THE DERIVATION AND USE OF AN INDEX OF DAIRY POTENTIAL

J. H. HOLMES*

University of New England

1. SUMMARY

Considerable advances have occurred in dairy research over the last decade, one outcome of which has been the increasing recognition of the need for resource appraisal and assessment of farm potential, as a basis for more accurate research into farm management, more effective extension methods and the formulation of more realistic policies affecting the industry. While this deficiency in research has been acknowledged, no

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major work has been undertaken to fill the gap. Until this is done much of current knowledge will remain uncertain, and investigations will be often repetitious and inconsequential.

A method of farm resource appraisal is outlined, its field application described, some outcomes of its use indicated, and others suggested.

2. INTRODUCTION

The last decade has witnessed a remarkable increase in the volume, diversity and depth of research into the dairy industry. In this, agricultural economists have not been left behind and have provided a wealth of data on the characteristics of the industry as a whole and of individual dairy farms and farmers. As a consequence, the report of the McCarthy Committee[1] is more accurate and well-informed, and its recommendations more realistic than might otherwise have been the case.

With their initial emphasis on the economic characteristics of farms (investment, costs and incomes related to farm type, output and management methods) and the economics of farm improvement (farm management, linear programmes, production functions), agricultural economists have been forced at times to investigate or speculate upon closely related phenomena outside their usual field of study. On the one side they must take cognizance of socio-psychological factors in the outlooks and intentions of farmers and the processes of decision-making, and on the other side of physical factors in the characteristics of the farms. Through lack of basic data, economists have been forced at times to venture with some hesitancy into statements on individual differences from farm to farm and from farmer to farmer, and many cases can be quoted where the economist would welcome more accurate data in these fields to give greater precision and wider application to his own research.

Some pilot sociological studies have been carried out in Australia by Fallding, including a study of dairyfarmers on the North Coast of New South Wales,[2] while others have been carried out by agricultural economists who have acknowledged this frontier of research.[3]

Another borderline field highly relevant to the work of agricultural economists is the precise study of characteristics and potential of farms. Research by agricultural scientists is generally not presented in a way which makes it readily useful to economists, directly concerned with the farm as an economic unit, and requiring accurate data on farm physical resources. This gap is evident from a perusal of methods currently used to describe farm characteristics and potential.

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[1] Parliament of the Commonwealth of Australia, *Report of the Dairy Industry Committee of Enquiry,* Canberra: August, 1960.

[2] H. Fallding, *Precept and Practice on North Coast Dairy Farms,* University of Sydney, Department of Agricultural Economics, Research Bulletin 2, Sydney, 1958.

[3] See, for example, a discussion by D. B. Williams on frontiers of knowledge in his paper entitled "Contemporary Agricultural Economics in Australia", *Proceedings of the Conference of Agricultural Economists,* Sydney, February, 1957, p. 40.

3. METHODS OF FARM RESOURCE APPRAISAL: A CRITIQUE

In most farm surveys it is considered necessary to provide some statement or index of farm resources, whether merely for perspective or for statistical enquiry. To the geographer, these definitions of resource base seem crude and elementary when compared with the precision of analysis of capital resources, inputs, yields and costs. The resource base is often dismissed in one or two sentences of vague generalities about total acreage, arable acreage, cleared acreage, prevailing slopes and average annual rainfall. This rough-and-ready description has sufficed even for intensive studies of three or four individual properties which may form the basis of a monograph!

Indices Based on Acreages

In sample surveys where there may be need for greater precision in providing an index of farm resources as a basis for regression analysis, the researcher has at times hoped that figures on acreage will give some idea not only of the size of the farm enterprise but also of the resources upon which the enterprise is based. Acreages may prove useful over a region of homogeneous soil-slope patterns, as in the Mid-West of the United States, but they are singularly inappropriate in a zone of topographic complexity characteristic of Australia's coastal dairy zone. In some areas of field research in coastal New South Wales the writer has found signs of a negative correlation between gross acreage and farm physical resources, this negative correlation being most apparent when farms in a complete river-valley are studied, incorporating smaller farms on flood plains as well as the larger units in the upstream hilly zone.

Some recognition of differences in land quality is indicated when acreages of alluvials or of "first" and "second" class land are shown. The 1953 Cost Survey, for example, classifies land into arable flats, arable slopes, flats suitable for pasture only, slopes suitable for grazing, and rugged or steep land unsuited to development.[4] No attempt was made at more precise differentiation, or at equating acreages with potential levels of production.

Indices Based on Size of Farm Enterprise

In some surveys herd size or level of production have been used as an indicator of farm basic resources. Needless to say, these indicators are quite inexact, as they depend upon such factors as level of improvement and management methods quite apart from resource base.

Indices Based on Valuations

Land valuations have been used widely in farm surveys, generally as indices of two quite distinct phenomena: firstly, as an index of the capital value of unimproved land or as an element in the capital cost of the farm enterprise; and, secondly, as an index of the potential of the farm for a

[4] *The Cost Structure and Management Problems of the Dairy Industry in New South Wales.* Report on a co-operative survey by the Commonwealth Bureau of Agricultural Economics and the N.S.W. Division of Marketing and Agricultural Economics, p. 35. This classification surprisingly fails to differentiate between slopes suitable for grazing milking cows and those suitable only for other livestock.

certain form of land use. Valuations are a useful tool for the first purpose, namely, in studies of capital investment and costs, although current and past market values may well be a more useful guide here.[5] For the second purpose, however, valuations are very ineffectual and often misleading. Land values adjust to the current cost and price structure of the industry for which the land is utilized, and where two different price structures exist, two different valuation standards will emerge. Thus a comparison of higher-valued farms in the Milk Zone against lower-valued butterfat farms will not provide an effective gauge of comparative resources. Even within the same cost and price structure other extraneous factors enter to vitiate the use of valuations as an index of potential for one specific form of land use. For example, land adjacent to urban areas may experience upward valuation, unrealistic in terms of dairy potential but reflecting their potential for urban uses. Even more disconcerting fluctuations can occur when an alternative, more intensive form of land use is reckoned in the valuation, the most startling cases being in the recognized banana growing areas on the North Coast, where low value steep slopes have at times experienced sharp upward revaluation even when still used for dairying.

Farm location can influence valuations, independently of productive capacity. An isolated, poorly serviced farm will have a lower valuation than a farm with similar productive capacity, but with good access and a wide provision of services. Of course access is most relevant in assessing the most suitable use for the farm, but the valuation no longer serves its purpose in gauging productive capacity. To suggest that the productive capacity of the former farm will not be realized because of its locational handicap is to beg the question. If the relative importance of both factors is to be gauged accurately, then basic data must clearly differentiate between the two.

Indices Based on Farmers' Opinions

As a last resort investigators have at times depended upon farmers' opinions as to the market value of the farm, or its carrying capacity, or its potential level of production. Gruen and Waring used this method in their survey of small dairy farms, but attempted to counter its imperfections by also using estimates from agronomists. The writers state that ". . . assessment of farm capacity by the farmer and the agronomist was generally in broad agreement".[6] This cautiously worded statement suggests that farmers' opinions are a useful starting point, but hardly an accurate gauge. Largely as a matter of interest the writer has asked farmers for opinions on the carrying capacity and the productive capacity of their farms. Contact with survey areas has been maintained over a period of seven years, and with changes in ownership it has been possible to obtain two informed opinions on the same farm in some cases. Estimates of carrying capacity have shown frequent but modest variations, but estimates of productive capacity have ranged from as low as 70 per cent to as high as over double the estimate of the previous owner. This order

[5] For a detailed analysis of problems associated with the use of land valuation statistics, see G. O. Gutman, "Investment and Production in Australian Agriculture", this *Review*, Vol. 23, No. 4 (December, 1955), pp. 237-310.

[6] F. H. Gruen and E. J. Waring, "A Survey of Small North Coast Dairy Farms", this *Review*, Vol. 26, No. 1. (March, 1958) p. 16.

of disagreement is not unexpected, when note is taken of the remarkable variations in yield per cow to be observed even on dairy farms located on similar land units in the same locality.

Indices Based on Multiple Factors

More comprehensive indices have been devised, based upon two or more criteria. Fallding used a method based upon combining value per acre with estimated carrying capacity. "First-class farms were defined as those whose unimproved capital value exceeded £15 per acre and which were also capable of carrying 50 milking cows or more. All the remaining farms were considered second-class farms. Within this category a farm was designated a poor second-class farm if it was valued at less than £15 per acre and was incapable of carrying more than 40 cows."[7] This dual index has merits as a general indicator of the quality and extent of farm resources, but it still retains the imperfections of its component parts. Problems associated with farmers' estimates have been mentioned above, while a further weakness in using valuations per acre lies in its often false assessment of farm quality. A common example is that of an otherwise "first-class" farm which, however, includes by chance a few hundred acres of poor quality steep slopes within its boundaries, which thus reduce the U.C.V. per acre to below £15, while a poorer quality neighbouring farm may average over £15 per acre merely because its boundaries do not enclose a similar extensive tract of poor land. Or a farmer could lead to a re-classification of his farm from first-class to second-class by the purchase of adjacent poorer land for sideline vealer raising, thus reducing the farm valuation to below £15 per acre, even though his farm would be a more prosperous and desirable unit than it was before the purchase.

4. THE NEED FOR ACCURATE RESOURCE APPRAISAL

Recognition of Need

The frequency of attempts at farm resource classification is sufficient recognition of the need for accurate appraisal, as also are the often uncertain generalizations about farm characteristics in which inadequacy of data is admitted directly or can be inferred as a logical sequel.

The 1953 Cost Survey was the first large-scale, intensive survey to draw attention to the heterogeneity of Australian dairy farms as producing units, and went some way towards recognizing farm resources as a more fundamental variation affecting costs and incomes than management, labour or investment in improvements: ". . . low incomes (or high costs) were largely the result of the small scale of operations on the farms concerned".[8] The survey remains content to analyse only as far as scale of operations, and goes on to suggest that the problem is one of raising volume of production on small farms. Gates, however, has pointed out that the survey data can be interpreted further, and tentatively concludes for the survey dairy farms, that ". . . while the marginal productivity of labour is well below its market price, that of capital, and especially land, is relatively high".[9] Gates' tentative assertion points to a need for more accurate study of farm resources.

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[7] Fallding, *op. cit.*, p. 16.

[8] *Op. cit.*, p. 110.

[9] N. T. Drane and H. R. Edwards (Editors), *The Australian Dairy Industry: an Economic Study* (Melbourne: Cheshire, 1961), p. 147.

Largely as a sequel to the 1953 survey, attention has been focussed upon the smaller farms and there has been increasing recognition that inadequacy of farm resources is the basic problem and small scale of operations the outcome. Recommendations concerning raising the volume of production on small farms have been, in large measure, replaced by recommendations towards the elimination of smaller units by amalgamation. On the small farms studied in the Gruen and Waring survey ". . . the most frequent reasons for low production were to be found in the nature of the farms and were not the result of disabilities of the operators".[10] Feasible means of converting the 74 survey farms to economic working units were suggested, and of the 65 cases for which recommendations could be made, 35 involved amalgamations, 8 involved better management, 10 increased investment and 12 changes in land use or sideline patterns.

The 1960 Report of the Dairy Committee of Enquiry

The report of the McCarthy Committee of Enquiry, mentioned earlier, is a significant step, not only in recognizing the existence of a large group of undersized farms, but also in outlining a selective programme designed to eliminate many of these farms. In doing so the Committee has pinpointed the lack of accurate data on farm resources and has provided a further, urgent reason for the provision of this data. A careful reading of the Report reveals how effectively the Committee has been able to utilize the research carried out on most aspects of the industry. The one notable exception, where the Committee complained of lack of basic data and found that first-hand observation was necessary, was in the matter of farm basic resources, as indicated approximately by farm size and carrying capacity.[11] This data, with other material gleaned from various unquoted sources, was then used as a basis for classifying dairy farms according to their potential production, with a potential of 8,000 lb. of butterfat per annum being considered a barely reasonable level for a satisfactory dairy unit.[12] Of the 83,500 estimated suppliers of milk or cream in Australia, the Committee estimated that 44,700 had dairying as the main source of income, and the remaining 38,800 were "mixed" farms with more than one-third of total income derived from other farm activities or from outside interests.[13] Of the 44,700 farms in the first group with which the Committee is directly concerned, an estimated 30,200 were producing from all sources a gross income equivalent of 8,000 lb. of butterfat per annum, this being the prosperous sector of the industry which has reaped most benefit from the subsidy. Another 11,400 farms were estimated to have the potential to achieve this level, and should be eligible for financial assistance towards this end, while the remaining 3,100 farms were considered incapable of reaching the desired level and should be eligible for financial assistance to leave the industry.

This is the crux of the Committee's recommendations for the betterment of the dairy industry: the abandonment of indiscriminate "support" by subsidy, in favour of selective assistance for existing, and particularly for potential, larger, low-cost producers to increase output and reduce costs,

[10] Gruen and Waring, *op. cit.*, p. 7.

[11] "Report of the . . . Committee of Enquiry", *op. cit.*, paragraphs 101-120.

[12] *Ibid.*, paragraphs 917-919.

[13] *Ibid.*, paragraphs 922-936.

while easing the smaller, high-cost producers out of dairying. The effectiveness of the programme is dependent upon an accurate assessment of farm potentials. However, the Committee has not only devised no procedure for estimating potentials, its own approximate figures, quoted above, being a product of enlightened guesswork, but also appears to believe that no accurate procedure can be devised. "No statistical division can be accurate when potential, which is a matter of opinion, is one of the criteria."[14]

The writer is in disagreement with this view. If approached systematically, assessments of potential can be made to the same order of accuracy as prevails in most statistical work. The assessment must be based on close analysis of the fixed or basic resources of soil, slope and climate, the output from which is variable depending upon the inputs. By means of experimentation, this method of assessing potential of various soil types has been used frequently in calculating possible crop yields at certain levels of cultivation and fertilization. The same procedure can be used to estimate yields of milk or butterfat per acre for various soil types, taking into account such variables as pasture and crop management, herd type and quality, and grazing methods. If carried out experimentally, the assessment can have a high order of accuracy; other methods with a lower order of accuracy can be devised, one of which is outlined later in this article. Even these go beyond the stage of being merely "a matter of opinion".

The successful implementation of the Committee's recommendation will depend upon accurate assessments of farm potentials, to differentiate between the small producers with the potential to achieve 8,000 lb. butterfat per annum and therefore eligible for financial assistance to increase productivity, and those units which do not possess this potential and are eligible for assistance to leave the industry.[15] Surely, the Committee is not happy to leave the basis of discrimination solely as "a matter of opinion".

Value of Farm Surveys

Quite apart from public policy and its implementation, there are other lines of enquiry which would benefit from more systematic methods of farm appraisal. This is true of all farm studies from random samples designed merely for studies of correlations or for extension work, to more refined analyses such as linear programming and production functions.[16]

The comprehensive, fact-finding farm surveys based on random samples, which have been the foundation upon which further research has developed, have been limited mainly to studies of correlations, and have progressed only slightly in determining causal relationships. Surveys of this nature are in danger of becoming repetitious and unrewarding. This is not surprising when only superficial attention is given to a fundamental difference between farms—the resource base. Thus, the investigation of causation is often incomplete. In its extreme form, this assumes the pattern of the single-reason classification of farm problems. For example, there are tables

[14] *Ibid.*, paragraph 930.

[15] *Ibid.*, recommendations 6 and 7, paragraph 1207.

[16] For a discussion on problems associated with varying land quality in deriving production functions, see E. O. Heady, "Elementary Models in Farm Production Economics Research", *Journal of Farm Economics*, Vol. XXX, No. 2 (May, 1948), pp. 213-215. Unless the tendency for better quality land to be farmed more intensively is accurately gauged, there is a tendency to exaggerate marginal productivities of labour and capital.

which suggest "farmer too old" or "sickness" as the reason for under-productivity. The investigator has found a contributory, but not necessarily a sufficient cause for low productivity. Similarly, an indiscriminate classification of disparate causes, of the type listed below, is hardly a logical analysis:

Farm too small;
Unsuitable land;
Farmer too old;
Increasing costs;
Lack of finance.

The first three causes listed above are directly related to individual farm traits, but the fourth cause, and, in certain contexts, the fifth, are problems whose impact is felt generally over the industry as a whole. Rather than listing "increasing costs" as a problem peculiar to certain farms, it is more relevant to find out why these farms are feeling the impact of increasing costs to a greater extent than are other farms.

In their survey of small farms, Gruen and Waring recognized these problems of contributory causes and of ubiquitous causal connections. In seeking reasons for low levels of production on small farms they confined their attention to individual characteristics of farms and work force, and also sought to identify the "main" reason on each farm, and, where applicable, a subsidiary reason or reasons.[17] They noted a tendency for poor management to be associated in part with farms with poor resource base, which would seem to indicate that in any case where the low productivity is explained solely in terms of labour problems, it is first necessary to check whether farm resources are adequate. The inevitable sequence of change of ownership from one generation to the next provides crises in the history of any farm. The impact of this crisis is generally less evident on an adequately based farm where usually a member of the next generation has remained on to give continuity or else a sharefarmer can be found without great difficulty. The problem is greater on the small farm which cannot adequately support two workers and the younger generation is obliged or more inclined to leave and reluctant to return, giving the farm a developing problem of ageing or invalided work force.

In a survey seeking reasons for the closure of dairies in certain selected areas of coastal New South Wales,[18] the writer found it necessary to use an exhaustive classification of possible factors against which each farm was closely checked. In a generalized form these categories, which coincide closely with those used by Gruen and Waring, were as follows:—

A. Immediate causes or individual characteristics:
  (1) Geographical factors (or farm characteristics):
    (*a*) Resources:
      (i) inadequate;
      (ii) unsuitable;
      (iii) problem, e.g., poor layout, susceptible to floods, weed infestations, pasture difficulties, etc.

[17] Gruen and Waring, *op. cit.*, pp. 14-16.

[18] J. Holmes, *Population and Production Decline in the More Sparsely Peopled Farming Areas of Coastal New South Wales*, Unpublished M.A. thesis. Department of Geography, University of Sydney (February, 1959), pp. 97-99.

(*b*) Location: particularly in relation to transport, basic services, urban centre and factory.

(2) Personal factors (or labour characteristics): age, attitude, managerial ability and strength of the work force.

(3) (Not included in original check list, and meriting addition): Institutional factors: financial burdens, death duties, conveyancing problems, etc.

B. "Universal" factors: economic, social and technological. The changing impact of these factors is felt on all farms, and, in association with individual characteristics, could be contributory factors to farm closure. However, these were not sufficient causes for farm closure, but could take effect only in combination with individual characteristics, even if only personal factors. The individual characteristics of each farm were outlined in detail, one example of which is given later in this article.

Farmers' Decisions and Extension

To complete this discussion on the need for accurate farm appraisal some reflections upon current levels of farm management and the role of extension may be relevant. Land is the largest capital component in Australian dairy farms, comprising 48 per cent of total capital investment on the 1953 Cost Survey farms, which had risen to almost 60 per cent in 1956 on the same farms, "mainly because of greater purchases in 1954-55".[19] High land values appear to be a leading factor in the overcapitalization of small dairy farms. Yet the possibility of varying land inputs is often neglected in linear programming and extension work, possibly because it may appear that, for any given farm, land is constant, and improvements, livestock and plant are the variables which should be studied experimentally and analytically as a preliminary to recommendations and decisions. However, land can be regarded as a variable, though generally cumbersome and difficult to recast as required. Farmers readily recognize land acquisition as one form of farm improvement, often to the detriment of other methods. It generally happens that the farms which are increased in size by amalgamations are the very farms least in need of this process, while owners of smaller holdings remain incapable of achieving optimum size through lack of finance. The recommendations of the McCarthy Committee are designed to break this impasse, and make it feasible to treat land as a variable in designing programmes for improvement of small farms.

Turning from land to land improvements, studies of farmers' investment patterns appear to suggest that, in general, land improvement is placed lowest on the list of farmers' priorities for capital expenditure, although this may not apply in all contexts.[20] Using data from Bollman, Carney and O'Hagan, Drane shows that in connection with land improvements, dairy farmers would appear to spend rather less than do other types of farmers,

[19] F. H. Bollman, "Capital Expenditure on Australian Dairy Farms", *Quarterly Review of Agricultural Economics,* Vol. XI, No. 1 (January, 1958), p. 36.

[20] K. O. Campbell, "Some Reflections on Agricultural Investment", *Australian Journal of Agricultural Economics,* Vol. II, No. 2 (December, 1958).

although land improvement is probably the most productive avenue for investment.[21] This particular reluctance to invest in land improvement is not easily explained. Drane briefly considers such possibilities as a higher proportion of gross investment needed for replacement than in other industries, greater need to invest in machinery to replace decline in manpower, and need for investment in unproductive items such as buildings and vehicles. He concedes that none of these offers an entirely satisfactory explanation.[22] It seems likely that, in all the above items save labour replacement, wheat farms would have heavier expenditure than dairy farms.

Largely from the evidence in Fallding's study of north coast dairy farms, Campbell suggests that intrinsic managerial qualities affect the priority of investment,[23] and Drane follows this to suggest the possibility of poorer entrepreneurial talent among dairy farmers. While Drane's suggestion has also been ventured in other studies, no satisfactory evidence on this point has been deduced. However, it is possible to suggest that this poorer performance of dairy farmers is related to entrepreneurial difficulties, without inferring that dairy farmers have less talent than other farmers in this direction, but rather by suggesting that they face greater difficulties in implementing land improvement programmes than do most other farmers. Certain factors need to be kept in mind when considering farmers' attitudes to land improvement.

Firstly, there is a more minute fragmentation of soil-slope patterns in the coastal dairy zone than in other land use zones, leading to an infinite variety of farm resource patterns. Practically all farms warrant treatment as highly distinctive units to which land improvement programmes must be adapted individually. Secondly, there is a lack of basic data on farm resources and yield patterns for various land types. Even in research work, yield data is crude, being often based upon the unrealistic criterion of "carrying capacity", or acres per cow rather than milk or butterfat yield per acre. These ratios are generally applied to the farm as a whole irrespective of variations in land units on the farm. With such rough-and-ready methods used even in research, it is not surprising to find that the farmer has no effective method of gauging the impact of land improvement programmes, and is therefore reluctant to invest in them. Inadequacy of farm resource appraisal has meant that there is no clear yardstick for farm-to-farm comparisons, so that the transfer of findings from one farm to another becomes largely a hit-or-miss affair. Thirdly, effective management of a dairy farm is a complex procedure, more complex than for most other types of farming. In most cases any land improvement programme will have an impact upon a wide range of farm activities, this impact being so widespread, that it is hard to measure accurately. The controlled input-yields studies so readily applicable in cash cropping or even in sheep grazing, have few parallels in dairying. Fourthly, the as yet unresolved pasture problems of the semi-tropical northern areas have retarded land improvement on farms located in these areas. The poor performance of these farms would tend to reduce the average for the dairy industry as a whole. Of the above problems, the first three can be tackled more effectively if more accurate methods of farm appraisal were used.

[21] Drane and Edwards, *op. cit.*, pp. 110-117.

[22] *Op. cit.*, pp. 116, 117.

[23] Campbell, *op. cit.*, p. 100.

5. DERIVING AN INDEX OF DAIRY POTENTIAL

Initial Problem

The problem of farm appraisal was thrust upon the writer in indirect fashion, when engaged on research into differential trends in rural population in coastal New South Wales over the period 1921 to 1954. In detailed studies of selected survey areas, it was found necessary to have an accurate measure of the distribution of farm resources, which could then be related to trends in the distribution of rural production and work force.[24] Differential trends in the latter two could be interpreted reasonably accurately only by reference to resource distribution. The method of mapping resource distributions is outlined below.

Classification and Mapping of Land Units

For the two survey areas, Moruya and Copmanhurst, land units were identified according to soil-slope characteristics, classified according to their farming potential and then mapped by reconnaissance survey and checked from air photographs. The generalized categories were as follows:—

A. Fertile alluvium ;
B. Moderately fertile alluvium and colluvium ;
C. Slopes suited to dairying (usually undulating) ;
D. Slopes suited to rough grazing (usually hilly) ;
E. Slopes of negligible grazing value (usually steep or rugged) ;
F. Poor, sandy soils of negligible grazing value ;
G. Swamps and salt marsh.

This generalized classification was considered applicable to all coastal New South Wales, and in individual survey areas sub-categories could be identified and given a figure notation (see Table 1). Categories A to C were classed as suitable for dairying or beef fattening, while category D was suitable only for grazing of breeders, young stock and (in good years only) dry dairy cows.[25]

For the same survey areas, existing farm boundaries were mapped accurately, as also were any boundary changes since 1921.[26] Farm boundary maps were superimposed on land unit maps, so that, for each farm, the acreage of each land unit within its boundaries could be calculated.

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[24] The main survey areas were the Moruya Police Patrol on the South Coast and the section of Copmanhurst Police Patrol within Copmanhurst Shire in the middle Clarence Valley. In these areas detailed mapping of land units and assessment of potential were accomplished. The upper Paterson and Allyn Valleys were also studied concerning production and population trends, and farm characteristics, but no resource mapping was undertaken. For further details on methods used and the characteristics of the survey areas, see:

J. H. Holmes, M.A. thesis, *op. cit.*

J. H. Holmes, *The Changing Distribution of Dairying in Coastal New South Wales.* Paper read to the second meeting of the Institute of Australian Geographers, Brisbane. (May, 1961.)

[25] A classification of a similar type was used by J. Rutherford, "Some Aspects of Land Utilisation on Dairy Farms on the Lower North Coast", this *Review*, Vol. 19, No. 4 (December, 1951), pp. 182, 183. Rutherford distinguished alluvials (A1, A2, A3), moderate slopes used mainly for dairying (B), and rugged areas for rough grazing (C). No attempt was made to relate these to potential levels of production.

[26] Parish maps were used as base maps for farm boundaries.

Conversion of Acreages into Potentials

The next step was to translate these acreages into potential levels of production, and here various conversion ratios could be devised according to the level of farm management, or inputs. The most accurate method would be from farm trials in which yields on the various land units could be measured in relation to variables in fertilizing, pasture management, herd type and quality, stocking rates, etc. This was neither necessary nor feasible within the scope of the writer's current research, and an alternative, satisfactory method was available. A detailed study of the history of each farm over the period 1921-1954 was being made, including factory records of all farm yields, for sample years over this period, and also, as far as possible, a history of land use, stocking rates, management methods and labour force over this survey period. It was thus possible to compare yields achieved over a long period with the resources available as measured by acreages of land units. More accurate data was available in more recent years including detail on fertilising and pasture management. Thus, for most land units, it was possible to compare yields achieved on farms with varying inputs and managerial efficiency. From this data it was possible to devise a "reasonable" average yield level under current management methods, reasonable being defined as well managed, but not outstandingly so, and with moderate inputs of capital and labour. Hence a few farms, very well managed, and often highly capitalized and well manned, would achieve average yields considerably above this level.

Table 1 shows average yield per acre ratios for Moruya land units, together with the number of acres of each particular unit considered necessary for an average production of 7,500 lb. commercial butter (6,160 lb. butterfat) and 9,750 lb. c.b. (8,006 lb. butterfat) per annum.

The initial ratios were based upon the middle column of figures in Table 1, namely the acreage considered necessary to produce 7,500 lb. commercial butter per annum, 7,500 lb. being the minimum standard for a reasonable dairy farm according to the findings of the 1953 Cost Survey.[27] After determining acreages necessary for this production level, it is then possible to calculate yields per acre, and also acreages necessary to achieve any specified level of production. This has been done in the third column, which is designed to suggest acreages necessary to produce 8,000 lb. butterfat per annum, considered to be the minimum potential for financial assistance towards farm development in the Report of the McCarthy Committee.[28]

From these standards the index of each farm's potential is calculated as follows: the acreage of each land unit on the farm is measured and expressed in equivalents of C2 units. From the above standards this involves multiplying A1 alluvials by 6, A2 alluvials by 5, B1 alluvials by $3\frac{1}{3}$ and so on. The addition of all C2 equivalents gives the index of farm potential. For example, a farm with 42 acres of A1 alluvials and 12 acres of B5 alluvials will have an index of $(42 \times 6) + (12 \times 3)$ or 288. A

[27] *The Cost Structure and Management Problems of the Dairy Industry, op. cit.*, p. 4.

[28] *Report of the Dairy Industry Committee of Enquiry, op. cit.*, paragraph 1207, recommendation 6. The 9,750 lb. c.b. figure has been used, converting to 8,006 lb. butterfat, the error of 6 lb. being negligible.

TABLE 1

Moruya Land Units: Average Yield Ratios

Land Unit	Estimated yield of commercial butter per acre	Acreage needed to produce 7,500 lb. c.b. (6,160 lb. butterfat)	Average needed to produce 9,750 lb. c.b. (8,006 lb. butterfat)
	lb.	Acres	Acres
A1: Alluvials of recent deposition	150	50	65
A2: Older,slightly leached alluvials	125	60	78
B1: Deua River Alluvials ..	83½	90	117
B2: Shallow, clayey alluvial and colluvial soils along tributaries	83½	90	117
B4: Silty or peaty drained marsh soils	75	100	130
B5: Recently sanded alluvials ..	75	100	130
C1: Basaltic soils	37½	200	260
C2: Granitic soils suitable for dairying	25	300	390

farm with an index of 300 was assessed as being reasonably capable of 7,500 lb. c.b. per annum, while an index of 390 is indicative of a potential of 8,000 lb. butterfat per annum.

An Appraisal of the Index

It must be remembered that the index is a measure of relative potential or reasonable expectation of production, an index of absolute potential being, of course, an unrealistic concept. This particular index is intended to suggest a reasonable level of output under current farming methods, which, naturally, will be exceeded on very well managed farms. Being a relative concept it is subject to revision on at least two main points.

Firstly, the evaluation of the potential of each land unit. There is need for flexibility in terms of place, time and level of inputs. At Copmanhurst, for example, where climatic conditions are less favourable for dairying, larger acreages of all units and especially of non-alluvial soils were considered necessary for a reasonable dairy, which would have a lower stocking rate of poorer-yielding cows and a less reliable production than its Moruya equivalent.

Changing methods can lead to a revaluation of units. The C2 soils of granite origin, at Bergalia, south of Moruya, have had a chequered career in dairying. In the early 1920's (and presumably in earlier decades) some farms on these soils did achieve a production level in keeping with their assessed potential, namely 20.8 lb. butterfat per acre per annum, with a minimum of introduced pastures and no fertilizing. However, already in the early 1920's these light soils were showing signs of exhaustion following

intensive dairying and maize cropping from the 1890's on. There were signs of depleted lime and phosphate reserves, deteriorating soil structure, sheet erosion and pasture deterioration, with problems of rickets and osteo-malacia (bone chewing) in dairy cows. From 1925 onwards, dairying rapidly declined, accompanied by sharp depopulation with most land reverting to unoccupied beef runs or wattle second growth. On the few remaining dairies, yields per cow continued to decline to 1939, and were considerably below other zones in the Moruya area. In post-war years the rapid development of large-scale, mechanized fertilizing and pasture establishment to which the area is well adapted, has led to the rehabilitation of the three larger farms, all of which have indices of over 400. These farms have ambitious programmes of regular pasture improvement, and have lifted production to an average of just over 30 lb. of butterfat per acre per annum. The largest unit, a two-man farm, has been the top producer for the district in all post-war years, averaging 32,360 lb. butterfat per annum over the five-year period from 1955-56 to 1959-60. This was achieved from 980 acres of improved pasture in 1960, with smaller acreages in earlier years. This same area averaged a yield of just over 5,000 lb. butterfat per annum in pre-war years. Over the remainder of the granitic soils, comprising small holdings with indices from 55 to 235, all holdings save one have remained in their neglected, pre-war condition, being used either for grazing paddocks, "dry runs", or sporadic, often part-time, dairy ventures noted for their brevity, low productivity and failure to attempt pasture improvement. None has exceeded 3,500 lb. of butterfat per annum in any post-war year. However, the performance of the larger units suggests that the assessment of 20.8 lb. of butterfat (25 lb. c.b.) per acre per annum is a reasonable one under existing techniques.

This favourable revaluation of C2 soils at Bergalia would not apply to similar granitic soils in the western sector of the Copmanhurst survey area, where climatic difficulties have so far prevented any parallel development of pasture improvement.

As mentioned earlier, the index has flexibility in relation to inputs, with varying levels of yield being obtained according to the intensity of farming practices. While a uniform standard would be a desirable criterion in comparative studies, as needed, for example, to implement the recommendations of the McCarthy Report, even here some variations in input levels must be recognized as, for example, between problem areas in the north compared with the south.

Secondly, the assessment of a reasonable dairy farm. Clearly, this figure will vary in time according not only to the changing economic structure within dairying, but also to variations in technology and living standards. Two assessments have been used here, with the second one being a later, upward revision of the first. Concerning the standard set by the McCarthy Committee of "a potential to produce at least 8,000 lb. of butterfat per annum or its equivalent",[29] the writer has assumed that the Committee was mindful of a minimal basic increment above the butterfat income merely from the sale of calves and culls, even on a farm with no sideline activities. Thus, on current prices, a farm producing 8,000 lb. of butterfat will receive a total income equivalent to over 10,000 lb. of butterfat by the

[29] *Op. cit.*, paragraph 918.

addition of minimal sales of livestock.[30] It is assumed that this is not sideline income, and that by the Committee's definition this farm has merely reached the borderline level of production.

In any case, the use of a fixed level of gross production or gross income is only an approximate method of forecasting the possible net return to the farmer. Other things being equal, the smaller farm on better quality soils will generally produce at lower costs than will the larger farm of comparable overall potential on poorer quality soils. For example, it may be found that, to achieve comparable net returns, a farm on A1 alluvials may require a potential for 7,500 lb. butterfat, while a farm on B4 soils may require 8,500 lb. butterfat potential. Thus, detailed farm budgeting, related to farm resources, is necessary to work out reasonable farm sizes for each unit in relation to a recommended net income. This, however, lies outside the immediate scope of this article.

The order of accuracy of the index is dependent upon the mapping of the land units and the conversion of these acreages into potential yields. These two points have already been discussed, and it is a matter of determining the order of accuracy necessary for the purpose of the work. Whatever order of accuracy has been achieved, the index is an objective piece of information for comparative work on farm differences. Once yield levels have been determined, they can be applied impartially to all farms in the area uncoloured by variations in management from farm to farm.

6. USING THE INDEX

Having established a useful definition of farm potential, the writer found it of value throughout most aspects of research on production and population trends. Only a sketchy account of these uses is given here. More detail can be found in the unpublished thesis manuscript.[31]

Farm Resources

In Moruya, the initial survey classification was based upon continuity of dairying. Farms dairied continuously since 1921 were classed as *stable*, those with interruptions to dairying as *unstable*. It was later possible to divide the unstable group into two: *marginal* farms, which had some deficiency in resources (either inadequacy with an index under 300, or unsuitability with a bad layout of resources) or else a severe access problem, and a *non-dairy* group which had no resource handicaps and had left dairying in favour of other forms of land use.[32]

The fragmentation of land units prevented any apparent correlation between farm size (measured in acres) and output, save only over limited areas of uniform soil-slope patterns as at Bergalia. Hence frequency graphs

[30] Assuming that the average production of 8,000 lb. butterfat per annum is obtained from a 50-cow herd, with an average yield of 160 lb. butterfat per cow, a conservative estimate of income from sales of livestock would be £455 at current prices. This income estimate is based upon the immediate sale of bull calves and unwanted heifer calves (approximately 35 at minimum of £3 per head) and culled cows (approximately 10 at minimum of £35 per head), allowing for some mortality.

[31] J. H. Holmes, *op. cit.*, p. 35.

[32] Undersized dairies in the stable group could also merit the term *marginal*. However, the classification was initially designed for the purpose of studying farms which had not been dairied continuously.

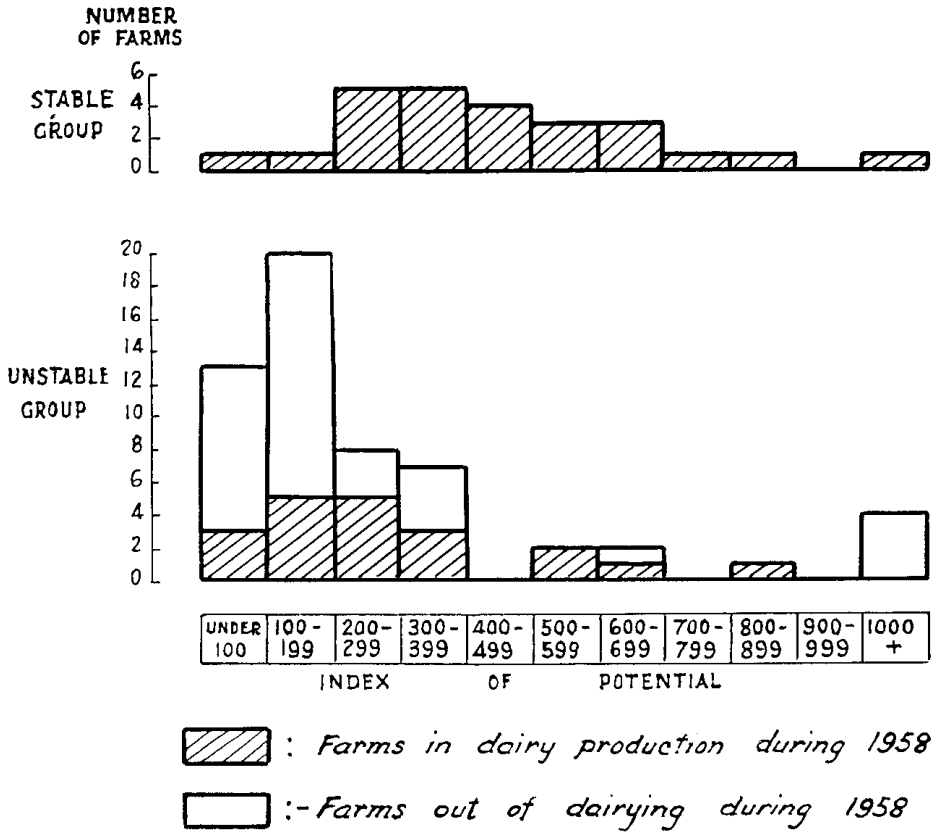

Fig. 1—Moruya Farm Groups: Frequency Graph of Farm Potential

of farm acreages showed almost identical distributions for both stable and unstable dairies, with both having almost half the farm units in the 200 to 499 acre range.

When each farm was plotted according to its index of potential, a different pattern was revealed, as shown in Figure 1. This graph shows remarkable variations in farm potential, ranging from a large group with indices below 100, to 5 holdings with indices over 1,000. While variations are to be expected, the surprising thing is the large number of undersized holdings. Fourteen have indices below 100 and another 21 below 200. Altogether 58 per cent of holdings were clearly undersized, having indices below 300, while an even larger group failed to reach the standard of 390, equivalent to the 8,000 lb. butterfat potential suggested by the McCarthy Committee.[33] Some effective amalgamations to adjacent properties have occurred, but the undersized holding is still dominant numerically, even if, by neglect, abandonment or temporary rental amalgamations to larger units, it no longer dominates in terms of number of producing units and work force. A classification of marginal farms according to their geographic handicap is given in Table 2, which is indicative of the character of their resource and location problems.

[33] New South Wales statistical returns suggest that Moruya Police Patrol has a pattern of smaller holdings than is general for the South Coast, with smaller herds and fewer workers per holding. This is the product partly of the early settlement pattern and partly of the persistence of small holdings favoured by proximity to the town.

TABLE 2

Moruya Marginal Farms Classed According to Geographic Handicaps

Resource Problem	No Access Problem	Access Problem
Adequate Resources	..	3
Poor	..	3
Small	13	12
Poor and Small	1	11
Poor, Small and Flood Problem	..	2
Total	14	31

A farm was assessed as small but not poor, when it was surrounded by suitable dairying land and was clearly undersized, having an index under 300. A farm was classed as poor when the combination of physical resources, even if adjacent land were included, was not satisfactory for a dairy farm even though the objective of 7,500 lb. c.b. annual production might be achieved. These farms were in areas with only scattered pockets of land suitable for dairying, or where unit D could be used for some unsatisfactory dairy production. These farms cannot easily be rehabilitated by a programme of amalgamations. A farm is classed as having an access problem if it is over one mile from a carrier route or two miles from the nearest cheese factory.

Farm Potential and Land Use

Figure 1 also shows some relationship between potential and farm history. Farms in the middle range of potential have generally remained as stable dairies, together with a few undersized holdings favourably located on the main alluvial flats. Farms at the extreme ranges of potential have formed the unstable group with changes in land use. This group comprises a large number of undersized holdings, some of which are still used for dairying, and a small group of very big holdings, whose owners have found more congenial activities in sheep or cattle grazing, or cash cropping. Very few holdings are large enough to provide an adequate livelihood solely from grazing. By way of contrast, in the Copmanhurst survey area, there were very few extremely small holdings, a slightly larger proportion of moderately undersized and adequate holdings (potentials 200 to 500), and a much larger proportion of big holdings. Because of this difference in size range of holdings, and also because of pasture problems and difficulties with access and the provision of basic services, dairying has, in the last two decades, been considered less preferable than beef cattle grazing. The larger properties have ceased dairying, while the smaller holdings have been obliged to persist with dairying with very little success. Thus, farms within the same group of potentials have persisted with dairying in both areas. However, at Moruya these are regarded as the middle-sized farms, while at Copmanhurst, they are regarded as the smaller farms.

Farm Potential and Production

For each sample year, scatter graphs of farm potential and production were drawn, a more recent year being shown in Figure 2. Farms below the diagonal line have produced below a reasonable potential in the year

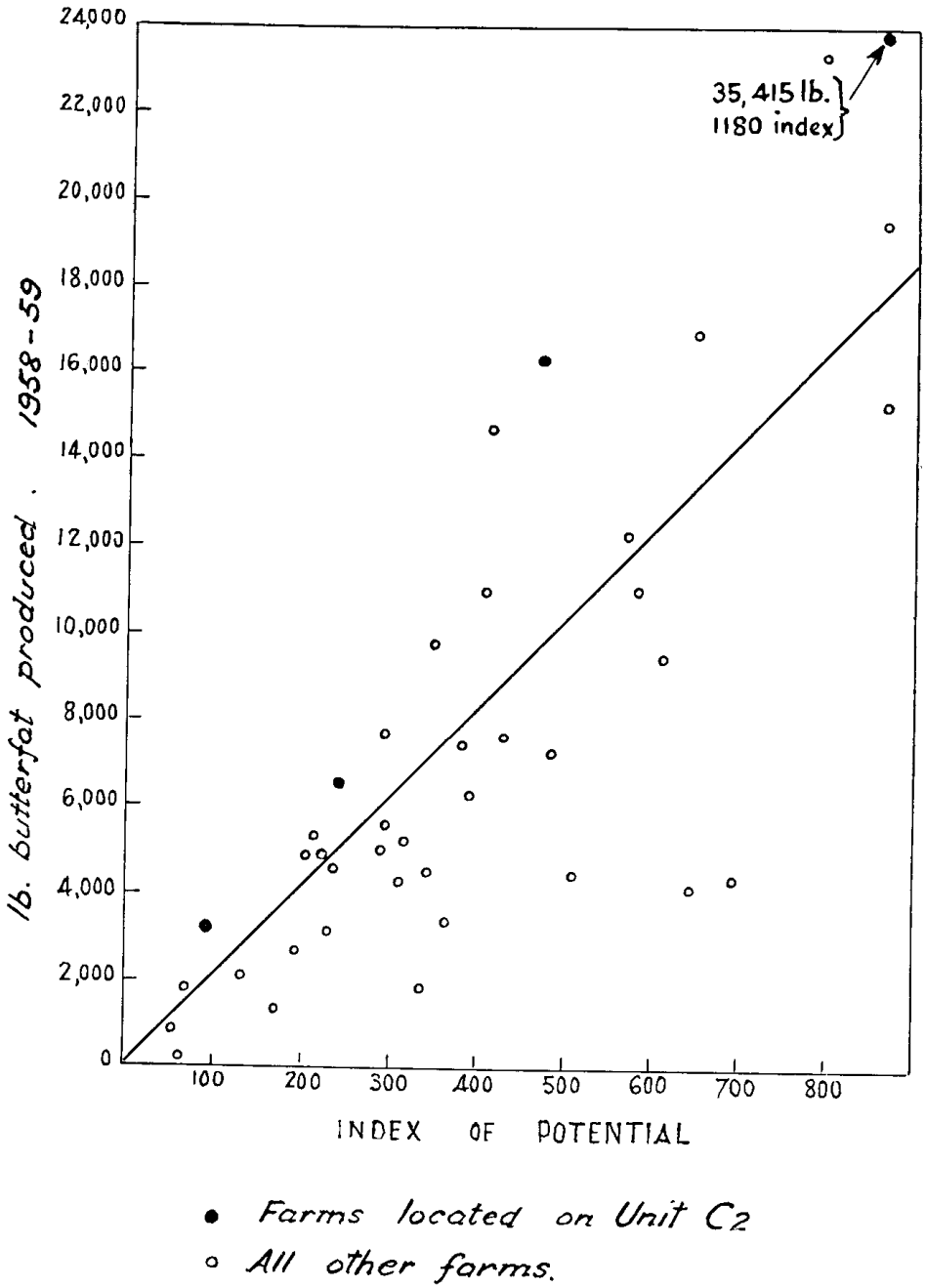

Fig. 2—Moruya Dairy Farms: Scatter Diagram of Potential and 1958-59 Production

The diagonal is the trend line for farms on which 1958-59 production equals assessed potential, plotted by equating an index of 400 with a potential for 10,000 lb. commercial butter, or 8,214 lb. butterfat.

Five farms shown on Fig. 1 are excluded from Fig. 2, these farms being used for dairying for only part of the season.

shown, while those above the line have exceeded a reasonable level. The season 1958-59 was slightly above average, which partly accounts for the number of farms exceeding their potential, based upon average annual production. The graph indicates that production variations from farm to farm are matched by variations in potential. There would appear to be no correlation between small potential and thorough use of farm potential. The very small farms appear to perform as frequently below their potential as do the larger farms. The writer has obtained indirect data on this point from a comparison of stable and marginal farms.[34]

Table 3 indicates that, allowing for seasonal factors, stable dairies have shown a slightly improved ratio of production to potential. As there has been an increase in sideline activities on most of these farms, the increase in productivity is even greater than the table suggests. Marginal dairies had equally high ratios up to 1933, but have since been making progressively less use of their land resources and are now well below the standard of the stable dairies. If sideline activities were included, the comparative position of marginal dairies would be even lower, as they engage less in sidelines than do the stable dairies. Keeping in mind that the ratio is based only on farms in dairy production, and also that marginal farms out of dairying are generally neglected and unproductive, it can be seen that the marginal group as a whole have become increasingly less effective in land resource utilization.

TABLE 3

Two Moruya Farm Groups: Percentage of Actual to Potential Production

Year	Average Index of Potential per Farm	Average Potential Production per Farm	Average Production per Farm	Percentage of Production to Potential
		Stable Dairies		
		lb. c. b.	lb. c. b.	per cent
1921	416	10,400	7,900	76
1933	402	10,050	8,500	85
1939*	379	9,500	9,400	99
1952-53†	407	10,150	9,500	94
		Marginal Dairies in Production		
1921	160	4,000	3,300	83
1933	166	4,150	3,600	87
1939*	182	4,550	3,800	83·5
1952-53†	190	4,750	3,100	65·5

* All years shown were above average, 1939 being well above average.

† Twelve months ended June 30.

[34] Further study of possible relationships between farm potential and intensity of use is planned.

Comparisons of Potential, Production and Work Force

Sufficient data was obtained to enable the projection of ideal patterns of production and work force, based on potentials, against which actual distributions could be compared. In a highly generalized form some of this data is shown in Table 4 and briefly discussed. This table shows that the stable group has a well-balanced production in relation to potential, but appears to be carrying an excess of workers by the standards suggested in the McCarthy Report. This excess is partially found on adequately sized holdings with two or more full-time workers, but is largely due to the overmanning of undersized farms. The marginal group shows a production well below potential in spite of an active work force in excess of total needs as indicated by the cumulative index of potential.

TABLE 4

Two Moruya Farm Groups: Overall Dairy Production and Work Force in Relation to Potential

	Stable Group	Marginal Group
Cumulative index of potential (all farms)	11,388	7,018
Projected number of farms*—		
Average index 300	38	23
Average index 390	29	18
Potential production (lb. c.b.)	294,700	175,450
Production as a percentage of potential—		
1921	76	53
1933	85	53
1939	99	56
1953	94	27
Work force employed (all farm workers)—		
1921	82	60
1933	78	53
1939	68½	46
1953	50	24½

*Obtained by dividing the cumulative index by 300, and by 390.

Note: Part-time workers are counted as half.

This work force is entirely confined to farms with only 48 per cent of the group's total potential, the remaining 52 per cent being held in unoccupied holdings or holdings with no active part-time or full-time worker. Thus, the worked marginal farms have a higher excess of workers than do the stable farms, this work force being restricted to small, overcapitalized farms often adjoining unmanned, neglected holdings. Thus in the marginal group there has been an increasing maldistribution (geographically speaking) or misallocation (in the economist's view) of labour and capital in relation to potential.

This situation has developed progressively as the smaller marginal farms have become increasingly less satisfactory units in relation to prevailing living standards and farming methods.

TABLE 5

Two Moruya Farm Groups: Worker and Productivity Ratios

Year	Workers per dairy farm		Lb. Commercial Butter per worker	
	Stable	Marginal	Stable	Marginal
1921	2·87	1·57	2510	2110
1933	2·73	1·73	3060	2060
1939	2·23	1·46	4050	2610
1952-53	1·78	1·20	5350	2560

Table 5 would suggest that most marginal dairies were satisfactory one-man farms by the standards of the 1920's and early 1930's, giving a reasonable living to an active worker. However, while the larger stable dairies have been able to reduce work force to fit changing standards and methods without dislocating the farming pattern, the smaller marginal dairies have been unable to do so without serious dislocation. Unable to support an active worker satisfactorily, farms have been neglected or abandoned, or else have been dairied fitfully by a few dogged originals, or by the aged and invalid, or on a part-time basis, or briefly by undercapitalized, optimistic, inexperienced newcomers in a pattern of recurrent pioneering. In all cases there has been an ineffective utilization of land, labour and capital improvements.

Amalgamation is rare, or is effected on an unwieldy and temporary lease or rental pattern. While the old, small-scale dairy pattern has been dislocated, there has been little sign of an effective alternative replacing it, other than the development of "dry runs" for the stable dairy farms. The only satisfactory alternative would appear to involve the development of larger holdings and a more effective deployment of labour and capital to potential, whether the type of land use is dairying or grazing. Until this occurs, the present unsatisfactory pattern of inefficient dairying mingled with neglect and abandonment will remain.

To place this problem in perspective, it is worth reiterating that the interpretation given above has been applied only to the marginal holdings, containing 23 per cent of the dairy potential of the survey area, with the bulk of the potential being utilized by stable dairies with continuity of dairying and by larger holdings in other forms of production. Also, though this same pattern of dislocation has been observed elsewhere by the writer, it would appear to be a more prevalent problem at Moruya than is generally the case.

7. SOME FURTHER USES FOR THE INDEX

The writer has found that the index has wider uses than those indicated above. In the Copmanhurst survey, an impartial index of farm potential was necessary for a study of the impact of poor transport and absence of basic community services on the decline of dairying in less accessible locations. As described earlier, it was a useful check against the opinion, widely held by local farmers, that it was the less fortunate farmer on the smaller holding who was obliged to remain in dairying while owners of large properties changed to beef grazing. In the case of low production farms, it enabled the separation of farms with inadequate resources from ineffectively managed farms. The index was also used to measure farm potentials against market prices for farms, and indicates fairly well the extent to which farm prices are overinflated, especially in readily accessible locations.

A wide variety of further uses has been suggested in Section 4, *The need for accurate resource appraisal,* impinging upon any research or extension work where accurate data on farm resources is of value. Unfortunately, it is not readily applicable to a random sample of widely scattered farms, although for a sample confined to one region, the farms might be measured with reasonable accuracy and without excessively laborious preliminary survey.

Should the recommendation of the McCarthy Committee be adopted, concerning selective financial assistance to farms according to potential, then an index along the lines described above would appear to be fundamental to its successful implementation. In this eventuality, some more detailed pilot surveys would be necessary to establish more accurate procedures and provide reference data on farm resources in selected areas. Land unit surveys along lines similar to those carried out by the Division of Land Research and Regional Survey, C.S.I.R.O., would be the initial step, though not necessarily with the same detail in soil analysis as has been done in their surveys, as yield data on soils can be obtained from available production records or trials. Areas with a concentration of problem dairies could be given priority in a survey programme. This data would be of value not only for implementing this recommendation of the McCarthy Report, but also as a stimulus and basis for a wide variety of research projects.