

SECOND CARNEGIE INQUIRY INTO POVERTY
AND DEVELOPMENT IN SOUTHERN AFRICA

Agriculture and Technology

Four Case Studies

by

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Agriculture and Technology - Four Case Studies.

The following plain and simple Observations are addressed to you, on a subject which deeply concerns you all; in which your interest is as much at stake as that of the Farmer and the Landlord.

You appear to have contracted a great dislike to the use of what are termed Machines, and chiefly to the use of the Threshing Machines. You have never well considered the Reason of your dislike. You merely state that Machines are hurtful to the Labourers - that they prevent the Poor being employed. Upon these grounds you proceed to destroy them.

The word Machine seems to convey to your minds, some contrivance necessarily attended with mischief to the Poor; whereas, in truth, the word Machine means the same as Tool or Instrument, on all occasions has the same signification. A Thrashing Machine is a tool or instrument with which we thrash; so is a Flail, only that it is a far less useful Machine.

(Address to Labourers on the Subject of Destroying Machinery, Henry Brouham, 1830, in Berg, 1979).

In looking at the application of technology in agriculture, analysis has too often been confined to the question of mechanisation, which in turn has been confined to looking at tractor/labour ratios. While these ratios do provide a rough index as to the degree of mechanisation, the application of technology today can be extended far beyond this.

In the first half of the twentieth century technological innovation was virtually synonymous with tractorisation, as farmers replaced animal-drawn ploughs with motorised tractors. This change caused a major revolution, not only in the labour

process, but also in the position of many squatters and labour tenants. The area under cultivation was extended and stock reduced. Both these trends encouraged the (forced) conversion of the more independent forms of rural existence to wage labour. As former labour tenants remember:

There first came the tractors and the big ploughs. The threshing machines came later. (People) were reduced as a result of those machines. They were rendered redundant because the machines had taken over.

Man, ever since they started cultivating with tractors and planting wheat, they told us to sell our cattle. They are using tractors only now.

Another former tenant, from the Schweizer-Reinecke district sees the system even more blatantly:

Jeffrey (the farmer) called a meeting and said, "All the people on these farms come to the meeting and listen to the new law." They came and said that halves were no longer to be practised. Agricultural methods had changed and tractors were being introduced. Those who had cattle would have to sell them.

(African Studies Institute interviews).

In the latter half of the century the move has been towards both bigger and more powerful tractors, and more advanced and specialised machinery, such as mechanical harvesters. All these machines have meant that the land has been more extensively cultivated and the area of "unused" bushveld greatly reduced. White farmers now have even less incentive to allow their workers to keep their own livestock on the small remaining areas. But farmers have also introduced science in other forms. Herbicides, pesticides, fungicides, fertilisation and irrigation are important components of "modern, scientific" farming. Many of these innovations facilitated the further expansion of farming.

They made formerly infertile or marginal land cultivable, and increased the need for large-scale farming to take advantage of the large capacity of the measures and to justify the relatively large expenditures. Tractors laid the necessary base for these innovations - indeed many of the new instruments are mounted on, or drawn by, tractors, while chemicals, fertilisers and irrigation equipment are applied from them. In this sense tractors provide a fairly good index of and basis for technology in agriculture. But to get a clearer picture we must look at all these elements and their specific effects separately.

It seems clear that firstly, we cannot view mechanisation as tractorisation alone, and secondly, the decision to introduce new technology in one operation depends on decisions with regard to other operations. One innovation implies another, and once on the course of mechanisation, it is often difficult to halt it. It is not every branch of farming which, like the sugar farmers in Natal, can temporarily "pack away" their tractors when the labour shortage diminishes, and return to previous methods of cultivation.

Some of the side-effects of modern scientific farming might well be appreciated, or even desired, by those who initiate the first moves. Machines and chemicals are often tempting options in a situation where labour is scarce or only available at a price above that which the farmer is prepared to pay. Control is also an important consideration - "...labour is more difficult to handle than a chemical". (Aires, 1976, page 4)

Individual farmers and the advocates of mechanisation in organised agriculture are certainly fully aware of the effects of technology on the size and composition of the labour force. These were and are, in fact, some of the chief motivations for the changes. Other effects, such as health hazards and ecological disturbances might not always be appreciated or anticipated. This is especially true when one takes into consideration the interlinkages between different technological innovations such as those described below. An understanding of these effects is important both for those who initiate the moves, and, more importantly, for those who will suffer or enjoy the

effects.

In examining the interlinkages, we have to abandon the overall statistics and examine developments in one area or one branch of farming. Patterns emerge from these specific studies, many of which would be lost in broader and more general statistical analysis. Here we present descriptive studies of four different areas and crops. Those with knowledge of other areas and crops will be able to see to what extent the same forces operate there.

Kirkwood

On the Kirkwood farm which forms the basis of one case study it was not labour problems which triggered the move to mechanisation, but rather that other scarce South African resource, water. Drought is a recurrent problem in the area, and water is an essential element in the efficient cultivation of the chief crop, citrus fruit.

The farmer studied identifies the current development as starting with the severe drought of 1969. Conditions were so bad at this time that many farmers in the area actually assisted their black employees to get alternative jobs in town. After the drought, with an increase in production on the farm, as well as industrial development in Uitenhage and Port Elizabeth, the previous labour shortages were exacerbated.

At that time the irrigation systems of all the farmers in the area were interlinked. The lands were irrigated by the flood method and all the farms in the area had to receive their water at the same time. The irrigation itself extended over a period of two weeks, during which workers were needed 24 hours a day to direct the water to the correct orchards. 21 people in three teams of seven were employed in this process on the farm in question.

Flood irrigation necessitated the building and maintenance of banks around each tree to retain the water. Much labour was involved in these two tasks. The banks also limited the options available to the farmer. Tractors driving between the trees

broke down the banks, which meant that they had to be rebuilt before irrigation. Work such as weed-killing thus had to be done in such a way as to minimise the use of tractors. Hand-hoeing, a very labour intensive operation, was used in some areas, and hand-applied weed-killers used in others.

Another, at first seemingly unrelated problem, emerged in the late 1970's, namely extremely brak water was being supplied by the central system. The cooperative in the area commissioned a professor from Pretoria to investigate the problem. He recommended the use of microjet irrigation. He also advised that farmers concentrate on reclaiming the soil by means of organic practices such as the planting of undercover crop, no discing and the use of gypsum.

Since microjet irrigation enabled ideal water application, it went hand in hand with soil reclamation. With microjet irrigation the water is passed through permanently installed pipes between each tree and there is thus no need for banks and basins around each tree. This means that tractors and other machinery can be freely used as there are no banks to break down and rebuild. Weed control could be effected by means of boom spraying from tractors and discing could be abandoned. Instead of sterilant, weaker systemic or contact weedkillers could be used, because the process could be done much more often - in a five or six week cycle instead of every six to ten months.

Many of the farmers, as well as the cooperative as a whole, rejected these findings, but some farmers, including the one studied, followed his recommendations. What influenced the individual decisions is a question which we are not able to answer at this stage. One obvious consideration is the cost of microjet irrigation. It is more expensive than flood irrigation, especially in the installation stage. On this particular farm two new dams were built. Pipes must also be laid between the trees. The whole system is centrally controlled, which involves more expensive and complicated machinery. A farmer with a big profitable farm will find it much easier to afford the large capital outlay. He will also benefit more from lower average cost per orchard.

There were definite other advantages to the new system beyond the possible solution of the brak problem. Firstly, the farmer was no longer reliant on the other farmers in the area as to when he would irrigate his lands. He could choose his own time. Secondly, and more importantly, labour needs were drastically reduced by the new system. Instead of 21 workers being tied up for two weeks at a stretch, the total irrigation staff was reduced to one person, who could sleep at the central point, and would wake up if the machine stopped working (because of the noise stopping!) Tractors could move faster over the flat ground, thus speeding up other processes. More extensive use of weedkillers obviated large teams involved in hoeing by hand. On this particular farm the reduction in labour needs was in fact so great that the farmer was considering reimplementing handhoeing on a few fields in order to keep workers busy and employed in the five to six slack months between picking periods.

Unrelated to the use of microjets, but still in the field of technological applications, is the question of growth regulating hormones. Citrus can only be picked when it is dry, which in the Kirkwood climate means only about five to seven hours a day. Picking times are also very critical, as each farmer has a quota for a particular period, and ships are waiting to transport the fruit overseas, the main market. Export fruit earns much higher returns than on the local market, yet at the end of the season only about half the fruit is of export quality. The farmers are thus keen to spread the ripening period of the different types of citrus as much as possible. In this way they spread the ripening of export quality fruit and allow for a more even spread of labour needs over a longer period. Growth regulating hormones are being investigated, both to control the ripening, and for purposes of colouring up fruit which is not for export. Thus far there has been progress technically in the field of growth regulators, but it is expensive to spray and the process can be adversely affected by the presence of certain kinds of weather or pests. Because of this they have not yet been implemented on a large scales. If and when they are, they will be a further step in the extension of the period during which the casual labour can be employed, as well as possible reduction in peak

demand. New cultivars which show a tendency to mature later are being experimented with.

On an average wage and with a family of five, the farmer calculated that there would need to be two wage-earners per household to get the household to a "decent" living level. As a result of this they "no longer employ the job seeker who has a very large number of dependents both young and old". Taken together with the fact that many of the males choose to work in the towns rather than on the farms if they possibly can, this means a great reliance on female labour. (The attraction of town employment can be seen from the fact that it is predominantly the farms nearer the towns which need to utilise the local prison farm). Although there is a large African population resident in the area - 500 souls on this farm at the time of the last census - this farmer sees the future in terms of greater utilisation of local women rather than having to compete with the towns for the males.

Citrus farming allows relatively large-scale use of female labour. In the past it was very unusual for women to pick from ladders. Researchers are looking to dwarf citrus trees which will obviate the need for ladders, and where ladders are necessary, a lighter type can be used. Both of these have increased the possibility of employing women. Another problem in using women is that they also do the housework and childcare and thus usually are able to work for shorter hours each day on the farm. But this is not such a problem in citrus harvesting in Kirkwood because of the later hours during which it is possible to pick.

Western Transvaal

The second area which we will look at is the maize-growing area of the Western Transvaal, an area studied in great detail by Mike de Klerk in his MA thesis. This provides an interesting contrast to the citrus example in that maize was the second crop in which the harvest process was extensively mechanised in South Africa. The wheat harvest was mechanised in the 1950's. Large-scale mechanisation of maize harvesting followed in the 1970's, a

period which falls squarely into De Klerk's period of 1968 to 1982. In most other crops, especially the fruit crops, adequate harvesters have not yet been designed or are not considered justifiable in terms of the easy availability of labour. Wheat and maize thus remain the only two virtually fully mechanised crops.

De Klerk separates the labour process into three distinct stages which he says can be separated both conceptually and chronologically in terms of mechanisation viz. harvesting, delivery and weeding. (He does not study the preparation of land at all). Mechanisation in each of these is an independent decision, in that the machines are different and one can mechanise one process without mechanising another. Yet, once again, the same factors seem to influence the decision to mechanise in all three processes, and once one process is mechanised the incentives are usually stronger to mechanise the others.

Delivery was the first process to be mechanised, the main changes taking place in the 1960s. Because of the control over maize distribution, all maize produced in South Africa has to be delivered to central points, the cooperatives, before it is distributed. Up until the 1960s most of this delivery was done in sacks. The change has been to bulk delivery by means of trailers. De Klerk goes into some detail in linking this development with the building of silos, which is obviously also dependent on the availability of sufficient capital in the hands of the cooperatives, if not the individual farmer. It is possible that some of the incentive to mechanise delivery came after the cooperatives built silos with some of the fairly extensive funds which they accumulated in the 1960s.

The change has had several effects. In the fields it has meant that the maize is loaded directly onto the trailers which will later transport them, rather than into the heavy 70 or 90 kg sacks which would then have to be loaded onto a delivery vehicle. At the delivery point the physical handling of heavy sacks has again been obviated, with the trailer emptying its contents straight into a chute. This process has effected a saving in

several factors. Firstly, the process is much quicker, as there used to be long waiting periods at the delivery site. Secondly, there have been great savings in toil and sweat, as it is obviously not a pleasant job to work with the heavy sacks. But, most importantly, these two savings have meant a great saving in labour. Machines have now replaced men in loading and offloading. And women and children have often replaced men in the harvesting fields, as now that the heavy work has disappeared, they are well able to accomplish the tasks.

Many of the Western Transvaal farmers have relied in the past on workers recruited from the Transkei and Bophuthatswana because of the shortage of local male workers prepared to do seasonal work on the farms. This has always constituted a problem in that farmers prefer local, resident people who are seen as much more dependable and controllable, no doubt because of their dependence on the farmer for a place to live. During the boom of the 60s there was a greater demand for workers in the towns. Bulk handling lessened the need for dependence on outside labour to the extent that outside men could be replaced by local women, but harvesting needs for casual labour which coincided with the delivery time, were still such that most farmers had to continue to recruit in the reserves.

Combine harvesters were already available in the early 1950s but were not used on a large scale until the mid 1970s. De Klerk attributes the decision to mechanise to (1) the growing size of the farms and (2) the increasing difficulty in recruiting labour. The latter was linked with the increase in mine wages in the early 1970s as the mines began to turn more to South African sources for their needs. With the "independence" of Bophuthatswana, many farmers saw migrant workers as becoming even more "uppity" and unkeen to work. De Klerk shows the substantial reduction in labour needed with the combines, in that less workers were needed at any one time, and the hours of work per day were able to be extended. Even more importantly, however, they cut the labour requirements precisely at its peak periods, i.e. the times when casual labour previously had to be brought in. Together with the changeover to bulk handling, this meant that on many farms it is now possible to rely almost exclusively

on on-farm labour supply.

The position in handling and harvesting can be contrasted with that in weeding. There are two options in the way the farmer can deal with weeds - either by means of first ploughing up the land with tractors, followed by hand-hoeing, or by the use of weedicides. There has been a substantial change over to weicide use rather than the tractor/hand process, to the extent that De Klerk found that 95% of his sample used weedicides in 1982. But this change was not quite as radical as the mechanisation of the other two labour processes. The technical reasons for this greater reluctance are the fact that several common weeds are seemingly impervious to the presently available weedicides and that to be effective, it is generally necessary that rain falls soon after application. Even technology has not yet succeeded in controlling the weather to that extent! Thus even where weedicides are applied, it is often necessary to supplement their application by hand-hoeing.

A second, less technical reason, is that hand-hoeing is easily done by women. It also occurs over a period of months, on a non-urgent basis, rather than at the peak periods. It is thus a suitable job for on-farm people, a means of "keeping them busy" and a means of their earning some income to tide them over the periods between harvests. On the plus side of weedicides are several factors. Firstly, newer and "better" weedicides are being developed all the time. Secondly, weedicides can be applied at the same time and by the same tractor as used for planting, thus saving even more labour. Thirdly, many farmers saw the rise in fuel costs as the most significant cost increase over the period. With no end in sight to these increases, many farmers are now finding it profitable to spray weedicides, rather than have to do the fuel-consuming ploughing preliminary to hand hoeing. Finally the rows of maize can be planted much more closely together if it is not necessary for the tractor to drive down between the rows. Thus there has been a definite change over the years, stimulated by the rise in fuel costs.

With all three processes De Klerk finds a correlation between the size of the farm and the occurrence of mechanisation in that the

larger firms mechanised each process earlier. As with the Kirkwood example, one would expect that the larger farmers have larger amounts of capital available to them, and that mechanisation involves relatively large fixed costs which would allow the larger farmers to take advantages of benefits of scale but which would be too much for the smaller farmer to cope with.

When read in conjunction with Young's earlier study of an Anglo American maize farm, the study also illustrates the very real difference between "invention" and "innovation". Virtually all the changes described in De Klerk's study had been effected on the Anglo farm much earlier. Young questions the "economic" advisability of the degree of mechanisation. But there are two points which can be noted - firstly, the greater size and easier availability of capital in the Anglo case as compared to the individual farmer, and secondly that techniques were available to those that wanted to use them at a much earlier date than usually applied. These points are further borne out by other Anglo subsidiaries, such as the Umfolozi sugar farm where Nelson found a much higher level of mechanisation than elsewhere. This farm was thus again a leader in the field, and virtually the only one cutting cane by machine. (See section below)

The mechanisation process in maize farming is not yet exhausted however, and in some areas is attendant on further research. By the early 1980s the Western Transvaal maize farmers had effectively reduced their peak demand for labour, that for the harvest. This had solved the major labour problems. Research is still proceeding as to how to mechanise the other processes, and in particular fertiliser spreading. Again, one conjectures that this demand has been stimulated by the increasing cultivation of marginal lands which the other mechanisation brought in its wake.

Stellenbosch

The third case study concerns seven wine farms in the Stellenbosch district. Here I am indebted to Wilfred Scharf, a researcher who has lived and worked in the area for a considerable time.

With viticulture we are again dealing with a production process in which not all processes have yet been mechanised. While there have been a few reports of recent breakthroughs in research, to date economic and efficient methods of mechanical planting, pruning, and picking have not been found. This has obviously affected the degree to which other innovations have affected farming, particularly as regards demand for labour, in that the harvest period is the one in which demand is highest. Planting is perhaps less important as, unlike maize for example, the vines do not have to be replanted each year.

Mechanisation has occurred in the other processes, however, and this has affected the pattern of farming.

The first change we will look at is irrigation. Irrigation is very important in viticulture. The vines should be irrigated about six times during the ripening season, which means that the process must take place about every three weeks. There is also not as much water available in the area as is needed, with some farmers actually having to buy water from neighbouring farms. Thus it is also important to find a method which is sparing of water.

Until 16 years ago irrigation was done chiefly by means of pivot hose pipes. The method is fairly labour intensive, and was able to cover only a small area at a time.

The first alternative to flood irrigation was a German method of joinable pipes through which the water was fed under high pressure. While this solved some of the problems, this system was even more labour intensive than the pivot hose pipes because of the constant need to shift the heavy pipes. As a rule the pipes were shifted about once every three hours. On one farm there might be six irrigation places, so that one tractor would be constantly occupied going from one point to another to shift the pipes. An 87 hectare farm would need a team of 12 to achieve this.

The newest forms of irrigation are micro and macrojet, which are slowly being introduced in the area. (Macrojet is in a more

developmental state at the moment than microjet. There are still mechanical and maintenance problems which have not been solved). As in Kirkwood, these systems are very expensive and have as yet only been installed on the larger and more profitable farms, where the farmer has access to the necessary loans and capital, and perhaps has tax problems which make it profitable to spend large amounts on capital! (It would be interesting to look at the effects of the 1977 change in the tax laws on this and other decisions to mechanise. In terms of the new law all capital equipment could be written off in the year of purchase). The system does have immense advantages in that less water is wasted and there is more control over the water. This lessens the dangers of downy mildew. As far as labour is concerned, one worker can now control the whole farm, which also enables the farmer to irrigate over weekends.

Another area in which technology has been applied is the chemical one. Up until two years ago most weeding was done by tractor and spade work. The tractor would first be driven down the rows between the trees, turning over the soil. Workers would then have to weed between the trees. Women were employed where light hoes were used, but for the strenuous work of "bankies gooi" it was necessary to employ men. Both these processes were very labour intensive.

In recent years farmers have started to use chemical for both weeds and pests. On most of the farms the chemicals are sprayed from tractor drawn sprayers which carry 500 litre tanks. One worker is needed to drive the tractor. For the average farm two such workers would be able to cover the whole farm for one disease within a period of two weeks. After this they begin the cycle for the next chemical. On a few smaller farms chemicals are sprayed from back-carried manual packs, obviously a much more time-consuming and labour-intensive operation, but one which is more practical for the smaller farm, in view of the high cost of the spraying equipment and the smaller area to cover.

A third change which has affected labour demand is the changeover from bush to trellis vines. At one time farmers attempted to use bush vines, which are lower, together with high clearance

tractors for spraying. They did this in order to be able to plant the vines close together and minimise tractor paths between them. Problems arose in that the tractor stilts did not work as well as expected, and that the bush vines were found to produce fewer grapes and grapes of a worse quality than trellises. With the increasing problem of a wine surplus, quality has now become more important than quantity, and most farmers have decided to return to trellis vines. A spin-off of the change was another decrease in the demand for labour as once the trellises are set up, trellis vines are much easier to maintain by mechanical means, in terms of spraying, pruning and cleaning.

While the innovations described above greatly reduce the labour needed for some processes, the peak labour demand on the wine farms has not been reduced. Harvest-time is still a period during which a great number of workers are needed. Since the early 1970s there have been recurrent complaints about a growing labour shortage in the area and farmers are thus reluctant to reduce the number of people resident on the farms. During the harvest itself there is a high labour turnover on the farms as people move from one farm to another and are granted residence by other farmers desperate for workers.

The Western Cape is traditionally (and by legislation) a coloured labour area and in the past the labour force on the farms was predominantly coloured. In the last six years alone, however, there has been an increasing reluctance of young coloured males to work on the farms, as evidenced by the estimated average age of the coloured males having increased from 25 to 35 over the period. This reluctance remains even today, despite the depression. To cope with the problem various strategies have been adopted. Farmers have realised that there is a need to improve wages and conditions of work and projects such as the SANCA Development Programme and Foundation for Rural Development have been instituted. On a more immediate and practical level, contract workers from the Herschel district are being increasingly employed. These men constitute about 70% of the labour force.

As well as using these less mobile migrants, increasing use is

also being made of women and children resident on the farms. The only jobs which are done exclusively by men are irrigation and the carrying of the heavy baskets at harvest time. Women plant, weed, pick, tie the vines to trellis, and even prune on some farms, although the latter is still done chiefly by men. Irrigation labour needs have fallen, as shown above, and people to carry baskets are only a small proportion of the total number needed during the harvest. As women are never employed on a permanent basis, the fluctuating level of demand over the year is not important in the case of women and children, at least from the farmers point of view, and they are thus seen as ideal for harvest work.

Contract workers are on the farm for the whole year bar a period of a few weeks when they are forced to return to the reserves and there is thus still a problem in the difference between harvest time labour demand and demand over the rest of the year. An important result of both the wine surplus and the surplus labour in the non-harvest period has been the change from virtually complete monoculture to a more mixed agriculture, with tobacco and vegetables now grown together with grapes on many farms. These crops require a more even labour supply throughout the whole year, and also usually involve quite a lot of lighter work which is considered suitable for women. Farmers who do not grow much besides grapes often allow "their" workers to take piece-work jobs on another farm where these crops are grown at periods when they are not needed on their own lands. In this way a greater supply is assured during the harvest.

Sugar farming in Natal

The chief source for the fourth case study is a BSc Thesis by Jane Nelson from the University of Natal, Pietermaritzburg. Nelson examines technical change and employment in the industry between the year 1972 and 1982. The thesis is based on data from interviews with 108 farmers of differing sizes and in different mill areas. Farmers were asked detailed questions about the means by which the different processes were effected on their farm, and as to the changes in the years being studied. The period studied was then divided into two five-year periods and

trends in the two sub-periods compared.

The analysis in the thesis itself tends to examine each process separately when looking at the reasons for its introduction and its effect on employment. However Nelson herself notes that "a point which was commonly raised in discussion was that in practical situations, farmers did not think in terms of separate categories, as for a particular production stage the factors influencing change were all interrelated," (page 35) and that sometimes it is not feasible or economically rational to mechanise one process if one does not change another process at the same time. Because of this approach we cannot trace the linkages between the processes in the same way as we have done with the other agricultural types, but her detailed separate analyses do provide some clues.

A second problem with the analysis for our purposes is that it concentrates almost exclusively on the effects of technical change on employment. Informal discussion elicited details as to non-employment factors, but these were obviously limited to those which Nelson had been able to pick up in studying employment. Additional information was obtained from officers at the South African Sugar Association Research Station in Mount Edgcombe and other industry sources in an attempt to fill in on some of the gaps. Whereas Nelson's analysis stresses the economic and labour aspects, the SASA theories concentrate on the technical factors, such as unevenness of terrain, small and irregular farms, etc. None would deny the importance of the labour aspect, however.

Mechanisation research in sugar farming is regarded and justified as insurance against the days when the workers "don't want to dirty their hands" any longer. Until that time it is not economically justifiable. As one of Nelson's informant's said, "Labour problems will have to be very severe before it becomes worthwhile." Or, as another put it, at present "labour requires less supervision than machines." These remarks are further corroborated by the oft-expressed relationship between the emergence of trade unions in the industry and the necessity of mechanisation.

Nelson's thesis is useful in that it covers virtually the whole of Natal. This is important in view of the great variety in soil types, terrain, climate, etc., and the effect that all of these have on the possibility for mechanisation. The Natal North Coast is relatively flat and more fertile than the rest of the province, and as a result is much more mechanised than both the more hilly South Coast and the less fertile interior. At yet the study is too small to allow for adequate breaking up into the separate areas, but further planned research should overcome this limitation. The data at present at least prevents one's getting a one-sided picture of sugar-farming as a whole.

The first stage in sugar production is the preparation of the land. Here $\frac{3}{4}$ of the farmers use mechanical methods. The exceptions occur where it is too steep and the ground is inaccessible to the tractors. Technical change in this stage has been a change over to a system of minimum tillage, where Roundup, a weedkiller, is applied, rather than actually turning over all the ground. In the first five years Nelson found there to be very little change in preparation methods. Over the latter period, however, most farmers were beginning to experiment with minimum tillage. What is interesting is that minimum tillage is more labour intensive than the mechanical method, in that Roundup is usually applied by workers from knapsacks. This is not a major drawback however, in that roundup is only applied once in the plant cycle, before the planting, to kill both the weeds and the old plants. Each plant will then produce up to four ratoons (i.e. harvests). Thus roundup need by applied only once every few years. The extra labour is warranted by the greatly increased efficiency of the Roundup in killing everything, as well as the benefits in terms of soil conservation.

The second and third stages in the production process are planting and the application of fertiliser. Changes in both these processes have thus far had very little effect on labour utilisation. Both the processes are very labour intensive. As with other processes, it is the uneven terrain and small and irregular shape of many of the holdings which has made mechanisation difficult. Casual labour, including a large number of women, is used extensively for this process, and this has also

lessened the pressure to mechanise.

About 30 workers per hectare are needed for planting. Fertiliser is usually applied by workers carrying 20 kg pouches and distributing the mixture with a tin used as a scoop - one tin per so many paces. The distribution process is easier than the application of Roundup, but must be done more often, i.e. both when planting and for top dressing after the harvest. Possible changes such as half ton bags are being investigated at present, but to date the savings induced have not warranted the costs of mechanisation involved.

Weeds must be eradicated on a regular basis, both before and after the plants emerge. Here many farmers still utilise handhoeing, especially for the particularly chemical-resistant weeds such as Babwe grass. Where chemicals are used, they are applied from knapsacks, rather than by means of boomsprays. In terms of labour, knapsacks are less labour intensive than handhoeing, one workers covering about one hectare a day. Spray application is uncommon and ineffective in most areas because of the unevenness of the land. Again, the pressure to mechanise is not so great in many areas because of the utilisation of casual (often female) labour from neighbouring reserves. Nevertheless the SASA Research officer described chemicals as a "major breakthrough" which had reduced labour demand to a "quite considerable" degree. Individual farms claim the productivity has increased 100% with the introduction of weedicide. (Nelson interviews)

Sugar farmers use virtually no pesticides. The plant is very hardy and continues to produce even when it has lost all its leaves to marauders!

The most labour intensive process, and that which has undergone least change, is the harvest. Nelson found that 99% of the farmers interviewed cut their cane by hand. The research station corroborated the finding on her sample when they put the percentage of farmers cutting by machine at under 2%. Although many farmers would like to mechanise, machines are both slow and often unable to operate at all on the terrain. Instead male seasonal workers are obtained from the Transkei and Kwazulu on

nine to ten month contracts to cover the cutting season. All informants are agreed on the decreasing availability of strong, young male labour. Some farms claimed that it was explicit government policy to cut down on the amount of male agricultural labour in Natal, whether resident or migrant. Informants are also agreed on the increasing availability of labour from neighbouring Kwazulu. Women from these neighbouring reserve areas are thus increasingly being employed, while the number of males between the ages of 20 and 30 is steadily decreasing.

The two most mechanised processes are the stacking of the cane, the loading, where 89% of the farmers had mechanised, and transloading (reloading for transportation off the farm.) There are several possible choices here, including various types of mechanical loading, and mechanical cutting with manual loading of the machine-prepared windrows. All of these methods are less physically demanding than a system of non-mechanical cutting and loading and would facilitate the increased employment of women and children. (The methods are not necessarily more pleasant in all respects. Hours of work, for instance, tend to be longer with mechanical stacking than with manual.)

Nelson notes a definite move towards infield loading. This move would have had the effect of making only one loading process necessary, and would have thus facilitated the employment of women. Which way the causation goes is a matter of debate.

Mount Edgcombe officers stated that women were viewed as both more reliable and displaying more interest in the work. They also noted that in the Midlands, there were women cutters, whereas on the coast the male migrants cut. This was attributed to the fact that Zulu people did not like cutting, whereas Pondo men did not mind. It could perhaps be more easily explained by the fact that the local Zulu people have more alternatives open to them and that in the Midlands, where the farming is more mixed, there tends to be a larger resident population and thus more women available. (Nelson notes, however, that in some areas of the Midlands additional off-farm women are loaded up daily for weeding and to apply Roundup. Cutters would probably still be permanent people, as it requires a greater degree of skill).

Nelson did not look at irrigation at all. Sugarcane is irrigated by surface or overhead methods. Surface irrigation is cheap in terms of equipment, but is labour intensive and allows very little control over the water. Because of the latter factor, it is limited to the flatter areas, such as Pongola and the Eastern Transvaal.

Overhead irrigation is by sprinklers, usually portable aluminium pipes. This is also very labour intensive, due to the need to move the pipes. The Research Station officers noted a definite swing over to the dragline system, which requires less labour and only slightly more equipment. The reason given was "the reluctance of labour to move the pipes, especially if a change is required at night". Other more mechanised systems, such as centre pivot, are very little used - "Capital and running costs are usually very high and our farmers can still find sufficient labour to get away without complete mechanization." (personal communication)

It can be seen from this brief description (a) that the sugar industry in South Africa is still very far from the near 100% mechanisation position in Australia in 1978 (This is also largely a factor of the less advantageous topography of Natal) and (b) that there are large difference in the degree of mechanisation reached in the different processes. What Nelson shows very clearly and repeatedly, however, is that whatever the degree of mechanisation in the different processes, the trend in terms of labour utilisation in the two periods was in the same direction viz in the earlier period there was a definite move towards labour-saving methods, while in the latter period this move was slowed down or even reversed. One informant said he knew of other farmers who had bought chopper harvesters and then resold them. Nelson, quite correctly, attributes these trends to the changing situation in the labour market. The majority of the farmers interviewed stated quite openly that labour availability was the major determining factor in their choice of techniques, more important even than relative "factor prices".

In 1982 90% of the sugar labour force was still male, and the

majority of workers were migrant. Prior to this the percentages were even higher. In the mid-1970s, after the rapid increase in mine wages, labour from the Transkei and Kwazulu was not so plentiful. The greater scarcity of labour coincided with a run of particularly good sugar seasons, with resultant increased demand for labour. It is perhaps not pure coincidence that the Research Station started its training department for farm workers in 1976!

In the second sub-period, however, with the recession, labour has become relatively plentiful. Methods such as herbicides which were "technically efficient" were no longer always "cost efficient". While it was still perhaps efficient to mechanise the more qualified tasks, where other job opportunities were open to the workers, this was not so for the majority of unskilled workers. In the case of other processes, where there are still many unsolved technical problems, farmers sometimes preferred to return to the previous tried and tested methods.

If our contention about loading is correct, we can take the argument further. Industry sources state that there has been a drop in mechanical loading because of the ready availability of labour in the 1980s (reflected by a drop in the wage index from a peak of 169,1 in 1977/8 to 151,0 in 1980/1). But Nelson notes that in-field loading is the one change which has reversed the least over the second sub-period. Insofar as this change facilitated the utilisation of a female and child labour force, which has become, if anything, even more plentiful with the ongoing removals in the area, this would be an economically "rational" move. While the decreased availability of migrant labour from the reserves reached its crisis point in the mid 70s, the change-over to women and children is a continuing development.

Sugar is perhaps exceptional in the South African situation in the depth and extent of ongoing research. There is a large range of alternative systems which are feasible in different circumstances and detailed costing has been undertaken on the alternatives. The emphasis so far has been on what is termed "semi-mechanised" systems, but even within this a large range of

options is included - for example up to eleven different methods for handling burnt sugar cane.

To a certain extent the different options apply to different circumstances. For the smaller farms, for example, manual cutting and stacking is still the cheapest. Bigger farms are said to be able to increase productivity by a factor of over two at the same cost by using the semi-mechanised methods. Fully mechanised alternatives, however, are not a viable alternative for any of the farmers, until the day when "for various reasons, manual harvesting of sugarcane might become less attractive to labourers." (De Beer, page 992)

General Discussion

The problems of the application of technology in agriculture are many, but it does not help to adopt a Luddite position. Choice of technology in the current climate depends on economic and political factors, rather than benefits or disadvantages to people, as is obvious from the above case studies, but this is not to deny that there can be benefits.

There is no doubt that the application of technology has often made work less arduous. In terms of sheer physical strength, all those changes which have allowed increasing employment of women have also meant that the work is less strenuous. The planting of trellis vines rather than bush vines has meant that the women working in the field are able to stand upright while working rather than working with backs continually bent. Farm work is usually not easy work, and insofar machines can eliminate the need for hard work, they have a potential for good.

There are also less pleasant aspects to the application of technology. The dangers of the increasing uses of pesticides, while well documented overseas, have not been at all adequately recorded or controlled in South Africa. The official figures for pesticide poisonings are the tip of the iceberg. Pesticides are registered for use in South Africa which are banned in overseas countries. Even overseas, serious debates are being expressed as to the laxity or even falsity of pesticide testing. [**] Yet the

illiteracy, malnutrition and general poverty of the farm population here can only mean that the effects are more severe.

Work is also sometimes more arduous when technology is applied. Harvesters with headlights permit longer working hours, and this is in fact mentioned as a benefit by one of De Klerk's informants. For the farmer this is rational as it means either greater utilisation of the expensive capital equipment over a larger area, or completion of the same amount of work in a shorter period, cutting the casual labour demand.

On the macro-ecological and agricultural side mechanisation presents a problem in that it tends to encourage the ever increasing use of marginal land. Machines can often only be justified if they are used over a large area. Farmers thus tend to cultivate land which otherwise would have been left fallow or used for grazing. This presents dangers to the land. It is also a process which is difficult to reverse. The change from cattle to maize is fairly simple, with reasonably quick returns. The change from maize to cattle involves a waiting period of at least three years before the cattle yield returns. Few farmers are prepared to go through this waiting period, and thus monoculture is undertaken and continued for a longer period than justifiable. De Klerk's study in the Western Transvaal showed definite evidence of over-cultivation of maize coinciding with the mechanisation process.

The application of technology has also seen minimal increase in skills among the farm population. Farmers are loath for workers even to acquire heavy duty driving licences as this means the workers would be more able to find jobs in the towns. Instead many farmers prefer to drive their trucks and heavy vehicles themselves. The Kirkwood farmer reported losing six drivers to Uitenhage in this way. Tractor driving and maintenance are still the most popular courses at the Kromme Rhee school, the training school for coloured farm workers. Here the skills are not as saleable on the urban labour market.

The most obvious problem with technology, however, is certainly the question of employment, which in the South African context

also means housing. Whereas overseas the application of technology in agriculture has freed workers and allowed them to leave the farms and go to the better life in the cities, in South Africa the "surplus" population finds itself restricted to the reserves. While some workers actually choose this alternative, whether to escape the control of the white farmer, or because of hope of the "Promised Land" in the "independent" reserves, the actual situation in which they find themselves is usually even worse than that on the farms they have left.

Researchers in the reserves find many people who have come off white farms. There has also been an absolute decrease in the number of agricultural workers in South Africa since 1970. Yet when questioning farmers one rarely finds one who will admit to having actually retrenched workers because of mechanisation. They will admit a saving in labour in certain processes, but claim that the labour is still being employed on the farm for other tasks.

There are several possible explanations for this seeming contradiction. There has been a noticeable concentration and centralisation in farm ownership. As we have seen, it is usually the bigger farms which are the most mechanised. It seems that very often when a farm is taken over and consolidated with another one in the same area, the workforce of the newly acquired farm is retrenched, and the workers on the original farm work both farms. Thus the farmer does not retrench what he sees as "his" workers, but people certainly lose their jobs.

A second explanation is that it is perhaps not the workers resident on the farms who are losing their jobs, but those in the reserves who are no longer being employed on a casual or longer term basis. Macro statistics on change in land size and change in population bear this relationship out. Once again, the effects of mechanisation are felt in the reserves, rather than in the white agricultural areas.

Thirdly, there is the point that workers need not be overtly retrenched for mechanisation. People who have left white farms rarely see their removal as clearly as the tenants of the 1920s

saw the reduction of their stock as related to mechanisation. They usually see their leaving the farm as the result of a personal difference with the farmer, or personal dissatisfaction with the farmer. But obviously these things are not unrelated. The farmer who has a smaller labour need is much freer to sack workers who do not behave as he would like them to behave. To quote one of De Klerk's informant's again, mechanisation makes it "makliker om arbeiders uit te skakel." The workforce can thus be decreased by attrition in a more inconspicuous way.

Finally, the change to female labour could account for the farmer not reporting retrenchments. The males resident on the farm, who formerly worked there, might be moving more and more into work on the towns. The farmer will often, however, have no desire to force the family off, as the women and children are forming an ever bigger part of his workforce. A decrease in the number of those working full-time on the farm as a proportion of people resident on the farm suggests that this is indeed happening. The men live on the farm and work elsewhere. Women, classified almost exclusively as "casual" labour, continue to both live and work on the farm. As the Kirkwood farmer remarked, women "will always be there", at least as long as the farmer has use for them. They have few other alternatives in terms of employment and accommodation. (We must note that it is not necessarily the first time that female labour has been used on such a scale and for "unusual" tasks. Scharf's discovered that women were being used extensively in the 1940s for pruning, as well as the arduous task of "bankies gooi").

What is worrying about the move towards female labour is that one suspects that it is accompanied by lower wages. It is difficult to substantiate this suspicion as casual farm wages are impossible to estimate with any accuracy, and in any case not comparable with regular wages. There is no reason to presume that farm wages would not follow the general pattern of lower female wages for equal work. One would also expect that farmers would justify the wages on the basis that the woman had her husband to support her and thus did not need a family wage. Family planning is a compulsory additional course for all students at the Kromme Rhee Training School, and while we would

not like to denigrate the importance of knowledge of and access to contraception, one can also well understand the utility to the farmer of smaller families and fewer dependents on his farm.

This paper has looked at four different farming operations in South Africa. While common themes have been drawn out, what has emerged is the complexity and variety of causes and effects in the application of technology in agriculture. This would be magnified if we were to extend the analysis to pastoral farming.

There are no glib or easy answers to the problems of agriculture. Instead of generalisations, we need studies firmly rooted on the ground.

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