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FARM DEVELOPMENT PLANS INCLUDING TROPICAL PASTURES FOR DAIRY FARMS IN THE COOROY AREA OF QUEENSLAND

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This paper attempts to define the income-increasing alternatives open to dairy farmers in a sub-tropical dairying area, and develops optimum plans from a "long-run" linear programming model. The results indicate that intensification, based on tropical pastures, is the appropriate development strategy for dairy farmers in this area, and that substantial increases in production are possible. Present lending policies of trading banks would provide adequate finance for farm development to a farmer who has high equity. It would appear that a substantial change from traditional attitudes towards dairying will be necessary before full advantage can be gained from the new pasture species available.

1 INTRODUCTION

1.1 BACKGROUND

Continuing public subsidies have failed to solve the chronic social problem of low farm-family incomes in the dairy industry of sub-tropical Australia. At the economic policy level the resource allocation problem within the industry is usually seen to be one of directing or encouraging movement of resources out of sub-tropical dairying.

Generalizations appear from time to time concerning the essential inefficiency of sub-tropical dairying. Most of these statements are based on the implicit assumption that, as technological innovations occur, they are of a nature which enhances the relative advantage of temperate zone farmers. Historical evidence tends to support this assumption. It is probably true to say that the desire for technological improvement in sub-tropical dairying has, in the past, led to a series of attempts to transpose practices shown to be successful in a temperate environment. As a result, dairy farmers in sub-tropical areas have been faced with an array of farming practices of doubtful or unknown economic value.

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This paper reports the substance of a thesis presented at the University of New England. I am indebted to Dr D. J. McConnell of that University for his advice, and to the Commonwealth Development Bank for financial assistance.

Many industry organizations and advisers are adamant that recent developments in tropical pasture establishment[1] will increase dairy production to a level comparable with that of temperate areas. The rapid increase in acreage of tropical pastures in some coastal dairying areas in Queensland in the last 9 years indicates that many farmers consider tropical pastures a highly profitable venture. The recent decision to extend public subsidies to approved pasture establishment demonstrates that the Queensland government also has been convinced that a frontal attack on the pasture problem could invigorate sub-tropical dairying.

The prevailing enthusiasm in many quarters can best be summarized by the hope that: "Tropical pastures will do for the north what clover has done for the south".

The ultimate proof of the economic desirability of any technological innovation must, in the long run, be its general acceptance and establishment by farmers, in place of practices traditionally thought to be the "best". Only a relatively short period has elapsed since tropical pastures have been introduced to the Queensland dairy industry—certainly too short to describe them as "tried and proven" in the usual sense. However, tropical pastures have been widely and successfully established in recent years, and it is certain that an increasing number of dairy farmers, at least in the Wide Bay area of Queensland, will allocate farm resources to their establishment. The desirability of economic evaluation of this new technology at this early stage is evident.

Economic literature relating to tropical pasture establishment, or indeed to coastal dairying in Queensland, is limited. An early comment from Gruen[2] suggests that research on sub-tropical soils and pastures offered the greatest scope for cost reduction in the Australian dairy industry. Bird[3] refers to the promising development of some sub-tropical pasture species in the Far North Coast area of New South Wales. The most substantial contributions have come from a series of partial budgeting studies by officers of the Queensland Department of Primary Industries, which have dealt in turn with cropping practices[4], irrigated pastures[5]

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[1] The term "tropical pastures" refers throughout this paper to various mixtures of tropical legumes and other species which have demonstrated capability of sustained growth under sub-tropical pasture conditions.

[2] See F. H. Gruen, "Crying Over Spilt Milk", *Economic Record*, vol. 37, no. 79 (September, 1961), pp. 352-70.

[3] J. G. Bird, "The Dairy Industry on the Far North Coast of New South Wales—An Economic Study", this *Review*, vol. 30, no. 1 (March, 1962), pp. 13-70.

[4] E. O. Burns and S. S. Doumany, "Cropping Practices", *Economic Investigation of Dairying Practices—Wide Bay Area*, Brisbane: Department of Primary Industries, Interim Report, No. 1, May 1963,

[5] E. O. Burns and J. E. Briggs, "Irrigated Pastures", *Economic Investigation of Dairying Practices—Wide Bay Area*, Brisbane: Department of Primary Industries, Interim Report No. 2, February, 1964.

and dryland tropical pastures[6] as measures to improve efficiency of dairying in the Wide Bay area. Briefly these studies concluded that:

(i) the extent of improvement necessary to reach an acceptable standard of economic efficiency on most farms was too great to be achieved by the adoption of cropping practices;

(ii) it is seldom that irrigated pastures *per se* with accompanying increases in stocking rates and production can be expected to produce a satisfactory result in terms of economic efficiency;

(iii) that dryland tropical pastures appear to be the most profitable single practice applicable on a large scale in dairying in the Wide Bay district.

1.2 OBJECTIVE AND METHODS

This paper attempts to define the production and income increasing alternatives facing dairy farmers in the Cooroy area of Queensland, and, through their specification in a linear-programming model of a representative farm, to develop optimum plans. A secondary objective is to examine briefly the roles of labour, capital and farm size in the development process. This is achieved through parametric variation of the initial linear programming matrix.

Existing, recommended and potential practices have been included. The income of the representative farm was maximized over a 15-year period, with the intention of representing a "long-run" planning horizon. The matrix was arranged to allow selected pasture establishment activities to be commenced in any of the first 5 years.

The dimensions of the matrix preclude its reproduction in this paper: a list of activities and restrictions appears elsewhere[7]. A summary is given in Section 2 below.

1.3 THE STUDY AREA

The Cooroy Area in the Wide Bay region of Queensland was chosen as an example of a "depressed" sub-tropical dairying area. The majority of farms consist largely of light podsolic soils. These soils are infertile, leach readily, and evidence suggests a significant decline in soil fertility in recent years. As a consequence, introduced Paspalum and Rhodes grass pastures have deteriorated and inferior species such as mat grass, blady grass, bracken fern and groundsel, have become established. The increasing proportion of these inferior species has been attributed to overstocking, and the common practice of annual burning of existing pastures.

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[6] P. A. Cassidy and E. O. Burns, "Dryland Tropical Pastures", *Economic Investigation of Dairying Practices—Wide Bay Area*, Brisbane: Department of Primary Industries, Interim Report No. 3, June, 1965.

[7] See R. C. Jensen, *Resource Situations and Production Possibilities for Dairy Farmers in the Cooroy Area of Queensland*, Lincoln College, Agricultural Economics Paper No. 424, 1968.

TABLE 1

Frequency and Level of some Farm Practices and Enterprises on Cooroy Farms (1962–63)*

Practice or Enterprise	Number of Farms with Enterprise Operating	Mean Acreage Established by Adopting Farmers
Oats for green fodder	8	8.5
Millet, panicum and setaria for green fodder	11	7.5
Lucerne for green fodder	0	..
All other green fodder	4	7.6
Hay produced from wheat, oats, barley, millet, panicum, setaria, lucerne, sudan grass	0	..
Silage of any type	0	..
Hay from permanent pastures	0	..
Irrigated fodder crops	2	7.0
Fertilized pasture	17	14.2
Irrigated introduced pastures	4	10.0
Introduced pastures other than paspalum	22	44.0
Beans	18	5.1
Irrigated vegetables	10	4.4

* Population: 81 farms.
Source: Bureau of Census and Statistics.

Local non-agricultural industries are limited. Apart from dairying, bean-growing is a significant source of income but other cropping activities are rare. Table 1 indicates the frequency and level of some farm practices on the 81 owner-operated dairy farms supplying commercial butterfat to the Cooroy factory in 1962–3. Fodder conservation is virtually non-existent, as are most of the practices recommended to improve productivity. Many farmers rely heavily on concentrate feeding during the drier months of the year. In general, farm management attitudes are not progressive, and reflect acceptance of the present low-income situation. Only in recent years has the traditional attitude to dairying been disturbed.

2 THE REPRESENTATIVE FARM

The resource situation and possible enterprises are discussed in detail elsewhere[8] and will be summarized here. The representative farm is 160.6 acres of undulating to steep country in the Cooroy area. Land type and potential land use are as outlined in table 2. A labour force of an adult male, an adult female and a juvenile male is available[9]. Livestock consist of a dairy herd containing 41 grade milking cows with replacements, and five breeding sows. The farm is an established dairy farm with equipment at a minimum consistent with continued operation. The market value of the farm with stock is about $16,000. About

[8] *ibid.*
[9] Labour restraints were included in the programming model for each of years 1 to 4, and for years 5 to 15 inclusive in one restraint.

$8,000 would be available as a bank overdraft[10]. No initial cash supply, but complete equity, is initially assumed.

TABLE 2

Land Type and Potential Use assumed for Representative Farm

Land Type	Area	Percent of Total
	acres	%
SCRUB OR HEAVY FOREST (frost-free and suitable if cleared for establishment of tropical pastures) ..	19.0	11.8
GRAZING AREA—		
(i) suitable for cultivation of row crops*	25.0	15.6
(ii) suitable for irrigation of row crops	17.0	10.6
(iii) suitable for establishment of tropical pastures† ..	63.0	39.2
(iv) suitable for establishment of clover-kikuyu pastures..	95.5	59.5
(v) suitable for vegetable (bean) growing	8.0	5.0
(vi) occupied by blady grass-bracken fern complex ..	28.5	17.7
Total‡	140.0	87.2
Occupied by House, Sheds, Yards, etc.	1.6	1.0
Total	160.6	100.0

* Includes also land suitable for irrigation from (ii).
† Together with 19 acres of cleared scrub or heavy forest, this provides 82 acres suitable for establishment of tropical pastures.
‡ Since an overlapping of land types occurs, the sum of the various categories exceeds the total grazing area.

After the preliminary rejection of several enterprises the following were incorporated as activities in the programming model:
Pasture and Fodder Activities:

Tropical pastures.
Irrigated pastures.
Clover-kikuyu pastures.
Mowing and slashing of existing pastures.
Green-chop feeding.
Rotational grazing.
Oats or panicum as annual fodder crops.

Cash-crop Activities:

Irrigated beans.
Non-irrigated beans.

Livestock Activities:

Dairying.
Beef (vealers).
Pigs (baconers).

[10] Lending policies of most trading banks would normally allow an overdraft of about 50 per cent of the market value of a dairy farm in this area.

In addition, two quite similar activities including "improved dairy practices" such as refrigeration, production recording, etc., were included. One of these activities incorporated the use of a pure-bred sire, the other incorporated subscription to an artificial insemination scheme. Other activities provided for the borrowing of capital, purchase of cows and sows, taking off-farm employment, employment of labour, purchase and sale of land, purchase of feed grain, and land clearing by hand or contract.

TABLE 3

*Optimum Plan and Probable Existing Plan for Representative Farm**

Activity	Unit	Initial Optimum Plan	Probable Existing Plan
Tropical pastures—Year 1†	acre	82	..
Irrigated pastures—Year 1	acre	9	..
Annual cropping—panicum—Year 1 ..	acre	15½	0–7½
Green-chop feeding—Year 4‡	acre	½	..
Beans	acre	4¶	0–5**
Clearing scrub by hand	acre	19	Rarely
Mowing blady grass and fern	acre	28½	Possibly
Pigs	breeding sows	8	0–2
Feeding skim milk to cows	..	..	Probably
Herd size	milking cows	98‖	4‡
Improved dairy practices	..	Yes	No
Commercial butter production	lb	26,860‖	Less than 6,000
Capital borrowed	$	5,640	.. ††
Annual net income§			
(i) Commercial butter	$	10,740	Less than 2,280
(ii) Beans	$	1,250	570
(iii) Pigs	$	3,200	
Total Annual Net Income‖ ..	$	15,190	Less than 2,850

* Figures are rounded.

† Where appropriate, the model made provision for pasture activities to be established in any of the first five years of the development period. "Year 1" indicates, for example, that the optimum plan calls for immediate establishment of that activity.

‡ Regarded as insignificant and not included in later discussion.

§ Net income is gross income less costs of the enterprises in the plan.

‖ Level reached after 15-year development period.

¶ Irrigated.

** Non-irrigated.

†† No accurate estimate available.

3 THE INITIAL OPTIMUM PLAN

The initial optimum plan[11] for the representative farm which maximizes net income over 15 years is presented in table 3. It is compared with a probable existing plan for the representative farm.

Bearing in mind the well-documented deficiencies of the linear programming technique, in particular the neglect of management, it is possible to draw some important conclusions from the optimum solution table 3. The most significant of these are as follows:

(i) The intensification of dairying, based on tropical pasture establishment would appear to be the appropriate development policy for dairy farmers in the Cooroy area. Significant increases in dairy production and income are possible, achieved by higher stocking rates, higher production per cow and improved dairying techniques.

(ii) In the search for the most desirable combination of pasture establishment enterprises for this area, tropical pastures emerge as dominant. Annual cropping for winter grazing (e.g., with panicum) as a supplement to tropical pastures appears to be justified, even on irrigable soils. Both the tropical pastures and annual cropping activities have low labour requirements, and their presence in the optimum plan in preference to the more "profitable" but more labour-intensive irrigated pastures activity, reflects the potential importance of the labour restraint on farms in this area. The optimum plan is, however, fairly unstable with respect to the level of irrigated pastures. Both the clearing of scrub to expand the area available for the establishment of tropical pastures, and the mowing of blady grass and fern on unimproved pasture appear to be justified.

(iii) Cash-cropping with beans should apparently remain a permanent feature of the farm plan. However, the variation in market prices for beans, and the relative instability of the irrigated beans activity in the plan, would make recommendations on the irrigation of beans a very difficult decision.

(iv) The plan would appear to contradict the established wisdom of the large number of dairy farmers in the area who have terminated the pig enterprise and feed skim milk to milking animals. The stability of the pig enterprise was a feature of the plan.

(v) Herd size should be considerably increased. Further, the improved dairy practices activity, incorporating the purchase of a pure-bred sire is a stable component of the plan. This would indicate that resources devoted to production recording, vaccination with "strain 19", the use of dairy boilers, refrigerators and coolers, etc., and genetic improvement by controlled mating with a pure-bred sire are justified in the long-run. However, a comparison of artificial breeding and natural breeding finds the former at a considerable disadvantage at present prices.

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[11] Excluding the possibility of employment of non-family labour or of taking off-farm employment and the possibility of purchase or sale of land.

(vi) Commercial butter production of 26,000 pounds (an increase of 350 per cent) would appear to be possible[12]. Production per cow was programmed at 274 pounds commercial butter and production per acre at 167 pounds commercial butter.

(vii) Development credit of at least $5,600 would be required. Farmers with high equity levels could be accommodated within the lending policies of the major trading banks.

(viii) Annual net income of over $10,000 from dairying should eventually be possible. By the third year of the development programme, net income should have reached $9,000; consequent increases in income from dairying will depend on production increases resulting from long term pasture and stock improvement programmes. The uncertainty associated with the bean market, would cast some doubt on the reliability of estimates of income from bean growing. However, it is probably reasonable to expect that most of the programmed income from the pig enterprise would eventuate. Overheads and living expenses were calculated at about $2,500, leaving a programmed surplus of $10,000–$11,000 as farm income.

4 PARAMETRIC ANALYSIS

The original study on which this paper is based included variation of the main parameters of the representative farm—labour supply and price; land type, supply and price; the price of credit, the level of equity, and the length of the planning horizon. To avoid lengthy description, the important conclusions reached as a result of parametric analysis are merely listed below:

(i) The intensification of dairying, based on tropical pasture establishment remains the appropriate development policy for dairy farmers in this area in all situations, except when the planning horizon is relatively short, i.e., 5 years or less. In this case, some labour would profitably be devoted to off-farm employment and the farm operated with a smaller herd grazing tropical pastures and an annual fodder crop.

(ii) Tropical pastures remain the dominant pasture enterprise in development plans. The role of irrigation is less certain. On smaller farms (up to 140 acres) the optimum plans call for the complete utilization of irrigable land by irrigated pastures—on larger farms (more than 188 acres) the plans do not include irrigated pastures. Between these extremes lie most of the farms in the Cooroy area. It would appear that irrigated pastures could wisely be included in farm plans only if labour is not limiting. As a general statement, irrigated pastures cease to be present in optimum plans at the maximum permitted by suitable land when the labour: land ratio falls below 50 man hours per year per acre of land, and disappears from the plans when this ratio falls below 35–40 : 1.

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[12] Recent production figures of progressive farmers in the Cooroy area suggest that these figures may in fact be conservative.

(iii) Cash cropping with beans remains a feature of farm plans.

(iv) No variation in the level of the pig enterprise from the maximum permitted by facilities is shown to be justified.

(v) Except in the case when the farmer's equity falls below about 85 per cent the present lending policies of the major trading banks would appear to provide access to sufficient development credit. Farmers at relatively low equity levels would require additional credit facilities.

(vi) The relative percentages of arable and irrigable land on farms in this area would not appear to be an important factor affecting optimum farm plans unless these percentages are quite low (less than 10 per cent).

(vii) The high return which can be expected from investment in a development programme of this nature is indicated by the insensitivity of the optimum plan to changes in the cost of borrowing. No change occurs in the optimum plan, or in the level of the borrowing activity until the rate of interest reaches 14.9 per cent.

(viii) Under conditions of full development, farm labour assumes a high shadow price. Labour from the representative farm should not be made available for off-farm employment in significant amounts at less than $4.40 per hour while the planning horizon is relatively long.

(ix) Development of farms in this area could be accompanied by significant increases in the price of land. If dairying net income per year increases to about $67 per acre, as the programming model suggests, land prices of $200–$250 per acre could eventuate.

(x) The activity representing improved dairy practices and incorporating the purchase of a pure-bred sire continues to be a stable component of all plans except those calculated for short-term planning horizons.

(xi) With a smaller labour force (married couple only), the activity allowing sale of land at $69 per acre enters the optimum plan at an acreage of about 225 acres. The level of this activity increases in direct proportion to increases in acreage, with a constant farm size in optimum plans of about 225 acres. The shadow price of land shows a tendency to fall below the price of land ($69), bringing the "sell land" activity into the optimum plan when the labour: land ratio falls below 20 man hours per year per acre of land.

5 CONCLUSIONS

The programming results indicate that intensification of dairy farming, based on tropical pastures, is the appropriate strategy for dairy farmers in the Cooroy area. Considerable increases in stocking rates, production per cow, and consequently farm income, are possible. Although irrigated pastures are more "profitable", their role seems less certain, depending largely on the availability of farm labour. The practice of annual cropping for fodder appears to occupy a valuable position as an adjunct to tropical pastures. The adoption of improved dairy practices based on the use of a pure bred bull, but excluding artificial insemination,

is justified, providing the planning horizon is "long term". Similarly, the present tendency for dairy farmers in the Cooroy area to reduce the pig enterprise, and feed skim milk to milking animals, is probably compounding inefficiencies in feeding practices. The inclusion of bean growing in general recommendations to farmers would need to be based on more informed estimates of likely responses of vegetable markets to substantially increased supply than currently exist.