. These areas are held on annual lease. All of the area of dedicated state forest in the study area is available for leasing for grazing. The customary management practice with forest leases is to leave them unstocked over summer and move the breeding herd on to these reserves after weaning. The breeding herd is kept on the lease country until just before or after calving. There are physical limitations to the time cattle can be kept in forest areas. For instance "dog" or "scrub" ticks become prevalent with the warmer

weather. Quite severe calf losses from scrub ticks were reported during the survey. In practice the annual rental for forest leases is based on estimates of carrying capacity over a 6–8 month autumn-winter-spring period. Allowances are made in setting the rental for availability of water supply, pests (bot flies, dingoes), and areas of thick scrub. At present the rental is calculated on a rate of $3.20 per head.

From the estimates available it appears that the carrying capacity of forest lease areas ranges from one beast to twenty acres to one beast to fifty acres for the 6–8 month period. Over this range the rental charged varies from $0·08 per acre to $0·03 per acre. To this figure has to be added shire rates, which can amount to as much as two-thirds of the rental. The activity budget for leasing forest reserves was drawn up on the assumption of a carrying capacity of one beast to forty acres, and a rental of $0.10 per acre (which included shire rates). Additional costs could be incurred in grazing of forest lease areas as compared with grazing on private pastures. These may arise from additional mustering, increased losses from strays and deaths due to poisonous forage and predators, and lower calving percentages due to lack of supervision. Because no data were available, no allowance could be made for these factors in the above calculations.

The forest lease activity provides a valuable opportunity for lifting the restraint of winter feed shortage. The assumed charge of $0.66 per dry cow month (DCM) is close to the generated marginal value product of $0.56 and $0.83 respectively per DCM for autumn and winter feed (see Table 2). However, the assumed rental was probably quite high in comparison with actual rentals and it is felt that there could be a case for an increase in rentals. This feeling is motivated by the suspicion that the carrying capacities could be higher than estimated by the authorities (and the landholders) owing to the relatively high incidence of native legumes in these areas. Further, from the information gathered in the survey it is suspected that landholders lease areas in excess of requirements anyway. Of course, this could be due to the fact that only larger areas are available because of lack of fencing. Or, it could be due to a shortage of watering facilities. These considerations, in view of the value of forest leases as winter feed supplies, provide a case for a revision of policy by the forestry authorities. Items for consideration would include the fencing of smaller areas and provision of adequate water supplies. In this way a beneficial system of dual cropping for timber and beef could be brought about.

However, the opportunity to make use of forest leases is not available to all beef producers. The linear programme for Farm A was therefore run without a forest lease activity, and the resulting plan is shown in Table 3. Activity $P_3$ was selected in the final plan. Omission of the forest lease activity meant that there was surplus feed in the October-December period, while the gross profit fell by $304.

## 5. COMPARISON OF PROGRAMMED AND ACTUAL FARM ORGANIZATION

### Type of Enterprise

A comparison was made between the programmed farm plans and resource allocation on those survey farms which were breeding for stores.

TABLE 3

*Optimal Plan for Representative Farm A—without Forest Lease*

| | Unit | Level |
|---|---|---|
| ACTIVITIES | | |
| $P_1$ Weaner Store Enterprise | cows | 0 |
| $P_2$ Yearling Store Enterprise | cows | 0 |
| $P_3$ 18-Months Store Enterprise | cows | 79 |
| $P_4$ 2-Year Store Enterprise | cows | 0 |
| $P_5$ Cropping Land, Native Pasture | acres | 75 |
| $P_6$ Cleared Grazing Land, Native Pasture | acres | 225 |
| $P_7$ Uncleared Grazing Land, Native Pasture | acres | 1,200 |
| $P_8$ Native Pasture Transfer 1 | acres | 451 |
| $P_9$ Native Pasture Transfer 2 | acres | 301 |
| $P_{10}$ Buying Lucerne Hay | D.C.M. | 0 |
| $P_{11}$ Growing Vetches | acres | 0 |
| Gross Profit | $ | 2,668 |
| SURPLUSES | | |
| $X_7$ October-December Feed | D.C.M. | 75 |
| MARGINAL VALUE PRODUCTS | | |
| $X_1$ Cropping Land | $/acre | 8.46 |
| $X_2$ Cleared Grazing Land | $/acre | 1.93 |
| $X_3$ Uncleared Grazing Land | $/acre | 1.33 |
| $X_4$ January-March Feed | $/D.C.M. | 1.39 |
| $X_5$ April-June Feed | $/D.C.M. | 1.88 |
| $X_6$ July-September Feed | $/D.C.M. | 2.77 |
| OPPORTUNITY COSTS | | |
| $P_1$ Weaner Store Enterprise | $/cow | 9.57 |
| $P_2$ Yearling Store Enterprise | $/cow | 5.00 |
| $P_4$ 2-Year Store Enterprise | $/cow | 3.36 |
| $P_{10}$ Buying Lucerne Hay | $/D.C.M. | 5.27 |
| $P_{11}$ Growing Vetches | $/D.C.M. | 7.21 |

The mean area of survey holdings in the size classification 1,000 to 1,999 acres was 1,328 acres, and the mean number of breeding cows normally carried on these holdings was 134 head. For holdings in the size classification 2,000 to 4,999 acres the mean size was 3,400 acres, and the mean number of breeding cows, 208 head. Roughly one-third of these properties carried on a weaner-store enterprise while one-fifth sold yearling stores and one-fifth sold stores of from 18 months to 2 years old. The remainder marketed stores at different ages from year to year.

In comparing the figures quoted above with the programming results in Tables 2 and 3, we observe the substantial difference between the number of breeders carried on the survey holdings and the number in the programmed farm plans. A second point of interest is the predominance of survey farms turning off weaner stores when this activity has such a high opportunity cost in the programmed plans. It is necessary to explain this real-world emphasis on the weaner-store enterprise.

One important difference in the actual management practices for the various store-breeding enterprises was the weaning age. Where calves were carried on past weaning, by far the biggest proportion were weaned in the period May-June (at 8–10 months). Calves sold as weaners were necessarily weaned, on the average, about two months prior to this.

It was felt that through the sale of weaners in March-April, and hence through the beneficial effect of early weaning on the breeder's subsequent calving performance, the marking percentage for weaner-store enterprises could be well in excess of the assumed 65 per cent. On the other hand, those holdings carrying stores through to later marketing ages, by not weaning until well into winter, were suffering a depressing effect on calving percentages. These factors might explain the emphasis on the weaner-store enterprise. To test this hypothesis, the financial return from a weaner-store enterprise with 80 per cent marking was compared with that from the 18-month store enterprise with 65 per cent marking.

The gross profit for the 18-month store enterprise with 65 per cent marking was $2,668 (see Table 3). When the weaner-store enterprise ($P_1$) with 80 per cent marking was the only livestock activity considered in the matrix the gross profit was $2,129 (see Table 4)—a difference of $539. The forest lease activity was excluded from these calculations.

On the basis of the assumptions made it is difficult, therefore, to justify the emphasis placed on breeding for the weaner-store market, and it must be concluded that there is some degree of resource mis-allocation on the survey properties.

## Income Levels

The gross margins of less than $2.00 per acre shown in the programmed farm plans reflect the extremely low productivity of the native pastures. The modal holding size is within the range 1,000 to 1,999 acres, hence a large proportion of landholders in the survey area are apparently not doing much more than covering living expenses let alone meeting reasonable charges for labour and capital. This substantial low-income problem is borne out in the net farm income figures calculated for those survey holdings from which adequate financial data were obtained. These figures were calculated for the financial year 1963–64, a year in which cattle figures for the area and the state were the highest on record. Seven of the ten land-holders with properties in the size classification 1,000 to 1,999 acres had negative net farm incomes in that year, ranging from minus $81 to minus $2,754. Of the four landholders with properties within the range 2,000 to 4,999 acres for whom net farm income estimates were calculated, three had negative net farm incomes. These were in the range minus $1,394 to minus $3,142.

TABLE 4

*Optimal Plan for Representative Farm A, Weaner Store Enterprise* (80 *per cent marking*)—*without Forest Lease*

| | Unit | Level |
|---|---|---|
| ACTIVITIES | | |
| Weaner Store Enterprise .. .. .. .. .. | cows | 91 |
| Cropping Land, Native Pasture .. .. .. .. | acres | 75 |
| Cleared Grazing Land, Native Pasture .. .. .. | acres | 225 |
| Uncleared Grazing Land, Native Pasture .. .. .. | acres | 1,200 |
| Native Pasture Transfer 1 .. .. .. .. .. | acres | 390 |
| Native Pasture Transfer 2 .. .. .. .. .. | acres | 309 |
| Gross Profit .. .. .. .. .. .. .. | $ | 2,129 |
| SURPLUSES | | |
| October-December Feed .. .. .. .. .. | D.C.M. | 74 |

## 6. THE PLACE OF SUPPLEMENTARY FEEDS

At the assumed costs, yields, and feeding values neither of the supplementary feeding activities came into the final plan. This is in accord with the existing situation as seen by the survey.

A point not allowed for in the programming study is that strategic supplementary feeding in the pre- or post-calving period may be economic due to an improvement in breeding performance. In view of the fact that marking percentages are so low in the study area, this point was given some consideration. Generally, it seems that after the first calf, cows are calving only once every two years.[6]

The situation was examined from the following angle. Given the supplementary feeds available and the cost of supplying them, what increase in marking percentages would be necessary to make supplementary feeding an economic proposition?

The following break-even points were budgeted[7]. For a 100-cow herd the number of calves marked would have to increase by 22 head if lucerne hay was fed, and by 27 head if vetch was fed. Given the existing situation in the study area these increases are not impossible, but are highly unlikely.

It should be borne in mind that research personnel at Grafton consider that other forage crops will prove superior to vetch as early spring feed. At the moment data are available only on vetch production; but its performance in this study provides a guideline to the likelihood of other forage crops making an immediate contribution to beef production in the area.

An important point which can be made here is that with the provision of improved nutrition by whatever means, substantial gains may be expected to accrue from increases in calving percentages and improved weaning weights.

[6] E. J. Sparke, CSIRO, Field Station, Baryulgil, *personal communication.*
[7] Duncan, Allocation of Research Priorities, *op.cit.*, p.153.

## 7. CONCLUSIONS

As a result of the above analyses it is concluded that forage crops do not appear to have a place at present in beef cattle enterprises in the store-breeding areas of the Clarence Basin. It is felt, therefore, that the immediate problem of the research team is to develop legume-based pasture systems to raise the year-round productivity of the area. Given higher productivity it will then become economic to use high-cost forage crops—especially in those periods of the year (late winter, spring) when there will always be a problem to provide feed from pastures.

Beef breeding is an enterprise which is best carried on in an extensive form. In conformity with this premise, it is felt that the pasture systems developed should be of a low-cost, extensive nature. Apparently a substantial low-income problem exists in the survey area, particularly amongst the store breeders with small holdings (1,000-2,000 acres). For these farmers, low-cost development designed to lift overall carrying capacity seems to be the best form of improvement.

Finally, it should be added that while the broad lines of attack as indicated by this study are presently being followed, the direction of the research programme is under constant review in the light of accruing knowledge and advancing technology.