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Articles in the field of agricultural economics, suitable for publication in the journal, will be welcomed.

Articles should have a maximum length of 10 folio pages (including tables, graphs, etc.) typed in double spacing. Contributions, in the language preferred by the writer, should be submitted in triplicate to the Editor, c/o Department of Agricultural Economics and Marketing, Pretoria, and should reach him at least one month prior to date of publication.

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2001

Macro resource planning and adjustment¹⁾

by
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1. THE NECESSITY FOR RESOURCE ADJUSTMENT IN AGRICULTURE

The necessity for resource adjustment in agriculture stems from the restraining factors which occur in this sector. A sub-optimum organization of resources occurs to a large extent and also over a wide range of farm enterprises. This fact is clearly indicated in many farm management studies. The net value-product of production factors used in agriculture can therefore be increased. Furthermore many farmers are in a financial position which often does not allow them to provide their families with the bare necessities of subsistence. Although conditions differ appreciably between areas and economic strata, rural families often compare less favourably with urban families with respect to their economic position. The financial position of the farmer is further reflected in the decline of rural communities which is further enhanced by the systematic exodus of rural families.

In the light of these restraining factors a solution is being sought for the agricultural problem. It is essential that the agricultural sector should be organized in such a way that it can make a maximum contribution to the national welfare. The most important question in this connection concerns the way in which the natural and human resources ought to be used over the longrun so that agriculture can make its maximum contribution to the economic growth of the country.²⁾ Furthermore the problem of the consolidation of the economic position of the farmer still remains important. The provision of positive benefits to the farmer as compensation for the progress to which he contributes, must, however, take place within the realm of the maintenance of natural resources.

II. CRITERIA FOR OPTIMUM RESOURCE USE

Due to the lack of an appropriate dynamic theory, static efficiency criteria are used here in order to evaluate the utilization of resources in agriculture.

The following three marginal principles are applicable:

- 1) The writer wishes to express his appreciation to Prof. J.A. Groenewald and Mr J.P.F. du Toit for assistance and useful suggestions contained in this paper.
- 2) Timmons, J.F. Land and Water Resource Policy. Journal of Farm Economics, Vol. 45, Feb. 1963. pp. 95-108.

- (a) Factor mobility: Is the payment to a production factor, in a specific use, equal to its potential compensation in alternative uses? The difference in compensation indicates the increase in the total product by the potential adjustment.
- (b) Are the production factors used to the point where the compensation to the production factors are equal to the respective value of their marginal products?³⁾ The difference between factor compensation and the value of the marginal product, indicates the potential increase in the national income, as obtained from a more efficient utilization of resources.
- (c) Is the compensation per unit of a production factor equal to the cost of producing a specific production factor? In other words, is the value to be sacrificed in order to produce an additional production factor, more or less equal to the value produced by this factor? This requirement is especially important when the creation of additional production factors is considered.

These marginal principles are useful, but the practice is characterized by dynamic conditions. Static criteria apply to the efficient distribution of resources to satisfy the demand under a given set of technological and institutional conditions. The dynamic aspects concern the improvement of the methods of transforming inputs and outputs, greater skills and more effective institutions. The influence of a disequilibrium situation on income provides some of the most important economic problems in agriculture. The process of the adaption of resource use, especially labour, is very important for a more efficient economy. Agricultural resource use should therefore not be judged on the basis of the marginal principles for a static equilibrium. A more appropriate criterium is the determination of whether the movement in the utilization of resources is in the desired direction, and also whether this adjustment is moving as rapidly as possible towards the equilibrium position.

The utilization of all production factors which are connected with agriculture will not be discussed. The aspects that will be discussed refers to the mobility of production factors between the agriculture and other economic sectors, including the associated problem of rural development, the mobility of production factors within

- 3) Applicable only if the production function is homogenous of order one.

the agricultural sector, the influence of agricultural policy on resource use, water as a production factor and investment criteria in agriculture and related industries.

III. (a) THE MOBILITY OF RESOURCES BETWEEN THE AGRICULTURAL SECTOR AND OTHER SECTORS

(i) Entrepreneurship

This aspect is by far the most discussed agricultural problem and often gives rise to emotional counterreactions. In so far as it is possible to classify the human factor - and taking into account that no classification is mutually independent - three groups of farmers can be identified.⁴

1. Low income farmers. The agricultural production of this group is small and they do not compete seriously for land and other agricultural resources. Factors outside the agricultural sector may influence their decisions to move out of agriculture (as for example employment opportunities, education, etc.)
2. Farmers who are relatively inefficient. They do not possess a comparative advantage in agriculture. These farmers, however, compete seriously for land and other resources; they influence and are influenced by agricultural surpluses, prices and income.
3. Relatively efficient farmers with a comparative advantage in agriculture.

Equilibrium, or the movement towards equilibrium, implies that group 1 and 2 farmers will disappear. Only group 3 farmers will survive and their numbers may even increase.

Such a definition is by no means new, but the important question which the economist still has to answer is how rapidly should this process of adjustment take place? What is the optimum rate of change, taking into account additional training requirements in the rural sector, the influence on the rural community and the absorption possibilities of the urban centre.

If this factor is the central problem in agriculture, the causal factors for this immobility should be thoroughly researched. Can it be ascribed to the cost of migration? Is age a factor? Is it as a result of non-market choices, in other words, are income differences only the compensation of an economic product that in reality forms a part of the national income, but normally is not calculated as such? Does an exodus of farmers imply bigger overall production? If so, will the total income decline as a result of the inelastic demand for agricultural products? If the income per farmer should increase, it is implied that the number of farmers should decrease relatively faster than the total income of the agricultural sector.

4) Tolley, G.S. and Farmer, B.M. Factor Market Efficiency for Agriculture. American Economic Review, Vol. 54, May 1964. pp. 107-119.

Any measures to increase mobility are praiseworthy. The hypothesis may, however, be ventured that the mobility of human factors is an aspect which stretches over many decades and cannot be solved by short-term means. There is a tendency towards equilibrium, and it will be continued in future, although the rate of adjustment will often not be as rapid as desired. Adequate training appears to be a long-term means of solution thereby creating attainable alternatives for rural families. Furthermore it may be economically justified to increase educational inputs in the rural areas even above those of urban areas. The marginal productivity of education may be higher in these areas if the prevention of future inefficient utilization of resources is also taken into account.

(ii) Land

It would appear that land is to some extent a mobile factor. Agriculture's bargaining power for land in urban areas is weak. On the other hand land for recreational purposes readily displaces agricultural land, while agriculture can readily displace land for forestry purposes (depending on the relative profitability). The reality market can therefore be divided into four sub-markets, where the mutual competitive positions are relatively weak. According to this criterion it would appear as if land is being utilized efficiently.

The situation is, however, not so good if it is taken into account that high quality land in South Africa is scarce. Roads, railways and similar undertakings often seriously compete for the best agricultural lands. The use of less productive land for such purposes would be more advantageous provided the social cost connected with such actions is not too high. Furthermore the tendency, especially in the environs of cities, to convert high potential land into prestige residential areas such as agricultural small holdings, should be condemned. Over the long-term such actions should be regarded as expensive because it lowers the future agricultural production capacity. Institutional measures should place such actions beyond the consumption bundle of the individual.

(b) RURAL DEVELOPMENT⁵⁾

Often the stimulation of rural development is seen as a method of increasing the adaptability of the agricultural sector. In the light of previous discussions it is not clear whether this argument is not an over-simplification of the problem. It may well make such a contribution, but the main motive for such a policy should be sought in the sociological field and further in the policy of decentralization to relieve the pressure on urban areas and water sources.

The inelastic demand for agricultural products and the tendency to substitute capital for labour through technological changes imply that activities

5) See also: Kotzé, H.A.: 'n Studie van die Ekonomie van die Noordoos-Kaap met Besondere Verwysing na die Landbou. D.Sc. (Agric.)-dissertation U.O.F.S., Bloemfontein 1966 and Du Toit, P.J.D.: Service Areas and Rural Development. Agrekon, Vol. 8, No. 2, April 1969.

other than the production of ordinary agricultural products should be considered. This is necessary if the economic growth of the rural community is the primary objective.

There are undoubtedly industrial possibilities in rural areas. It should be remembered, however, that the greatest potential for the employment of individuals of rural origin is in secondary and tertiary industries. Whether these individuals live in urban, sub-urban or rural areas is another matter. The possibilities of alternative employment for the agricultural community lie mainly in industrial, commercial and service industries which disclose the tendency to be concentrated in urban complexes.

The aspect of regional development implies answering the following questions: How should the economy be organised regionally so that the national product is maximized subject to regional factors, technical coefficients, demand restrictions and transport costs? Are the present location patterns based on economic factors? Can a change take place in location patterns on an economic basis?

Any regional development plan revolves round available resources, the size of the population and technology in a specific area. Unless an area is completely dependent on subsidies in order to develop, the economic system of the area will be directly or indirectly dependent on adequate material resources.

Some areas do not necessarily have adequate resources at their disposal to ensure a decent livelihood for all their people. The idea of regional development always acknowledges the fact that sufficient resources might not exist in a localized area - and tries therefore to provide a larger resource area (functional economic areas). The most important aspect of enlarging a planning area, revolves round increasing the ratio between natural resources and the population. When there are insufficient natural resources in such an area, there may be factors, such as for example consolidation, which could have a favourable effect, but seldom are these economics of scale sufficient to overcome the shortage of resources. A regional development plan should take into consideration the equilibrium between resources and the local population. The solution may imply that the amount of human resources in a specific area must be decreased, and the material resources increased. The resettlement of people, however, is often an emotional issue which cannot be carried out easily.

Rural development does not necessarily therefore imply the stimulation of each local unit. Some areas cannot continue to exist on available resources, while other areas can develop. It is therefore extremely important that the areas with development potential be identified.

This is a difficult task to accomplish seeing that there is apparently a world-wide lack of data on a regional basis. Several adjustment techniques are usually necessary to break down national data to a regional basis. It is amazing, however, to see how much regional economists have achieved, or attempted to undertake with the insufficient data.

Regional models applied thus far are either of a descriptive or conditional nature. These

models could be applied usefully as indicators of the development potential of an area or could identify the serious problems in an area. Regional models are, however, so far still relatively unsophisticated, mainly as a result of insufficient data. Several suggestions have been made as to the usefulness of the results to public authorities as well as private firms. Such indications are quite justified, but micro-decisionmaking units are ignored. The micro-adjustment problems are avoided in the hope that other researchers will follow up these problems.

IV. MOBILITY WITHIN THE AGRICULTURAL SECTOR

It is often experienced that there is a lack of adaptability in agriculture in the sense that specialized agricultural resources and location advantages are not combined with specialized managerial skills. A planning model proposed by Prof. Groenewald, has definite application possibilities in this connection. He suggests that the physical potential of agricultural land and climatological factors in the country should be isolated. According to these physical factors the possibilities for crop cultivation and livestock production should be established. Furthermore marketing possibilities (*inter alia* transport and storage facilities), domestic and foreign must be established, together with yield and price variability. The optimal location of the various agricultural activities can then be determined accordingly. The potentiality of such an approach is great and Von Thünen's descriptive classification may be applied empirically and possibly proved.

It is often alleged that price supporting measures inhibit the adjustment of production possibilities between areas and within areas. It is quite correct, but a more pertinent question would be the magnitude of these factors. This effect is empirically measurable, if the total cost of production under alternative geographical distributions of production is compared. The effect on the total income, resulting from the lack of adaptability can then be calculated.

The disturbances in factor substitution caused by high land prices (only partly the result of too high product prices) should be relatively small. The adverse effects of this factor consists in that the entry of young group 3 farmers is being inhibited. Furthermore the division of land within the agricultural sector is being reduced as a result of the high price demanded by present owners. A positive aspect connected with high land prices is the possibility that capital appreciation can increase this mobility. For example, a farmer can be induced to sell his land because of the high market value of his capital assets and obtain a position in the non-agricultural sector, thereby increasing his net welfare.

A further adjustment possibility within the agricultural sector which should also definitely be considered, are the possibilities of the resettlement of farmers on new irrigation schemes. Here one thinks specifically about the weak economic

position of farmers in the extensive livestock regions, which came about as a result of relative price changes, droughts and the deterioration of natural pastures. These farmers may claim precedence when irrigation schemes are established.

V. AGRICULTURAL POLICY

An economic policy is usually evaluated by determining to what extent the objectives of such a policy are obtainable, subject to certain restrictions. The objectives of the agricultural policy in South Africa can in general be defined as follows:⁶⁾

1. The promotion of productivity;
2. the maintenance of a numerically strong agricultural sector;
3. the conservation of natural resources; and
4. the provision of a steady income and living standard for the producer.

These objectives must however, not excessively influence the principles of optimal utilization of resources, such as -

- (a) the adaptability within the agricultural sector;
- (b) the adaptability between sectors; and
- (c) the maintenance of free competition and private initiative.

The first aspect to be considered, is the determination of the extent to which the basic objectives of the agricultural policy are competitive or complementary. So for example it is not clear how to reconcile the promotion of a numerical strong agricultural sector with the other criteria such as the promotion of productivity, the increase of producer's income or the conservation of natural resources. Similarly the objective of the conservation of natural resources conflicts with the objective of shortterm profits. All the objectives of an agricultural policy are therefore interdependent and a decision should be made on the weights granted to each objective in the agricultural policy. On a priori basis, a suggestion that a numerically strong agricultural sector should carry a weight of zero (or near to zero) should not be debatable to a high degree.

The second aspect of evaluating the agricultural policy, is to determine how the policy measures instituted to achieve specific goals, are influencing the restrictions. In the proposed model these restrictions have been put as the minimum influence on adaptability within and between sectors as well as on free competition and private initiative.

Before evaluating the agricultural policy against this model, one aspect should be clarified. The idea that a return to free market conditions can solve all agricultural problems seem erroneous. Studying the effect of free market prices is only of academic importance. Techniques for increasing yield are applied in practice without

considering the effect it will have on prices.⁷⁾ Because of the inelastic demand for food, such actions will force down prices and therefore, also income. Furthermore the producer also does not feel inclined to apply idle capacity as is the case in industry. A return to free market prices will result in an extremely unstable position. This instability will only be solved when the free competitive market structure has degenerated into some degree of monopoly. Both the process of adjustment, on this basis, and its eventual result are thus undesirable.

The agricultural policy will be discussed only with regard to the effect it has on efficient resource use. Only a few groups of policy measures will be discussed as for example price policy, supply control measures, natural resource conservation measures and "aid organisations" (assistance to farmers, other forms of credit, drought aid etc.).

(a) Price policy

To what extent does a price supporting programme succeed in obtaining an increased income as well as income stability and promoting efficient resource utilization in agriculture?

The first aspect which should be considered, is the influence of a price policy on the income distribution in the agricultural sector. Although the purpose of price support measures do not necessarily amount to changing the income distribution of farmers, this aspect should nevertheless be mentioned. There is little reason to believe that the price policy has succeeded in changing the income distribution relatively. Price support could have changed the relative income distribution if it could be demonstrated that these programmes did relatively increase the income of the farmers in the lower part of the income scale and by so doing reduced the exodus of farmers. In such a case one would be able to postulate that the income distribution is now more skew than it would have been without support. It cannot be seen, however, how it actually would have happened.

One of the greatest effects of a price supporting programme is to increase or maintain the producer's income for some areas relative to others. In the absence of price support measures, relative prices would most likely have come about that differ from the present patterns, and thus the income distribution between areas will also differ. Over the shortrun, price supporting measures could well have been of benefit in certain areas. Over the longrun the relative profits associated with a specific area and/or programme would disappear, if no limits are put on the movement of labour or on land prices. After such an adjustment took place, an adjustment which is often coupled with an unfavourable structural change, especially in marginal areas (sizes of farms

6) See inter alia: C. van der Merwe: Die Landboupolitiek; in: Die Ekonomiese Politiek van Suid-Afrika, edited by J.A. Lombard, H.A.U.M. 1967. pp. 11-26.

7) Hattingh, H.S.: Farm Management - A Prerequisite for Sound Agricultural Development. Agrekon, Vol. 8, No. 2, April 1969. pp.54-59.

etc.) and consequently an deterioration of natural resources, it is extremely difficult to correct this maladjustment. This problem is not only the result of price supporting measures by the authorities. An example of this aspect (in a worse degree) can be observed in the extensive sheep grazing areas of the country, where high wool prices occurred in the 50's, with tremendous adjustment problems for the 70's.

A readjustment would make the study of supply elasticities necessary. For example consideration has been given to the possibility of differentiated prices as a means of solving large mealie surpluses. Whether a differentiated price system may influence production (a shift in crop patterns) depends inevitably on the supply elasticity of mealie production in the different regions. It is stated on a priori basis that the supply elasticity in the High Veld and Eastern Free State would probably be greater than in the Western Transvaal, because there are greater crop cultivation possibilities. Such a price system would naturally have corresponding serious results for the agricultural income of such an area, with large short-term privations.

Researchers who study the factors which result in labour moving out of agriculture, generally come to the conclusion that product prices have a small influence on the decisions whether to move out of the agricultural sector or not.⁸⁾ The tendency to leave farms would perhaps have been greater if prices of products were lower, but it is not certain whether the exodus would have been concentrated on lower income groups or whether the movement would not rather have been spread proportionately over all income groups.

In summary it can be said that higher prices (income support) were effective in increasing farm income over the short run. Over the longrun these benefits would disappear, after sufficient capitalization of the benefits of the supporting scheme, sufficient change-over of owners, substitution between inputs and other techniques for bypassing the programmes.

The magnitude of price supporting measures on resource adjustment within agriculture, is however a subject for empirical verification.

(b) Supply control

Here one thinks especially about the withdrawal of land from production or similar steps to limit the area under a specific crop. This aspect is not applied to such a large extent in South Africa as in some overseas countries, but the quota system is wellknown in South Africa.

In general, supply restrictions can be regarded as a disregard of all principles for which economics stand, namely larger yields of saleable products, efficient resource allocation and the consideration of the interdependence between

sectors. Supply quotas (in various forms) result in a loss of freedom, lack of adaptability in resource use and the impossibility to limit production (as a result of factor substitution). Other factors⁹⁾ which result from supply restrictions are as follows:

- (a) It provides a windfall profit to present owners in the form of higher land values - supply restrictions are therefore the most effective way of creating a cartel;
- (b) a windfall profit to the present generation, implies a cost to the following generation because production rights becomes expensive and thus inhibits the entry of future entrepreneurs;
- (c) it is easy to introduce quotas, but difficult to abolish it; and
- (d) the skew distribution of income is increased because the capital assets are increased in accordance with possession before the introduction of such a measure.

This policy measure, therefore, contributes little to the other policy standards.

(c) Criteria for maintaining and increasing technological innovations in agriculture

In the shortrun this objective conflicts with shortterm income increase. The rapid advance in technology and the diffusion of these technological innovations in agriculture and elsewhere, result in yield increases. The implications of Engel's Law are clear in an economy characterized by increasing productivity. Labour sources in agriculture must shrink continually because the demand for farm products will not increase in proportion to the increase in per capita income. Unless farmers move out of the agricultural sector, their incomes will decrease relatively. This premise should be qualified if differential productivity movements occur between the various sectors. If productivity in agriculture increase more rapidly than in other sectors, this trend is accentuated.

Is there any reason for stressing the development and adoption of new techniques in agriculture, if it has such a tremendous influence on agricultural income? Can technological innovations not be limited or regulated in accordance with the domestic food requirements of the overseas population? Such a one-sided approach would have an adverse effect on the economic development of the whole country. It will weaken the competitive position of the South African agriculture on international markets, and thus have a serious influence on the economic development of the country, seeing that agriculture makes an important contribution in the earning of foreign exchange. It can also adversely influence the cost structure of other sectors. Serious consequences may also occur in the internal food production capacity over the longrun.

8) Schuh, G.E.: Econometric Investigation of the Market for Hired Labor in Agriculture, Journal of Farm Economics, Vol. 44, pp. 316-317.

9) Paarlberg, Don: Discussion: Contribution of the New Frontier to Agricultural Reform in the United States. Journal of Farm Economy, Dec. 1962, pp. 1179-1183.

One can venture to say that the rest of the economy will be prepared to tolerate a "degree" of inefficiency as well as some form of assistance to the agricultural sector - especially if the adoption of new technology has the direct result of supplying food relatively cheap.

The disadvantage connected with applying new techniques can only be seen as the temporary adjustment problems which arise in the labour market. This aspect cannot be regarded as a disadvantage on the medium to the longrun, seeing that technological changes again creates new employment opportunities.

(d) Measures for the maintenance of natural resources

It is accepted here that the limited resources available for the conservation of nature are utilized optimally, or can be utilized optimally without any difficulty.

From a general point of view the question, whether nature conservation (soil conservation) is economically justified, is permissible.

The determination of the effect of nature conservation depends mainly on the period taken into consideration. If shortrun profits are taken into consideration, nature conservation will most likely be uneconomical. Nature conservation is obviously a longrun problem.

Nature conservation conflicts directly with short-term profits and this aspect is aggravated further by the lack of structural adjustment in agriculture (small farms, wrong production combinations, etc.). In an effort to maintain short-term profits, nature is consequently exploited. In so far as other policy measures thus inhibit this aspect of adjustment, it must be seen in direct conflict with the longrun welfare of the entire population of South Africa.

Should an optimum structure come into being, problems with nature conservation would still occur. These problems can be ascribed chiefly to the appearance of "external economies", in other words, the market mechanism does not discount all costs incurred in the production of a specific product. Here the natural resources lost in production should be seen as a production cost item. Even if this factor is identified and discounted by the market mechanism (which is an unrealistic assumption) there will still be a tendency not to relinquish the optimal amount of resources to nature conservation. This can be ascribed to the rational inclination towards short-term profit maximization.

Where there is a conflict in motives between private and community welfare, interference by authorities is justified. Such a programme implies the redistribution of resources between generations which thus affects the whole population. The whole population must therefore contribute towards such conservation and not only the agricultural sector.

The amount of resources which the present generation must transfer to future generations,

is virtually insoluble in practice. The amount of resources which is being utilized, is determined by "consensus" (as reflected in the political process) and there may therefore be divergent opinions concerning the adequacy of such resources.

(e) "Aid organisations"

Under these measures fall "aid to farmers" and other forms of credit, drought aid, etc.

Here one speculates only in general about the role of these measures in the objectives of agricultural policy.

These measures are introduced especially with humanitarian considerations in mind and may or may not conflict with the economic considerations. Should humanitarian considerations enjoy priority, this measure may again be at variance with the objectives of agricultural policy, namely, productivity, maintenance of natural resources and thus by implication also with the factors of general adaptability. A clear statement of the weight which humanitarian considerations and economic considerations carry is therefore necessary.

An analysis of these measures is extremely risky. So for example is aid to farmers in the extensive regions of the country during droughts justified on the basis of humanitarian considerations. The question, however, is to what extent the so-called natural disasters are a regular phenomenon in these areas, according to which the farming structure should be adjusted.

A related aspect which will be mentioned here only briefly, is the question of granting credit. Credit will play an important role in the adjustment (consolidation) of the agricultural sector in future. It is therefore important that the granting of credit is based on rational grounds. Here one middle-term credit.¹⁰⁾ Furthermore by combining credit and economic information with respect to the farming organisation and related matters, a large contribution will be made towards the efficient utilization of resources.

(f) Summary

Two quotations in connection with agricultural policy may be quoted here without comment: "I believe that it is time to face up to the possibility that the relative low return to labour in agriculture is due to the low level of education and skills of a large segment of the farm population",¹¹⁾ and further "Farm policy should be directed to those farmers who market most agricultural products - the commercial farm".¹²⁾

10) Steyn, F.G.: Die Finansieringspatroon in die Suid-Afrikaanse Landbou met Spesiale Verwysing na sekere Streke. M.Sc. (Agric.)-thesis, University of Pretoria, 1968.

11) Johnson, D. Gale: Efficiency and Welfare Implications of United States Agricultural Policy. Journal of Farm Economics. Vol. 45, May 1963, p.339.

12) Schnittker, John A.: Farm Policy - Today's Direction. Journal of Farm Economics. Vol. 48, Dec. 1966. p. 1094.

The most important question put here is whether serious efforts are justified to keep income in the agricultural sector above a "minimum" level, even if it has an adverse effect on the other objectives and the norms of optimum resource use. A just criticism against the agricultural policy implies a quantification of the different aspects. Unfortunately research on agricultural policy aspects is limited in South Africa.¹³⁾

In so far as it is possible to predict the tentative direction in agricultural policy, it would appear as if the abolition of present policy measures (especially prices and quotas) will not take place. The abolition of these measures (which have already been generally adopted) will result in serious shortrun implications for the agricultural sector. There is a tendency therefore to propose that the status quo be maintained. Furthermore it would appear as if future measures will be introduced mainly to increase the mobility of the human factor. In this respect any institutional criteria (other than already instituted prices and quotas) which inhibit mobility, should become suspect and any institutional criteria for increasing mobility should be welcomed.

Finally it must be stated that any coercive measures (to force farmers out of agriculture) conflict with our criterion of free initiative. Measures in the spirit of the livestock withdrawal scheme (which is perhaps not directly applicable here) - under which an incentive is provided for the under-average farmer to co-operate voluntarily and the above-average farmer not to belong to the scheme - appears to be an ideal type of policy measure.

VI. WATER¹⁴⁾

Often and quite rightly one of the most important problems in South Africa has been identified as a water shortage - while the distribution of available water is being ignored. The creation of additional supplies has often been suggested as a solution for the following problems:

1. Supply: Where the regional demand is greater than its long-term water supplies;
2. variability: where natural seasonal or short-term fluctuations do not correspond with the demand;
3. distribution: where distances between supply point and demand point occur; and
4. quality: where the quality of the supply of water does not correspond with the quality asked for.

13) With exceptions such as: Gregory, J.J.: Prys en Inkomstebeleid in the Landbou: Met Besondere Verwysing na Suid-Afrika. D.Sc. (Agric.)-dissertation, University of Pretoria, Pretoria, 1962.

14) This sub-division is mainly based on: Timmons, John, F.: Water allocation: Supply and Demand Relationships. Unpublished paper presented at a Seminar on opportunities for Regional Research on Water Resource Problems, Chicago 1968.

Water as a production factor is however not so unique that it ought to escape system analysis,¹⁵⁾ or programming techniques.¹⁶⁾ Water is, just like any other scarce resource, subject to the economic laws of resource distribution. There is a tendency at present to regard water as a "free good" within the limits of supply. Diseconomies consequently arise in the use of water, especially -

- (a) between uses,
- (b) in intensity of a specific use, and
- (c) through externalities.

One-sided approaches lead to the ignoring of questions such as where and when additional supplies should be created and how big these schemes ought to be. Potential technological factors such as desalinization, "rain making", chemical synthesis and subterranean storage provide enough uncertainty, and the possibility may exist that many longterm projects will be obsolete before they are completed. An important point which should not be ignored, is whether water requirements or the requirements of additional water supplies can be established - before an efficient distribution has been obtained.¹⁷⁾ Does the tendency not exist to incorporate built-in inefficiencies when additional water supplies are being obtained?

(a) Factors which play a role in the distribution of water

The calculation of demand and supply in the case of water implies the distribution of a non-homogenous product. Water supplies differ and so also the use of water. The quality of water supplies varies tremendously through impurities produced both by natural and human factors. Different water sources therefore have different uses for which they can be utilized. So for example different qualities of water are required for human consumption, navigation, generation of power, irrigation, food processing industries and recreation. Within these requirements further differentiation are possible. For recreational purposes the quality of water required for swimming differs from the quality required for scenic beauty. When demand and supply of water are therefore analysed, the heterogeneity of water must be thoroughly known.

(b) Methods for efficient water distribution

A method which is applied very effectively on other products - namely the market mechanism - can also be applied to the factor, water. Subject to the region and temporary occurrence, water

15) Hufschmidt, M.M. and Fiering, M.B. Simulation Techniques for Design of Water Resource Systems. Harvard University, Cambridge 1966.

16) Hall, W.A., Butcher, W.S. and Esoqbae, A.: Optimization of the Operation of a Multiple-Purpose Reservoir by Dynamic Programming; Water Resource Research, Vol. 4, June 1968.

17) Hirschleifer, J.J., De Haven, J. and Milliman, J.: Water Supply: Economics, Technology and Policy: University of Chicago Press. Chicago 1960.

can be measured and sold to consumer bodies. Therefore when water becomes scarce, it is automatically rationed to the institutions where the highest marginal value product occurs. The increase in water supply (capacity) can then be motivated on the basis of present and expected prices. This method will naturally ignore traditional claims on water. The full implications of such a mechanism has, however, not yet been evaluated.

A second method is naturally institutional rationing, which will no longer be based on traditional rights, but will apply to enterprises where water shows the highest productivity. Such a distribution entity, where the market mechanism does not function, can allocate values to water according to the differentiated demand and supply.

Such values can be obtained by the following aids:

(i) Value productivity: The price of water is determined by a synthetic market (shadow prices) on the basis of the industry's contribution to the area or national product. Such an application was done in Arizona and the results are indicated in Table 1 where the personal income per acre foot water is indicated.

Especially striking is the fact that 90 per cent of the water supplies are used for agricultural crops where the income varies from \$14 to \$80 per acre foot of water. On the other hand the income in other industries varies from \$1 685 to \$82 301 per acre foot of water. It would thus appear as if agriculture cannot compete for water when serious shortages occur.

TABLE 1 - Personal income per acre foot of water, used in the different sectors of the Arizona economy as well as the rank for 1958 18)

Percentage of water consumed	Sector	Personal income per acre foot of water in (\$)	Rank
90%	Food and fodder grain	14 (\$3) ¹⁹⁾	10
	Fodder crops	18 (\$1)	9
	High intensity crops	80 (\$13)	8
	Primary metals	1 685	7
	Livestock and poultry	1 953	6
	Utilities	2 886	5
	Mining	3 248	4
10%	Agricultural processing industries	15 332	3
	Commerce, transport and services	60 761	2
	Manufacturing industry	82 301	1

18) Robert Young and William E. Martin: The Economics of Arizona's Water Problem: The Arizona Review. Tucson, March 1967. p. 10.

19) Personal income indirectly produced by inputs bought from other sectors.

This type of information can also be used fruitfully in solving the problem of water shortages at certain irrigation schemes. The question often arises whether water should be transported to such areas and whether the farmers should be moved to new water supplies. If agriculture does not seriously compete with other industries in a specific area, it would appear as if water could be transported to the areas in short supply, provided the cost of transport and distribution does not exceed the income obtained from the production of crops and livestock products. In the said example the cost should be smaller than \$14 for grain and less than \$80 for high intensity crops. If the requirement cannot be complied with, other alternatives should be considered.

(ii) Opportunity cost based on shadow prices

This approach is complementary to the value product approach, but is based on the cost as indicated by the shadow prices of uses which should be sacrificed or reduced.

Several examples will be mentioned here to illustrate the procedure. Suppose a factory situated on a river is compelled not to use water, in order to propagate the fishlife in the river. The loss in product through the compulsory closure of the factory is R100 000. This action results in the production of 20 000 fish per annum. The cost per fish therefore amounts to R5. Assuming otherwise that only 50 per cent of the water requirements are supplied to the factory, with a consequential loss of R50 000, with the production of fish still at 20 000 per annum, then the cost per fish is R2.50. Alternatively the factory can obtain its water elsewhere at a cost of say R50 000 - then the cost per fish is still R2.50. Another possibility is that the factory decides to treat its pollution material say at a cost of R25 000, then the cost per fish amounts to R1.25.

When there is a choice between agricultural and non-agricultural use of water, the following principle should be recognised. Let us assume that water is the only production factor. Water should then be allocated between the two industries to the point where the marginal rate of product transformation between agricultural products as a group and non-agricultural products, should equal their price ratio. This implies that the potential sacrifice in agricultural products due to a shift in one unit of water to industry should equal the potential gain in industrial production. This hypothesis tantamounts to an alternative definition of the opportunity cost principle.

On a more micro-level it is implied that the marginal product of water in the different uses in agriculture, as well as non-agriculture, should be known and the allocation of existing water should therefore be done on this basis.

More rational criteria for the distribution of water therefore exists. These distribution criteria are specially applicable in a given area and even when a whole river basin is under discussion.

When the planning area enlarges however, further aspects should also be taken into consideration. Among these aspects, factors like the specific region, time, quality, technology, water sources, costs, and benefits count.

Regional determinants are important in the framework of the national economy. Regional water problems are changed or intensified, depending upon the movement or concentration of people in industry. Can industrial complexes be changed and opportunities for employment attract people to water surplus areas - as for example the Orange River Complex? Such a movement may be the most economic long term solution. Quality problems should be investigated in terms of actual sensitivity of industries with respect to the quality of water required. Food processing industries, domestic use and to some extent irrigation water may be sensitive to high quality water, while many other uses might not be so sensitive. Technological variables appear to contain the greatest possibilities for the future. The amount of support which this aspect will obtain, depends mainly on the political process.

Water sources should also be reflected in the regional development opportunities. The development or further development of a region where water tend to be the limiting factor, implies the study of a large set of alternatives. These alternatives include subterranean water, surface water, transport of water and the use and re-use of water. The most important aspect in the context is the fact that the solution of the water scarcity problem do not involve a unique solution (building more dams), but a set of alternatives that must be solved simultaneously in order to determine the most economic strategy or combination of strategies. Cost-benefit aspects imply that a strong case be made for increasing the "price" of water, in order to stimulate an improvement of technology and water distribution.

(c) Pollution

The identification of the quality parameters in the various uses of water often implies the internalisation of externalities.²⁰⁾ The use of water by private or public bodies often gives rise to external waste (external diseconomies) between competitive uses. It implies that cost is shifted from one firm or industry to another in the area. Certain activities (especially pollution) are the cause that more expensive methods must be applied by the other industries to enable them to use the water. This may even inhibit further use. For example, industrial pollution will affect the quality of the water for irrigation purposes. Benefits connected with the treatment of pollution may also result in external effects. For example an industry may not be willing to treat its pollution material if it cannot recover the full benefit of such an action from further consumers. For instance an industry along the Vaal River is considering the treatment of its waste products so that farmers further down along the river

can obtain suitable irrigation water, the industry will not be prepared to follow such a course unless it can recover compensation from the farmers.

These types of externalities can be overcome by establishing a regional authority who will try to internalize the externalities. The most important problem of such a body will be to identify the Pareto-relevant situations.²¹⁾

VII. INVESTMENTS BY AUTHORITIES IN AGRICULTURE AND RELATED INDUSTRIES

Closely connected with the idea of regional development which *inter alia* includes water supply schemes, is the aspect of a rational investment policy by the authorities. Such investments often require large amounts of capital. As government funds become subject to more competition for alternative uses and the population movements turn against the rural areas - this aspect develops into a serious economic problem.

Authorities usually provide public or semi-public goods where the market mechanism cannot reflect the preferences and intensities of preferences, as disclosed by market prices. Other criteria should therefore be developed to evaluate these aspects. The problem is also further intensified when present investment projects are looked at. So for example investment in water supply schemes has multiple objectives. The primary aim is usually to increase national income, but also includes such aspects as regional development and the improvement of the quality of the natural environment.

The problems to which government investment decisions are subject in a quantitative economic analysis, are called cost-benefit analysis. Cost benefit studies are applicable to problems such as the product combination, size, location, capital intensity, durability and other aspects of the design of individual projects.²²⁾ The wider objectives of cost-benefit studies is the maximization of utility - subject to the limits put by the economic and political factors.

The greatest problem that is being experienced to subject government investment decisions to economic analysis is to define the government's utility function. Only if an approximation to this utility function can be obtained do cost-benefit studies have any purpose - in the sense of weighing up alternatives within the government sector.

For cost-benefit studies to play a role in planning, the following stadia should be compared:

21) Buchman, J.M. and Stubblebine, W.G.: Externalities, *Economica*, Vol. 29, Nov. 1962, pp. 371-384.

22) McKean, R. Efficiency in Government Through System Analysis with Emphasis on Water Resources Development, John Wiley and Sons, New York 1958.

20) Kneese, A.V. The Economics of Regional Water Quality Management, John Hopkins Press Baltimore 1964.

- (a) The setting up of objectives;
- (b) the distribution of resources between sectors; and
- (c) the derivation of criteria for the design of individual projects.

The determining of cost-benefit relationships has an advantage over "ad-hoc" planning methods for the following reasons:²³⁾

1. It will contribute towards the reduction of differences in the marginal efficiency of alternative possibilities to realize the objectives (for example between irrigation and other methods to increase agricultural production);
2. it will make it possible to determine the cost of obtaining one objective in terms of the sacrifice that is experienced not to undertake an alternative project; and
3. no national plan in the institutional framework can guarantee national interests, but the possibility to accommodate specific "interest groups" will be impeded in the light of concrete data.

The specific objectives of cost-benefit studies in the evaluation of projects can be put in terms of:

- (a) The increase in total consumption;
- (b) income redistribution - sometimes based on non-economic motives such as political factors - these objectives are often burdened; and
- (c) to be self-supporting.

The purpose of designing projects can therefore generally be put as the maximization of net benefits subject to certain restrictions (financial, physical, etc.).

Several practical problems are experienced when measuring cost and benefits in actual practice - an aspect which will be discussed briefly later on.²⁴⁾ However three conceptual problems in the application of cost-benefit studies will subsequently be pointed out briefly.²⁵⁾

1. Time and rates of interest

Benefits connected with a project are realized only over a long-term. Should future benefits carry the same weight as present or more recent benefits? The weight placed on future benefits, is often one single rate of interest. It is used for lack of other criteria and the aspect of allocating weights is ignored. The determination of an interest rate is a field of study on its own and will not be discussed here.²⁶⁾

The net benefits realized over a period of time are often measured by the net present value rule (there are however several alternatives possible) which is defined as follows:

$$\text{Net present value} = \sum_{t=1}^{\infty} \frac{B_t(x)}{(1+r)^t} - K(x)$$

where t = time

$B_t(x)$ = benefits from project B with a size of x

r = discounts rate

K = capital and other costs connected with the project

The measurement problem is further magnified by risk and uncertainty. Benefits are only realized as the future unfolds. Uncertainty is further increased because government projects are often large in scope.

Risk can be handled to some extent as in the case of the run-off of the Orange River. Here the run-off of the river cannot be calculated with certainty for the following year, but based on historical data certain probabilities can be calculated.

Uncertainties on the contrary are influenced by technological changes, deviations from planned levels of investment, etc.

2. Dynamic aspects

When must the project be started? Cost-benefit studies are to a certain extent not applicable in this case. The aspect of when a project should be started and in how many stages and the lapse of time between stadia have not yet been solved satisfactorily.

3. Priorities

Cost-benefit studies cannot determine priorities objectively. If the benefits exceed costs, the project is justified. The question is, however, must the projects be tackled first where the greatest benefits occur? Here it must be acknowledged that cost-benefit studies are not a social choice mechanism. This aspect is a part of the wider problem of determining the function of an economist. The economist ought to identify problem areas and suggest the alternative solution possibilities. Further actions by the economist depend upon the philosophy of the specific school to which he belongs. One opinion suggests that the economist should suggest specific actions which in his opinion are the best solution method. The final decision making function is, however, in the political arena, which in the ultimate analysis is better able to decide social preferences.

To approach the above discussion more practically the following example can be mentioned. Suppose a specific irrigation scheme is initiated with, *inter alia*, the result that low production lands now become highly productive. Supply and demand factors may now lower the production value (financial) of other land. This will be the result, even if the costs exceed the benefits. There will therefore be a tendency to drive out of production lower productive land not developed by the authorities.

23) Marglin, S.A.: Public Investment Criteria: M.I.T. Press, Cambridge 1967.

24) Dorfman, R. (ed.): Measuring Benefits of Government Investments. The Brookings Institution, Washington D.C. 1965.

25) Prest and Turvey: Cost Benefit Analysis: A Survey. Economic Journal, Vol. 75. Dec. 1965.

26) Haveman, R.H. The Opportunity Cost of Displaced Private Spending and the Social Discount Rate. Water Resources Research, Vol. 5. Oct. 1969.

In the usual cost-benefit analysis, when direct costs and direct benefits are used, the benefits derived from the development project are approached by the increase in the yield of the land. The costs of the project are regarded as the market costs of the construction and related operations required to develop the land.

Direct net benefits measured as usual, thus reflect the influence on the national income as determined by government investment over the long-term. This procedure is consistent with the marginal requirement, namely, that the effect on the national income by the creation of a production factor, is reflected in the differences between factor yield and the production costs of this factor.

A practical problem which is experienced, is that direct benefits are relatively easily measurable, while indirect benefits are characterized by a lack of insight and/or measurability.

In the said example the short-term benefits of the irrigation scheme will most likely be smaller than calculated. This will be the result of the indirect effects, namely the potential tendency that there will be to drive out of production lower productive land in other parts of the country. This will lead to the transfer of farmers on such land. The farmers, however, will not move immediately to non-agricultural sectors, and this will reveal tendencies towards increasing surplus production and unwilling under-employment because of the lack of a market.

To sum up it can be stated that cost-benefit studies form a quantitative basis for more rational planning. It is a fact that this method is subject to theoretical as well as practical problems. Seen in the light of the amounts of capital that government investments comprise, the value productivity of such an approach will be high.

CLOSING REMARKS

A few of the important problems affecting macro resource planning and adjustment have been enunciated here. These factors are inter alia responsible for the lack of optimum resource utilization in agriculture. The removal or improvement of this inefficiency in agriculture is necessary for a healthy economy. This efficiency gap was very important especially in the past when the contribution from agriculture to the gross domestic product was percentually large. Nowadays the motivation for efficient resource utilization is, however, main concentrated on the provision of a higher standard of living to the farmer.

Efficiency in agriculture will continually increase as the entrepreneurs with less managerial skill and smaller amounts of capital move out of agriculture. This exodus implies, however, that, if the farmer reacts to economic forces, the surplus capacity in agriculture will continue to exist and the marketing problem will therefore be maintained or enlarged. This increase in yield per unit does not necessarily mean a larger total income to the agricultural sector. A smaller total income may well lead to a larger income per farm. The most important problem will, however, remain, namely how the economic position of the farmer can be consolidated subject to two requirements:

- (a) The provision of consumer benefits in the form of relatively lower food prices, as realized by the decrease in resources used per unit; and
- (b) positive benefits to all farmers which are the result of the progress to which they contribute.