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A F R I C A N S T U D I E S I N S T I T U T E

African Studies Seminar Paper to
be presented at Seminar in RW 319
at 4,00 pm on Monday, 14 May 1984.

SEASONS THAT WILL NE'ER RETURN: THE IMPACT OF FARM MECHANIZATION ON EMPLOYMENT, INCOMES AND POPULATION DISTRIBUTION

by Mike de Klerk

> To everything there is a season . . .
> A time to plant, and a time to pluck up
> that which is planted ...
> What profit hath he that worketh in that
> wherein he laboureth?
>
> Ecclesiastes 3, v. 1,2,9.

The study[1] on which this paper is based is set out to assess the nature and strength of the link between recent changes in agricultural technology and employment in South Africa. Amongst its objectives were to determine

- the degree to which mechanisation has occurred on maize farms in recent years,
- how the labour process has changed,
- changes in the level of employment and the characteristics of farm workers,
- the causes of mechanisation,
- and whether any decline in employment has led to a rise in unemployment.

From the findings, it was possible to make a number of deductions about changes in the geographical distribution of the population and in the incomes of farm workers and their families.

1. RESEARCH METHOD

In February-March 1982, a survey was conducted of sixty one maize farms in six magisterial districts of the Western Transvaal: Coligny, Delareyville, Koster, Lichtenburg, Schweizer-Reneke and Wolmaransstad (see Figure 1.). Maize production almost certainly generates considerably more employment than any other branch of agriculture in South Africa, and the Western Transvaal, in most years, produces more maize than any other region. Information was gathered about harvesting, delivery of the harvest and weeding for the years 1968-81. In 1968,

FIGURE 1 : The Geographical Distribution of Farming Units Visited

KEY

● - farming unit for which data was available for 1968 -1981

O - farming unit for which data was available for 1973 - 1981

✪ - farming unit for which data was available for 1977 - 1981

★ - farming unit for which data was available for 1981 only

- area covered by six magisterial districts included in survey

—·—·—·— - South Africa - Botswana border

———— - Bophuthatswana boundary

— — — — — - provincial boundaries

..... - magisterial district boundaries

++++++++++++ - railways

■ LICHTENBURG - main cities/towns

Sources: 1. Bureau for Economic Research re Bantu Development (BENBO): "Bophuthatswana Economic Revue 1975", Pretoria, 1975.

2. RSA, Department of Community Development, Chief Director of Surveys and Mapping: 1:250 000 topocadastral maps no's 2524, 2624, 2724, 2526, 2626, 2726, Cape Town, 1980.

...2/However,

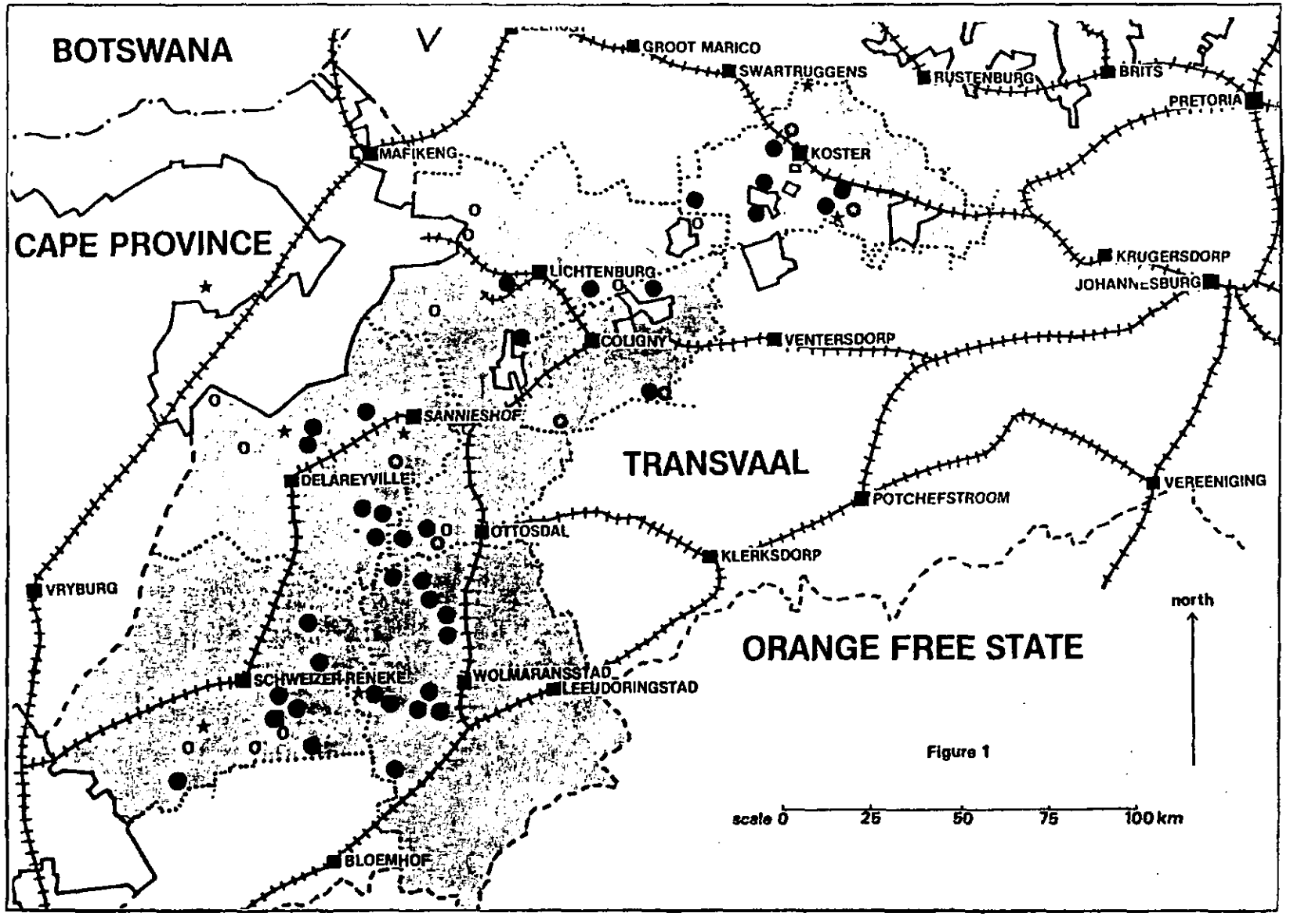

BOTSWANA
GROOT MARICO
SWARTRUGGENS
RUSTENBURG
BRITS
PRETORIA
MAFIKENG
KOSTER
CAPE PROVINCE
KRUGERSDORP
JOHANNESBURG
LICHTENBURG
COLIGNY
VENTERSDORP
SANNIESHOF
TRANSVAAL
DELAREYVILLE
VEREENIGING
POTCHEFSTROOM
OTTOSDAL
KLERKSDORP
VRYBURG
north
ORANGE FREE STATE
SCHWEIZER-RENEKE
WOLMARANSSTAD
LEEUDORINGSTAD
scale 0 25 50 75 100 km
BLOEMHOF

Figure 1

these were the last three tasks for which large numbers of seasonal workers were still employed.

It was not possible to select farms on a statistically random basis. The sample was therefore non-random. By watching its characteristics in terms of farm size and geographical distribution as closely as possible to those of the overall population recorded in censuses, it is hoped that the degree of sampling error has been reduced to acceptable levels.

The most significant source of sampling error is likely to have been the over-representation of very large farms and the under-representation of very small farms in relation to census data.[2] The probable direction of bias is therefore towards an over-estimate of the degree of mechanisation and a corresponding under-estimate of employment. However, there is no obvious reason to suppose the degree of error to be gross.

One of the more important potential sources of non-sampling error arises from what one could call 'class bias'. Because all the data were collected from farmers, they could consciously or unconsciously have been biased in favour of capital. The ideal would have been to interview both farmers and workers. On farms, this was generally not possible, and might have been counter-productive. But the off-residence of seasonal workers - out of season - made it easier to interview them. A second, smaller and less formal survey was undertaken in the Transkei, partly with the intention of assessing the degree of non-sampling error. Seasonal workers employed in 1981 and in previous years on four of the farms visited, were interviewed, and the same questions concerning inter alia employment and the payment of wages were asked. Quite without prompting, most of the answers bore a close resemblance to those given by their employers. While these four farms represent only about six percent of the total, the corroboration received does suggest that the error resulting from class bias is not serious.

The stability of the sample - which depends on the sample size - should be reasonable since the number of farms included always represented one percent or more of the population.

In analysing the data, four years - 1968, 1973, 1977 and 1981 - spread at more or less equal intervals were focused on.

2. CHANGES IN THE TECHNOLOGY AND STRUCTURE OF FARMING

2.1 HARVESTING TECHNOLOGY

Harvesting maize involves both reaping - that is, picking the "head" or "blaarkop" from the stalk - and threshing, or removing the seeds from the head. Both can be done by hand or mechanically but it is many years since maize was last threshed by hand in the Western Transvaal. The basic alternatives are therefore: reaping by hand and threshing mechanically - called "hand-harvesting" - or reaping and threshing with the same machine, i.e. "combine-harvesting". In both cases a number of variations are possible.

Until twenty five years ago, all maize was reaped by hand. Hand reapers walk down the rows breaking the heads loose from the stalks and putting them into a container which they carry with them. The work is tiring and makes heavy demands on one's whole body.

Typically, a team of seasonal workers, anything between ten and two or three hundred strong, is employed to reap. The tractors and trailers used to transport the "blaarkoppe" from the fields to the threshing machine, vary in number between one and a small fleet and are driven by permanent workers.

To operate a threshing machine, two men are needed to feed the "blaarkoppe" into the hopper - a dirty and tiring job - and one to control the tractor which powers the machine.

The combine-harvesters which appeared in South Africa in the 1950s presented farmers, for the first time, with a choice between fundamentally different harvesting techniques. The first generation of combines were pulled by tractors and like threshing machines took their power from the propeller shaft of the tractor. For this reason they are often called "PTO" (power take-off) combines. By comparison to the later self-propelled combines, they are simple, robust, reliable, well-suited to smaller farming units, and relatively inexpensive, so it is not surprising to find that the majority of combines currently in use in the Western Transvaal are still of this type.

In the late 1960s a second important change in the range of harvesting techniques occurred with the marketing of the first self-propelled ("SP") combines. These, as the name implies, were no longer drawn by tractors but were equipped with their own engine. They also had a considerably greater intake capacity which made it possible to harvest the same area with fewer machines and drivers. But relative to PTO combines, they are more complex, temperamental, suited to larger farming units and expensive to buy and maintain. The mechanical process is similar for both types of combine, and the threshed grain is collected in a tank in the combine which is emptied periodically by auger into a truck or trailer.

Opinions vary as to the relative efficiency of combines and hand-harvesters, but even farmers most convinced of the superiority of machines still employ seasonal workers to supplement them. Gleaning - that is, picking up the "blaarkoppe" left behind the combine - is almost universal.

At a stroke, combines have eliminated much of the toil and grime of the harvest season. Gone is hand reaping, and gone is the handling of "blaarkoppe" in transport and threshing. But gone too are most of the jobs. For seasonal workers, generally, only employment in gleaning remains - where, though the work is less arduous, the number of jobs is far smaller. Also, with the change from hand harvesting to gleaning, it has been possible to replace men with children. Women have always made up the greatest part of seasonal teams.

At the start of the data-collection period, in 1968, between twenty five and thirty percent of the area planted with maize was being harvested by combine. By the end of the period, in 1981, this had risen to about ninety five percent. The greatest part of the change-over took place between 1973 and 1977. The most popular machine used was the smaller, tractor-drawn combine. (See Figure 2 below.)

2.2 DELIVERY TECHNOLOGY

The farmer's final task is to deliver his crop to a co-operative depot. There are two ways in which this may be done: in sacks or in bulk.

If the crop has been reaped by hand, it is passed through a threshing machine and emerges from an outlet chute into sacks. When a sack has been filled, the flow is cut off momentarily, by closing the chute, and the full sack is removed and replaced by an empty one.

All delivery sacks nowadays hold 70kg of maize, though in days gone by, the standard weight was 200lb (90kg). When a bag is full it should contain about 70kg, but the exact weight needs to be checked before it can be sealed. So from the threshing machine or trailer sacks are moved to a scale and are topped up or emptied a little as need be. With the weight correct, they are sewn closed, ready for loading onto a truck or trailer.

Handling 70kg sacks is not an easy task, especially when it has to be done all day and sometimes well into the night. Only young, able-bodied men are employed to do this. Normally four men - one at each corner of the sack - are assigned to loading, and another two on the truck itself for stacking and helping with unloading at the depot. Even for moving the sack from the threshing machine to the scale, two are needed, and another two to move it off and seal it. So usually at least ten men would be involved in the delivery process at the farmer's end. Then, of course, each truck or tractor towing a trailer needs a driver, and, unless the farm is small, two or more vehicles are used to ply between the threshing machine and the depot.

At the depot the sequence is : weighing the trailer with its full cargo, sampling the delivery for grading, off-loading, weighing the empty trailer, the stacking. So the same heavy job of shifting the sacks by hand has to be performed twice over again. For these tasks, workers from farms are joined by a team from the depot.

From the point of view of workers delivery in bags represents a substantial number of jobs: from the point of view of farmers, on the other hand, it is a time-consuming and expensive operation. It is not surprising, therefore, that since the early 1960s, co-operatives in the Western Transvaal have invested millions of rands in bulk handling and storage facilities, though other reasons such as prolonging storage life were also important. The towering concrete silos that one can see from so far away in the flatness of the Western Transvaal are the most obvious manifestation of these.

Handling and storing grain in bulk certainly substitutes a realtively simple process for a more complicated one. On farms the output of the threshing machines or combine is allowed to flow directly into a bulk trailer. Hand-labour is required only to spread the flow evenly with a shovel. The need for filling and weighing each individual sack is eliminated, not to mention the sweat of handling thousands of sacks.

At the depot, the weight of the load is again determined by weighing the entire truck or trailer, first fully loaded and then empty. Off-loading is simply a matter of stopping the trailer on top of a grid below which is the hopper for the silo's grain elevator, letting down the sides of the trailer and shovelling the load into the hopper. Or, if a specially-built V-shaped bulk delivery trailer is being used, all that is necessary is to open the sluices in the bottom of the truck. Also, sampling for grading no longer requires the opening of sacks. These changes have almost totally eliminated the need for seasonal labour.

The adoption of bulk handling and storage techniques was more advanced than combine harvesting in 1968: by that stage, more than

half the crop - fifty four percent - was already being delivered in bulk, and by 1977 virtually the entire crop was reaching silos in this way. (See Figure 2 below.)

2.3 WEEDING TECHNOLOGY

Having planted, the dryland farmer must simply wait for the main ingredient of succe s - rain. But there are two important ways, independent of nature, in which he may encourage the growth of his crop: fertilising and weeding. Both can be done mechanically while the plants are still small enough to use a tractor without causing damage, but this is possible later only if the rows have been planted seven feet or more apart. For weeding, the procedure is simply to uproot the unwanted growth by ploughing lightly. Early weeding has for many years been done in this way.

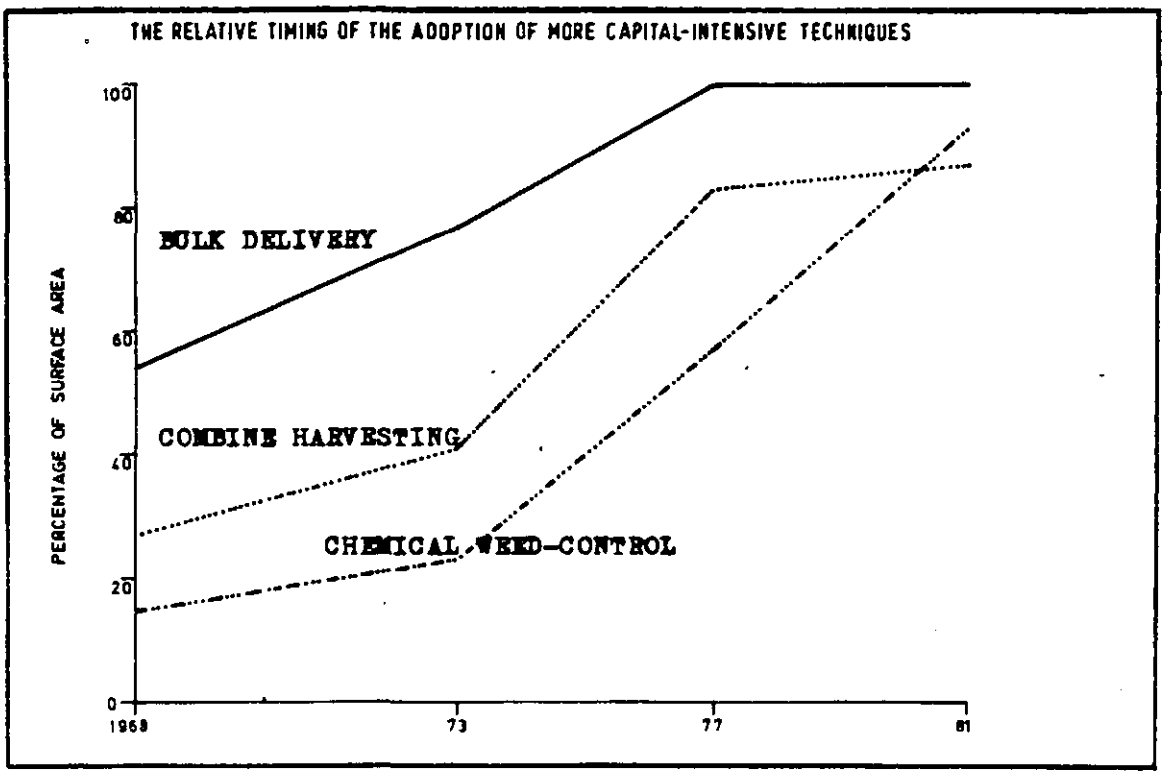
Later weeding on farms where the row width is less than seven feet, has until recently, had to be done by hand. Hoes must surely be the most ancient of agricultural implements still in use today in an unchanged form. And for a good reason: they are very effective. But they also require long hours of work. In recent years, chemical weed-sprays have offered a labour-saving alternative to the traditional part-hand, part-mechanical method.

Hand-hoeing needs little description. The work is not as tiring as hand-reaping and so is generally done by women and children. Nor is it as urgent. In contrast to reaping which must be done as soon as the crop is ripe - this often occurs simultaneously on farms in the same district - hoeing can usually be done when workers become available and does not need as many workers. Partly for these reasons, most hand-hoeing has been done by the families of permanent farm workers, living on "white" farms.

Weedicides are usually sprayed onto the soil during, or shortly after planting by a tractor towing or mounted with a tank and spraying equipment. Because spraying is not effective against all weeds, it is normally followed in mid-summer either by hand-hoeing or by part-hand, part-mechanical hoeing. Hand-hoeing teams employed for this work are considerably smaller than if the entire weeding operation is done by hand or part-mechanically.

By comparison to harvesting and delivery, chemical weed control was not nearly as widespread in 1968. Only fifteen percent of the area planted with all crops was being sprayed with weed-killers at that stage. But the pace of advance was quick and by 1981 weed-killers were being used on roughly ninety five percent of the total crop surface area. (See Figure 2.)

FIGURE 2.



Besides technology, the three factors on which employment patterns appear to depend most are the surface area of farming units, the yield or output of maize per hectare and wages.

2.4 FARM SIZE AND YIELD

The connection between changes in technology, wages and output per hectare, and changes in the level of employment needs no explanation. Between changes in farm size and changes in employment, the link is not so obvious. Farm enlargements increase potential economies of scale, i.e. they create the opportunity to lower the average cost of production. This generally involves either purchasing more or larger labour-replacing machines, which it would not be profitable to use on smaller areas of land, or using existing machinery and labour on an enlarged area. The second of these options is frequently chosen: farmers are reluctant to retrench permanent workers who have worked for them for some while but who have become redundant as a result of mechanisation. However, there are no such personal ties between farmers and workers employed on other farms. So when additional land is bought or rented, the workers who were previously employed on that land are often not re-employed.

Over the thirteen years, the average gross surface area of farming units in the survey grew by almost seventy five percent from 664 ha in

1968 to 1,155 ha in 1981. No less than two thirds of the increase came about in the period 1973-1977. These changes should be seen against the background of a near-constant total area planted with maize, and therefore indicate a substantial increase not only in the size of farms but also in the degree of concentration of ownership or control. The reasons for this crucial change in the structure of agriculture require further research.

Despite some sharp fluctuations in the middle '70s, the trend of output per hectare was firmly upwards. On average, the expected yield grew by a little short of six and a quarter per annum, resulting in a total rise of almost 120 percent between 1968 and 1981. Since then yields have dropped sharply.

2.5 WAGES

Between 1969 and 1976, data collection by the Department of Agriculture shows the average cash-only[3] daily wage of seasonal maize-harvest workers to have roughly doubled from -39 to -77 cents per day. The average found in the author's survey was R1,54 per day in 1981 (R1,64 for weeding). Rather less than half of the workers employed for this task were paid a daily cash wage. The alternative was to pay workers a proportion of the crop - generally four or five percent for hand-harvesters and eight to ten percent of gleanings for gleaners. In most years this would appear to lead to a considerably higher effective wage: in 1981, when an all-time record crop was harvested, hand-harvesters earned on average R4,74 per day on the four farms in the sample where the crop was still harvested in this way. Gleaner's wages cannot be calculated accurately, but can be estimated at about R3,50 per day in 1981 for those paid in a proportion of the crop.

With just two exceptions, only 'internal' seasonal workers, i.e. the families of permanent workers resident on farms, were paid on a daily cash basis. Living at home, and with the income of permanent workers in their households assured, it would have been possible, if not attractive, for such people to view seasonal wages as no more than a small supplement to family income. Indeed, at an average of R1,54 per day, one can only imagine that most had in some way to be coerced into accepting work. What the leverage farmers would have needed was probably provided by residence: women and children dependent for their income and shelter on the continued employment on farms of the chief bread-winners of their households, would have been in a far weaker position to negotiate wages or refuse employment than independent communities living far afield.

As will be shown later, one of the most noticeable features of the change in employment patterns that accompanied the extensive mechanisation of harvesting, crop delivery and weeding in the Western Transvaal in the 1970s, was the transfer of seasonal jobs from 'external' to 'internal' workers. This is particularly striking in the case of maize harvesting, the largest source of seasonal employment. In 1968, 'internal' workers occupied only nine percent of such jobs. By 1981, this had risen to forty eight percent. While mechanisation itself seems to have taken place for a number of reasons, most of which are not directly related to the wage differential just described, the transfer of seasonal employment from 'external' to 'internal' workers was greatly facilitated by the growth of capital intensity.

Without doubt, one of the most important reasons for this transfer was the lower wages that could be offered to seasonal workers resident on white farms.

For permanent workers, the average all-inclusive[4] annual wage rose almost three-fold between 1970 and 1977 - from R220 to R653. The author's estimate for 1981, based on the same method of calculation, was R1,777. On a daily basis, the increase was therefore from about -60 cents to R4,85, between 1970 and 1981. However, caution should be exercised in relating the estimates of the Department to those of the author. Other evidence suggests either that the author's estimate for 1981 was above the true average or that the Department's estimates for 1970-1977 and subsequent years were below the true average.

When the rise in the cost-of-living is allowed for, the real wage increases are seen to be much smaller. For seasonal workers, between 1969 and 1981, it is no more than twenty percent. That is, from -39 cents per day in 1969, the real wage rose to only -47 cents in 1981 (at 1969 prices). The gain for permanent workers was more tangible; the real wage rate increased from R220 p.a. in 1969 to R338 p.a. in 1977 (at 1970 prices). The author's 1981 estimate, also at 1970 prices, was R564 p.a. Bearing in mind the above qualification, this represents about a two-and-half-fold real increase. On a daily basis, the real rise was therefore from about -60 cents in 1970 to R1,55 in 1981. (See Figures 3 and 4).

Details of the method of estimation and composition of wages are to be found elsewhere.[5]

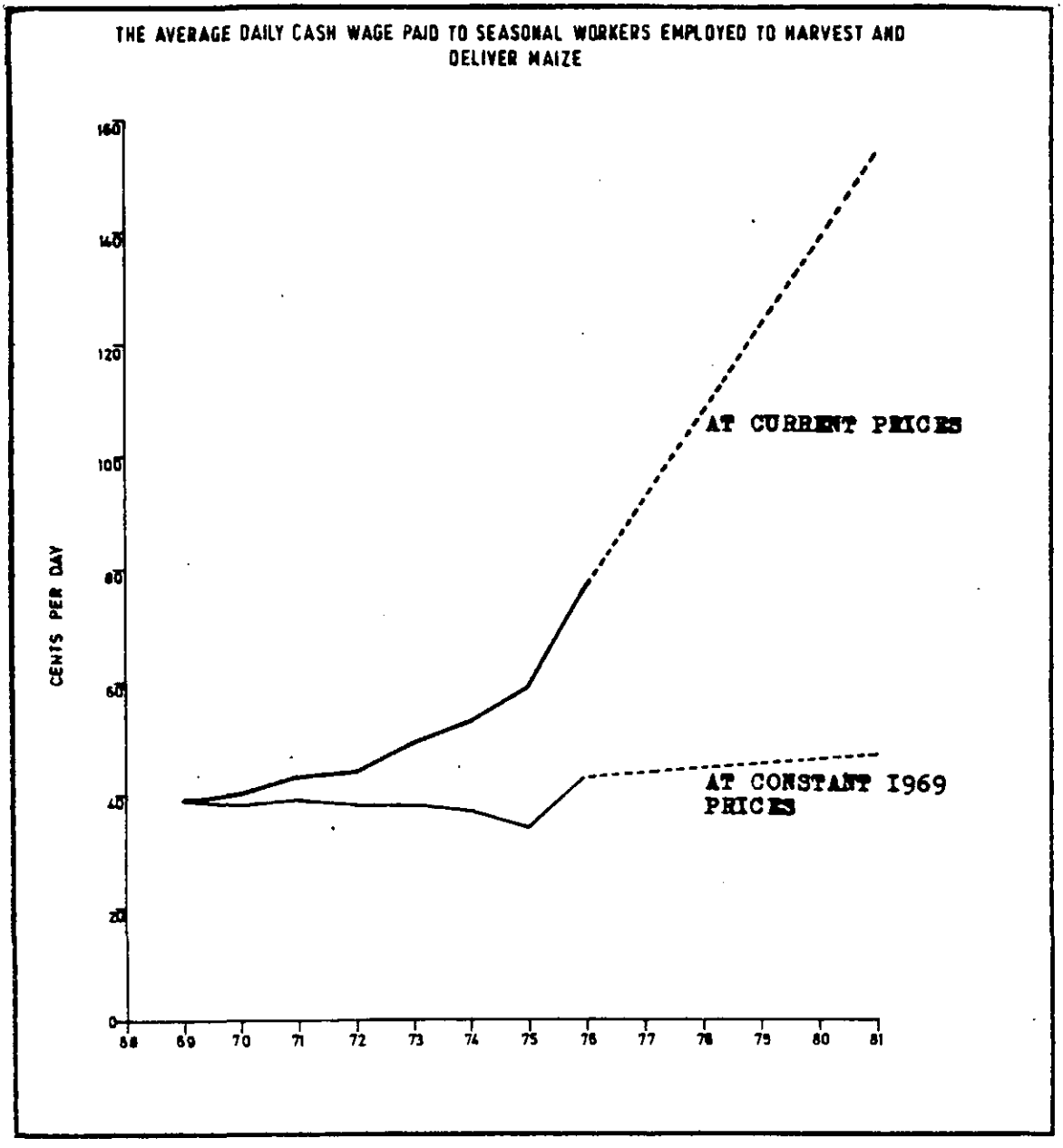
3. CHANGES IN EMPLOYMENT PATTERNS

3.1 THE LEVEL OF EMPLOYMENT

Between 1968 and 1981 the average number of seasonal workers per farming unit engaged in harvesting and delivering the maize crop fell by about fifty percent. For permanent workers, the fall was restricted to twenty percent. However, when the increase in the average size of farming units is taken into account so that employment is measured on a constant (per 1,000 hectares) basis, the decline in the number of jobs is seen to have been almost seventy percent for seasonal and fifty percent for permanent workers. Because the total area planted with maize in the Western Transvaal changed little over the thirteen years, these estimates give the best indication of the percentage change in the actual number of workplaces in harvesting and delivery. (See 'total' trend line in Figure 5.) In addition to the fall in the number of seasonal workers employed, the average period of employment fell noticeably, from ten to eight and a half weeks per farm.

In the other major form of seasonal employment, weeding, the adoption of new techniques also led to a contraction in the number of jobs. The number of seasonal workplaces per farming unit fell by between twenty five and thirty percent over the thirteen years. On a constant (per 1,000 ha of arable land) scale, the contraction turns out to have been much greater - about sixty percent. As in the case of harvesting, this gives a reasonable indication of the fall in the actual level of seasonal weeding employment available in the Western Transvaal. Also in common with harvesting, the period of sharpest decline occurred in the mid-'70s - between 1973 and 1977. The average

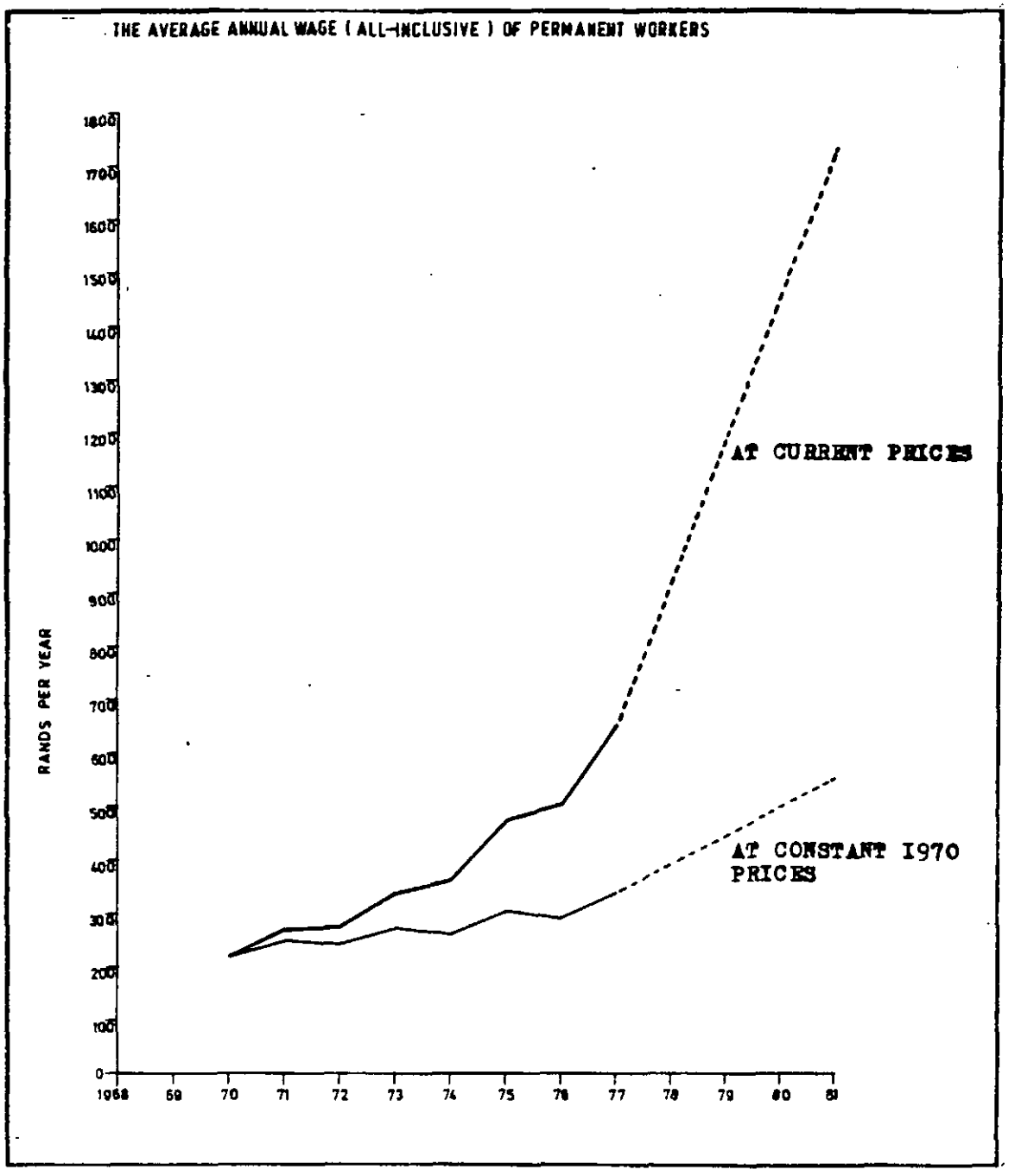
FIGURE 3



duration of seasonal weeding employment also shortened, from about eight and a half to eight weeks per farm.

The actual number of workers who found seasonal employment in weeding and/or harvesting cannot be calculated accurately. However, in the six magisterial districts covered by the survey, it appears to have been approximately 105,000 in 1968 and 40,000 - 45,000 in 1981. Although the number of permanent workers per 1,000 ha harvested fell by nearly fifty percent, because harvesting, delivery and weeding are only three of the full annual range of activities for which permanent

FIGURE 4



workers are required, census data shows the number of permanent farm workers employed in the region to have fallen much less than proportionately - from about 30,000 in 1969 to 26,000 in 1978 (the latest year for which census data is available).

Of the total decline in seasonal employment between 1968 and 1981, about thirty seven percent can be ascribed to the replacement of hand- by mechanical-harvesting, about thirty two percent to the adoption of chemical weed-sprays, about twenty four percent to the reorganisation

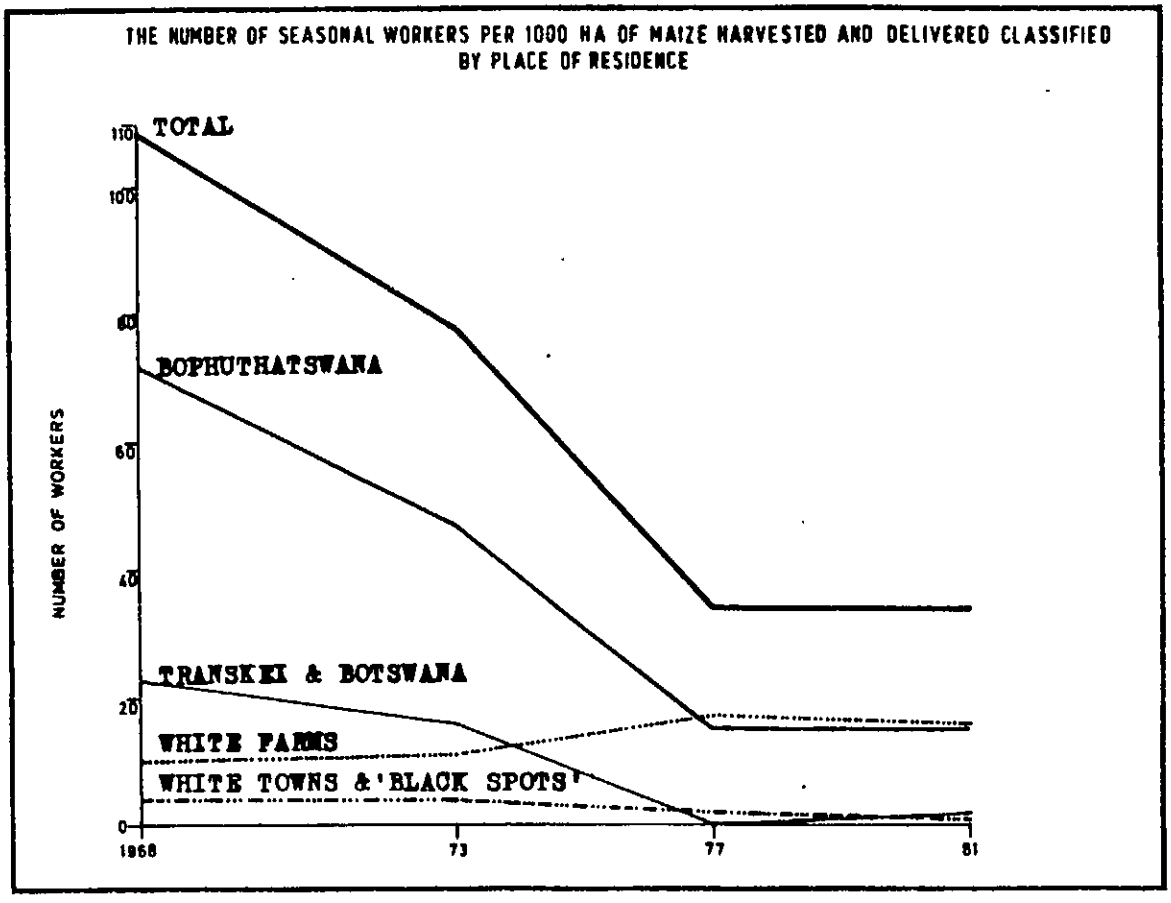
of hand-harvesting prior to the introduction of mechanical harvesting techniques,[6] about seven percent to the introduction of bulk handling and storage techniques, and less than one percent to the replacement of tractor-drawn by self-propelled combines.

3.2 THE COMPOSITION OF EMPLOYMENT

At the start of the period sixty six out of every 100 seasonal harvest workers came from Bophuthatswana. By the end, no more than forty four out of every 100 did. All of the balance and more was taken up by the families of permanent farm workers, whose share of seasonal harvest employment increased from about ten percent to almost fifty percent during the thirteen years. People from the Transkei, Botswana, white towns and "black spots" were also employed, but in comparatively small numbers.

When the pattern of residence is superimposed on the pattern of falling harvest employment, it is found that whereas in 1968 workers drawn from "external" sources, i.e. Bophuthatswana, Transkei, etc., could count on about 100 workplaces per 1,000 ha of maize harvested, by 1981 the number was less than twenty. Even those from "internal" sources, i.e. who lived on white farms, whose share of employment had

FIGURE 5

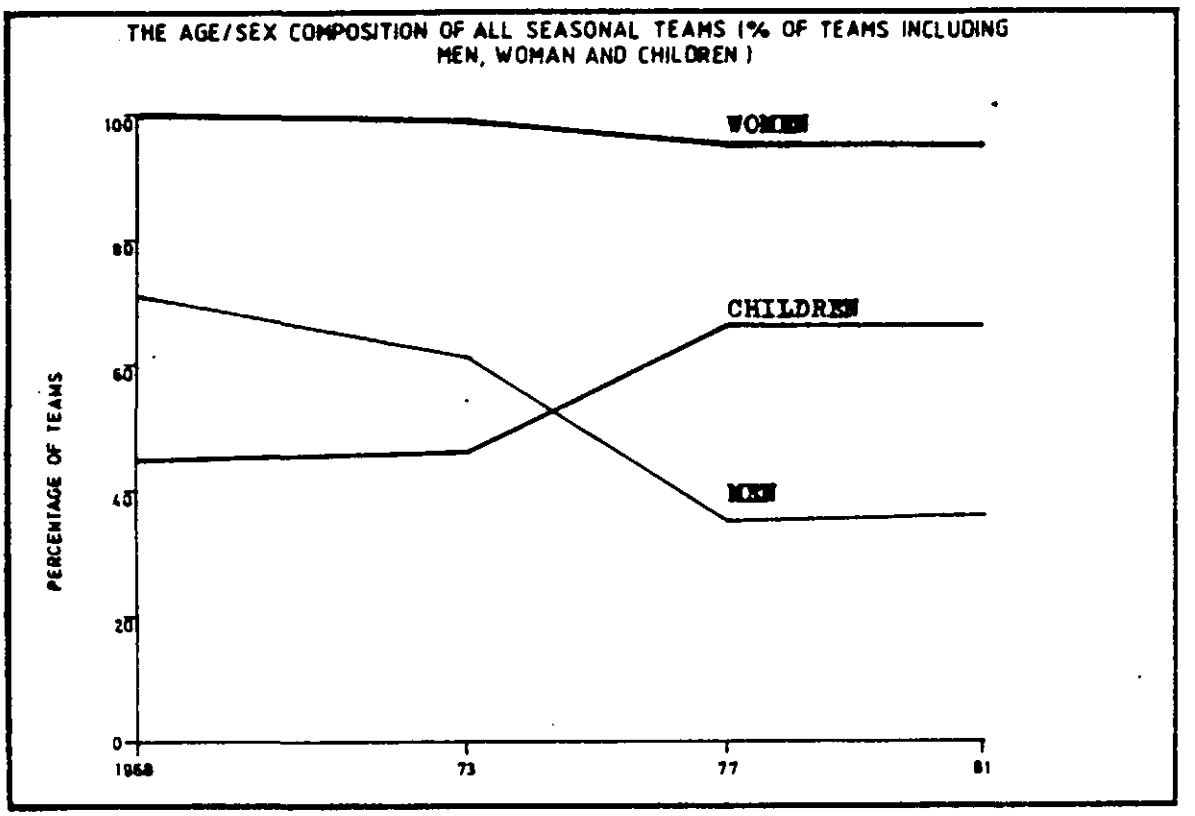


grown so much, benefitted little in net terms: from ten jobs per 1,000 ha in 1968, the actual number increased only to sixteen in 1981. Figure 5 illustrates.

Almost all "external" seasonal harvest workers came from rural communities, and, though few had their homes in "black spots", the majority lived in areas where people from "black spots" are known to have been relocated. The data collected does not allow one to estimate the number of relocated people who found seasonal work on white farms, but there are several indications that it was small.

Women formed the backbone of almost all seasonal harvesting teams, and appear always to have done so. Men, on the other hand, made up a declining, and children a steadily rising, proportion. Whereas in 1968 all but a few teams included men and only thirty percent included children, thirteen years later only about forty percent had adult male members as against about sixty five percent which incorporated children (See Figure 6). Teams from external sources were most likely to include men, and those recruited internally, children. Children were most likely to be called on to glean behind a combine, and men to harvest by hand and handle sacks.

FIGURE 6



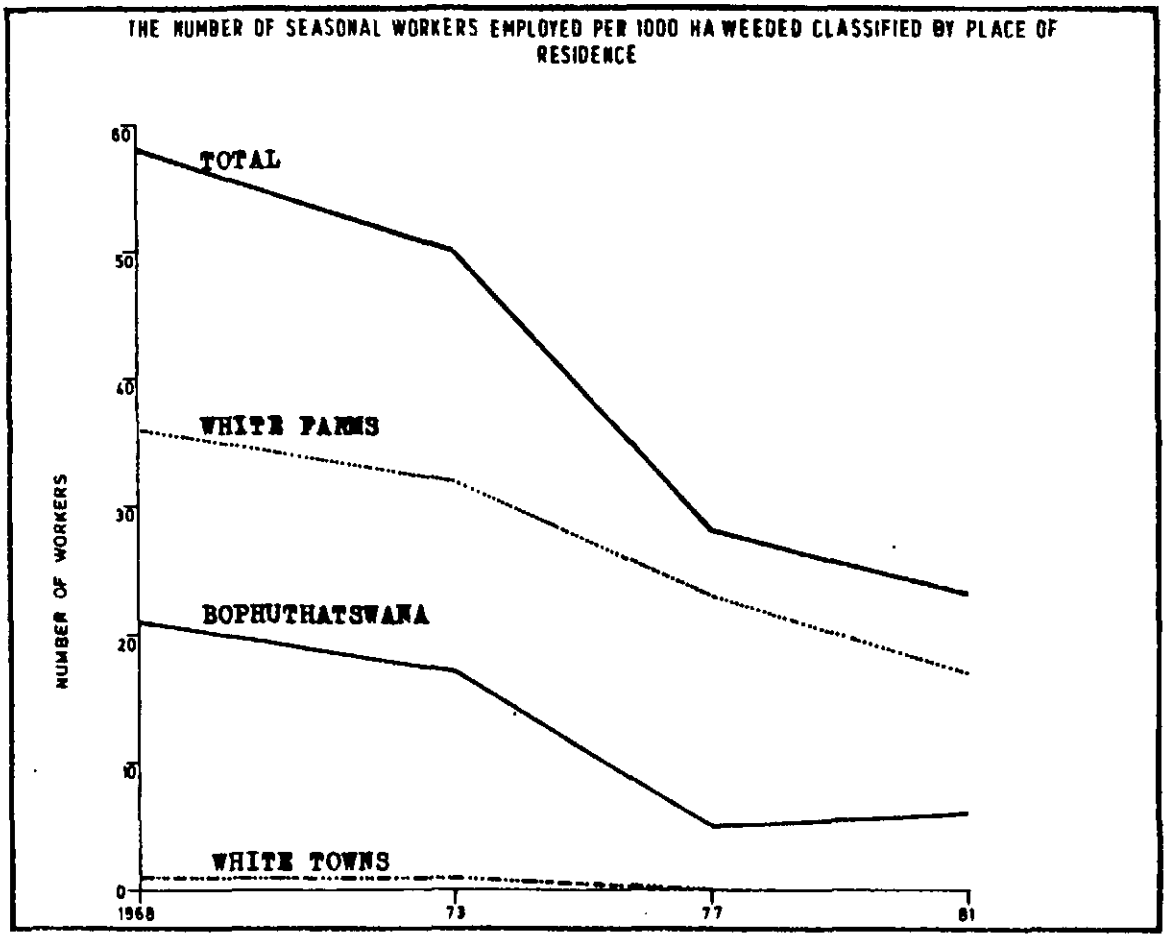
If one were to try to sketch a profile of a typical seasonal harvesting team, at the start of the period when most harvesting was still

done by hand and most delivering in sacks, the team would be comparatively large - about fifty strong - would be recruited from a black rural area - most probably Bophuthatswana - and would consist of men and women in more or less equal proportions and a few children. In contrast, at the end of the period, when most harvesting was done mechanically and most delivering in bulk, the typical team would be comparatively small - about half the size it was thirteen years earlier - would be drawn from the families of permanent farm workers and would be composed rather more of women than of children with perhaps a sprinkling of men.

In keeping with mechanisation, the greatest part of these changes occurred between 1973 and 1977.

For seasonal workers employed to hoe, the picture is noticeably different. Even in 1968, between sixty and sixty five percent of workers were recruited from families of permanent workers, and by 1981 this had grown to between seventy and seventy five percent. In terms of the number of workplaces per 1,000 ha weeded, while places were available for thirty six internal and twenty two external workers in 1968, in 1981 the respective numbers had dropped to seventeen and six. (See Figure 7.)

FIGURE 7



As in the case of harvesting, almost all external weeding workers came from rural communities, although, from the mid-'70s, very few came from localities into which people are known to have been moved in terms of the state's relocation programme. Again, it was women who were in the majority in hoeing teams, though throughout the period two out of every three teams included children. Men played a relatively small and diminishing role. Almost all children came from white farms, while most teams from "outside" sources included men. On average, hoeing teams were considerably smaller than harvesting teams in 1968, having about thirty members, but their numbers seem to have been much less noticeably reduced by the adoption of more capital-intensive methods: in 1981 the size of the average hoeing team was still between twenty and twenty five, almost the same as for harvesting. Once more, the period in which the characteristics of weeding workers changed most was the middle '70s.

Over the years the likelihood of both harvesting and weeding being done by the same workers increased steadily. As early as 1968, nearly sixty percent of harvesting teams shared some workers - mostly seasonal - in common with weeding teams. By 1981 this had risen as high as ninety percent. Together with the shift of seasonal jobs from external to internal workers, this suggests that the contraction of seasonal employment during the last decade or so has been accompanied by a considerable increase in what one could call "the degree of concentration of job occupancy". The consequences of both trends is that fewer and fewer households are sharing the income generated by agricultural production.

Except in one respect, little information was collected about the characteristics of permanent workers. The great majority appear to have been men who lived with their families on the farm where they were employed.

At harvest time in 1968, a little more than half operated machines, while the remainder performed manual work. Surprisingly perhaps, the proportion of machine operators hardly increased in the following thirteen years, and in 1981 roughly sixty percent of permanent workers were machine operators and forty percent manual workers. Mechanization reduced the number of harvesting jobs for both - by between forty five and fifty percent for machine operators per 1,000 ha, and by about fifty five percent for manual workers. Once more, most of this change came about between 1973 and 1977.

One unexpected consequence of mechanisation for permanent workers was the relationship between mechanisation, wages and family incomes. Though mechanisation has been associated with an increase in the real wages of permanent workers, and with an increase in seasonal income for farm families, it appears to have led to a decline in the income of families from on-farm sources. The reason for this is that mechanisation has also been associated with a decrease in the average number of permanent workers per family, and this has more than offset the rise in the permanent wage rate and in seasonal income.

Unless mechanisation has also brought with it an increase in migrants' remittances, it has therefore tended to make farm families worse rather than better off. Income from urban areas has become more important for black rural families, not only in black rural areas, but also on white farms.

4. CAUSES OF TECHNOLOGICAL CHANGE

When questioned about their reasons for mechanising harvesting, farmers mentioned the following factors (in descending order of importance):

1. labour unabailable
2. combine harvesting quicker
3. labour unreliable
4. combine harvesting cheaper
5. combine harvesting easier to control
6. bulk handling made combine harvesting easier
7. wages became too high

4.1 LABOUR SHORTAGE

From the first, third and seventh of these factors, it appears that farmers perceived a shortage of reliable labour at wages rate that they were prepared to pay, as one of the most important reasons for harvest mechanisation. But complaints of difficulty in finding workers have been a feature of capitalist agriculture in South Africa for many years, so this explanation should not simply be accepted at face value. In particular, in the case of seasonal workers such complaints should be treated with caution. As has been pointed out in an analysis of seasonal employment on Californian farms,

> "... the farmer's incentives are entirely in the direction of more intense demand (for harvest-labour) than crop or climate require. Here is the explanation for the persistent reports of labour shortage while no crops spoil. The farmer's demand (for harvest labour) is more or less as he states it. He can, by the large, provide some employment for most of the workers he calls for. He could also harvest the crop with many less. So long as the cost of recruiting additional labour remains negligible and the cost of unemployment is borne by the community, and so long as the piece rate system prevails, the farmer will continue to demand a larger number of workers for a shorter period of time in preference to a small number of workers for a longer period of time."[7]

Nevertheless, there is a good deal of evidence to support the farmer's complaints. During the crucial years of the early and middle 1970s, when most mechanisation was taking place, the real wages of permanent farm workers did rise. (See Figure 3.) At the same time, permanent employment on farms fell. This combination of events does suggest that men were more reluctant to take permanent farm jobs.

Also although Figure 2 does not show any increase in the average wage of seasonal workers, it is likely that such a rise did actually occur. The reasons for this are both that women and children were progressively replacing men in seasonal teams, and that an ever-

increasing number of seasonal workers were employed to glean rather than harvest by hand. Since it is likely that women and children were paid less than men, and it is certain that gleaners were paid less than hand-harvesters, an unchanged average real wage implies that women and children employed to glean were, in fact, paid more than previously. So the same combination of events - a rise in real wages and a fall in employment - can be identified for both permanent and seasonal workers.

Further support for farmers' complaints is to be found in developments elsewhere in the economy in the early and middle 1970s. While real farm wages rose in absolute terms, relative to real wages in mining, manufacturing and construction - the industrial sectors which were the main alternative sources of employment for men from rural areas - they actually fell. And, during this period employment opportunities in these sectors expanded rapidly. In other words, for men employed on farms, urban jobs became increasingly attractive. It does therefore, appear that, to a significant extent, mechanisation on farms took place in response to an increasing urban labour pull.

4.2 ECONOMIES OF SCALE

The fourth of the farmers' reasons for harvest-mechanisation concerned the relative cheapness of combine-harvesters.

The greater the initial fixed outlay for a particular method of production, the greater the potential for lowering the average cost by increasing the level of production. This is often referred to as "economies of scale". More capital-intensive techniques, therefore possess greater potential economies of scale than less capital-intensive techniques. To realise this potential, it is necessary, first, to have a range of techniques of varying capital-intensity, and second, that the scale of production be increased sufficiently.

In the case of maize-harvesting in the Western Transvaal, the first of these conditions was fulfilled in the 1960s, when combine-harvesters became generally available. The degree of fulfilment of the second condition varied from farm to farm, but was given a considerable boost in the late '60s and particularly in the early and middle '70s, both by the rapid increase in the average size of farms and by the marked, if little unstable, rise in crop yields. In the survey twenty three percent of the purchases of additional land were accompanied in the same year, or followed in the next year, by the purchase of a combine.

When costs are calculated, it is surprising to find that the critical harvest tonnage above which it was cheaper to use combines was only 250 tonnes. Only two or three percent of farms in the sample handled tonnages which were below this in 1976. And even in 1968 when the average harvest tonnage was considerably smaller, and the relative cost of hand-harvesting lower, no more than about ten percent of farms in the sample would have found it cheaper to harvest by hand.

This is a crucial finding because it shows that on all except the smallest farms, the switch to combine harvesting was merely a question of time and of a suitable stimulus, from the time that combines first became generally available. The growing reluctance of men to take farm jobs and the simultaneous rapid increase in the size of farms in the first half of the '70s appear to have provided the stimulus but in

the end it is chiefly to the development of new technology abroad that harvest mechanisation should be ascribed. This suggests that the reduction in farm employment was due mainly to a "rural labour push" rather than to an "urban labour pull".

4.3 INCREASING FARMERS' CONTROL OVER THE LABOUR PROCESS

There are so many aspects to this complex issue - few of which have yet been explored - that the following can only be offered as initial thoughts.

Almost all of the seven main reasons given by farmers for harvest mechanisation can, in a loose sense, be interpreted as attempts to increase their 'degree of control', in particular, the second and fifth, i.e. 'combine harvesting quicker' and 'combine harvesting easier to control'. In fact, so important did the Marais Commission rate 'ease of control' that it argued that profit maximization is often relegated to a subordinate position:

> "Experience has shown that farmers tend with the greatest eagerness to accept ... a new implement if it offers possibilities for making the task or life easier for them ... (and are) inclined to think of the economy of the matter after (they have) decided that the particular implement is ... the one (they) would like to have."[8]

The many tasks performed by hand which were subsequently taken over by machines represent only one aspect of control. The composition of seasonal teams is another. Recall that the size of seasonal teams shrank considerably. Also, while women were always the mainstay of seasonal teams, children to a large extent replaced men and residents of white farms tended to replace residents of black rural areas. Fewer workers are certainly more readily controllable than many; women and children less fractious than men; and the families of permanent farm workers living at or near the site of operations a more accessible and dependable source of labour than independent communities living far afield. To this one can add the appreciable shortening of the harvest period.

Furthermore, while the traditional techniques were still in use, farmers had no option but to go to black rural areas and negotiate for the men they wanted - who were not available in sufficient numbers among the families of permanent workers. With the introduction of combines and bulk handling, physical strength and stamina were no longer as important, and the bargaining position of communities in black rural areas was undercut. This shifted the balance of power more firmly into the hands of farmers.

However, there is another side to this. Many machine operators who remain - mostly drivers of combines and heavy duty delivery vehicles - have acquired new skills, some of which are in demand in urban areas. Though the "training school", Boskop, in Potchefstroom is regularly over-booked and most farmers approved of its courses in principle, many expressed reluctance to send workers employed on their own farms for training - particularly in the driving and vehicle maintenance courses - because of the tendency of such workers to leave farms soon after training. For workers, driver's licences and maintenance skills

create more than a little leverage. Wage patterns seem to reflect this. Organising labour - which many farmers expect in the foreseeable future - may be less difficult in these circumstances.

4.4 THE CUMULATIVE NATURE OF TECHNOLOGICAL CHANGE

The sixth reason given by farmers for the purchase of combines was that "bulk handling made combine-harvesting easier".

Without bulk delivery and storage system, the manual handling of 90kg sacks would still have remained. This required the presence of men, who could be recruited in sufficient numbers only from the "reserves". It was the prior introduction of bulk-handling on most farms that opened the way for combine-harvesting to phase out seasonal teams from black rural areas.

To a lesser extent, combine-harvesting in turn played the same catalytic role in the adoption of chemical weed sprays, though the process was rather different. In contrast to harvesting, hoeing seems generally to have been allocated to the families of permanent farm workers, as a matter of tradition. So there was relatively little scope to switch labour sources. However, with the spread of combines, there was a tendency to plant maize in three foot rather than seven foot rows, although this was more than just harvesting convenience. Between seven foot rows a tractor can plough lightly, which is the normal preliminary to hand hoeing. Between three foot rows, this is no longer possible, and even wielding a hoe is difficult, once the maize is a foot or two high. So weed sprays applied at or shortly after planting were a natural complement to the use of combines fitted with three foot intakes.

While it would be wrong to suggest that there is a simple chain reaction in the process of technological change, these two examples do serve to demonstrate the presence of an important cumulative, interdependent element.

4.5 INSTITUTIONAL FACTORS

State policy on farm labour and on the cost of farm inputs in general, perhaps unexpectedly, does not appear to have been a notable cause of the technological changes considered here.

In a variety of ways, state policy has long favoured the substitution of capital for labour on farms. But this does not explain why, when such policy measures had made machinery cheaper and easier to purchase in the '50s and '60s when combines first became available, most farmers only mechanised harvesting in the middle '70s.

The only significant change in state policy on the pricing of capital goods that occurred during the period being considered was the tax provision which enabled farmers to write off the entire cost of new machinery in the year of purchase, thereby reducing both their tax liability and the cost of new machinery. But this was introduced only in 1977, by which time the greatest part of mechanisation had already occurred, as can be seen from Figure 1. Farmers were asked explicitly about this, but few said it had influenced their decision to purchase machinery.

What may have been more important was the descent of real interest rates into the negative range that accompanied the upsurge of infla-

tion in the middle '70s. In other words, borrowing became so cheap that it was highly attractive for farmers to raise loans and purchase land and machinery. This was compounded by the rise in real farm wages that appears to have occurred at the same time. But both of these processes were only tenuously connected to changes in institutional factors.

Potentially more important was the state's population relocation policy, which was in full swing during the 1970s. However, the rural areas of the Western Transvaal seem to have been less affected than most. By the '60s labour tenancy had effectively disappeared. Even the older farmers could remember little about 'woon volk'; the Surplus Peoples' Project records only a few isntances of black families being removed from white farms; and, in contrast to most other regions in the Transvaal, only one of the six magistrial districts in the survey was covered by an Abolition of Labour Tenancy notice.

In addition, though many 'black spots' were 'cleared', only a very small percentage of workers on white farms had their homes in these areas, as Figure 4 shows. Nor is there any evidence that the activities of (farm) Labour Control Boards were important. So the relocation programme appears at most to have been a minor cause of mechanisation.

Rather, events happened in reverse. To the extent that they have led to the retrenchment and removal of permanent workers and their families to black rural areas, farm consolidation and mechanisation should be seen as an informal, perhaps unintended, element of the relocation programme.

But, two caveats: first, it is chiefly seasonal workers from black rural areas not permanent workers resident on white farms who have been affected by the events described above. And second, though there is clear evidence that the number of permanent workers on white farms in the region has fallen, it is not clear how far this has been accompanied by their and their families' move from white to black rural areas. Findings presented elsewhere[9] show that at least part of the decline in permanent farm employment has been absorbed by a contraction in the average number of permanent workers per family (living on white farms). This suggests that, instead of whole households leaving white farms, some of the younger members are now looking for work in urban areas, while their families - still numbering at least one permanent farm worker - remain on their former employer's farm. Several farmers referred to just such a set of circumstances, and the continued rise in the black population of white rural areas recorded by the 1980 census adds to the evidence. Influx control does not always appear to immobilise farm workers. Only one fact emerges for certain: that is the increased dependence of rural black families on income from urban areas.

5. UNEMPLOYMENT

What happened to the workers who left the farms? The way in which the research was undertaken did not provide a direct answer. However, from national and regional wage and employment statistics, it appears that the fall in farm employment was to some extent compensated for by a rise in industrial employment.

For men, the main alternatives to farm work were jobs in mining, manufacturing and construction. During the economic boom in the first half of the 1970s, employment and real wages in these industries increased rapidly. This suggests both that jobs in these sectors became more attractive and that many men previously employed on farms were able to find work in urban areas. In the second half of the '70s, the number of jobs and real wages in these industries rose more slowly, and actually fell in some instances. But during this period, the number of permanent workers on farms seems to have remained fairly constant, and even risen slightly. So, many, perhaps most, men who could no longer find employment in agriculture, or who no longer wanted it, were probably able to find work elsewhere.

For women employed on farms, on the other hand, the only significant avenues of alternative employment were in urban domestic service and in the "informal sector". There are no records of informal employment and wages, but it is clear that there was no appreciable increases in either employment or real wages for domestic workers. In contrast to men, therefore, most women made redundant by technological change on farms - and they made up the bulk of those whose seasonal jobs were phased out - would probably have found it difficult to get other work. For those who relied on seasonal or domestic work on farms merely to supplement regular income from other family members, this would have been unfortunate. But for those with no such stable sources of income, it would have been disastrous. It is women living in black rural areas who have borne the brunt of technological change on farms.

SUMMARY AND CONCLUSION

Extensive mechanisation and increases in farm size have taken place on Western Transvaal farms in the last decade and a half. The causes appear to have been manifold, including periodic labour shortages; economies of scale; falling real interest rates and rising real wages; action by farmers to increase their control over the labour process; the cumulative nature of technological change; and, to a limited extent, some changes in institutional factors.

Mechanisation has been accompanied by a substantial reduction in employment, mainly of seasonal workers; by the transfer of seasonal jobs from workers living in black rural areas to those living on white farms; and by the replacement of men by women and children in seasonal teams.

Those on whom the burden of having to find alternative employment has fallen most heavily are residents of black rural areas. Households which have relied chiefly on female breadwinners are most likely to have suffered a critical loss of income.

The contraction in permanent farm employment manifested itself partly in an exodus of black families from white farms and partly in a decline in the average number of permanent workers per family. Both are likely to have increased the dependence of black families in white rural areas on income from urban sources, despite the increase in the real wages of farm workers that has accompanied mechanisation.

Though mechanisation has probably increased the degree of farmers' control over the harvesting, delivery and weeding processes, there may, paradoxically, now be greater potential for labour organisation.

With hindsight, 1981 was a high-water mark - the culmination of a decade of favourable weather and rapid output growth in the Western Transvaal. What the consequences of three years of drought and of the current marketing crisis in the maize industry will be, remains to be seen.

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NOTES

1. M.J. de Klerk: "Technological Change and Employment in South African Agriculture: the Case of Maize Harvesting in the Western Transvaal, 1968-1981", unpublished M.A. (Economics) thesis, University of Cape Town, 1983.

2. However, many if not most of the very small farms recorded in censuses are small-holdings whose chief source of income is not maize. They would therefore not have formed part of the population for the author's survey. The degree of their under-representation may therefore be more apparent than real.

3. Insufficient data was collected to calculate an accurate all-inclusive wage for seasonal workers. A rough approximation of the average daily value of food supplied (free) in 1981 is -47 cents.

4. Items included are weekly or monthly cash payments, payment in form of bags of threshed maize, cash bonuses, food, clothing, grazing and cultivation rights, medical assistance and paid leave. The most important omission is housing. The method of estimation follows that adopted by the Department of Agriculture.
(See M.J. de Klerk: "The Incomes of Farm Workers and Their Families: A study of Maize Farms in the Western Transvaal", Second Carnegie Inquiry into Poverty and Development in Southern Africa, Conference Paper No. 26, University of Cape Town, 1984).

5. M.J. de Klerk: op. cit.

6. In the 1960s, before the general adoption of combines, farmers re-organised threshing in a way that saved a considerable amount of labour without the purchase of additional machinery. This was done by having one central threshing point instead of moving the threshing machine from field to field. This part of the calculation is based on time studies conducted by the Department of Agriculture.

7. L.H. Fisher: The Harvest Labor Market in California, Harvard University Press, Cambridge Massachusetts, 1953, p.11. Not all of Fisher's assumptions apply perfectly in the Western Transvaal, but the analogy is close enough to be highly relevant.

8. Republic of South Africa, Commission of Inquiry into Agriculture (chairman: M.D. Marais) Second Report, Government Printer Pretoria, RP 84/1970, p. 165.

9. M.J. de Klerk: op. cit.