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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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An application of economic theory in the long-term planning of the scale of operation in the primary production of wine grapes

by

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1. INTRODUCTION

During the past 40 years the wine industry in the traditional wine producing areas has acquired a reputation for stability of production. In addition to relative production stability, an analysis of the producer prices of agricultural products in South Africa reveals that those of wine grapes and slaughter stock have shown the biggest increases since 1948.[1] One would therefore expect the wine industry to be characterised by general economic stability.

In spite of these favourable indications, several production cost studies[2] have shown that the wine farmer receives a poor return on capital investment and is worse off than farmers in other enterprises in the Western Cape. In 1970 a further thorough investigation of the primary production cost structure of the wine industry was undertaken in collaboration with Prof. W.E. Kassier of the Department of Agricultural Economics at the University of Stellenbosch. Production costs were calculated for the individual producer and for the industry, the results showing that on average the wine farmer earned 4,36 per cent on capital investment in 1969/70, as against an estimated 3,85 per cent in 1968/69. On the other hand, table grape farmers received a mean return of 8,50 per cent on their capital in 1969/70, as against 10,98 per cent in 1968/69. The 1968/69 study also shows that pear farmers earned an average return of 12,97 per cent, apple farmers 13,05 per cent, canning peach farmers 4,76 per cent and apricot farmers 6,51 per cent on their capital.

From these studies it therefore appears that, in spite of favourable factors such as stability in production and a relatively rapid increase in producer prices, the wine industry still yields unsatisfactory economic results both as an industry and to the individual producer.

In order to identify structural problems in the primary industry, the influence of several independent variables on net farm income was investigated by means of multiple regression. It was found that yield per hectare of bearing vines and total number of hectares under vines have a significant ($p = 0,05$) positive influence on net farm income.[3]

Since production control exists in the industry and the above-mentioned problems had, among others, been identified an investigation of the cost structure of the industry was carried out with special reference to returns to scale.

2. SELECTION OF DATA

The universe of the production cost study and the subsequent analyses was defined as all quota holders who produced more than 50 tons of grapes in 1968. This universe represents 94 per cent of the total wine crop in 1968. All quota holders producing less than 50 tons were eliminated, since they were not producing wine grapes principally for economic considerations.

Every thirteenth quota holder was drawn from this universe with the aid of a computer. The sample size amounts to 7,7 per cent of the universe, although an effective sample size of 5 per cent was aimed at. Altogether 163 observations were effectively included in the sample, constituting 5,1 per cent of the universe.

3. ECONOMIC PRINCIPLES UNDERLYING THE STUDY

In planning an established enterprise, a distinction is made between fixed and variable costs in the cost structure in the short run, the enterprise being tied to a specific cost structure for a specific scale of production.

In the long run, however, structural adjustments are possible, and the enterprise can construct any scale of production; all factors and costs are therefore variable.

The long-run average cost curve is derived theoretically from the short-run average cost curves at the different scales of production attained as the enterprise expands.

In the long run it is theoretically possible to construct a new scale of operation with every additional unit produced and the long-run average cost curve is described mathematically as the

1) J.A. Groenewald. The state of South African agriculture - a diagnosis. Agrekon, Vol. 10, No.1, 1971, pp.12-26

2) Production cost studies undertaken by the Department of Agricultural Economics of the University of Stellenbosch under the direction of Prof. W.E. Kassier, 1967/68 and 1968/69

3) Unpublished data of the K.W.V.

envelope curve of the short-run average cost curves[4]. The long-run average cost curve therefore describes the lowest possible cost per unit if the enterprise has sufficient time to construct the most favourable scale of production.[5]

The minimum point on this curve yields in the long run the scale of production associated with the lowest cost per unit. If free competition prevails and entry is completely open, competition will cause each firm to produce at the minimum point of an efficient long-run average cost curve. The product will be supplied by the "correct" number of firms, since some will be forced out, while newcomers will enter the industry.[6]

The cost structure of the industry is constructed from the combined cost structures of individual enterprises, each in a different phase and operating at a different scale of production, and the operating cost curve can be described as the envelope curve derived from the short-run average cost curves of enterprises with different production structures and scales of production in a particular year.

Since the wine industry does not operate under pure competition - which implies, inter alia, perfect knowledge and the absence of restrictions - the firms will not, however, automatically tend towards the minimum point on the long-run average cost curve.

Production restrictions such as quota arrangements can, in the first instance, prevent the individual producer from attaining his optimum (profit maximizing) level of production where marginal costs equal marginal revenue. Production restrictions can furthermore cause a producer to maintain a scale of production in the declining phase of the long-run average cost curve - in other words, a scale smaller than that represented by the minimum point.

This phase corresponds to the phase of increasing average output[7] and thus includes irrational production[8]. In order to place the wine industry on a sound footing, it is essential that the size of the enterprise be at least sufficient to allow production to occur in a rational phase.

4. MODEL

On the basis of the known total costs of individual enterprises, as determined in the 1969/70 production cost study, the average costs per metric ton for all observations in the sample were calculated and the average cost curve for the primary industry was fitted by means of regression analysis. This average cost curve is not an envelope curve, but a regression line, describing the average costs of the different observations in the sample.

Although this fitted curve does not therefore correspond to the theoretical long-run cost curve, it is hoped that the results thus obtained can nevertheless be used to evaluate the present condition of the industry with respect to scale. A quadratic function of the form $Y = a + bX + cX^2$ was fitted, and the following results were obtained:

REGRESSION ANALYSIS

Dependent variable : Y = Cost per metric ton in rand
Independent variable : X = Total production in metric tons
Fitted function : $Y = a + bX + cX^2$

Results

Variable	Regression coefficient	Standard error	Fiduciary limit	t value	Partial correlation coefficient	Error sum of squares
Intercept (a)	61,212 240 0	4,086 700	8,108 000	14,98	-	122 336,0
X (b)	-0,069 973 0	0,027 100	0,053 800	2,58*	-0,22	47 395,6
X^2 (c)	0,000 066 7	0,000 033	0,000 066	2,02*	0,17	46 503,3

Degrees of freedom : 131
Error sum of squares : 45 099,1
Residual error : 18,554 4

Multiple correlation (R) : 0,940 0
Coefficient of determination (R^2) : 0,883 6

*Significantly different from zero at the p = 0,05 level of significance

4) Richard H. Leftwich. The price system and resource allocation, Revised Edition, Holt Rinehart & Winston, New York, 1960, p.155

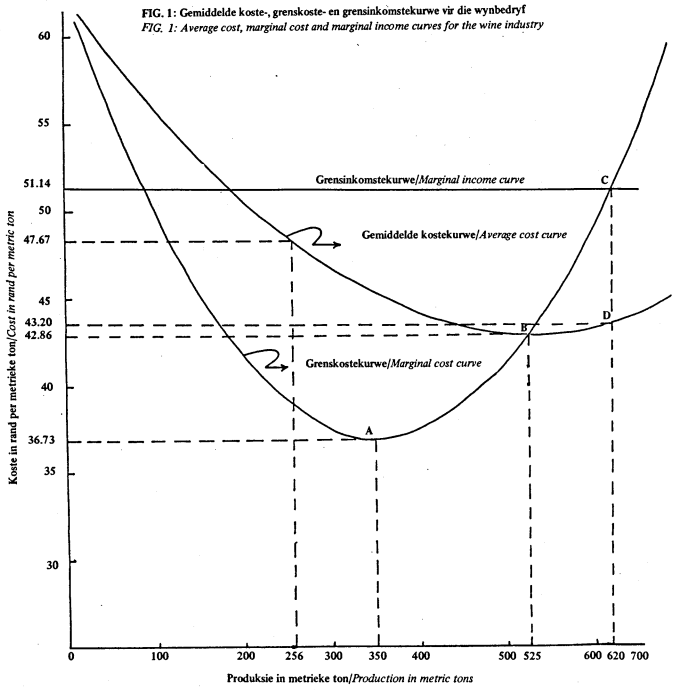
5) Ibid., p.154

6) Paul A. Samuelson. Economics: An introductory analysis, Sixth Edition, Mc Graw-Hill, New York 1964, p. 470

7) F. van den Bogaerde. Beginsels van die prysteorie, J.L. van Schaik Ltd., Pretoria, 1970, p.66

8) Earl O. Heady. Economics of agricultural production and resource use, Prentice-Hall, Englewood Cliffs, N.J., 1960, pp.91-92

FIG. 1: Gemiddelde koste-, grenskoste- en grensinkomstekurwe vir die wynbedryf
FIG. 1: Average cost, marginal cost and marginal income curves for the wine industry



From the foregoing regression analysis, the average cost per metric ton for the primary industry is described by the following equation (coefficient of determination R^2 = 0,883 6, error sum of squares = 45 099,1 and residual error = 18,554 4):

$$Y = 61{,}212\,2 - 0{,}069\,973X + 0{,}000\,066\,7X^2$$

Where Y = cost per metric ton, and
X = production in metric tons

From the foregoing equation the total cost function for the primary industry was calculated mathematically as:

$$Y_1 = 61{,}212\,2X - 0{,}069\,973X^2 + 0{,}000\,066\,7X^3$$

Where Y_1 = total cost for the industry in rand, and
X = total production in metric tons

The marginal cost equation of the primary industry is obtained mathematically by calculating the first derivitave of the total cost equation. Marginal cost is thus described by:

$$Y^1 = 61{,}212\,2 - 0{,}139\,946X + 0{,}000\,200X^2$$

Where Y^1 = marginal cost per metric ton, and
X = production in metric tons

Figure 1 shows the long-run cost structure of the primary production of wine grapes as described by the average and marginal cost curves.

5. THE ECONOMIC IMPLICATIONS OF THE LONG-RUN COST STRUCTURE FOR THE PRIMARY INDUSTRY

(a) Scale of production

The long-run average cost curve indicates a minimum average cost of R42,86 per metric ton at a production level of 525 metric tons.

The long-run average cost curve may shift in course of time and is not static, actually describing a broad relation rather than an absolute line; as already stated, the fitted functions are not envelope curves. This analysis of the cost structure nevertheless furnishes a clear indication of the production level at which rational production commences. This level of production is indicated by point B in Figure 1. At a production of less than 525 metric tons, production in the industry is still on average, in an irrational phase since decreasing average costs can be obtained by the construction of larger scales of production.

Minimum marginal costs of R36,73 per metric ton (Figure 1, point A) are obtained at a production level of 350 metric tons. It can conversely be stated that maximum marginal returns are obtained at a production of 350 metric tons. This is therefore the level of production at which maximum interest can be earned on the production of an additional unit. At a level of production lower than 350 metric tons, production still takes place at decreasing marginal costs.

Since a fixed price is paid for wine grapes, the realisation per metric ton can be accepted as constant, viz R51,14 as calculated during a production cost survey.[9] Maximum profit is obtained where marginal costs equal marginal revenue (point C, Figure 1). (With a constant realisation, marginal revenue is constant and equal to the realisation.) Maximum profit is therefore obtained at a production level of 620 metric tons (Figure 1). At this level, average costs amount to R43,20 per metric ton (point D, Figure 1). The producer therefore obtains a net income of R7,94 per metric ton.

9) Cost of production of wine grapes (1969/70), in collaboration with the Department of Agricultural Economics, University of Stellenbosch

These data must, however, also be interpreted carefully. It will be shown below that many producers produce considerably fewer wine grapes. If all of them can and do expand their production considerably, this may bring about a decline in prices and therefore in the optimum level of production. Maximum profit will then be obtained at a lower level of production and will amount to less than R7,94 per metric ton.

It can, however, be asserted that a high level of efficiency cannot be attained if average production per farm is smaller than that represented by the minimum point on the long-run average cost curve. This point is indicated by B in Figure 1.

(b) Present production pattern

In the 1969/70 production cost survey it was found that an average production of 256 metric tons per unit was obtained in the industry. It is therefore evident that the scale of production is at present below optimum and also irrational, since production takes place at decreasing marginal and average costs.

From Figure 1 it is also clear that considerable cost advantages can be obtained by increasing the scale of production to at least the point where rational production commences. With an average production of 256 metric tons, the production costs are R47,67 per metric ton, so that a cost advantage of R4,81 per metric ton can be obtained if the same total output is produced in the industry at an average production level of 525 metric tons per unit.

As already mentioned, the calculated cost functions (and therefore curves) dealt with in this article do not meet the theoretical requirements of a long-run envelope curve; they consist of a fitted regression function and curve. This fitted curve naturally lies above the envelope curve. If, however, it is accepted that the minimum point on the envelope curve would be at a production level close to that of the minimum point on the fitted curve, a further assertion can be made regarding farmers producing less that 525 metric tons of wine grapes per annum. It appears, namely, from the theory of production that such farmers will produce their output at the lowest cost if they construct a scale of production somewhat larger than the scale necessary for such production and then produce in the declining phase of the short-run cost curve[10]; this in itself represents under-utilisation of capacity and also inefficiency.

10) See Leftwich, op. cit., p.160

The existing inefficiency in the primary industry cannot summarily be ascribed only to poor management. Exogenous factors confront the producer with serious structural limitations - e.g. marketing structure, quotas and finance facilities, etc.

In an industry such as this, which is subject to production control, it is imperative to note that the production limitations can be the main factor forcing producers to produce below optimum and irrationally at a high cost structure. Producers can even be prevented from utilising the advantages of both decreasing marginal costs and average costs.

Therefore, when the need for greater efficiency on the part of the individual producer is stressed, it should, at the same time, be established whether the structural composition of the industry, within which the producer operates, is adapted and conducive to greater efficiency.

In planning future production control, it would therefore be wise to consider the size of production quotas and the number of producers in the industry. If production control is linked to the goal of maximum revenue for the producer, the demand for the final product will also have to be given proper consideration.

6. CONCLUSIONS

(a) The average production unit in the wine industry is at present producing below optimum in an irrational phase with a high cost structure.

(b) The scale of operation is a determining factor in the profitability of the production of wine grapes.

(c) Exogenous factors, such as the marketing structure, price ratios, quotas and the number of producers in the industry, probably prevent the primary producer from constructing an optimum or rational scale of production - aspects which require further investigation.

(d) The cost advantages which can be gained by constructing a rational scale of production in the industry are so considerable that it is improbable that comparable benefits can be obtained by greater efficiency on the farm within the existing farming framework.

(e) The common assertion that many of the problems in the industry are due to the inefficiency of a great percentage of our farmers must therefore be judged in the light of the structural inefficiency of the industry - something which is beyond the control of the individual producer.