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INVESTIGATION INTO THE ALLOCATION OF BANANAS TO TWO MARKETS IN SOUTH AFRICA*

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1. INTRODUCTION

The Banana Control Board has to consider almost constantly the allocation of bananas to the various local markets. Such decisions affect both local prices and the total income of the banana industry.

Producers want this allocation of available supplies to take place so that the total income from the sales on all markets is maximised collectively. However, any optimum allocative strategy requires a thorough knowledge of the demand for bananas in each of the various markets.

In this article two alternative methods of allocation are compared. The methods of allocation are also compared with the strategies actually followed by the Banana Control Board. These are based on the results of demand studies on bananas on the two main local markets, namely the Rand and Pretoria (northern market) and Cape Town and environs.[1] The boundaries and relative importance of each market, together with the nature of and differences in the demand for bananas in both markets were identified and discussed in a previous article.[2] Next the historical allocation of bananas and incomes realised for the periods 1963/64 to 1970/71 may be compared with the potential optimum quantities and incomes for the same period.

2. MARKET STRUCTURE

The Banana Control Board, as sole suppier of bananas outside the proclaimed production areas, may be regarded as a monopolist. However, because it is expected of the Board to act in the best interests of both producers and consumers, its situation differs considerably from that of an ordinary monopolist.

By negotiating favourable and, in particular, stable prices at wholesale level and recommending consumer prices to the retail trade, the Board is in a position to influence prices on the Rand-Pretoria market directly (the Board's price policy has since been amended). On the Cape auction market, however, the Board can influence prices at both wholesale and retail level only indirectly through the regulation of the quantities of bananas offered there. By means of a prohibition on the marketing of specific poorer quality bananas the Board has in the past also periodically influenced the quantities of bananas marketed directly.

In a statistical demand analysis it was found that the demand for bananas - and in particular the elasticity of demand - on the Rand-Pretoria market differs from that on the Cape market.[3] It was consequently possible for the Board to maximise the income of the industry through a policy of market discrimination. In practice such a policy, because of differences in both demand and marketing costs between the markets, would also amount to a policy of price discrimination.[4]

3. PRICE DISCRIMINATION

When the demand for and marketing costs of a specific product differ between two markets price discrimination may be illustrated as shown in Figure 1.

Assume V_1 and V_2 represents the net demand curves in markets I and II, respectively, in other words, the average net income curves after deduction of marketing costs. To maximise total net income the total quantity of the product must be allocated to these two markets in such a way that the marginal incomes on both markets are equal and greater than or equal to nought. According to Figure 1, quantity OH_1 should be offered or sold at a price OP_1 on market I and quantity OH_2 at a price OP_2 on market II if the total quantity ($OH_1 + OH_2$) is marketed. It is

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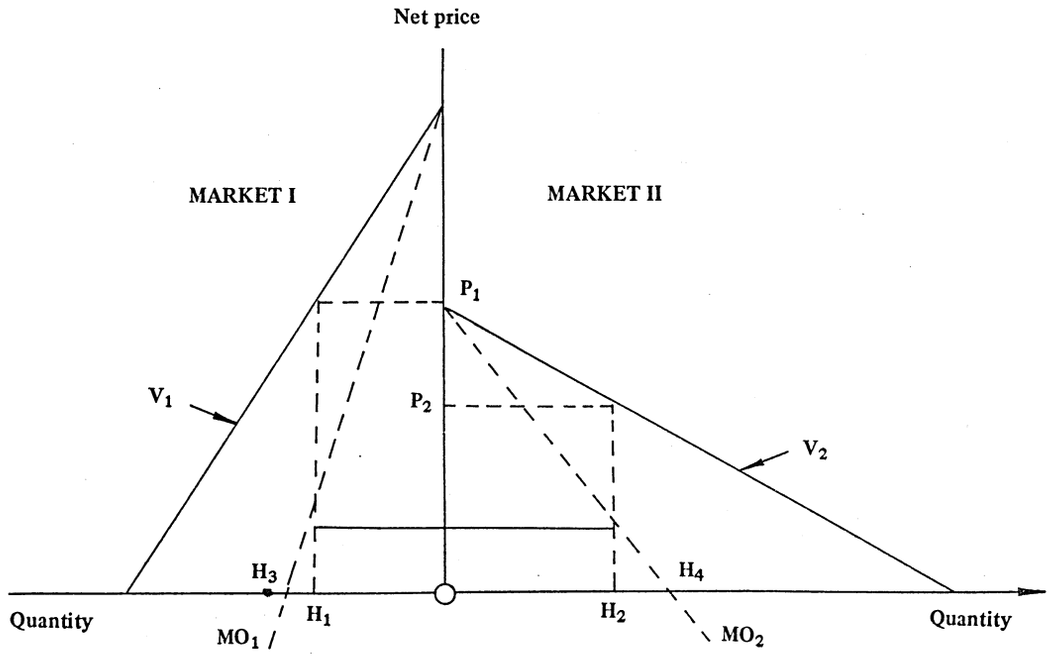

Fig. 1 - Price discrimination in case of demand and marketing cost differences between markets

assumed here that no quantity restrictions are applied for price purposes. If it is accepted, according to the theories of Alfred Marshall, that the area below the demand curve also represents the consumers' utility, such as strategy would also mean that the consumers' utility is maximised.

An alternative allocative strategy would involve a restriction on the total quantities marketed.[5] It is in precisely this respect that the Banana Control Board does not act like an ordinary monopolist; as long as prices exceed marketing costs bananas are marketed. An ordinary monopolist would on occasions create artificial shortages. According to the situation represented in Figure 1, this means that quantities OH_3 and OH_4 to markets I and II, respectively, may not be exceeded.

4. MARKETING MARGINS

The Rand and Pretoria, where the only ripening depots were situated at the time of the investigation, were taken as the point of departure. It was accepted that marketing costs between the production areas and those centres represented a fixed cost and therefore could not fundamentally affect the allocation of bananas to the two most important markets.

The margin for the Rand-Pretoria market was calculated as the difference between the weighted average retail price and the weighted average wholesale price of bananas. For the Cape market the margin was calculated in the same way, except that the additional transport cost per unit of bananas from the Rand to Cape Town was added. This method was chosen because there was no statistically significant relationship between the margins and the total quantities on the two markets.[6]

5. DEMAND FUNCTIONS USED

The following six estimated linear demand functions were chosen as the basis for the division of bananas between the two markets for the various seasons during the period 1963/64 to 1970/71:

(a) Rand-Pretoria market

(i) Aug.-Nov. (season 1)

$$X_1 = 4{,}61500 - 0{,}39603\ X_2 + 0{,}00239\ X_3 - 0{,}14449\ X_5 - 0{,}76105\ X_6 - 0{,}09131\ X_9 + 0{,}86222\ X_{11} + 0{,}15997\ X_{12}$$

(ii) Dec.-March (season 2)

$$X_1 = 4{,}15456 - 0{,}32067\ X_2 - 0{,}14887\ X_9 + 0{,}70388\ X_{11} + 0{,}65638\ X_{12}$$

(iii) April-July (season 3)

$$X_1 = 2{,}70879 - 0{,}35122\ X_2 + 0{,}00468\ X_3 - 0{,}21540\ X_5 + 0{,}78393\ X_8 + 0{,}09975\ X_9 + 0{,}83809\ X_{11}$$

(b) Cape Town market

(i) Aug.-Nov. (season 1)

$$X_1 = 4{,}76993 - 0{,}48845\ X_2 + 0{,}00293\ X_3 - 0{,}31353\ X_5 - 0{,}25284\ X_9 + 0{,}79248\ X_{12}$$

(ii) Dec.-March (season 2)

$$X_1 = 3{,}07883 - 0{,}36317\ X_2 + 0{,}39962\ X_9 + 0{,}59086\ X_{10} + 0{,}93571\ X_{11}$$

(iii) April-July (season 3)

$$X_1 = 3{,}13716 - 0{,}28198\ X_2 + 0{,}00106\ X_3 - 0{,}30478\ X_5 + 0{,}27049\ X_8$$

where:

X_1 = monthly per capita consumption of bananas

X_2 = deflated monthly retail prices of bananas in cents per kg

X_3 = real per capita disposable income

$X_5, X_6, \ldots, X_{12}$ = quantities of per capita sales of apples, pears, peaches, grapes, oranges, mangoes, pineapples and pawpaws, respectively

These estimated demand functions must be regarded as average demand functions for the period concerned because the demand has evidently undergone certain shifts periodically.[7] In order to keep abreast of such shifts the actual values of the various shift variables (for example $X_3, X_5 \ldots, X_{12}$) were multiplied by the calculated regression coefficients of each. In this way the demand functions were adjusted or approximated to what they apparently were in a specific month in the past.[8] [9] The various demand equations were thus reduced to the following form:

$$PR = \frac{ar - QR}{br} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

and

$$PK = \frac{ak - Qk}{bk} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

where: PR and PK = deflated monthly retail price of bananas on the Rand-Pretoria and Cape Town markets, respectively

QR and QK = average monthly per capita consumption of bananas on the Rand and Cape Town markets, respectively

ar and ak = adjusted intercepts of the demand in terms of price and quantity on the Rand-Pretoria and Cape Town markets, respectively

6. ALLOCATION MODELS

6.1 Method 1 - No restriction on quantities marketed

The purpose of this strategy is to determine what quantities of bananas must be allocated to each market in order to realise the highest possible income from the sales of the total quantity of marketable bananas. The marginal income on the two markets must therefore be equal after marketing costs have been taken into account. These optimum quantities were calculated with the aid of an equation which is derived as follows:[10]

Suppose IR = HR (PR - MR)
= QR.BR (PR - MR)
= QR.BR.PR - QR.BR.MR
..... (3)

where: IR = total net income at wholesale level for the Rand-Pretoria market

BR = total population in the Rand-Pretoria market

and MR = marketing margin for the Rand-Pretoria market

Substitute for PR its value according to equation (1), then it follows that:

$$IR = QR.BR\ \left(\frac{ar - QR}{br}\right) - MR$$

$$\therefore IR = \frac{-HR^2}{BR.br} + \frac{HRar}{br} - HR.MR \quad \ldots\ldots\ldots \quad (4)$$

$$\text{Similarly } IK = \frac{-HK^2}{BKbk} + \frac{HKak}{bk} - HK.MK \ldots\ldots \quad (5)$$

The marginal income for each market is calculated by differentiating IR in relation to HR and IK in relation to HK, respectively.

$$\therefore \text{Marginal income on the Rand} = \frac{dIR}{dHr}$$

$$= \frac{-2HR}{BRbr} + \frac{ar}{br} - MR \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

Similarly the marginal income on the Cape Town market

$$= \frac{-2HK}{BKbk} + \frac{ak}{bk} - MK \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

By equalisation of these marginal incomes the optimum quantities HR' and HK' could be calculated for the Rand-Pretoria and Cape Town markets, respectively.

$$\text{Suppose } \frac{-2HR'}{BRbr} + \frac{ar}{br} - MR = \frac{-2HK'}{BKbk} + \frac{ak}{bk} - MK \ldots (8)$$

With HK' = H – HR', where H represents the total quantity of bananas offered in a specific month on these two markets, equation (8) may also be written:

$$\frac{-2HR'}{BRbr} + \frac{ar}{br} - MR = \frac{-2(H-HR')}{BKbk} + \frac{ak}{bk} - MK \ldots . (9)$$

After simplification and rearrangement of terms it follows that

$$HR' = BRbr.\ BKbk\ \frac{\left(\frac{2H}{BKbk} - \frac{ak}{bk} + MK + \frac{ar}{br} - MR\right)}{2\,(BKbk + BRbr)} \ldots (10)$$

$$\text{and } HK' = H - HR' \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

6.2 Method II: Restriction of quantities marketed

According to this alternative method of allocation the total income from sales of certain quantities of bananas can be maximised in the true sense of the word on both markets. The basic principle of allocation remains the same as that described above, except that it is required that the marginal income on each market be greater than or equal to nought. On the condition that

$$\frac{dIR}{dHR} = \frac{dIK}{dHK} \geq 0$$ (see equations 6 and 7) the optimum quantities HR* and HK* could be found for both markets.[11]

The results obtained on the basis of these two methods of application appear in Tables 1 and 2.

7. RESULTS

In summary, during the period 1963/64 to 1970/71 the Board succeeded to a great extent in allocating available stocks of bananas fairly rationally between the two markets. Results contained in Table 1 show that the Board obtained higher incomes during 1963/64 and 1969/70 than can be obtained with the first method of allocation. In these two years the historical income exceeded the calculated optimum income by R81 400 (4,6 per cent) and 348 000 (9,7 per cent). Both years, particularly 1969/70, were characterised by exceptionally high banana production. The fairly large and positive residuals on both markets means that the estimated demand functions possibly do not offer very satisfactory explanations for the variance in the consumption of bananas in certain months of these two years.

With the exception of 1969/70 the calculated optimum income during the second season (December-March) was consistently higher than the historical income. For this season the average income improvements varied between R18 000 in 1963/64 and R261 900 in 1970/71. The relatively large income improvement for this season during 1967/68 (R246 800) and 1970/71 (R261 900) may be queried again in the light of the fact that the calculated optimum quantities differed relatively little from historical quantities. The regression fitting for the purposes of determination of demand in this season was less satisfactory than for those of the remaining two seasons.[12] Because of significant autocorrelation transformed data eventually had to be used. This, together with the effect of other stochastic influences which were apparently not taken into account, may be responsible for the dubious distribution results obtained for this season.

With the exception of the last two seasons of 1964/65 there were from the first season of 1963/64 up to and including the second season of 1967/68 consistently too many bananas marketed on the Rand-Pretoria market, on one hand, and too few in Cape Town, on the other hand. This oversupply of bananas on the Rand-Pretoria market varied between 14,1 per cent (season 3, 1965/66) and 0,3 per cent (season 3, 1967/68). The consequent undersupply on the Cape Town market varied during the corresponding period from 24,9 per cent to as little as 0,6 per cent. From the third season in 1967/68 up to and including the end of 1970/71 too many bananas were marketed on the Rand-Pretoria market on average in three seasons, namely the first of 1968/69 (10,2 per cent), the third of 1969/70 (1,6 per cent) and the first of 1970/71 (3,7 per cent). In the remaining seasons the undersupply of bananas at this market varied between 10,1 per cent and 0,3 per cent. In the first season of 1968/69, however, 16,6 per cent, or nearly 799 000 kg bananas too few were allocated to Cape Town, as against an undersupply of 5,8 per cent in the same season of 1970/71.

In six of the eight years the calculated incomes relating to the calculated optimum quantities in prices exceeded the actual income realised. This total annual income improvement was the highest for the years 1965/66 (16,3 per cent) and 1966/67 (10,1 per cent) and amounted to R365 000 and R280 000, respectively.

For the period 1963/64 to 1970/71 as a whole, the calculated income improvement amounted to R919 000, which is 4,0 per cent higher than the actual income realised for the same period on these two markets.

Results obtained with the alternative allocation procedure (method 2) are given in Table 2. In all eight of the years higher incomes could have been obtained if bananas had been allocated to the two markets in accordance with this method. The historical income exceeded the calculated optimum income in the case of only three of the seasons.

It was found that in all the months of the years 1963/64 and 1969/70 and nearly all months of 1970/71 too many bananas were offered on both markets. The seasonal oversupply in 1963/64 varied in the case of the Rand-Pretoria market between 40,7 per cent (2,18 million kg) during the second season and 43,7 per cent (2,51 million kg) during the first season. Corresponding figures for the Cape Town market amounted to 20,4 per cent (0,685 million kg), 61,7 per cent (1,61 million kg) and 48,3 per cent (1,15 million kg) in three consecutive seasons of the same year. From December 1968 to the end of 1970/71 the actual quantities exceeded the calculated optimum quantities on the Rand by between 1,2 per cent and 44,0 per cent (3,53 million kg). On the Cape Town market this oversupply varied during the same period between 6,7 per cent and 90,4 per cent (3,36 million kg).

During the years 1964/65 and 1965/66 shortages were experienced and maximum income would have required the marketing of considerably more bananas on both markets. With the exception of a few individual months and the season April to the end of July 1967/68, too many bananas were supplied on the northern market and too few on the Cape Town market during the period 1965/66 to the end of March 1968.

The average total income improvement over this eight-year period was calculated at R215 000, R69 700 and R39 400 per year for seasons 1, 2 and 3, respectively. The total income improvement according to this method of allocation amounted to R2 596 000. This amount represents a total income improvement of 11,4 per cent, which is considerably higher than the 4,0 per cent improvement of the other method of application, under which no bananas are withheld from the market.

8. SUMMARY

The implications of the first method of application (without quantity restrictions) differ little from the implications of the allocative strategy

TABLE 1 - Optimum allocation and income in comparison with the historical allocation and income of bananas on the Rand-Pretoria and Cape Town markets according to seasons, according to method 1 (no quantity restrictions), 1963/64 to 1970/71

Year	Season	Total quantity of bananas	Optimum allocation				Historical allocation				Income improvement			
			Quantities		Total income		Quantities		Total income					
			Rand and Pretoria	Cape Town	Rand and Pretoria	Cape Town	Rand and Pretoria	Cape Town	Rand and Pretoria	Cape Town	Rand and Pretoria	Cape Town	Total	Percentage improvement
			Million kg	Million kg	R1 000	R1 000	Million kg	Million kg	R1 000	R1 000	R1 000	R1 000	R1 000	%
1963/64	1	12,355	7,400	4,955	512,7	135,4	8,311	4,045	531,9	158,1	- 19,1	- 22,6	- 41,7	- 6,0
	2	11,745	7,326	4,420	513,1	78,3	7,527	4,218	463,8	109,3	49,9	- 31,2	18,0	3,1
	3	10,795	7,140	3,655	427,2	112,0	7,279	3,517	466,8	129,9	- 39,8	- 17,9	- 57,7	9,6
1964/65	1	9,345	6,398	2,947	741,9	168,2	6,751	2,593	660,3	157,0	81,5	11,3	92,8	11,4
	2	6,012	4,653	1,358	604,3	84,2	3,981	2,031	522,7	140,8	81,7	- 56,6	25,2	3,8
	3	5,686	4,150	1,536	532,8	145,3	3,964	1,722	504,3	170,2	28,4	- 25,1	3,3	0,5
1965/66	1	9,955	6,394	3,581	756,9	255,1	7,281	2,674	696,8	201,0	60,0	54,1	114,1	12,7
	2	7,441	5,466	1,975	808,0	161,0	5,691	1,750	577,9	139,3	230,2	21,8	252,0	+35,1
	3	4,721	3,398	1,323	476,9	152,4	3,997	1,228	502,9	127,2	- 26,0	25,2	- 0,8	- 0,2
1966/67	1	9,317	5,869	3,448	691,9	272,9	6,116	3,302	743,0	233,2	- 51,1	39,5	- 11,6	- 1,2
	2	10,968	7,341	3,627	866,1	187,2	8,136	2,831	739,5	147,9	126,7	39,3	166,0	18,7
	3	7,625	5,419	2,206	797,7	244,3	5,942	1,687	722,4	143,4	25,5	100,9	126,4	13,8
1967/68	1	14,067	8,652	5,415	999,8	345,8	9,578	4,492	1057,7	309,9	- 57,9	35,7	- 22,2	- 1,6
	2	11,532	7,620	3,912	997,4	260,7	7,642	3,888	814,7	196,6	182,6	64,1	246,7	24,4
	3	7,273	5,409	1,864	774,7	187,0	5,034	2,157	708,5	195,3	66,3	- 8,1	58,2	6,4
1968/69	1	12,683	7,857	4,826	913,7	330,9	8,656	4,027	1008,2	241,0	- 94,6	89,8	- 4,8	- 0,4
	2	10,365	7,429	2,935	1003,0	168,0	7,283	3,081	878,2	177,5	124,7	- 9,4	115,3	10,9
	3	10,329	7,404	2,925	841,3	186,3	7,255	3,074	831,6	200,7	9,8	- 14,4	- 4,6	- 0,5
1969/70	1	19,210	11,366	7,843	945,5	230,5	10,219	8,990	1042,4	296,0	- 96,7	- 38,4	-135,1	- 10,3
	2	18,612	11,584	7,027	886,5	20,3	11,537	7,075	843,0	162,1	43,3	-141,6	- 98,3	- 9,8
	3	13,599	9,340	4,259	933,3	224,3	9,494	4,237	986,3	286,0	- 53,0	- 61,7	-114,7	- 9,0
1970/71	1	18,987	11,563	7,424	1029,0	219,6	11,996	6,991	1163,4	220,3	-114,3	- 0,5	-114,8	- 8,3
	2	11,408	8,331	3,078	1202,7	187,7	8,206	3,059	947,1	181,7	255,8	6,1	261,9	23,2
	3	12,083	8,432	3,651	918,7	228,1	7,815	4,268	884,9	215,9	45,0	11,2	56,0	4,2

TABLE 2 - Optimum allocation and income compared with the historical allocation and income of bananas on the Rand-Pretoria and Cape Town markets according to seasons, according to method II (with quantity restrictions), 1963/64 to 1970/71

Year	Season	Optimum allocations						Historical allocations							
		Total Quantity of bananas	Quantities			Total income		Quantities		Income		Income improvements			Percentage improvement
			Rand and Pretoria	Cape Town	Dump or withhold	Rand and Pretoria	Cape Town	Rand and Pretoria	Cape Town	Rand and Pretoria	Cape Town	Rand and Pretoria	Cape Town	Total	
		Million kg	Million kg	Million kg	Million kg	R1 000	R1 000	Million kg	Million kg	R1 000	R1 000	R1 000	R1 000	R1 000	%
1963/64	1	12,355	5,801	3,360	3,195	568,8	191,4	8,311	4,045	531,9	158,1	37,0	33,3	70,3	+10,2
	2	11,745	5,348	2,609	3,788	597,7	155,6	7,527	4,218	463,8	109,3	134,0	46,3	180,3	+31,3
	3	10,795	4,163	2,372	3,259	508,8	165,0	7,279	3,517	466,8	129,9	42,0	35,2	77,2	+12,9
1964/65	1	9,345	6,246	2,813	0,268	743,1	169,4	6,751	2,593	660,3	157,0	82,6	12,5	95,1	+11,6
	2	6,012	4,653	1,359	-	604,3	84,2	3,981	2,031	522,7	140,8	81,7	- 56,6	25,1	+ 3,8
	3	5,686	4,150	1,536	-	532,8	145,3	3,964	1,722	504,3	170,2	28,4	- 25,1	3,3	+ 0,5
1965/66	1	9,955	6,374	3,541	0,040	756,8	255,2	7,281	2,647	696,8	201,0	60,0	54,1	114,1	+12,7
	2	7,441	5,465	1,975	-	808,0	161,0	5,691	1,750	577,9	139,3	230,2	21,8	252,0	+35,1
	3	4,721	3,398	1,323	-	476,9	152,4	3,997	1,228	502,9	127,2	- 26,0	25,2	- 0,8	- 0,2
1966/67	1	9,317	5,752	3,330	0,234	692,7	273,7	6,116	3,302	743,0	233,2	- 50,3	40,3	- 10,0	- 1,0
	2	10,968	6,687	3,026	1,255	878,1	198,1	8,136	2,831	739,5	147,9	138,6	50,2	188,8	+21,3
	3	7,625	6,186	2,206	-	797,7	244,3	5,942	1,687	772,4	143,4	25,5	100,9	126,4	+13,8
1967/68	1	14,067	7,839	4,598	1,630	1021,8	367,9	9,578	4,492	1057,1	309,9	- 35,9	57,8	21,9	+ 1,6
	2	11,532	7,180	3,506	0,846	1006,3	268,9	7,642	3,888	814,7	196,6	191,5	72,3	263,8	+26,1
	3	7,273	5,409	1,864	-	774,4	187,0	5,034	2,157	708,5	195,3	66,3	- 8,1	58,2	+ 6,4
1968/69	1	12,683	7,351	4,316	1,015	921,9	339,6	8,656	4,027	1008,2	241,0	- 86,4	98,0	11,6	+ 0,9
	2	10,365	7,152	2,680	0,532	1005,2	170,0	7,283	3,081	878,4	177,5	126,8	- 7,4	119,4	+11,3
	3	10,329	7,023	2,676	0,630	850,6	192,4	7,255	3,074	831,6	200,7	19,0	- 8,3	10,7	+ 1,0
1969/70	1	19,210	8,619	5,760	5,521	1085,4	371,6	10,219	8,990	1042,4	269,0	42,9	102,6	145,5	+11,1
	2	18,612	8,012	3,711	6,884	1159,1	273,0	11,537	7,075	843,0	162,1	316,1	111,1	427,2	+42,5
	3	13,599	7,730	3,202	2,667	982,5	256,9	9,494	4,327	986,3	286,0	- 3,9	- 29,4	- 33,3	- 2,6
1970/71	1	18,987	7,886	4,845	5,130	1160,4	332,4	11,996	6,991	843,0	162,1	- 2,8	112,2	109,4	+ 7,9
	2	11,408	7,105	2,868	0,436	1205,5	190,2	8,206	3,059	947,1	181,7	258,4	8,5	266,9	+23,6
	3	12,083	7,629	3,123	1,331	953,1	238,9	7,815	4,268	884,9	215,9	50,3	23,1	73,4	+ 6,7

followed to date by the Board.[13] On various occasions bananas were sold at relatively low prices on both markets and even at losses on the Cape Town market. The advantage of low prices is therefore almost consistently passed on to the consumers. The rigidity of marketing margins leads to the conclusion that commerce benefited considerably from the historical allocative policy of the Banana Marketing Board through increased turnover in times of surplus. The restriction of the total supply of bananas to certain optimum quantities would result in even higher incomes for the industry. Such an allocative strategy, however, would imply that large quantities of bananas would have to be destroyed periodically, particularly in times of surplus. In cases where certain quantities of bananas have in fact been destroyed sporadically in production areas the Board has been sharply criticised, particularly for ethical reasons.

The Board's policy of not deliberately withholding high quality bananas from the local market, as long as marketing costs can be covered, in order to obtain higher prices shows that, although the Board does have monopolistic powers, is does not act purely monopolistically. It also shows that the Board has not acted only in the interests of producers, but in certain circumstances has also benefited the consumer.

This investigation may perhaps serve as an illustration of the essential need for conducting demand analyses and using the results for the planning and evaluation of marketing strategy in agriculture.

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10. For a fuller exposition see Du Toit (1973), *op. cit.,* pp. 157-160.
11. Only in those months in which there was a shortage of bananas would HR* + HK* = H, that is to say the optimum quantities for both markets together would be equal to the total quantity available. Otherwise HR* + HK* + D = H, where D represents that quantity that could be sold only at negative marginal income and therefore had to be withheld from these markets.
12. *Ibid.,* pp. 120-122.
13. *Ibid.,* pp. 177-186.