SYMPOSIUM: THE AGRICULTURAL USE OF THE SNOWY WATERS

I: ECONOMICS AND THE USE OF THE SNOWY WATERS

P. DUANE

Bureau of Agricultural Economics

To determine the best use of the Snowy waters in an economic context is to pose the question of what is the most efficient use of the nation's scarce resources. Time is an important consideration in the development of water resources and cannot be ignored in a discussion of this nature. Due to lack of perfect knowledge about future prices and changes in technology, it is difficult to make economic decisions about an irrigation project as large as the one envisaged at present. A period of even twenty years is probably inadequate in view of the longer time required for such a scheme to reach maturity. However, the best guidance possible must be given to the use of the Snowy waters in terms of all the relevant information about the future economic conditions that is available now.

At present, there are huge amounts of resources which are irrevocably committed in the Snowy Mountains area and which are past the immediate concern of interested planners. However, many economic problems still face the use of the Snowy waters for irrigation and this must surprise those who have followed the progress of the scheme over the past ten years. The problems relate to farm size, choice of enterprise, the profitability of farm development, etc., which are familiar enough to the agricultural economist ; but it may be asked why they exist at this late stage of the Snowy diversion. A discussion of scarce resources and their use might fruitfully begin at the beginning.

The Role of Economics

In fulfilling its share of responsibility for the successful outcome of public investment in the water resources field, economics must be as honest and professional in its contribution as are the other related disciplines of engineering, pedology, agronomy and hydrology. Unlike these and the numerous other physical sciences which are involved, economics cannot always be expected to provide a clear-cut answer. All the disciplines may occasionally be faced with problems which are too difficult. With economics the difficulties of measurement and applicability of empirical data is much more evident, however, even when a solution is feasible. In addition, the pursuit of complete solutions to economic problems often demands a knowledge of the precise borderline between the areas where monetary values can or cannot be applied. Despite these exigencies, a carefully prepared economic

argument cannot easily be ignored and can only enhance the value of work by other disciplines.

Such a beneficial role has not always been available to the economist in the field of water resources. Indeed, it is claimed that, in some instances, this role has been denied :

> " . . . Too often, economics is called upon to save a project from collapsing, instead of being used to assist in constructing a sound project in the first place, or is used as a measure of rationalising or justifying what has already been done. This is not sound public policy nor is it economical public policy, whatever else it may be."[1]

Economics Restated

Many definitions of economics are centred around efficiency. The following quotation is a standard form of the usual textbook definition :

> " Economics is the study of the principles governing the allocation of scarce means among competing ends when the objective of the allocation is to maximise the attainment of those ends."[2]

We hear much of the plea that water is our most scarce resource. In fact, much of our literature on the Snowy Scheme, both before and since it started, does not let us forget it. Perhaps the first role of the economist is to recognise what resources *are* scarce and limiting to Australia as a whole. Water would certainly be one of them, but its conservation and distribution for power and primary production must compete with other developments which also require scarce resources such as capital and labour.

Before he expounds on the efficient use of water resources, the economist must admit that although efficiency is an important social objective, it is not the only one. Social, political and other objectives are involved in the authorisation of water resource projects and these should not be reflected in economic analysis. Any economist in the field of public policy is well aware of this. For many reasons, however, economics has not played its full role as a partner in formulating plans for irrigation in Australia ; but there is reason to expect that it will play an increasingly greater part in such decision making in the future.

It must be recognised that current and future large scale water developments in Australia will be increasingly expensive and less remunerative now that the more obvious schemes have been completed or are under way. Their consideration and execution will place a premium on efficient resource use. Economics must also expect to play a greater role following improvements in its techniques and methods of enquiry.

The conservation and allocation of water will probably never be directed on the basis of efficiency criteria alone. This is accepted. But efficiency

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[1] Dudley F. Pegrum, *Proceedings of the Conference on Economics of California's Water Development* Ed. by S. V. Ciriacy—Wantrup and Stephen C. Smith. Issued by Committee on Research in Water Resources, University of California. (February 1958) p. 69.

[2] Stigler, G., *The Theory of Price* (London : Macmillan and Co. Ltd., 1946), p. 12.

is an important goal and certainly needs to be given more consideration in future projects.

Before embarking on the application of economics to the problems of water use, it would be profitable to review very briefly just how it has fared to date.

Economics : Past and Present Opportunities

Before the Snowy Mountains Area was developed, the alternative proposals for diverting its catchment waters may have been evaluated according to the criteria then available for appraising water resource development projects. Such criteria could have permitted a comparison of the following alternatives :

(a) variations of the same scheme.

(b) investment of public monies in other catchment areas, or,

(c) investment in entirely different fields.

The present scheme was chosen as the most attractive mainly because of its potential power output. The comparatively enormous contribution of hydro-electricity to the existing capacity of thermal and hydro-electric power stations throughout Victoria and New South Wales gave the project a broad recommendation for encouraging future industrial expansion ; not only by reason of its absolute addition in kilowatts but also from its load complementarity with thermal power. The defence value of having power stations reasonably isolated or underground was another favourable aspect of the scheme in terms of post-war defence policy.

In turning to the scheme's consequences for irrigation, as they were regarded at the time,

" It was felt that the factors having the greatest economic and political significance were :

(a) Physical practicability of using the Snowy waters diverted.

(b) The economy in the distribution of this water.

(c) The cost of getting the water to each specific project and the added value of production which would result.

(d) Development in production.

(e) Reconstruction of existing settlements.

(f) Stabilisation of rural industries.

(g) Development of the countryside and provision of amenities."[3]

These factors were adopted from a report by an Economic Investigating Committee[4] which concluded that sufficient additional commandable land existed both in the Murrumbidgee and Murray Valleys on which the

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[3] *Proposals to Divert the Snowy River*, Final Report by Commonwealth and State Officers. (Dept. of National Development, Canberra, May 1950), p. 19.

[4] Economic Investigating Committee, " Report on Agricultural Aspects of a Proposed Diversion of the Snowy River to either the Murrumbidgee River or the Murray River " in *Report on Proposals to Divert the Snowy River into the Murrumbidgee and the Murray Rivers.* (Departments of Works and Housing and Postwar Reconstruction, Canberra, June 1947.)

whole of the water diverted could be absorbed. It admitted, however, that considerable further investigation would be necessary. This Committee had terms of reference only slightly broader than those which still obtain today ; i.e., what should the States do with the Snowy waters ?

The States, of course, were to assume direct control of the additional waters following their diversion into the Murray and Murrumbidgee systems. Any possibility of a central authority to plan and supervise all aspects of the Snowy diversion, including downstream developments, was naturally prevented by the existence of State institutions in the field of irrigation, and the traditional belief that State rights should not be usurped.

The scheme was ultimately recommended, therefore, on the generation of hydro-electric power and although this power was sacrificed to some extent by large diversions to the Murrumbidgee Valley (where better facilities for irrigation existed), nevertheless, the potential of the Snowy waters for irrigation was considered to be a comparatively poor and distant relation : so poor in fact that the provision of irrigation water below the major headworks was to be completely subsidised by the sale of electricity.

Such a background to the provision of this additional irrigation water to the States has meant that there was never any thorough economic appraisal made of the scheme as a whole in terms of a quantitative benefit-cost analysis. The absence of suitable precedents in such a difficult subject was an understandable excuse and it is significant that the final recommendations for the Snowy scheme were contemporary with a report published in America which was the first serious attempt to evaluate river basin projects. In reporting to the Federal Inter-Agency River Basin Committee, the Sub-committee on Benefits and Costs stated that :

> " In its planning of the benefit-cost study as a whole, the sub-committee has been constantly impressed by the fact that although the problem is far-reaching in its effect on Federal project planning and construction policies, there have been no previous studies in the field of benefit-cost analysis that have been pushed to a final conclusion. To a large extent, the sub-committee's work is a pioneer effort."[5]

The last decade has seen a considerable response to this gap in our knowledge with an increasing flow of literature on benefit-cost theory, particularly in relation to public investment in providing the more marketable services. Some major developments have been :

(a) The application of the opportunity cost principle to the public investment of tax gathered revenue ; if not in relation to public investment in alternative fields, i.e.—equi-marginal returns, then

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[5] Sub-committee on Benefits and Costs, *Proposed Practices for Economic Analysis of River Basin Projects* (Report to the Federal Inter-Agency River Basin Committee) (Washington, May 1950) p. 70.

particularly to the interest rates appropriate for measuring the social cost.[6]

(b) The theory of public investment in time of full employment in contrast to what is socially expedient during periods of economic depression.[7]

(c) A continuing emphasis on the need to evaluate projects in terms of their multiple benefits.

(d) A recognition that the application of criteria in the past have tended to overstate benefits and to understate costs.

(e) A growing feeling that the indirect benefits and external economies associated with irrigation projects have been over-emphasised.[8]

The application of this more " experienced " economics to the problems of water use is perhaps of greatest value to organisations which will be responsible for the appraisal of future schemes. Meanwhile, it will serve to emphasise the fact that distortion and double counting of benefits have often been used to justify Australian irrigation projects ; for despite warnings at home[9] and abroad,[10] this practice still persists.[11]

We are aware, therefore, that the opportunities for applying economics to irrigation projects are much greater now than they have been in the past ; but before it is related to the Snowy waters, it is proposed to consider some further aspects of economics when it is applied.

Economics Applied

The study of the efficient allocation of water comes under the heading of " applied " economics which is the application of economic theory and techniques to a specified problem of resource allocation. Within this context, economics must recognise that its efficiency criteria have to be applied within an institutional framework. This does not mean, however, that it is completely limited in its scope. If, on reflection, certain

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[6] Eckstein, Otto. *Water Resource Development—The Economics of Project Evaluation.* Harvard University Press. Cambridge, Massachusetts, 1958. Ch. 4.
Krutilla, John V. & Eckstein, Otto. *Multiple Purpose River Development—Studies in Applied Economic Analysis.* Published for Resources for the Future, Inc. by The Johns Hopkins Press, Baltimore, 1958. Part I, Ch. IV.

[7] *Water Resource Development*, op. cit., Ch. 2. *Multiple Purpose River Development*, op. cit., p. 51.

[8] Margolis, Julius. " Secondary Benefits, External Economies and the Justification of Public Investment ". *The Review of Economics and Statistics*, Vol. XXXIX, No. 3, (August 1957). Harvard University Press.

[9] Gutman, G. O. " Investment in Development Projects ". Paper presented to Section G at the 30th Meeting of the Australian and New Zealand Association for the Advancement of Science. Canberra, January 1954. Also McKay, D. H. " Land Development ", *Quarterly Review of Agricultural Economics*, July 1952.

[10] Ciriacy-Wantrup, S. V., " Benefit — Cost Analysis and Public Resource Development ", *Journal of Farm Economics*, Vol. XXXVII, No. 4, November 1955.

[11] One method still being used to justify irrigation in Australia indicates that so long as State revenue derived from the total value of irrigated production is equal to the annual charges of upkeep, the scheme would not be a losing proposition for the State. Besides other serious deficiencies, this approach does not even have the right viewpoint.

institutions or their practices appear to be in conflict with the criteria of efficiency economics, it is valuable to examine their implications. Many problems are not considered as such because they have become institutional.

For example, the pricing of irrigation water deserves come comment. Disregarding the arbitrary way in which water is valued, the division of water costs into fixed and variable elements has certain features which oppose (in principle) the efficient use of water *if* it is a nationally scarce resource.

Suppose that the water rights for a large area irrigation farm total 200 acre feet and they are rated at the legislated amount of £1 per acre foot while additional water may also be purchased at the same rate. The water rates are fixed for the whole amount of the water rights whether they are used or not ; in contrast, the cost of additional water is variable. Under this arrangement, the average variable cost of using water is zero if an amount below 200 acre feet is delivered during the watering season ; likewise, its marginal cost is also zero. For deliveries above 200 acre feet (x) the marginal cost is £1 but the average variable cost (y) is determined by formula (1) which indicates that the average variable cost of water varies according to the amount of additional water which is bought.

$$y = £\frac{x \times 1}{200 + x} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Theoretically, such a pricing system has two deficiencies. The first one revolves around the efforts of the economist as a farm management worker who is trying to determine the *real* or *economic* cost of water used on different crops or pastures throughout the watering season. The second one centres on the influence which a dual price system has on the decisions of the farm operator. In reality, they are two sides of the one penny.

A plea for a revised price system to help the economist in his endeavours would not receive much consideration ; but it may be argued that where the water rights are appreciably large, and there is a fixed charge covering their title, the existing arrangements for collecting water revenue are liable to promote wastage during a good season. When the demand for water is low, the irrigator may not extend the amount of irrigation beyond his farm's water rights ; he is aware in a practical way that it then costs him nothing to irrigate and he may well be justified in wasting what is presumed to be a scarce national resource.

A simple solution lies in the separation of water rates from the physical supply of water, each unit of which would then have a constant average variable cost equal to marginal cost.[12] Water rates may still be applied to the legal tenure of water rights, and if charges are redesigned, the same amount of revenue may still be obtained.

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[12] I.e., in terms of the example used above, the water rights remain at 200 acre feet, but each and every unit delivered to the farm is bought at the same cost per acre foot, even if the amount delivered is less than 200 acre feet.

The administrators of water policy may consider that the above analysis does not warrant any such change in water pricing. The suggested effects are admittedly more likely to occur on farms where the average consumption of water does not exactly exceed their water right. However, the example is offered more as a variation to the usual attack on the "home maintenance area" concept which dominates political thinking on closer settlement; either of these examples would indicate that economics does not necessarily have to conform with any social or political terms of reference. One comment on this is :—

> "It may be felt that economic analysis of water resources policies has the dry taste of theory and cannot be applied to the political and legal facts of life. Economists restrict their own usefulness severely if they consider water policies only within the framework of present statutes. In many cases it is relevant to view laws as tools or obstacles of policy, and economists should make proposals for such changes."[13]

In circumstances where institutional conditions have to be accepted unconditionally, applied economic analysis must conform to their framework, otherwise its objectives of maximisation and optimisation are meaningless.

Before leaving the various ways in which economics can be applied to the use of the Snowy waters, there remains the selection of viewpoint. For example, the process of maximisation can be made from the points of view of the nation, the State, the region, or the farm unit.

One might think that the interests of the nation and the State would be parallel. However, the Economic Investigating Committee had reservations about this.[14] Its conclusions that diversion to the Murrumbidgee provided a more satisfactory answer to its criteria than did diversion to the Murray was based on a viewpoint of the nation at large and free from considerations based on State boundaries. It admitted, however, that the value of its recommendations would depend on the policy of subsequent use determined by the State of New South Wales.[15]

The division of interest between the region of development and the two larger entities such as the nation and State may also be significant. The introduction of intensive dairying may well be a profitable industry for the region if its productivity under irrigation is as efficient as we believe it to be; but this comparative advantage, if pursued, must be weighed against its direct effects of worsening the existing situation in marginal dairy areas. Economics, therefore, is not the only factor involved.

The same division of interest can be traced down to the attitude of the individual settler who is to use water. Whereas the line of reasoning behind national and State interests rests on agricultural policy and over-all

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[13] Ciriacy-Wantrup, S. V. "Cost Allocation in Relation to Western Water Policies" —*Journal of Farm Economics*, Vol. XXXVI, No. 1, February 1954.

[14] Report on Agricultural Aspects, *op. cit.*, pp. 2, 43.

[15] In general, the current New South Wales developments are not in conflict with the recommendations outlined by the Committee.

marketing considerations, the individual settler is a free agent whose private policy of maximising his own benefits may run contrary to the wider viewpoint. There seems to be no reason why dairying will not develop on Coleambally, for instance, irrespective of the farm design being somewhat different to that which might suit its special requirements.

If water on the whole is a nationally scarce (and, by implication limiting) resource, the efficiency objective from the national point of view is to maximise returns from it. The conditions of supply to the settler, however, may be such that water is not his most scarce resource, in which case he is moved to maximise his returns according to what *does* limit his net income, e.g., capital.

In considering the viewpoint of efficiency, therefore, the two outlooks most likely to be contrasting will be used here ; i.e. the objectives of the nation at large and the objectives of the individual who is to spread the water.

A final reservation regarding the form of approach which is implicit in the application of efficiency criteria is the necessary one distinguishing between the concepts of " what ought to be " and " what is or will be ". Applied economics can include in its objectives to be maximised certain preferences other than the common one of obtaining the largest net income. Working hours, standards of leisure and so forth can be incorporated into the " wants " programme to be analysed ; it cannot, however, include all of them and to this extent it is normative, especially when the economics is applied in the form of farm management. All farm survey data reflects to some degree, the values accepted by the sample members. The work of irrigation planners can be highly accurate, but by the same token unrealistic, if standards of efficient resource use are set above those generally accepted by farmers in comparable circumstances. To establish high standards of productivity is not altogether an extension problem or a technological one but reflects partly a desire to convert the farmer from his own set of values to those of Economic Man.[16]

Mindful of some important reservations, therefore, we can take for granted that efficiency is individually and nationally important. The question for discussion would appear to be the contribution that economics can make in achieving the efficient use of the Snowy waters.

THE PROBLEMS

The first pertinent application of economics to the use of the Snowy waters would be to enquire whether the cost of reticulation is outweighed by the benefits accruing to new development. This suggests a budget on the large scale of a benefit-cost study. The fact that the water is supplied free to the States has no bearing on the apparent simplicity of this approach. The Snowy scheme now so far advanced implies that the bulk of the resources have been committed, either in the past, or are well and truly approved and therefore earmarked for future commit-

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[16] See Glenn L. Johnson, " Value Problems in Farm Management " Proof circulated in advance of The Agricultural Economics Society's (Great Britain) December meeting, 1959.

ment. Had the States agreed to pay for their water, exactly the same sentiments would be valid ; from the State exchequer's point of view, the maximisation of benefits might then have read " the cutting of losses ".

However, even at this stage and especially with the information on hand, the measurement of benefits still begs the question of the form they will take. The total benefits from the use of the Snowy waters depend on the productivity of water and other resources on the individual farm. We must therefore look at this new farm in terms of *what* it will produce and *how* it might produce it.

One of the first problems which is still presenting difficulties is the type of industry which might be pursued with enlarged irrigation. What might be an attractive group of enterprises is in turn related to the bundle of resources available to each farm.

The type of production, whether it should be rice, dairy products, horticulture or fat lambs and beef, may be determined by many criteria, all of which must be weighed against each other to ensure that they are not conflicting. For example, one simple illustrative approach is that if water is the most scarce resource and horticulture provides its most intensive use, an extension of horticulture is apparently justified. Justification of this approach is eventually dependent on the elasticities of demand for the products of water and the ultimate necessity of equating marginal returns from the whole range of possible products.

Quite apart from the purely market considerations, the extension of an enterprise may be influenced by Government policy including subsidies or restrictions on enterprise expansion. It will be apparent that such policies seldom encourage the most efficient transfer of resources between enterprises.

The question of " how " the desired products are to be produced is an economic problem in so far as there is a choice available among the means to produce them. In this respect, it is not intended to probe into too much detail. To consider the right amount of fertiliser to use in top-dressing would be presenting the problems out of all proportion. The ones which cannot be ignored are those such as farm size, the economic relationship between dry and irrigated land, the provision of farm credit and the overall need to express their complexity and inter-relationship in quantitative terms. The appropriate order in which to consider these questions depends primarily on what is to be produced.

The Product Market

The general opinion of the Economic Investigating Committee (1947) was that the bulk of the water would be best directed towards the production of fine wool, crossbred wool, fat lambs, fat cattle and sideline cereals. Horticultural developments[17] were thought to be strictly limited in their

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[17] Citrus, fresh fruit, canned fruits, dried fruits and vegetables.

economic prospects. The physical capacity to expand dairying was stated as considerable and was economically attractive in the two regions, particularly on the Victorian side of the Murray Valley. Any decision to expand dairying in the irrigation districts, however, depended more on considerations of policy than on economic grounds. Thus the Committee reported that :

> " If the policy is to maintain the status quo of existing dairying settlements, the emphasis on such expansion would be considerably less than it would be if policy were to press towards lowering of subsidies and elimination of higher cost units."[18]

Two of the most intensive forms of water use, horticulture and dairying, were thus restricted and this further limited the economies of water reticulation, provision of amenities and public facilities afforded by intensive settlement.

The production of fodder (for sale) was investigated with the idea that demand from dry area graziers would make this attractive in average seasons and of national advantage in times of drought. It was subsequently shelved for want of information on the economics and practical problems of fodder production as well as the regulations required to pursue national interest and direct its conservation for drought periods.

Expansion in rice growing was frowned upon because any future expansion of the export market would have to be made at the expense of growers' returns ; it was incidentally unpopular due to the heavy water demands of this industry.

The Committee was therefore left with the staple products of Australia's dry land farming, namely fine wool, crossbred wool, fat lambs, fat cattle and sideline cereals ; and these happened to be attractive mainly because they would not materially affect the overall marketing position of the Commonwealth.

This review of the Committee's general evaluation of the market prospects for different commodities is interesting on several counts. It was necessary at the time to forecast market conditions 15-20 years ahead ; in turn, a knowledge of the most promising products assisted the Committee in the preliminary survey of which valley (the Murray or Murrumbidgee) could best produce them. The conclusions determined by the Committee are of further value because they are still valid today. The only perturbing aspect about the products which did seem the " most promising " is that they were acknowledged as such by a process of residual imputation.

When we come to consider commodities other than the familiar ones already grown under irrigation, their ability to efficiently use water and other resources in competition with these traditional products is a matter of conjecture. There are a number of limitations to the expansion of such crops as cotton, tobacco or oilseeds. They include either limited markets, unsatisfactory yields under irrigation, or an inability to compete

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[18] Report on Agricultural Aspects, *op. cit.*, p. 7.

with imported substitutes ; and in addition there is a lack of knowledge concerning their production requirements. The satisfactory development of such import saving crops will depend, therefore, on more economic and technical knowledge and on Government policy.

The extension of rice growing to new areas will promote their initial development but at the same time will be limited by the adverse market outlook for the short grain varieties if they are still grown. If production is pushed to its economic limit, it can be anticipated that the role of rice as the most profitable pioneer crop will vanish. From the farmer's point of view, this will be regretted ; from the irrigation planner's point of view, another panacea of settlement ills will be lost ; but from the nation's point of view, this is free competition and a more efficient use of resources.

If rice growing remains as a measure of short-term expediency, then it cannot be considered as a basis for long-term settlement. Subject to the possible inclusion of cotton and other new crops, livestock products and incidental cereals to be grown in rotation with pastures still remain as the most promising products. Approximately 80% of all water delivered to the Murrumbidgee Irrigation Areas is delivered to large area farms growing crop and livestock products. It can be assumed that an even greater proportion of the Snowy waters will be used in the same direction but with less emphasis on rice production. A more tentative assumption that dairying cannot be considered as a major avenue of water use concludes the framework necessary for the discussion of how these products might best be produced.

The Purpose of Irrigation

On those large area irrigated farms in the Riverina which produce wool, fat lambs, vealers and incidental cereals there appears, at first sight, to be a superficial uniformity both in products and available resources. Rice farms have their own special features, but can be added to this rather loose group. On closer inspection, the fundamental difference between the two forms of irrigation settlement, the Area and the District, suggests the first major problem of resource allocation ; i.e., is water to be used in encouraging a marginal addition to the nation's livestock products or is it better directed towards stabilising the existing production of the region's dry land farms ? The deciding factor resides in which policy would secure the greatest net gain in the long term. The choice of which road to follow therefore represents a decision between two different philosophies of water use and determines the way in which other resources are best combined.

The Economic Investigating Committee considered the same matter from several points of view but reached a stalemate due to lack of information. The relative expensiveness of widespread reticulation of water under conditions of partial irrigation was submitted to them as being uneconomic and obviously inferior to the more intensive " solid block " principle of irrigation. Recognising this, the Committee reviewed several methods of jointly operating a dry land sheep property and a specialist irrigation farm, but was still handicapped by lack of sufficient factual evidence to support their justification. For example, the proposal of

having irrigation farms in common ownership with dry area stations " requires a liberal attitude to land holding but has sufficient possibilities to warrant investigation as one of the possible alternatives. The theory seems sound but the real test is what form of use would develop in practice."[19]

The real value of this direct integration of irrigated and dry land farming lies in its mitigation of production uncertainty.[20] One observer has said that :

> " If this is the primary role of irrigation, there is a strong case for some change in the traditional emphasis in irrigation development. There has already been some shift towards the development of farms with limited irrigation rights and the provision of stock and domestic water supply schemes. But this needs to be carried further. We need to encourage spatial diversification of farms."[21]

This kind of thinking has been more thoroughly dealt with by Rutherford,[22] who has extended the concept to cover all types of relationship between irrigation and dry land economies. For example, he lists as an " off-farm " type of integration the movement of stores from dryland breeding areas for fattening on irrigated pastures ; accomplished, of course, through the market mechanism.

Looking at integration from the point of view of an " on-farm "[23] example, the dry portion of the farm unit is relieved of production uncertainty because of its direct access to the stabilised production of the irrigated portion.

The object of combining dry and irrigated land under the same management is therefore the efficient *conservation* of the nation's and the individual's resources. Further possible economies from this arrangement lie in the " vertical " integration of livestock production. The fattening of lambs, for instance, can be accomplished on the irrigated property while the breeding of first cross ewes may be undertaken on dry land. Such a production policy also leads to a diversification of enterprises with some reduction of risk. If irrigation farms are developed independently and must cover their relatively high fixed costs, there is serious doubt whether irrigation reduces fluctuation of income in every case.

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[19] Report on Agricultural Aspects, *op, cit.*, p. 17.

[20] Of course, an irrigation farm independent of such an arrangement is afforded the same reduction of risk, but its security of production would be of greater value to the nation if areas suffering greater uncertainty could share in its production stability.

[21] Keith O. Campbell, " The Challenge of Production Instability in Australian Agriculture ", *The Australian Journal of Agricultural Economics*, Vol. II, No. 1, July 1958, p. 19.

[22] John Rutherford, " Integration of Irrigation and Dryland Farming in the Southern Murray Basin " Parts I and II. *Review of Marketing and Agricultural Economics*, Vol. 26, No. 4 (December 1958), pp. 227-283 and Vol. 27, No. 3 (September 1959), pp. 146-233.

[23] I.e. Both dry and irrigated properties, perhaps non-contiguous, are run as a single business.

Even if irrigation affords stability of production, a completely irrigated unit is liable to high economic risks induced by price fluctuations.[24]

There are strong grounds for recognising a further relationship between dry and irrigated land to the extent that they tend to be technical complements. A small area of irrigated green fodder is often advocated for the efficient utilisation by ruminants of large quantities of dry feed. Conversely, a small area of dry land is a valuable holding paddock for the management or health of stock on intensely irrigated properties.

Enough has been said above to justify the importance so far attached to the concept of integrating dry and irrigated land. It has been recognised as important in the past, sufficiently so in fact that suggestions have been offered towards liberalising traditional attitudes to land holding in order to achieve a lessening of production uncertainties.[25] Each alternative for water use has vital implications for planning the long term combination of enterprises and of resources.

Until these ideas have been quantified with factual evidence, or dismissed or accepted out of hand, the economist can see little point in considering a serious attack on the next logical sequence of problems. Irrespective of whether the problem is " ignored away ", however, it seems desirable to at least state some of the principles involved.

The Allocation of Resources to the Farm Unit

When the irrigation planner assumes the task of directing the nation's public and private resources at this more detailed level, he is faced with equally complex considerations. Apart from the fact that he must still view the problems from an efficiency viewpoint—applied with a knowledge of farm management—the pressures from above (public policy) and below (regional and local interests) can distort the role of partnership which economics is able to play. As stated earlier, economic efficiency is frequently compromised with other objectives and this is understood and accepted. It is intended here to postulate the efficiency objectives of resource allocation at the level of the farm design. This will at least provide the base from which the desirable compromises can be effected.

In looking at farm size from the nation's viewpoint we want to determine the size of farms which, under various conditions, would result in the most economical production of farm products. From the viewpoint of the farm operator, we are concerned with how his farm size effects the efficiency and net income of his farm.[26] Admittedly, some allowance must be made for changes in technology, if indeed it is possible to forecast their effects. In considering the farm size already determined for Coleambally, does its physical area and combination of dry and irrigated land fully express the requirements of an efficient farm unit ? A purely

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[24] See Otto Eckstein, *op. cit.*, p. 218.

[25] Report on Agricultural Aspects, *op. cit.*, p. 17. Rutherford, *op. cit.*, has offered the concept of " corporate land management " as a possible solution worth investigation.

[26] See, for example, Russel O. Olsen, " Review and Appraisal of Methods Used in Studying Farm Size ", *Resource Productivity, Returns to Scale and Farm Size*, Ed. by Earl O. Heady, Glenn L. Johnson and Lowell S. Hardin. The Iowa State College Press, Ames, Iowa, U.S.A., 1956, p. 53.

empirical approach to determining the long-run average cost curve as influenced by farm size does not appear to be the best approach in view of the types of mixed farming in the Riverina. Perhaps the only alternative lies in theoretical models built around discreet units of labour.[27] Whatever is the case, the need for reconstruction of farm areas on the Murrumbidgee Irrigation Areas in the past attaches a high degree of importance to the determination of farm size.

There is not much to be said on rural credit or even the use of the individual's capital in developing new farms. If the farms can be proved to be an economic proposition, then capital should flow in their direction of its own accord. If full reticulation of the Snowy waters is stamped with approval then, if it becomes necessary, a suitable rural credit policy must be forthcoming in order to back it up.

The Need for Empirical Data

Given the water resources and the money, it is physically possible to extend irrigation ;[28] to do so economically requires sound application of economic principles and techniques from the time the irrigation scheme is proposed until the last acre foot of water is allocated. In some cases, neither all the facts nor an elaborate economic analysis is required to indicate the answer. Rough calculations may be all that are necessary to determine that certain developments are not feasible or are obviously inferior to alternative ones. But when the problems involve the choice of farm size, the number of breeding ewes to be run on a property, or the exact amount of capital to be advanced as credit, the number of possible discreet solutions seems infinite rather than a few. Any detailed planning of the use of the Snowy waters theoretically involves a very large number of decisions each of which is only one of the many that appear possible. When it is realised that many of the decisions are interdependent,[29] an imposing problem of multiple variables takes shape. This automatically recommends the use of advanced techniques but at the same time demands that they be applied to data which is worthy of their preciseness.

It was suggested earlier that the principles of economics, particularly when applied to farms, are normative in so far as their criteria of maximisation do not always coincide with the attitudes of entrepreneurs. When there is scant information available to an irrigation planner concerning likely levels of productivity, costs and returns on proposed farms, the need to invent it introduces further likelihood of unrealistic conclusions. Despite the inadequacies of empirical data derived from farms in com-

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[27] See, as an example, Fellows, I. F., Frick, G. E. and Weeks, S. B., " Production Efficiency on New England Dairy Farms : 2. Economics of Scale in Dairying—an exploration in farm management research methodology ", Conn. Agr. Exp. Sta., Storrs, Bul. 285, 1952.

[28] Even a brief tour of the Coleambally Irrigation Area is sufficient for one to be impressed by its engineering accomplishments in extending water canals.

[29] For example, the pattern of production can influence optimum farm size ; the size of farm may influence total and seasonal water requirements which in turn determine the design of supply channels. Such factors can even dictate the nature of major storage dams.

parable areas, such information is obviously superior in measuring human endeavour to a knowledge of what is technically feasible and obtained under non-commercial conditions, e.g., experiment farms. As mentioned before, empirical data has the merit of including what the farmer is willing to accomplish rather than what is expected of him.[30]

In planning the use of the Snowy waters so far, the persons responsible have been obviously handicapped by a lack of factual information. It is imperative, therefore, that suitable data be obtained. In view of what has been said already about possible alternatives in the type of development now taking place in the Coleambally Irrigation Area, it would be premature to forecast the specific nature of the data required. In the meantime, the farms now taking shape could benefit considerably from the application of farm management analysis in solving their problems of resource allocation. This is farm planning in terms of what is the best use of the resources which have been decided for them. This type of extension work requires factual information about the farms.

Other types of data obtainable only under conditions of controlled experiment would be a valuable help to any economic advisory service to beginning farmers. Such experiments would naturally be of greater value if they were designed jointly by the physical scientist and the economist with the intention of obtaining the levels of response under as many conditions as possible.

CONCLUSION

The role of the economist in guiding the use of the Snowy waters is confined to what he can demonstrate in terms of the efficient use of resources. Although economic efficiency is not the only objective of the nation or the individual, it deserves a high priority. It is therefore imperative that economics be given its due share of responsibility and so relieve other professions of the need to solve problems of an economic nature.

At this stage of the Snowy diversion, the first responsibility of the economist is that of determining whether irrigation development is attractive enough to merit the public investment necessary to carry it out. In doing this he must use economics and not some curious substitute.

A thorough reappraisal of water policy is required regarding the purpose of irrigation in south-eastern Australia. While it is true that irrigation affords stability of production, it seems unnecessary that areas outside its immediate vicinity still have to contend with production uncertainty. If wool and meat are to be the major products of the Snowy waters, there are two distinct ways of encouraging their output. The first one creates an intensively irrigated oasis which affords limited benefits to surrounding dry properties. The second one involves legal and economic ties between the same oasis and the dry area, thus extending the benefits of production stability over a much wider field.

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[30] See, for example, P. Duane and A. H. Rowe, " Planning the Response to Economic Change on an Irrigated Farm ", *Quarterly Review of Agricultural Economics*, Vol. XIII, No. 1, January 1960, pp. 15-24.

If the major decisions are in favour of one or several forms of irrigation development, there are exceedingly complex considerations which still remain before the settler takes over his farm. It is not a question of justifying the role of economics in dealing with these problems ; it is more pertinent to ask how they can be resolved without using its most advanced techniques. For example, how can farm size for Coleambally be decided without the aid of linear programming ? One academic thinks that this would make a good examination question.

Whatever the particular application of economics may be, it must have sound data with which to work. The difficulties now being experienced in extending irrigation are partly due to lack of information ; and it was lack of knowledge that dogged planners during the early investigations into the use of the Snowy waters. It is unlikely that any amount of data will ever be regarded as adequate for planning, but now is the time to exhaust what is available and to obtain as much as possible of what is lacking. Information must be collected not only from farmers and scientists but from those administrators who have a wide knowledge of water affairs.

It would be ambitious even to suggest that this paper has covered more than a few of the economic problems of using the Snowy waters. But an attempt has been made to present the critical issues at stake in the hope that they are not overlooked or avoided.