COTTON IN THE MAZOE VALLEY

SUMMARY

The area and yields of cotton are recorded for selected years over a period of half a century, supplemented by the number of growers and percentage of the crop under irrigation in recent years. Some factors of production, cultivars, rotations, fertilizer, crop protection, labour, marketing, prices and gross margins are discussed.

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Introduction

This article describes cotton production in the Mazoe Valley with particular reference to its distribution and yields over a period of half a century. Included is a description of cultivars sown and agronomic practices together with prices and marketing which were identical to those adopted elsewhere in the middle veld which until quite recently produced all the cotton in the country. Cultivars and agronomic practices emanated from the research station at Gatooma which for a long period like the ginneries, prices and marketing, was controlled by the Cotton Research and Industries Board and its successors the Cotton Research Institute and the Cotton Marketing Board.

Commercial cotton production commenced in Rhodesia in the early years of the present century with "discouraging results" (Nobbs, 1925). A cotton expert was appointed in 1918 and trials were conducted in the Mazoe District in that year (Southern Rhodesia Year Book, 1924). Cotton seed was distributed to farmers in 1919 and "substantial prizes" were offered in 1920 by the British Cotton Growing Association but little was grown (Nobbs, 1925). Cotton experiments were conducted on the British South Africa Company's Virginia Farm, Mazoe in 1922–23. Yields were low but the quality was reported to be excellent (Weinmann, 1972). In that year only 1,6 hectares were grown in the Mazoe District producing 635 kg of seed cotton (Statistical Bureau). In 1923, 510 hectares were planted in the District yielding "good crops" (Nobbs, 1925) but averaging only 483 kg/hectare, slightly more than the national average of 479 kg/hectare. The crop was based upon seed of medium staple American Upland imported from the Union of South Africa.

Owing to a marked upsurge in world market prices, rapid expansion of the crop followed in the Mazoe District during the next two seasons with 5 409 hectares in 1924–25 rising to 8 735 hectares in 1925–26, yielding 220 and 134 kg/hectare respectively (Statistical Bureau). However the crop on Sweet Valley farm, Glendale produced 1 009 kg/hectare in 1925, an isolated case but one that adequately demonstrated the potential of cotton yields in the Valley (Stead, 1925). Also in that year a ginnery was opened in Bindura (Jennings, 1925). In 1926 a severe attack of Jassids *Empoasca spp.* was the cause of the drop in yields. On subsequent research evidence it was proved that jassid, bollworms and cotton stainers were collectively the main cause of failure of early cotton introductions.

The area planted to cotton in the Mazoe Valley dropped drastically in 1926–27 and following years and remained at a low figure for four decades. For example, the 1930 crop from 709 hectares yielded 368 kg/hectare (Southern Rhodesia Year Book, 1932) and in 1948–49 only 115 hectares were planted (Central Statistical Office). Although the area and yields were very low there is a published photograph of 30 hectares of the jassid resistant cultivar U4 on Chipoli Farm in July, 1950, which was expected to average over 1 000 kg/hectare (Chipoli Farm, 1930). This was another example of the potential yield of the crop in the Valley as also was the case elsewhere in the middleveld.

The expansion and contraction of cotton in the Valley over half a century is illustrated in Table 1. Prior to 1950 the statistical area was the Mazoe District comprising some 700 000 hectares which included extensive areas above 1 200 metres altitude where cotton could not be grown. Subsequently statistics were collected from each I.C.A. and four of them, Marodzi/Tatagura, Glendale, Bindura and Shamva produced by far the bulk of the cotton crop in the Valley, as well as a goodly share of the European crop in the country. The data in Table 1 is supplemented by figure 1 which shows the contrast in areas and yields over two recent periods 1950 to 1958 and 1966 to 1975.

A further measure of this rapid rise and decline of the crop was the erection in the twenties of additional saw ginneries at Sinoia and Gatooma as well as the one at Bindura in response to favourable world market prices and the prospect of expanding the crop. With the slump in production the entire crop of the country was carried to Bindura, which ginnery operated until after the middle of the Second World War. Ginning then commenced at Gatooma, to which the local crop was carried. The Bindura gin was closed in 1948 although it had ceased to operate some years earlier. Later, in 1966, due to the rapid expansion of the crop in Rhodesia following the success of pest control methods a new ginnery with four gin stands was opened at Tafuna on the banks of the Poti River between Bindura and Shamva, followed in 1970 by a second one at Glendale with five gin stands. The latter plant also operated machinery for the production of acid delinted seed for planting by growers.

TABLE 1

The area and production of cotton in the Mazoe Valley for selected years, also expressed as a percentage of the total Rhodesia crop grown on European farms

Year	Area		Production	
	Hectares	Per cent.	Tonnes	Per cent.
Mazoe District				
1924	510	31,9	230,8	30,1
1925	6 409	25,3	1 417,5	53,0
1926	8 735	32,6	1 175,8	31,5
1930	709	28,3	260,9	30,1
1949	115	7,4	31,9	4,8
Four I.C.A.s—Marodzi/Tatagura, Glendale, Bindura, Shamva				
1953	1 812	24,6	376,5	31,0
1956	172	34,8	failure	nil
1958	44	8,3	4,3	1,1
1966	4 830	26,6	n/a	n/a
1974	25 633	n/a	35 010,0	n/a

Source: Statistical Bureau, Central Statistical Office.

Table 1 also shows the varying contribution of the Mazoe crop to the total crop grown by European farmers in the country. The recurrent build up of insect pests both in the Valley and nationally until the early 1960s was the prime reason for the recurrent drastic fall in production notwithstanding determined organized research efforts at Gatooma since 1925 to find a solution by plant breeding coupled with entomological and agronomic work.

Cultivars

The variety Bancroft was one of the first cottons to be grown commercially but it was susceptible to the Jassid insect, *Empoasca fascialis* Jac. From 1925 onwards the introduction, breeding and selection of suitable cultivars at Gatooma Cotton Breeding Station provided seed of two well known cottons which were grown in the Valley and other areas. The first was U4, introduced in 1927 and its derivatives U4/64/V, 9L18 and 9L34, which were planted during the period from the late 20s to 1959 (Herring 1970, Weinmann 1975, McKinstry 1955, Gilham 1959). U4 "was actually a single plant selection out of a mixed stock received probably from Uganda" by Parnell at Barberton in the Transvaal and which later was introduced to Rhodesia (Prentice, 1972). It had the merit of "possessing surface hairs on the leaves (particularly the undersides) and stems which formed a physical barrier to the feeding mechanism of the Jassid" (Herring, 1970).

In 1960 U4 was replaced by Albar 637 which in addition to adequate resistance to Jassid also carried resistance to bacterial blight or blackarm *Xanthomonas malvacearum* (Herring, 1970) and possessed a higher ginning out-turn (McKinstry, 1955). Albar owed its origin to selection of seedlings resistant to blackarm by Hutchinson and his colleagues in Uganda who had introduced seed from Nigeria. The parent of this seed was the old American upland variety Allen which after introduction from the United States acquired resistance to blackarm by "genetic contact with the local *Gossypium punctatum* already acclimatized in the north of Nigeria" (Prentice, 1972). Undoubtedly the success of Albar is related to the diversity of its origin. It was the only cultivar seed issued from Gatooma for both the

TABLE 2

The area of cotton under irrigation, percentage of total crop and number of farms growing irrigated cotton

I.C.A.	1969–70	1970–71	1971–72	1972–73	1973–74	1974–75
Area in hectares						
Marodzi/Tatagura	Nil	Nil	2	Nil	Nil	Nil
Glendale	270	531	730	1 084	514	1 078
Bindura	257	526	779	1 249	817	896
Shamva	1 495	1 786	1 783	2 265	644	1 486
Group	2 022	2 843	3 294	4 598	1 975	3 460
Irrigated area as a per cent. of total area of cotton						
Marodzi/Tatagura	Nil	Nil	3,3	Nil	Nil	Nil
Glendale	8,8	15,2	17,8	23,3	9,5	17,5
Bindura	3,5	7,1	9,8	12,3	7,4	9,3
Shamva	22,9	27,6	25,4	26,7	7,0	19,3
Group	11,7	16,1	17,2	19,7	7,7	14,6
Number of farms with irrigated cotton						
Marodzi/Tatagura	Nil	Nil	1	Nil	Nil	Nil
Glendale	11	15	15	16	11	19
Bindura	11	16	15	17	13	14
Shamva	29	28	24	30	13	18
Group	51	59	55	63	37	41

Source: Central Statistical Office.

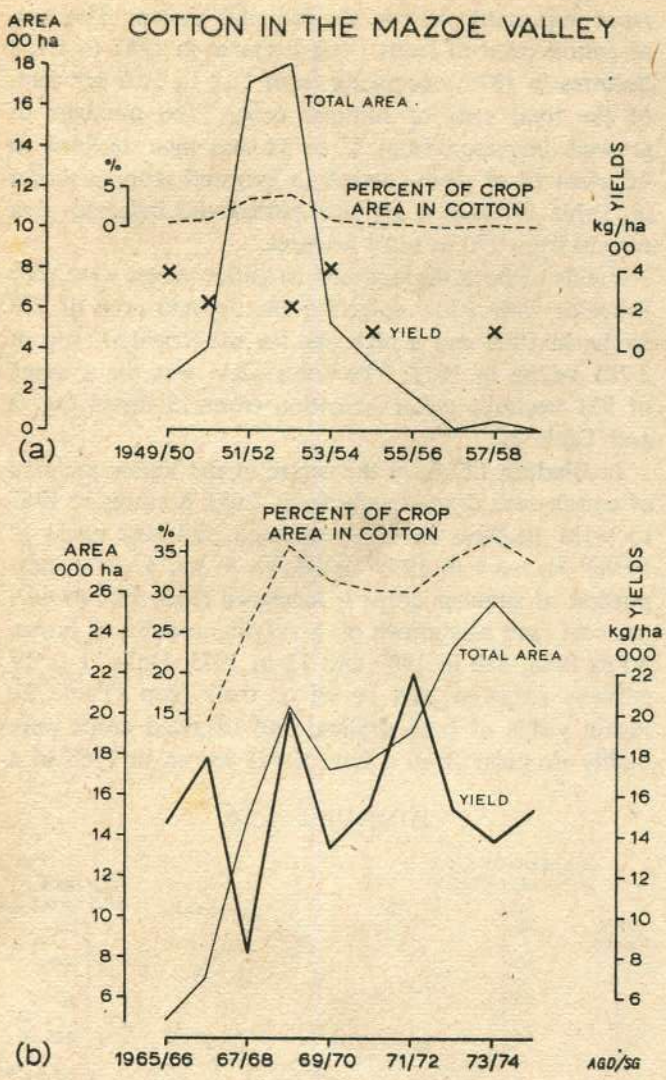

FIGURE 1

The area and yield of cotton, together with the percentage of crop area in cotton for two periods: top 1949-50 to 1958-59 and bottom 1965-66 to 1974-75. No cotton was grown in 1956-57 nor 1958-59. Figures drawn from the statistical returns for four Intensive Conservation Areas—Marodzi/Tatagura, Glendale, Bindura and Shamva.

middleveld and the lowveld in the period 1961 to 1971 when Deltapine became available and this in turn was followed by Del Cerro in 1972, renamed Delmac in the following year. The medium staple Albar was all hand picked. The 100 hectares of Deltapine sown in three I.C.A.s in 1971 for mechanical picking in 1972 on an experimental basis fell to only two hectares in the following season. In 1973/74, 121 hectares were planted followed by 144 hectares in 1974/75, both in Shamva I.C.A. The long staple Delmac was planted in Shamva I.C.A. on 3 459 hectares in 1972 increasing to 3 961 hectares in 1973 and to 4 276 hectares in 1974. These cultivars are briefly described by Herring (1970) and in the Cottton Handbook (1977). Normally a farm was permitted to grow only one variety in a season.

Cotton Statistics

Details of cotton cropping statistics on European farms in four I.C.A.s from the 1949–50 season are presented in figures 1 to 5. Within the first decade cotton was not grown in two seasons 1956–57 and 1958–59, while in the other years the yields ranged from almost nil to 402 kg/hectare. In the early years of the 60s cotton was not recorded in the annual statistics covering these four I.C.A.s which indicates that at first little was grown. Assuming that the crop in the Valley was one third of the national area the estimated area may have been of the following order:

1959–60	271 hectares	1962–63	857 hectares
1960–61	341 hectares	1963–64	1 591 hectares
1961–62	136 hectares	1964–65	4 349 hectares

For it was in this period that Albar was released for commercial production in place of U4 (Herring, 1970) followed closely by a new comprehensive insect control programme (Tunstall and Mathews, 1961) for the whole country. In the Valley this led to a dramatic increase in yields, e.g. from 97 kg/ha over 44 hectares in 1958 to 1 785 kg/ha over 6 978 hectares in 1967. The area later rose to a maximum of 25 633 hectares in 1974 and was accompanied by markedly irregular trends in over-all average yields with a low of 809 kg/ha in 1968 to a high of 2 204 kg/ha in 1972. The initial expansion was due to higher yields not to an increase in price which was 17,46 cents/kg for Grade A in 1960 and did not rise above this value until 1972, having fallen to 14,70 cents/kg in the meantime.

Cotton occupied an increasing proportion of the total area of summer crops, rising from nil in 1959 to 13,9 per cent. in 1967 to 36,9 per cent. in 1974. Only to a limited extent did it take the place of maize for the

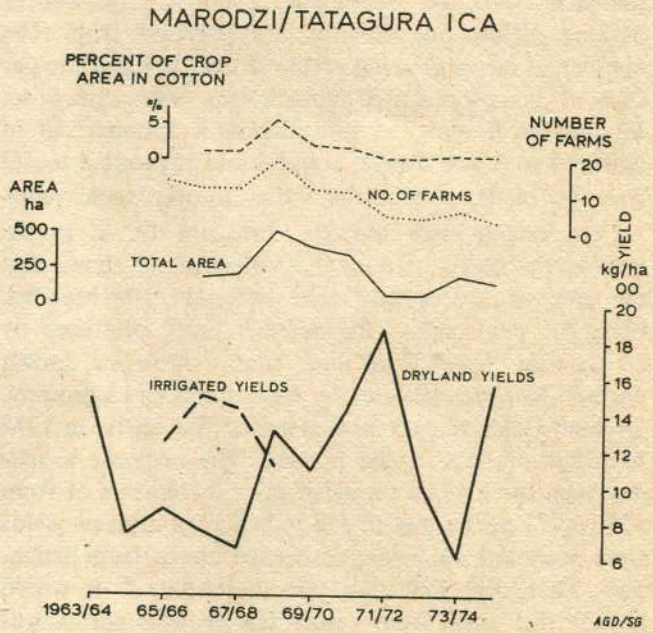

FIGURE 2

The area, yields, percentage of crop area in cotton and the number of farms growing cotton in the Marodzi/Tatagura Intensive Conservation Areas from 1963-64 to 1974-75.

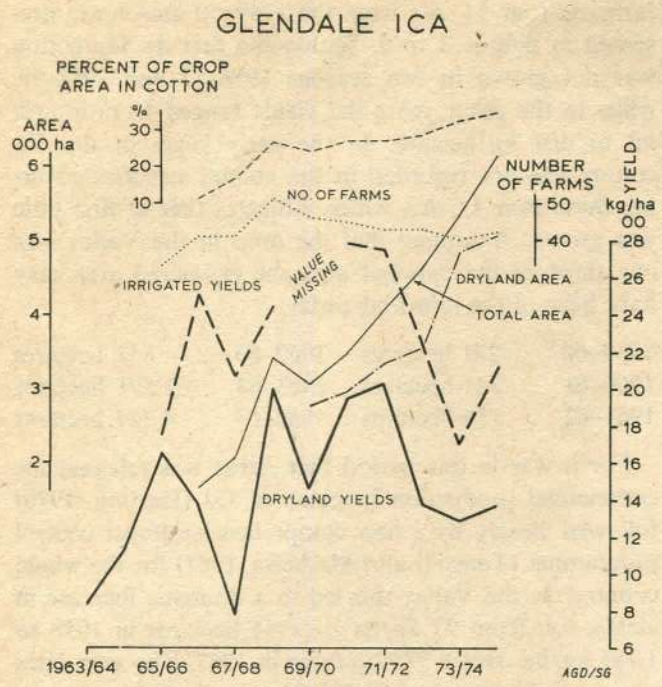

FIGURE 3

The area, yields, percentage of the crop area in cotton, and the number of farms growing cotton in the Glendale Intensive Conservation Area from 1963-64 to 1974-75. The irrigated area is the difference between total area and dryland area.

total area of summer crops increased substantially (Davis, 1976).

This expansion of cotton in the Valley conceals marked differences among the four I.C.A.s making up the total upon which fig. 1 (b) is based.

Unfortunately the available records over the period for each I.C.A. are incomplete. There is a full run of dryland yields, but not for the irrigated crop. The number of farms growing cotton is available but the per cent. of the cropped area under cotton is not always so. Be that as it may the information is summarized in figures 2 to 5 and Tables 2 and 3 and presents a useful coverage of the crop in the Valley during recent years.

Commencing with Marodzi/Tatagura I.C.A. in the west in the higher part of the Valley, fig. 2 shows that the area of cotton only once exceeded 500 hectares, being 5,1 per cent. of the summer crop, produced by 20 growers. Apart from three years cotton was grown on less than 250 hectares by from three to 12 growers. Dryland yields ranged from a low of 614 kg/ha in 1974 to a high of 1 877 kg/ha in 1972. The response to irrigation in three years provided poor increments of from 377 to 777 kg/ha and in the fourth year dryland yields were recorded as having exceeded those from irrigation. Thereafter irrigation was discontinued. It would appear that apart from a very few growers cotton was not a successful crop in this I.C.A. where both altitude and sand veld soils provided severe limitations to production.

In the adjacent Glendale I.C.A. cotton occupied a more important place in the cropping system. The area of cotton climbed from 1 662 hectares in 1967 to 6 158 hectares in 1975, occupying from 11,2 to 32,6 per cent. of the total area of summer crops. The numbers of growers increased from 33 to 51 and then declined to 42 when 14 of them carried an irrigated crop as shown in Table 2. Over a six-year period the irrigated area ranged from 270 to 1 084 hectares.

Yields of both dryland and irrigation crops were very irregular with a low value for the dryland crop of 778 kg/ha in 1968 and a high one for the irrigated crop of 2 785 kg/ha in 1971. The latter yield was the average of 531 hectares under irrigation from 15 farms (fig. 2 and Table 2).

In Bindura I.C.A. in the centre of the Valley the area of cotton rose dramatically from 2 091 hectares in 1967 to 9 131 hectares in 1969, declined and rose again to 10 969 hectares in 1974, as shown in fig. 4. As a proportion of summer crops it increased from 15,0 to 46,9 per cent. and was grown on a varying number of farms, 30 in 1966, 112 in 1969 and 72 in 1975. Only 11 to 17 growers irrigated part or all of their crop (Table 2). Again yields of both dryland and irrigated crops were highly irregular from a low of 671 kg/ha in 1968 to a

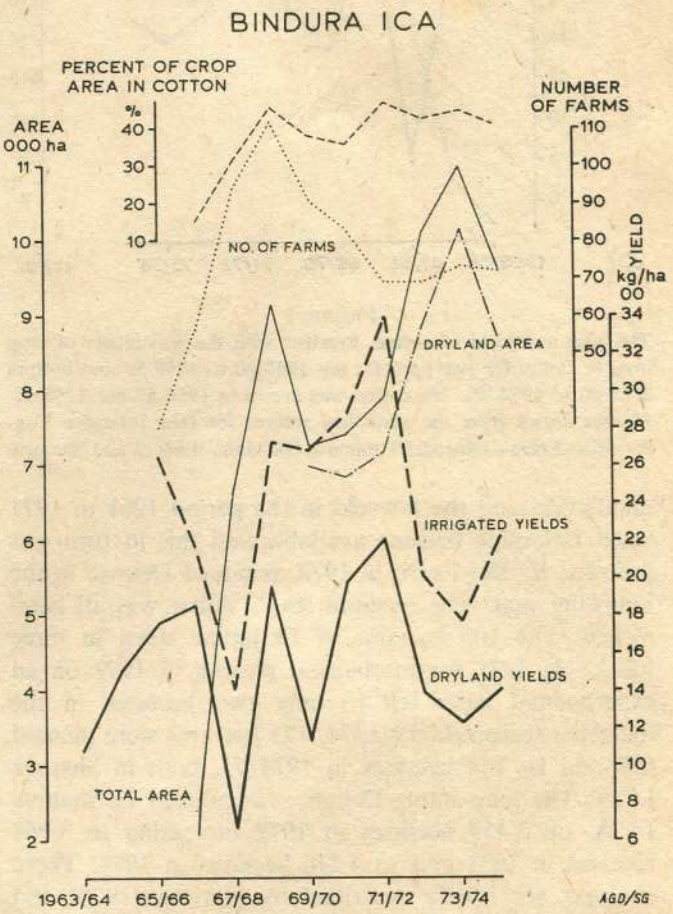

FIGURE 4

The area, yields, percentage of the crop area in cotton, and the number of farms growing cotton in the Bindura Intensive Conservation Area from 1963-64 to 1974-75. The irrigated area is the difference between the total area and dryland area.

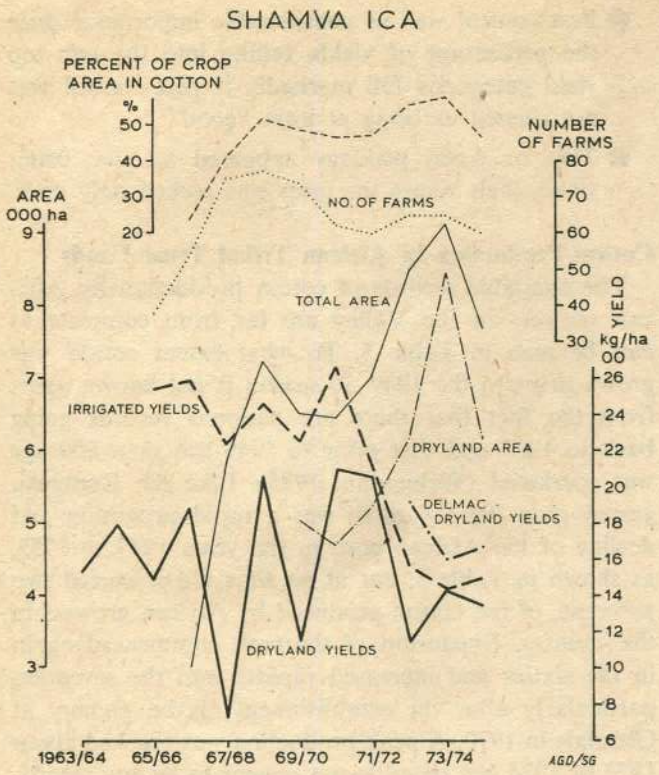

FIGURE 5

The area, yields, percentage of the crop area in cotton, and the number of farms growing cotton in the Shamva Intensive Conservation Area from 1963-64 to 1974-75. The irrigated area is the difference between the total area and dryland area. Yields for the whole period are for Albar; yields for Delmac are shown separately.

high of 2 205 kg/ha in 1972 for the dryland crop, while in the same years the values for the irrigated crop were 1 410 and 3 395 kg/ha. The last figure was the average yield from 779 hectares produced by 15 growers (Table 2). Apart from 1972 when 13 hectares of the cultivar Deltapine were grown yielding 1 615 kg/ha, Albar was produced during this period and incidentally in that year outyielded Deltapine by 590 kg/ha.

The area of cotton in Shamva I.C.A. in the lower and warmer part of the Valley was less than that grown in Bindura I.C.A., otherwise the trends in production were comparable (fig. 4 and 5). Cotton however occupied a larger proportion of the area of summer crops rising from 23,8 to 57,6 per cent. In one year, 1973, there were 30 farms with 2 265 hectares of cotton under irrigation (26,7 per cent. of the crop) followed by 13 in the next year out of a total of 65 farms growing cotton in both years (Table 2).

The cultivar Deltapine, adapted for mechanical picking, was introduced experimentally on three farms in 1972 but grown on only one farm during the following three years. Yields ranged from 620 to 2 273 kg/ha over the period with a maximum area of 144 hectares in 1974/75 and apparently poor response to irrigation. Delmac, a long staple cultivar, was introduced on 25 farms in 1973 and by 1975 occupied 80 per cent. of the cotton area. According to the Central Statistical Office reports, this cultivar out-yielded Albar under both dryland and irrigation (Table 3) and in 1973–74 it was grown on 24 out of the 65 farms. The reasons for the difference in yield is currently under investigation.

Irrigation

Yields of irrigated cotton were published from the 1965–66 season onwards but area figures only became available from 1969–70. The data are presented in figures 2 to 5 and Tables 2 and 3, and has already been partly discussed. The practice of irrigating cotton was primarily carried out in the three I.C.A.s of Glendale, Bindura and Shamva and where the over-all extent ranged widely from a low of 3,5 to a high of 27,6 per cent. of the crop and in the 1972–73 season approached a total of 4 600 hectares in area (Table 2). In the following year the area declined to less than 2 000 hectares but recovered in the 1974–75 season to over 3 400 hectares.

Yield responses to irrigation were greater on average during the first five-year period 1967–71 than was the case over the last five years 1971–75 in respect of the cultivar Albar (Table 3). Among the three I.C.A.s the differences were not consistent. In Shamva I.C.A. the higher dryland yield of Delmac (compared to Albar) together with its response to irrigation helps to explain its successful expansion over a short period.

The range of values for the coefficient of variation shown in Table 3 were greater for the dryland crop over the period 1966–67 to 1970–71 but were surprisingly high for the irrigated crop relative to the dryland crop in the following period. Good irrigation would eliminate moisture deficiencies and so lead to similar yields among growers. Therefore it would appear that irrigation practices varied widely confirming Robertson's (1974) report and a preliminary unpublished survey by the author, notwithstanding detailed advice contained in the Cotton Handbook (1964 with subsequent revisions) issued to all growers based upon schedules prepared by Metelerkamp (1968) and others. The practice in this region of the middleveld is essentially supplementary irrigation normally requiring a pre-planting watering followed by one or two light irrigations for germination and establishment prior to the onset of the rains. A long drought spell later in the season would require a further irrigation—all so far as the author is aware with overhead sprinklers. With the aid of supplementary irrigation the crop can be planted, with advantage, towards the end of October and early in November when temperatures are high and thereby provide the necessary long growing season of about 180 days. The majority of irrigated crops occurred on farms adjacent to the Mazoe River or its main tributaries the Murowodzi, Mwenje, Pote, Tsambe, while some crops received water from the Umwindsi River via a furrow and tunnel.

As was the case with maize (Davis, 1976) annual fluctuations in dryland yields shown in figures 2 to 5 were primarily a function of weather conditions during

the growing season. Irrigated yields although higher than dryland were also influenced by season and in some instances the difference between two consecutive years were very marked, e.g. the high values in 1971–72 vs the low ones in the following year in Bindura I.C.A. Long term predictions by Hannington (1972) of average cotton yields based upon the number of rainy pentades over thirty years provided a value of 1 552 kg/hectare for Bindura I.C.A. whereas yields were less than this in seven years out of the last twelve, while the average for the period was 1 521 kg/hectare. The high values of the coefficient of variation in Table 3 were a reflection of the wide differences in yields among growers. This is illustrated in more detail in Table 4 which shows the range of yields by classes for both dryland and irrigated crops in each of five years from 1971 produced by growers in the Bindura I.C.A. (Robertson, 1972, 1974; Wilson, 1975, 1976). Included in the data are also the weighted area averages, yield distribution in terms of standard deviation, coefficient of variation and mean as well as the percentage distribution of the classes. The data reveals an extended range of yields for both crops with 11,4 and 10,6 per cent. of the classes approaching the weighted average. Similar information is available for the cotton yields in the other I.C.A.s. This variation in yields was investigated by Robertson (1974) by means of a questionnaire covering 236 lands in the 1971–72 season in the districts of Mazoe and Hartley/Gatooma. He reported on a number of husbandry practices which affected the disparity in yields between farmers:

- Cotton yields were generally higher where cotton followed legume or maize crops than cotton; yields were also generally higher in fields which were ploughed moist than dry ploughed,
- Crops which germinated before the end of November yielded better than crops which were planted after this,
- Plant populations appeared to have little effect on final yield,
- Pest control was of considerable importance since the percentage of yields falling into the two top yield categories fell markedly if pest control was not classed as being at least "good",
- Two or more pickings appeared to give better yields than where the crop was picked only once.

Cotton Production in African Tribal Trust Lands

The available records of cotton production by African growers in the Valley are far from complete as can be seen in Table 5. To what extent cotton was grown prior to the 1949–50 season is not known apart from the fact that there are national records going back to 1937 and that prior to 1949 less than 500 kgs was marketed (Weinmann, 1975). Like the European grown crop (fig. 1), there was a rapid expansion and decline of the African crop in the years 1949 to 1955, as shown in Table 5, but at no time did it exceed two per cent. of the cotton produced by African growers in the country. Expansion of the crop commenced again in the sixties and increased rapidly into the seventies, particularly after the establishment of the ginnery at Glendale in 1970. A peak production was reached about 1973 or 1974 but there do not appear to be any records to substantiate this. As regards quality, 98,7 per cent. of the crop sold by members of the Producer Co-operative Societies in 1964 was Class I, while in subsequent years a similar high standard was maintained.

Over the years the entire crop was grown under dryland conditions by a relatively large number of growers on small plots of land. The total area grown in each tribal trust land is available only for two years (Table 5) and on average provided yields of 758 and 820 kg/ha. The small areas under cotton in some T.T.L.s were a reflection of soil types e.g. poor sands in Chinamora yielding 717 kg/ha in 1976–77 whereas productive red clays in Bushu yielding 900 kg/ha in the same season.

All growers were registered and like the European farmers planted the cultivar Albar, seed being obtained from the ginneries. The amount of fertilizer applied to their crops is not known. Obviously they applied

TABLE 3

The five-year average yield in kg/ha of Albar seed cotton for two periods* 1967-71 and 1971-75 and Delmac for three years 1973-75, together with Coefficient of Variation (CV)

I.C.A.	Marodzi/Tatagura	Glendale	Bindura	Shamva	
1967–71					
Dryland	1 049 CV 32,0	1 515 CV 32,8	1 530 CV 39,0	1 583 CV 39,3	
Irrigated	1 352† CV 15,0	2 453 CV 12,1	2 374 CV 25,4	2 437 CV 7,8	
Difference	303	938	844	854	
1971–75					Delmac 3 years
Dryland	1 301 CV 37,9	1 604 CV 22,3	1 648 CV 25,9	1 617 CV 27,1	1 726 CV 9,9
Irrigated	—	2 319 CV 19,8	2 444 CV 28,2	1 851 CV 28,4	3 283 CV 59,2
Difference	—	715	796	234	1 557

* Overlap by 1 year; † 4 years.

Source: Department of Conservation and Extension 1972, 1976 Area and Farm Yields, Central Statistical Office.

insecticides and acaricides otherwise they would not have achieved such satisfactory yields. It is interesting to note that these yields are substantially higher than those obtained elsewhere on the continent by African growers (Cotton Research Corporation, 1971).

Agronomic factors

Pertinent to the successful expansion and production of cotton in the Mazoe Valley has been improved cultivars and irrigation previously referred to, the influence of altitude, soil type, rotations, lime and fertilizer, crop protection, availability of labour for picking, method of marketing and of course a pricing structure which enabled growers to make a profit. While these factors were not different from those experienced elsewhere in Rhodesia, they are important in this study.

The relatively smaller area and lower yields of cotton in the Marodzi/Tatagura I.C.A. in the western sector of the Valley than in the other I.C.A.s can be attributed to both higher altitudes and sandveld soils. The former provides too short a thermal growing season, although research is currently in progress on Umsasa Farm to find suitable cultivars for the higher altitudes (Prentice, 1977), while the latter is associated with low yields and more especially serious soil erosion (Robertson, 1969) when the crop is young owing to poor plant cover.

At lower altitudes on the more fertile red soils cotton produces excessive growth and boll shedding may occur in the lower part of the plant profile when a period of overcast skies, cool temperatures and persistent rainfall follows upon warm weather. The extent of the losses is not known. Boll drop may also occur following adverse conditions e.g. nitrogen starvation, drought, disease or insect attack.

Rotations

The only detailed record in the Valley of rotations involving cotton is by Buttress (1971, 1973) who in a survey of five lands on each of one hundred farms in the 1970–71 season sought information on their cropping over the previous five years. Cotton was grown on fifty-nine farms in the survey which unfortunately did not include farms in the Shamva I.C.A. Only three out of 223 lands had carried four years of cotton, none had five. Even on good soils, 49 per cent. of the lands had only one year in five under cotton, 27 per cent. had two years and 22 per cent. had three years out of five. On the poorer soils mainly of the sandveld type 72 per cent. of lands carried cotton only one year in five.

On a few farms with a restricted area of arable land cotton was grown on the same lands in four years out of five whereas on larger arable farms it was restricted to one, two or three years but never four on the same land.

Along with cotton, the rotations included primarily maize, tobacco, sorghums and to a limited extent green manure, soya-beans, ground-nuts and ration beans. In 1970–71, 18 crops out of 119 cotton crops followed fallow while in the previous season five crops out of 89 in cotton followed fallow. The effect of the preceeding crop or fallow on the yields of cotton was not ascertained although it is known and indeed recommended that cotton being a long season crop is best planted after a short season crop in the previous year which would have allowed the carry over of subsoil moisture provided the previous year was not unusually dry. The choice of such crops was necessarily limited comprising relatively few in number, maize, soya-beans, ground-nuts on lighter soils, sorghum or planted pastures depending upon their relative profitability. On sandveld

TABLE 4

The distribution of yields by class intervals of Albar cotton in the Bindura I.C.A.

Year	No. of growers	Yield Class 0	1–249	250–499	500–749	750–999	1 000–1 249	1 250–1 499	1 500–1 749	1 750–1 999	2 000–2 249	2 250–2 490	2 500–2 749	2 700–2 999	3 000 plus	Yield distribution: Weighted average	SD	CV	Mean
Dryland Crop																			
1970–71	79		1	2		1	3	7	16	14	21	11	2	1		n/a	495	26,8	1 846
1971–72	67			1	1	1	3	3	7	10	11	9	4	6	11	n/a	665	30,4	2 184
1972–73	68	1	2	1	3	9	13	8	9	11	5	3	2		1	1 397	617	43,1	1 432
1973–74	72		1	4	8	7	17	13	8	10	4					1 236	486	38,9	1 250
1974–75	71		1	2	7	9	13	10	9	11	5	3		1		1 402	556	40,5	1 371
Total of class	357	1	5	10	19	27	49	41	49	56	46	26	8	8	12				
Percentage distribution of classes		—	1,4	2,8	5,3	7,5	13,7	11,4	13,7	15,6	12,8	7,2	2,2	2,2	3,3				
Irrigated crop																			
1970–71	16										1	2	2	3	8	n/a	295	10,5	2 820
1971–72	15									2		3		2	8	n/a	454	16,4	2 775
1972–73	17						1	1	2	1	4	2	2	1	3	2 046	595	26,4	2 257
1973–74	13						3		1	3	1	3	1	1		1 671	558	28,6	1 952
1974–75	14						1	2	2	1	2	1		2	3	2 225	697	31,7	2 196
Total of class	75						5	3	5	7	8	11	5	9	22				
Percentage distribution of classes							6,6	4,0	6,6	9,3	10,6	14,6	6,6	12,0	29,3				

Note.—SD = Standard Deviation. CV = Coefficient of Variation.

soils, even on slopes of less than five per cent., where serious soil erosion is always a real risk under cotton which provides poor cover during the first eight to 10 weeks of growth, Robertson (1969) recommended a rotation of two years cropping followed by four of grass with cotton always following the grass. The 1977 edition of the Cotton Handbook carries a blanket recommendation for the whole country that successive cotton crops should not be produced on soils with slopes greater than about 3 per cent. However there does not appear to be any experimental evidence to illustrate the importance of either recommendation.

The increase in the area of cotton since Buttress's survey of 1970–71 may have led to the crop being grown more frequently on the same lands particularly where supplementary irrigation was present.

Fertilizer and Lime

From the 1965–66 to the 1973–74 season all European farmers in Rhodesia were required to report the usage of fertilizer on their cotton crops. In the Valley the average applications set out in Table 6 ranged from a low of 278 to a high of 594 kg/ha. As was the case with maize over the same period (Davis, 1976) the rates applied would appear to be excessive on soils of good to medium fertility. If, for example, the application was 500 kg/ha composed of 400 kg of Compound "D" or Compound"L" (8N, 15 P_2O_5 and 10 K_2O) plus 100 kg of ammonium nitrate (34,5N) it would amount to 66,5 kg N, 60 kg P_2O_5 and 40 kg K_2O per hectare.

Research by Lang (1977) emphasized the relatively small effect that applied nitrogen has had on yield of seed cotton. Thus, using values from trials carried out by the Department of Research and Specialist Services in the Valley, the following average increments above the yields of the control plots in kg/ha were obtained from increasing applications of nitrogen:

Year	Control	20	40	80	120	160 kg/ha
1972–73	2 205	+44	+72	+120	+3	+147
1973–74	1 789	−49	+12	+39	—	+7

By using Compound "D" or Compound "L" and without the added application of ammonium nitrate growers were applying more nitrogen than was necessary. Indeed "on soils of known or suspected high soil nitrogen availability initial nitrogen should be omitted or kept to a minimum" (Cotton Handbook 1977). Compound "L" differs from Compound "D" in containing 0,2 per cent. of boron.

There is no record of the amounts of lime applied but because the crop is very sensitive to soil acidity, it requires a slightly acid to neutral soil, and because relatively high average yields were obtained in some years, it must be assumed that farmers applied adequate or near adequate amounts of lime where necessary.

Crop Protection

The successful production of Albar in terms of yield and area was made possible by the introduction in 1961

TABLE 5

Production of seed cotton in tonnes by African farmers and plot holders in the Mazoe Valley by districts and Tribal Trust Lands over selected years

District	1949–50	1950–51	1951–52	1952–53	1953–54	1954–55
Bindura	1,18	3,17	14,54	6,75	3,99	—
Concession	1,04	1,41	4,45	0,69	0,24	0,25
Shamva	1,28	1,07	4,61	4,36	2,77	1,45
Total	3,50	5,65	23,60	11,80	7,00	1,70
Total as a per cent. of all African production in Rhodesia	0,17	0,39	1,43	2,25	1,57	3,86

T.T.L.	1963–64	1969–70	1975–76		1976–77	
Chinamora	—	1,67	2,87	(4)	3,58	(5)
Chiweshe	—	279,73	19,09	(54)	30,83	(77)
Bushu	—	25,17	260,01	(316)	400,93	(445)
Madziwa	0,43	n/a	237,32	(304)	371,05	(436)
Masana	—	24,15	59,72	(99)	65,60	(100)
Masembira	2,95	4,84	32,82	(42)	17,63	(22)
Total	3,38	335,57	620,83	(819)	889,82	(1 085)

Note.—The term "district" used in the Cotton Research and Industries Board report refers to an administrative area of the Board at the time; the record for 1963–64 refers to cotton grown by members of Co-op Prod. Soc. not the total crop. Numbers in brackets are area in hectares in each T.T.L.

Source: Districts—19th Report Cotton Research and Industries Board, 31st December, 1954. T.T.L.s—Secretary for Agriculture, 1964; McKinstry, 1970; Ministry of Internal Affairs, 1976, 1977.

TABLE 6

The average application of fertilizer to the cotton crop in kg/ha

	1969–70	1970–71	1971–72	1972–73	1973–74
Marodzi/ Tatagura	278	284	389	533	480
Glendale	361	383	396	594	395
Bindura	405	418	454	436	471
Shamva	417	383	401	400	485

Source: Central Statistical Office.

of a rigorous programme for the prevention and control of insect pests (Tunstall *et al.* 1961, 1962). Earlier, various experimental measures had been tried in addition to end of season plant destruction date (normally 10th September) which has been in force under statutory regulations with suitable amendments since 1936. The earliest planting date has also been restricted, normally not before 10th October under the authority of the Plant Pests and Diseases Act, 1958. Later in 1964 the Rhodesia Cotton Growers' Association provided each registered grower with a Cotton Handbook. This, together with subsequent revisions in 1966, 1968, 1971, 1972 and 1977, was prepared with the material assistance of the cotton research staff of the Ministry of Agriculture. In it the more important pests were illustrated in colour together with detailed methods of scouting and control, including aerial spraying. The main pests have been and still are: Red boll worm—*Diparopsis castanea* Hmps, American boll worm—*Heliothis armigera* Hbn, Spiny boll worm —*Earias biplaga* Wlk and *E. insulana* Boisd, Pink boll worm—*Pectinophosa gossypiella* Saund, Cotton stainers —*Dysdercus* spp., Jassid—*Empoasca facialis* Jac, various leaf eaters, Grasshoppers, Aphids, *Aphis gossypii* Glov, Red spider mite—*Tetranychus* spp., and Termites.

Recommended insecticides in the late sixties and early seventies were carbaryl, D.D.T., endosulfan, dimethoate, binapacryl, dieldrin, monocrotophos and tetradifon.

The well known importance of weed control when coupled with supplementary irrigation and adequate fertilizers was demonstrated on Henderson Research Station in the 1963–64 season (Secretary for Agriculture, 1964) with the following spectacular (at the time) yields of seed cotton.

Supplementary irrigation + heavy fertilization + weed control . . . . 3 440 kg/ha
Supplementary irrigation + standard fertilization + weed control . . . 2 833 kg/ha
Supplementary irrigation + standard fertilization with no weed control during first 40 days . . . . . 2 030 kg/ha

The recommended herbicides for weed control were trifluralin or nitralin applied at pre-planting, fluometuron or prometryne at planting and M.S.M.A. as a post-emergent directed spray (Farm Management Handbook, 1968). However, successful weed control normally entailed a mixture of hand weeding, mechanical weeding and the application of herbicides by knapsack or tractor-mounted sprayer.

With both insecticides and herbicides their successful use was dependent upon adhering to the instructions on how and when to apply them, mitigated by rainfall immediately after application in the case of some of them.

Red spider mite resistance to dimethoate and closely related compounds became widespread so a rotation of chemically distinct acaricides involving a change every two years was recommended for each major cotton growing area by the research staff at Gatooma. The concept involved all the cotton growers in the Valley using a particular group of chemicals and later changing to another group.

A measure of the extent with which growers applied insecticides, acaricides and herbicides is illustrated by the input costs for these items (Table 7). These items amounted to one sixth of the variable costs of production over the period 1968–69 to 1970–71, as recorded for the Mazoe group of farms by the Management Advisory Service of the Rhodesian National Farmers' Union. Incidentally in these reports there was no relation between input costs of the herbicides, insecticides and yield.

It will be noted in Table 7 that the input costs of herbicides trebled in the short period whereas the costs of insecticides only rose by 30,3 per cent., indicating that growers materially increased their efforts to control weeds. The price of the chemicals, of course, did rise in that period. Together the two inputs represented 18,6, 16,6 and 21,7 per cent. of the variable costs from 1968–69 to 1970–71, exclusive of labour to apply them.

In the last season of this report, three growers with an average area of 59 hectares obtained an average yield of 2 814 kg/ha. The input cost of their herbicides

TABLE 7

The expenditure per hectare on African labour, lime and fertilizer, herbicides, insecticides and acaricides in relation to total variable costs over a three-year period, together with other relevant information

	1968–69	1969–70	1970–71
African labour	$22,45	$19,63	$25,01
Lime and fertilizer	8,55	10,89	11,73
Herbicides	1,07	1,55	3,07
Insecticides and acaricides	9,24	8,33	13,27
Total variable costs	55,29	59,50	75,16
No. of farms	27	21	17
Average area of cotton (hectares)	77,7	60,2	72,1
Average yield (kg/ha)	1 562	1 273	2 237
Sale price of cotton (cents/kg)			
Grade A	15,17	15,17	16,34
Grade B	13,34	13,34	14,51

Source: Duncan, Thomas, Cobban and Poulson (1971).

and insecticides amounted to less than 13,6 per cent. of the variable costs. While admittedly these were but a small sample of the total number of growers in the Valley, the information does indicate a measure of crop protection associated with producing cotton.

A more recent and important factor concerning crop protection has been the use of aerial spraying by single engine fixed wing aircraft. This commenced in the Valley on an extensive scale in the 1965–66 season but there are no reports on areas covered. Observation indicates that this technique has been widespread.

Labour

Over the entire period the cotton crop was hand-picked (apart from a few hectares of Deltapine), the additional labour required being normally the wives the children of the permanent African labour force on the farm reinforced by the employment of casual workers from neighbouring Tribal Trust Lands. Duncan, Thomas, Cobban and Paulson (1971) records the use of labour in dollar terms ranging from 19,63 to 25,01 per hectare in the period 1969 to 1971 (Table 7). Since actual numbers employed on cotton are not separately recorded in the annual statistics, a measure of their importance in farming owing to the large share of the land in cotton may be gained by an inspection of Table 8 dealing with employment in the Bindura and Shamva I.C.A.s in 1957, 1968 and 1974. The available information does not permit of direct comparison from year to year but does show an increase in the permanent employment of African labour and also the extent of the employment of casual workers. The grand total of permanent and casual workers in the four I.C.A.s in 1974 was 28 911. Robertson (1974) in his survey of factors affecting yields, referred to earlier, added the rider that "no matter how well a crop is grown, unless a farmer is able to attract adequate casual labour for picking, yield losses can be considerable, which in some cases have been severe during past years when demand for casual pickers has exceeded the supply during years of high yield". Work studies in Rhodesia show that the average cotton picker reaps 22 kg of seed cotton per day (Burgess, 1977). The value of this quantity in 1974 ranged from $4,54 to $6,16 depending upon its grade. Wages paid to casual employees were not recorded.

Marketing and Prices

Both the sale of seed to the grower and the purchase of his crop has been carried out by one authority in Rhodesia. In the period 1936 to 1954 it was the Cotton Research and Industries Board, a statutory body which also operated the ginneries and controlled the Cotton Research Station at Gatooma. In 1955 cotton research was transferred to the Ministry of Agriculture and the Cotton Research and Industries Board became the Cotton Industries Board. With the sale of its spinning assets the remaining functions were taken over in 1961 by the Grain Marketing Board and later in 1969 by the Cotton Marketing Board under the Agricultural Marketing Authority. The Board under its various names has been solely responsible for various operations which today include:

- The multiplication and rigorous inspection of "Breeders", "Foundation" and "Certified" seed crops of the different cultivars issued by the Cotton Research Institute, Gatooma
- The purchase and ginning of the entire crop grown by European and African farmers
- Delinting of seed for multiplication and planting
- Grading of the lint and marketing the lint and cotton seed.

European growers were registered with the Board and paid a variable levy as from the 1953–54 season, e.g. 0,33 cents/kg in 1970, 0,265 cents/kg in 1971, 0,26 cents/kg in 1972 to 1974. From 1975 the levy was changed to 1,4 per cent. of the value of the crop sold. The crop produced by the African grower was also subject to a levy from the 1949–50 season. They paid 10 per cent. into a fund for general development under

TABLE 8

The employment of African labour on farms in the Bindura and Shamva I.C.A.s in three selected years

Year	I.C.A.	Per cent. of crop land in cotton	Cotton reaped tonnes	Class	Males	Females	Total
1957	B	Nil	Nil	n/a	4 322	n/a	n/a
	S	Nil	Nil	n/a	3 269	n/a	n/a
1968*	B	32,0	4 655	n/a	4 948	667	5 615
	S	40,9	5 333	n/a	3 896	667	4 563
1974*	B	44,9	13 911	Permanent	6 187	827	7 014
				Casual	1 018	2 205	3 223
				Total	7 205	3 032	10 237
1974*	S	57,6	13 885	Permanent	4 258	671	4 929
				Casual	1 572	1 731	3 303
				Total	5 830	2 402	8 232

* As at the end of September
Source: Central Statistical Office.

the Native Development Fund Act of 1948. Moneys from the European levies were made available for research and cotton promotion. In addition to the Cotton Marketing Board, the Rhodesia Cotton Growers Association (European) has played a vital and continuing part in looking after the interests of European growers, supporting research and the promotion of cotton. At any one time one or more members of the Rhodesia Cotton Growers' Association have served on the Cotton Marketing Board. Cotton growers in the Mazoe Valley have taken a leading part in these activities.

A further extent of the centralized control of the crop is the provision of samples of each grade of seed cotton on which the growers crop was classified and purchased. Samples of each grade are prepared annually by consultation and agreement between representatives of the Cotton Marketing Board and the Rhodesia Cotton Growers' Association. Boxes containing the different samples are issued to each ginnery for use by the classifier so that all grade A samples in the country are identical, likewise Grades B, C and D. The Board's system of grading and purchasing growers' crops in the form of seed cotton whether hand or machine picked is very satisfactory to all parties concerned and in many ways is unique to Rhodesia.

The Board currently rents suitable hessian "packs" to growers for transporting their crop to different ginneries, recommending a weight of approximately 180 kg. Production statistics originally published in lbs. have since 1970 been expressed in tonnes, always as unginned cotton. Ginned lint emerging from the two ginneries at Tafuna and Glendale is packed in 200 kg bales. Since metrication in 1971, seed is sold in 10 and 50 kg bags.

During the last three decades the number of grades under which the growers' cotton was sold has only changed three times commencing with four reduced to three in 1955, then raised to four in 1962 and since the 1968–69 season raised again to 7. The price of Grade A has risen irregularly from 7,34 cents/kg in 1946 to 28.00 cents/kg in 1974. Information on the proportion of the Mazoe crop in each grade is not available.

Gross Margins

The grand period of expansion and production of cotton in the Valley has taken place during the last decade of this study. The survey conducted by the Management Advisory Service of the Rhodesia National Farmers' Union (Duncan *et al.* 1971) provides an economic measure of the crop in the centre of that decade. The relevant data presented in Table 9 shows that the highest gross margins were associated with the highest yields within years and between years. The lowest yield provided a negative gross margin of over five dollars per hectare. The highest yields were three times the lowest yields. Admittedly the sample was small and may well have represented the more successful growers who were and are conscious of the value of recording the cost of their operations.

Prospects

The rapid expansion of cotton production when circumstances permitted was a measure of the farmer's response to applying the necessary technology primarily in respect of crop protection in order to grow a profitable crop. The area under cotton reached a peak in the 1973–74 crop when it occupied over 2 500 hectares in the four I.C.A.s plus probably at least 1 000 hectares grown by African farmers and plot holders in the Valley. Maximum average drylands yields of 2 200 kg/ha were achieved in the 1971–72 crop during an exceptionally good season.

Cotton has a potential yield of 6 600 kg/ha (Cotton Handbook, 1964) in this country so it would appear that on average only one third of this yield has been obtained in the Valley, and that in a good year. Furthermore, yield increments will not be easy to obtain, not that it is a difficult crop to grow, but because weeds and insect pests of cotton thrive in that environment and therefore demand first class management at all times in order to keep them in check.

Expansion of the area under cotton from a peak of 35 per cent. of the crop area on European farms in 1973–74 could take place (in Shamva I.C.A. it was 57,6 per cent. in 1974) but could not be maintained owing to the need to adopt and maintain a suitable soil

TABLE 9

Selected economic factors in the production of cotton in the Mazoe Valley

	Bottom third	Middle third	Top third	Average	Bottom third	Middle third	Top third	Average	Bottom third	Middle third	Top third	Average
	1968–69				1969–70				1970–71			
Total variable costs $	48,98	54,23	62,68	55,29	59,40	59,38	95,71	59,50	69,14	65,97	93,43	75,16
Gross output $	55,60	86,01	130,47	90,69	54,09	73,83	98,52	75,48	102,05	135,88	209,97	145,73
Gross margin $	6,62	31,78	67,79	35,40	—5,31	14,45	38,81	15,98	32,91	69,91	116,54	70,57
No. of farms	3	9	9	27	7	7	7	21	6	6	5	17
Average area of cotton in hectares	68	74	89	77	53	71	56	60	69	85	59	72
Average yield kg/ha	976	1 481	2 230	1 562	943	1 237	1 640	1 273	1 454	1 854	2 814	1 996

Source: Duncan, Thomas, Cobban and Poulson (1971).

fertility restoration rotation in order to maintain high levels of yield. Expansion of supplementary irrigation following construction of additional dams would enable an increase in both area and yield but such development is most unlikely in the immediate future. If cotton were to receive preferential treatment price wise over its competitors maize and soya-beans (McKinstry, 1976) obviously all the existing area under irrigation would expand into cotton and likewise much of the dryland area. Although the percentage of crop area in cotton grown by African farmers is not known it is unlikely to have exceeded 35 per cent., nor can it be increased owing to the need to grow food crops, a factor which will also affect land currently owned by European farmers.

Over-all it will be desirable to continue with hand picking both to provide employment and quality of crop. The forthcoming political changes will not alter these desirable objectives.

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