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281.8  
Ag 835

Vol. 25 No. 1  
FEBRUARY 1986

Price 50c  
(45c + 5c GST)



Agrekon

FOUR-MONTHLY JOURNAL  
ON AGRICULTURAL  
ECONOMICS

Issued by the Department of Agricultural Economics and Marketing



# SUPPLY LIMITATION ACCORDING TO PRODUCT QUALITY

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## ABSTRACT

A prohibition on the sale of the lowest grades of products during conditions of supply pressure and attendant low prices is a common occurrence and is even incorporated in South African marketing legislation. If the support of producers' income is the aim, it cannot be accepted as a matter of course that the lowest grades should be the first to become subject to supply controls. Such a measure could cause a decline in producers' income. The characteristics of the demand for the various grades will determine the proportion in which quantities must be withheld according to grades. Only specific economic analyses can determine this proportion. In practice the required type of economic analysis presents various problems, however, which restrict its application or even make it impossible to apply.

## INTRODUCTION

The chronic trend in agriculture towards over-production and the periodic instability in the quantities of individual agricultural products offered have given rise to a variety of statutory measures to limit the effects of these circumstances. Production quotas, surplus announcements, minimum, maximum and absolute price fixings, supply control and price support by means of purchases on the open market are a few of these measures which are also common in South Africa. The objectives aimed at with these measures are, among others, to limit price and/or income instability, to support agricultural income and to bring about so-called orderly marketing. Apart from the doubt that exists concerning the economic justification of certain of these measures *per se*, the ways in which they are applied in practice are sometimes also not above suspicion.

The purpose of this article is to cast more light on the practical application of one of the generally more acceptable measures of supply limitation, namely the prohibition on the sale of the lowest grades of products during times of supply pressure and accompanying low prices.

This measure, which is not unique to South Africa, is formalised here by means of sections 67 and 77 of the Marketing Act, 1968, (1:pp. 64, 68-70). In terms of section 67 "a scheme may empower its control board to prohibit from time to time, with the approval of the Minister, any producer from selling

any product to which the scheme relates and which he has produced, except such class grade, quantity or percentage thereof as the board has determined, or except for such purposes as the board has defined" and in terms of section 77 "a scheme may empower its control board to prohibit from time to time, with the approval of the Minister, any person from introducing into any area defined by the board, the product to which the scheme relates, except such class or grade thereof as the board has determined or except for such purposes as the board has defined". Such provisions are included in several control schemes and observed by the control boards.

The practical application of the prohibitions arises periodically in respect of several products and is announced by means of Government Notices in the *Government Gazette*. The notice usually determines that a certain class or grade (normally the lowest) of a product may, from the date of the notice, no longer be introduced into a certain, defined area (controlled area) or into a specific market and sold.

## THE PROBLEMS

Several related questions with regard to the application of this measure arise: Why must the prohibition be imposed, in other words what is the objective that must be achieved? When and in what circumstances should such a prohibition apply? To which grades or classes of a specific product should the prohibition apply?

In practice, the answers to these questions are somewhat dogmatic:

- (i) "The prohibition is to be imposed to counter the country-wide product surplus, supply pressure and over-production and the resultant low prices that are prevailing at present."
- (ii) "The poor quality product forces down the price of the higher grades and is therefore prohibited from the market."
- (iii) "The over-utilisation of the physical marketing facilities has necessitated supply limitations and for this reason the lowest grades are prohibited from the market."

Apart from the fact that (i) is symptom rather than problem-oriented and not specific enough, it also exhibits a few inconsistencies. First, a surplus, by definition, originates when the quantity offered is more than the quantity desired at a specific price. On the free market, where no statutory minimum or absolute prices are enforced and where prices can reach low levels as a result of supply pressure, a

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surplus can therefore not originate as long as buyers are aware of the available marketable stocks. Secondly, if the prices on specific markets rise as a result of a prohibition the supply pressure will not be countered country-wide. It will merely shift spatially and manifest itself in a more concentrated way in other market areas. Furthermore, countering low prices or supply pressure with temporary prohibitions is not justified economically, except if the demand has relatively little price elasticity and the purpose is to increase producers' incomes at the expense, in the short term, of the consumers.

The statement made in (ii) implies cross elasticity of demand between high and low grades, which is not necessarily the case. The existence and nature of relationships like these can be determined only by specific economic analyses.

The over-utilisation of the physical marketing facilities on a specific market, referred to in (iii), necessitates the regulation of supply in terms of quantity and not quality. Once again, the grade combination that should, in fact, be allowed on the market can be determined only by specific economic analyses and it is not a foregone conclusion that priority given to the highest grades will maximise the producers' income from the market concerned.

Two basic questions must therefore be considered together:

What total quantity should be allowed on the market? and

What should be the grade combination of the quantity allowed?

The physical capacity of the market facilities sets a maximum limit to the amount that can be allowed on the market. If this is the only reason for a quantity limit, the producers' income will depend on the grade combination allowed. If the aim is to maximise the producers' income from the market the optimum amount can be less than the physical market capacity, depending on the price elasticity of the demand for the product per grade on the specific market. The income of the producers is also influenced by the grade combination here.

In neither of the two cases can it be accepted as self-evident that the lowest grade should be subject to a quantity limitation first.

## ECONOMIC ANALYSES

The nature of the economic analyses to be conducted can best be illustrated with a simple example, involving only two grades of a product.

The producers' total income (R) from two grades of a product on a market can be represented as

$$R = p_1 q_1 + p_2 q_2$$

where  $q_1$  and  $q_2$  are the amounts of Grades 1 and 2, respectively, and  $p_1$  and  $p_2$  the prices fetched.

A realistic inference is that

$$p_1 = 125 - 4q_1 - q_2$$

$$p_2 = 60 - q_1 - 3q_2$$

and that these equations are true as long as  $5 \leq q_1 \leq 25$  and  $0 \leq q_2 \leq 10$ . This implies that  $p_1 > 0$  and also  $p_2 > 0$  with  $p_1 > p_2$ .

The producers' total income (objective function) is therefore

$$R = 125q_1 - 4q_1^2 - 2q_1q_2 + 60q_2 - 3q_2^2$$

for various grade combinations as in Table 1. Assume the total crop was 25 units of Grade 1 and 10 units of Grade 2 and the physical market capacity was 25 units, in other words a typical over-supply or supply pressure situation.

TABLE 1 - Income from different grade combinations

$q_2 \backslash q_1$	5	10	15	20	25
0	525	800	975	900	625
5	700	925	1050	925	600
10	725	900	975	800	425

If the aim is merely to limit the quantity to the physical market capacity, 25 units of Grade 1 and none of Grade 2 (that is a prohibition on the lowest grade) would generate an income of 625, while no prohibition on the lowest grade and a partial prohibition of the highest grade would generate an income of 975. The optimum income at full market capacity is obtained by maximising the objective function, subject to the physical limitation  $q_1 + q_2 = 25$ . By allowing 16,5 units of Grade 1 and 8,5 units of Grade 2 on to the market an optimum income of 986,3 can be generated.

However, if the aim is to maximise income from the market even if it means a limitation to less than physical market capacity, 14,3 units of Grade 1 and 5,2 units of Grade 2 should be marketed. This would produce a maximum income of 1 051,7. In the event of a total prohibition being placed on Grade 2, the maximum income would be only 976,6, while only 15,6 units of Grade 1 should be allowed. Neither of the above-mentioned aims, therefore, can be realised with a total prohibition on the lowest grade only.

## PRACTICAL EXAMPLE

By way of illustration a partial analysis of potato marketing on the municipal market at Epping (Cape market) for the period<sup>1</sup> 1 October 1982 to 16 February 1984 was conducted. During this period no prohibition was in force and all five quality and size groups of potatoes were allowed on the market.

Initially an effort was made to find a linear comparison for each quality and size group that would show the relationship between price (independent variable) and the quantities of the five quality and size groups (independent variables). The calculated coefficients for Class 1 Small and Lowest Class potatoes was not statistically significant. For the purposes of this investigation it was therefore decided to include only Class 1 Large, Class 1 Medium and Class 2.

$$\begin{aligned} \text{i.e. } P_{11} &= f(Q_{11}, Q_{12}, Q_2) \dots\dots\dots [1] \\ P_{12} &= f(Q_{11}, Q_{12}, Q_2) \dots\dots\dots [2] \\ P_2 &= f(Q_{11}, Q_{12}, Q_2) \dots\dots\dots [3] \end{aligned}$$

with the objective function

$$R = P_{11}Q_{11} + P_{12}Q_{12} + P_2Q_2 \dots\dots\dots [4]$$

where

- R - total weekly income (rand) from the sales of potatoes on the market
- P - weekly average price (rand) per 15 kg unit
- Q - weekly average sales in 15 kg units

and footnotes

- 11 - Class 1 Large
- 12 - Class 1 Medium
- 2 - Class 2

TABLE 2 - Comparisons of the relationship between the price (rand) and quantities (15 kg units) of potatoes on the Cape Market according to quality and size groups (October 1982 to February 1984)

Price	a	Quantity			F	R <sup>2</sup>
		Q <sub>11</sub>	Q <sub>12</sub>	Q <sub>2</sub>		
		b <sub>11</sub>	b <sub>12</sub>	b <sub>2</sub>		
P <sub>11</sub>	11,274 2	-0,000 117 151 (3,6)**	-0,000 041 615 8 (4,5)**	-0,000 050 488 5 (8,6)**	27,2	0,55
P <sub>12</sub>	11,282 1	-0,000 064 796 1 (2,1)*	-0,000 061 654 8 (6,9)**	-0,000 049 289 6 (8,7)**	31,0	0,58
P <sub>2</sub>	9,497 69	-0,000 079 963 8 (2,7)**	-0,000 044 305 7 (5,2)**	-0,000 045 864 7 (8,5)**	26,7	0,54

\* = Statistically significant where P = 0,05

\*\* = Statistically significant where P = 0,01

By adjusting the comparisons in Table 2 in [4], the quadratic income comparison [5] is obtained.

Maximise R where -

$$R = 11,2742Q_{11} - 0,000 117 151Q_{11}^2 - 0,000 106 411 9Q_{11}Q_{12} - 0,000 130 452 3Q_2Q_{11} + 11,282 1Q_{12} - 0,000 061 6544 8Q_{12}^2 - 0,000 093 595 3Q_{12}Q_2 + 9,497 69Q_2^2 - 0,000 045 864 7Q_2 \dots\dots [5]$$

Subject to -

$$Q_{11} \geq 0; Q_{12} \geq 0; Q_2 \geq 0$$

This quadratic programming problem with limitations is solved with the aid of existing programming methods. The objective function is concave, since the Hessian matrix is negatively definite everywhere (2; pp. 422-423). Wolfe's algorithm (3; pp. 382-398) can therefore be used. The solution arrived at with the aid of this method is:

$$\begin{aligned} Q_{11} &= 0 \\ Q_{12} &= 57 216 \\ Q_2 &= 45 160 \end{aligned}$$

The actual weekly average sales over the investigation period were:

$$\begin{aligned} Q_{11} &= 10 062 \\ Q_{12} &= 47 679 \\ Q_2 &= 46 635 \end{aligned}$$

The optimum strategy requires that 2 000 units less be marketed. Of these 525 units must be from Class 1 and 1 475 from Class 2. It would therefore be incorrect to assume as a matter of course that the total reduction should be applied only to the poorer quality potatoes.

## CONCLUSIONS AND RECOMMENDATIONS

The type of economic analyses required pose a variety of problems when applied in practice:

- (i) The determination of statistically reliable relationships of the types [1], [2] and [3] above becomes increasingly complicated as the number of grades involved increases.
- (ii) Where, from the nature of the case, time series data are used to determine these relationships, it implies certain *ceteris paribus* assumptions which will not necessarily apply when an optimum strategy for the future is determined.
- (iii) Adequate time series data that render all possible practical situations on the market may simply not be available.

- (iv) A special case of (iii) originates when one or more of the grade specifications of the grading regulations are changed.

However, these problems are not unique; they are common whenever an attempt is made to model mathematically consumer behaviour and elements of the market mechanism.

Even if it did prove practically possible to calculate an optimum market flow for each grade, such a system would be difficult to apply in practice. At the least, it would mean that each producer would have to be instructed as to how much of each grade he should supply to the market and when. The fact that a number of different markets may exist for the products and that there are many producers throughout the country who each produce different grade combinations could create an insurmountable administrative problem.

The solution to the problem of marketing pressure therefore does not lie in the application of sections 67 and 77 of the Marketing Act. It should rather be sought in the generation and dissemination of information in the form of price forecasts, expected plantings, actual plantings and crop forecasts to all potential producers.

## REFERENCE

<sup>1</sup>This specific period was decided upon in view of the fact that new grading regulations came into effect on 1 October 1982. The week ended 16 February 1984 was the last week in which sales of Lowest Class potatoes were permitted.

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