Mechanization and agricultural development: no miracle in Africa

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I. MECHANISATION EXPERIENCE

1. Development and mechanisation.

The assumption that developing countries will quickly introduce the production techniques of advanced western nations has influenced early attempts to mechanise agriculture in Africa. Historical experience of farm mechanisation which was associated with a steady movement of rural labour to the cities and rapid mechanisation only when the proportion of population in agriculture declined to well below 30 per cent, has generally been ignored. Politicians presume the possibility of speeding up transformation of techniques by introducing the most advanced available technology, attempting in one stage what has elsewhere been achieved by steady evolution over generations.

There is now a long history of such attempts, dating from the Colonial period but followed with renewed vigour after the era of independence. Since the Second World War most attempts to introduce mechanisation have failed. In tropical Africa mechanisation has been accorded an importance far beyond its current use—actual or potential. The traditional cultivator sees the tractor as symbolic of an easier life where government provides subsidised purchase or hiring services which allow him to dispose of his hoe and machete and farm the easy European way. The politician sees in the promise of a tractor, a guarantee of the rural vote and evidence of development in agriculture which is otherwise so difficult to plan. Aid programmes (*) have sometimes promoted uncritically mechanisation of agriculture. Agricultural technologists have sometimes attempted to transplant the mechanised farming methods of temperate countries (where they are trained) as the patent, if revolutionary, alternative to the intractible problems of developing traditional agriculture. Such a revolutionary change, involving an entirely new system of farming, appears to avoid the need for detailed study of traditional farming as a pre-requisite for gradual improvement and development. Economists, constrained by the objectives of politicians and technologists, and lacking the detailed information necessary for an understanding of the economic organisation and motivations of traditional farmers, have offered faint criticism of the financial (as opposed to social which is relevant) profitability of mechanisation projects. Sometimes effort has been devoted to investigating ways in which the politician's desire for mechanisation could be satisfied, rather than to emphasising the likelihood of financial and economic failure in the light of both theoretical analysis as well as past experience.

(*) Such as Food Aid Schemes to buy a tractor for the poor unemployed farmers of Umbeleland ! Trade missions, the pressures of tied-aid and the exhortations of " experts " trained in a Western farming environment also influence the choice of aid.

2. Apparent advantages of Mechanisation.

Unfortunately, both the economic and technical environment of the developing countries in Africa is generally quite different from that of the countries in which agricultural mechanisation, centred on the tractor, has developed recently and rapidly. In favourable conditions the agricultural tractor facilitates more timely operations and the elimination of some labour bottlenecks. Consequently individual farmers may be able to cultivate more land. Tractor power facilitates cultivation of heavy land, sometimes impossible by traditional means, and also reduces risk by providing a reserve capacity in times of adverse weather conditions. These potential advantages could result in higher yields, although there is little evidence to suggest that mechanical cultivation by itself increases them directly.

Although mechanised cultivation may induce soil erosion, especially with large

fields, it also introduces the capacity for greater erosion control and the construction of terraces. Mechanisation is also seen as a way of improving the technical level of traditional agriculture since it is often accompanied by a general extension drive to introduce " improvement packages " in which improved seeds, fertiliser and insecticide innovations are offered simultaneously.

Mechanisation may release labour from arduous tasks such as seedbed preparation. Through mechanisation rural labour is eventually freed for urban employment.

3. The Experience of Mechanisation.

Most of the potential benefits have not been achieved in Africa except under special conditions such as in S. Africa, Rhodesia and parts of Kenya where farming enclaves are protected from a free market. In some cases, however, the introduction of mechanisation has not led to an increase in gross agricultural production, either by expanding the area of cultivation, by increasing unit yields, or by reducing unit costs.

As one process which limits area cultivated is mechanised another, non-mechanised process, takes its place as a constraint on production. In group farming schemes in Uganda, for example, the mechanisation of seedbed preparation and cotton sowing and weeding created difficulties at harvesting, which could not be mechanised, and adequate amounts of labour could not be recruited for harvesting alone. The mechanised system of cotton growing required less than half the total labour of the manual one, but the harvesting requirements were similar as shown below:—

Monthly Man Hours per Acre for Cotton : Hand Hoe and Mechanised Cultivations

(hours per acre)

	Land Preparation	Weeding	Harvesting	Total
Mechanised	11	30	201	251
Manual.	136	229	223	588

Source : HALL (M), 1969 (1).

In the Niger Agricultural Project initiated after the Second World War, mechanical land preparation was expected to lead to a cropping acreage of 24 acres for each farmer. This proved to be a wildly optimistic estimate, as farmers could not cope with weeding which was not mechanised (2). Similar difficulties were experienced with the Groundnut Scheme in Tanganyika (3) during the same period.

Many mechanised schemes have produced yields lower than expected. The earlier schemes suffered most in this respect as equipment and techniques were not suitable, but later schemes have also been troubled by the low margins which remain after deduction of tractor costs. Jones (4) commenting on the large-scale mechanised farming in Busoga, Uganda between 1949 and 1954, stated that,

> " ... the general conclusion which must be drawn from the scheme as a whole is that given the general market conditions and price structure in Uganda for annuel crops (particularly food crops), it is extremely unlikely that the return from crops which could be grown in an area like Busoga largely by mechanical means would be sufficient to meet the overheads which this type of undertaking implies. "

This situation has been fairly generally experienced and later schemes have given no indication of solving this underlying problem.

Part of the reason for the low returns has been the small size of the internal market, already in equilibrium for many of the crops grown. Cotton is an exception to the general rule as it is almost all exported, but the margin left to the farmer after paying for tractor operations on the cotton crop has often been very disappointing. In the case of the Uganda group farming schemes, these lower margins have not been compensated by higher cotton acreage per farm family because of the harvesting constraint and when the official cotton price was reduced for the 1966-1967 cotton crop, almost half of the 3,573 participants left the scheme. As mono-cropping is ruled out for most schemes, food crops are rotated with cotton. Any increased food production can, however, easily saturate national markets, reduce prices and thus affect non-participants adversely. When the production level is such that export outlets must be found, farmers and agricultural experts are often dismayed at the low level of prices ruling on the world market compared with domestic prices.

4. Large-Scale Mechanisation. Projects.

Projects have focussed attention on methods of reducing production costs and are usually designed to take advantage of economies of scale, in the case of large tractors, or to adapt equipment to small-scale use by developing smaller versions or employing animal powered equipment. A common method has been to create optimum field conditions for the use of large tractors and their equipment by organising large-scale farms. These farms have exhibited a range of organisational types ranging from the Uganda Group Farms, where the large fields are sub-divided by markers so that each farmer owns a portion and is responsible for hand-operations on this portion, to state farms where all labour is hired. The former type of organisation has many advantages from the viewpoint of accommodating, rather than totally eradicating, traditional farming patterns. This facilitates the acquisition of land held under customary tenure as it causes less social disruption. Farmers are also free to continue cultivating their previous holdings if these have not been absorbed by the group farm. While this arrangement facilitates large scale tractor operation and professional management, there are many problems concerned with plot allocation in relation to quality of land. In addition, management by participants has disadvantages where committees of farmers not acquainted with the technical and agronomic problems of new farming systems have often been able to overrule the decisions of the professional managerial staff.

With a system of state farming other equally important problems exist. The acquisition of land from owners who are not allowed to participate in the projects causes severe problems of eviction or compulsory purchase unless wholly unclamed land is secured. Even in Africa such land is rare, unless there are important reasons for its previous non-cultivation such as insufficient rainfall for cropping as opposed to grazing. Such sites are often remote and require an enormous capital outlay on roads and water supplies. In rare cases the land is suitable for cropping but has not previously been settled because of the infestation of tsetse fly and the problem of attracting settlers or labourers in sufficient numbers has often proved to be a serious one (5). State farms have been far from successful and de Wilde (6) has written of the Ghana State Farms :

> " Experience, while not permitting a definite judgement in all respects, has shown how difficult it is to make such schemes successful. ... The productivity of the state farms, whether expressed in terms of land or labor employed, has generally been very low and evidently far from sufficient to meet the annual operating costs, including those of machinery and labor, quite apart from any return on development costs. "

The existence has been reported (7) in Ghana in 1969 (repeating similar experience in 1955) of repair yards containing hundreds of broken-down tractors and of fields containing new tractors unused since delivery following the breakdown of the mechanisation initiative. These failures followed the

experience of the big push towards mechanised cultivation in Ghana which expired in the middle 1960's. But just as the 1950's experience provided no constraint on the schemes for mechanisation in the 1960's, the repeated experience of the 1960's, though better documented, is unlikely to influence later proposals when the time is ripe. " Ripeness " for mechanised development is determined by the co-existence of

1. A developed country wishing to export machines designed for temperate agriculture to increase the scale of output in its domestic factories.
2. A political pressure enforcing subsidised farming and the need to " demonstrate " advanced technology in less Developped Countries.
3. Technical advisers completely oblivious to the economic and technical conditions of traditional domestic food production employed in the economic planning institutions of both donor and recipient countries.

5. Tractor Hire Services.

Government controlled tractor hire services require no change in tenure and allow most of the managerial decisions to be exercised by the small holder while securing the advantages of centralised purchasing and repair facilities. An investigation of hire services in Ghana, Nigeria, Gambia and East Africa (7) stressed the importance of co-ordination by a single agency and discussed the subsidies necessary to make the service attractive to farmers. In Ghana, the cost of wheeled-tractor operations was subsidised up to 42 per cent. and charges for clearing by crawler tractor were subsidised up to 62 per cent of total cost. In Uganda, reduced productivity of tractors during the 1960's has been ascribed to the rapid rise in numbers during this period (1) during which travel time rose to 35 per cent of working hours. In 1967, with an average of 384 chargeable hours per tractor, the average revenue per hour was only Shs.24 and cost Shs.64, implying a government subsidy of Shs.40 per hour. In terms of total cost and revenue, it was calculated that each tractor would have to work over 1,700 hours per annum to break-even by spreading overhead costs. This is difficult if not impossible to achieve given past experience in Africa.

Conclusions reached on Tractor Hire Services by IBRD (8) may be applicable throughout Equatorial Africa :

1. Since cost per hour of tractor operations varies inversely with the number of hours per year of tractor use, costs are substantially lower where relatively simple cultivations are carried out on large tracts.
2. The transport of the tractor and equipment amounts to about one-third of the total running hours, in both the governmental and private sector. More concentrated tractor use would help to reduce this loss of time.
3. The total cost of tractor operations in East Africa ranges from about $ 2.10 to $ 6.30 per hour. Off-season work could considerably reduce this figure.
4. Government tractor pools have had to be highly subsidised, often by more than 50 per cent. It seems questionable whether the increases in output resulting from mechanisation would meet the full costs of the service.

6. Small-Scale and Animal Powered Equipment.

An alternative to large-scale mechanised farming has been the use of small-scale equipment. Unlike the seemingly successful introduction of small tractors in many parts of Asia, however, the generally more rugged conditions experienced in Africa have led to many technical troubles. Hunt (9) has described the initial failure of the horticultural rotovator in the *robusta* coffee area of Uganda. The comparative complexity of the machine, poor maintenance facilities and the inability of the smallholders to service equipment caused the majority to be discarded in favour of hired labour. Indeed the cost of mechanised cultivation exceeded that of hired labour. If the cultivator was used only for four coffee weedings per annum, over 21 acres of coffee would have to be possessed before it became as cheap as hand weeding at the local labour hire rates (10). Most coffee smallholdings are only a fraction of the size necessary to reduce even small tractor costs to the level of wage labour costs. This factor plus the recent political emphasis on employment creation, as opposed to labour saving, may delay for a long time the successful introduction of such machines. Most small tractors are sold with attachments for a wide range of farm tasks but, in most cases, this means that the demand for family labour is reduced and the price of this extra leisure might be considered too high by the average farm family. The diversion of national resources to create more leisure on smallholdings is curious from a national policy standpoint as the usual problem is one of unemployment or under-employment.

The use of draught animals and small-scale equipment has many attractions. The cost is very low in terms of foreign exchange as the draught animals, usually oxen, may already be available on farms or can be obtained locally. Most ox-equipment is still imported but it could be made locally under licence or indigenous designs could be evolved. The relative simplicity of the equipment and its general ease of maintenance is more suited to the abilities of smallholders who are usually completely inexperienced with mechanical equipment. Equipment costs can be very low if the items are shared and it has been estimated in the Cameroons (6) that one plough could serve three or four farmers and one cart as many as ten farmers. Communal ownerhsip is easier than with the more complex and delicate motorised equipment. In Mali, co-operatives have acquired oxen and equipment for the use of members and in the Bokoro region of the Chad efforts have been made to encourage the co-operative ownership of implements (6).

Disadvantages include the slowness of operations at times where speed is highly desirable. The difficulty of controlling the oxen makes some jobs hazardous as crops once established, are often vulnerable to trampling. Comparative lack of power makes oxen virtually useless for seedbed preparation on some heavy or lateritic soils unless they are big and strong animals. But the peak period for ox-cultivation often follows the time of year when fodder is in shortest supply and the African zebu cattle are generally small and light. The presence of debilitating disease carriers such as tsetse fly precludes the use of oxen in some areas and the high population pressure in others makes it too expensive to devote land to feeding them. Other areas are populated by non-cattle-keeping people and here their introduction is certain to be a long process and they may be more slowly accepted than motorised equipment. Nevertheless, oxen seem to be more economically desirable in many areas than tractors. Collinson (11) concluded an investigation of the potential for the mechanisation of cotton growing in Sukumaland, Tanzania, by stating.

> " There is no case for the introduction of tractors in areas where ox-ploughing is established, these can perform the same function as tractors more cheaply. "

II. THE ECONOMIC ISSUES

7. The Economic Background.

Pressure for rapid development tends to lead to a neglect of the importance of achieving the correct inter-sectoral and intra-sectoral allocation of resources in developing countries. Unlike many manufacturing processes, where the dictates of product quality demand the adoption of technologically-advanced, capital-intensive production methods, most forms of agricultural production are amenable to a wide range of production techniques. Almost all agricultural products can be produced either by labour-intensive or capital-intensive methods. The optimum choice of input proportions is dependent on national factor endowment.

Rapidly rising population levels, slow increase in employment in the manu-

nisation of traditional agriculture in Africa. Instead of obtaining a better utilisation of the three major factors of production, land, labour, and capital, further distortion may result from premature mechanisation. For any given level of output, mechanisation saves labour and creates a " substitution of costly for cheap factors of production " (12, p. 2), accentuating the basic underemployment problem in African countries. The use of foreign exchange for mechanisation, when returns to capital and foreign exchange would be greater in other forms of development investment, makes the support of mechanisation a dubious policy. The necessity to divert large numbers of highly trained planners and technicians from other forms of agricultural development and the utilisation of resources for creating training facilities for others involved in mechanised projects, would also appear to involve an extremely high opportunity cost.

8. Mechanisation and Food Supplies.

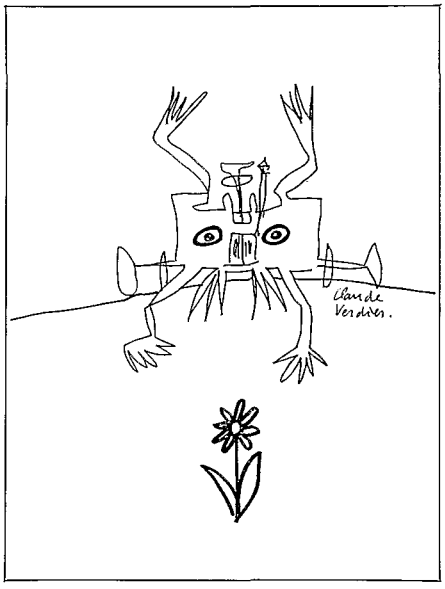
The general case that premature mechanisation, in the domestic food producing sector, contributes to a misallocation of national resources can be summarised briefly. In most countries in Africa the supply of food has kept pace with demand, as there is still some unused, cultivable land and underemployed labour.

While domestic food production can keep up with demand by extending the boundaries of cultivation using existing technology, there seems less need to allocate scarce development resources to it. Nevertheless, although production food has apparently been able to keep in step with demand in the past using existing technology, it cannot do so forever.

When the current plentiful resources of land and labour become more scarce it will become increasingly profitable and appropriate to employ new inputs and technology to increase productivity. It is important, however, to emphasise the importance of an appropriate sequence in introducing changes in technology. The most profitable changes at present will concern the introduction of complementary resources which can be superimposed on the existing systems of production. Examples of these changes are better varieties of crops, fertilisers and disease control materials, all of which have been successfully introduced in limited areas. The possibility of achieving increased output by these means, which are relatively low-cost with respect to the critically scarce resources of capital and foreign exchange, depends upon adequate attention to agricultural research and extension programmes relevant for the existing farming systems. It is important to note that innovations of this type are highly divisible, rather than lumpy inputs like machines and can be applied relatively efficiently by small-scale farm units.

The proportion of population in agriculture will be reduced in the long-run and the structure of developing economies will be modified by transformation which reduces the present dominance of the agricultural sector. Demand for food — and in particular the demand for purchased food — will increase concurrently and it will eventually become profitable to introduce labour-saving machinery, even if this involves radical change in farming systems. To impose mechanisation before an economy is ready for it leads either to a failure of the project or to the misallocation of resources which will slow down development.

The concept of the traditional agricultural sector producing as much food as the rest of the economy can pay for, may be very strange to those with knowledge of the literature on food production in Africa. Much discussion of African agricultural development has concentrated on under-nutrition and food shortage. However, some writers (13) have concluded that there is currently no general shortage of staple foods in Africa and that supply is more or less in equilibrium with demand. Of course, in limited areas and in scarce seasons, shortages sometimes occur. But to produce enough food to be certain of supplying the market each year would mean an undisposable surplus in most years. Most farmers in Africa are still subsistence cultivators because, where substantial production for the market occurs, it is grafted onto a subsistence family unit which produces its own food requirements plus some little surplus for the market. Where 60 to 80 per cent of the population is engaged in domestic food production, the demand for purchased food is relatively small. Cash to buy food is also limited because of the small size of the non-agricultural sector. Consequently, until this sector is expanded substantially, small scale farmers in Africa are unable to earn enough from the sale of food to purchase improved agricultural inputs, such as fertiliser and insecticides. Indeed, until the size of the non-farm population increases it is often not economic that they should do so.



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9. Labour-saving Techniques in Conditions of Underemployment.

Another outstanding problem is the impact of mechanisation on the unemployment situation. In most underdeveloped countries there is unemployment or underemployment particularly in domestic agriculture. This may take the form of disguised unemployment where, although everyone is doing something, large numbers of people can be moved from the land without affecting the production level because of greater efforts or longer hours worked by those who remain on being given access to a larger proportion of the market. The substitution of mechanised for labour-intensive methods may increase employment in the tractor manufacturing complexes of the western world but, to the extent that the introduction of mechanisation is successful, it aggravates underemployment problems in poor countries.

Agriculture in developing countries has to supply labour for the expanding non-agricultural sector, but in Africa there is no problem of getting people to leave the land, the problem is to provide enough jobs outside farming. Perhaps the most serious political problem in Africa at the moment is the large numbers of school leavers who have been educated to expect an urban job and who congregate in the towns providing a pool of politically influential and dangerous unemployed. Clearly, in countries where about 80 per cent of the population are engaged in agriculture, about 80 per cent of school leavers will have to be employed in agriculture if there is to be education for all. The necessary structural transformation to reduce the proportion of the labour force in agriculture can only take place extremely slowly. Moreover, the fact that large numbers of unemployed can be maintained, apparently indefinitely, in the cities of Africa by their relations and friends, suggests that food is not a particularly scarce commodity.

Development requires a relative expansion of the non-agricultural sector and a better general infrastructure. To the extent that scarce capital is used unnecessarily to substitute for underemployed labour in agriculture, it involves in a serious misallocation of national resources. Capital surplus has to be generated in agriculture to provide development resources for the rest of the economy. Some way has to be found therefore, for using the low-cost, non-scarce resources of land and labour to provide a surplus for diversifying the economy away from domestic food production perhaps into agricultural exports

facturing sector, an incipient or actual shortage of foreign exchange and generally low pressure on land resources create serious obstacles to the mechabut particularly the non-agricultural sector. Mechanisation may contribute to this process, but it is generally a net consumer of capital rather than a net supplier and to this extent, there may be a critical misallocation of resources. Consequently, it is difficult to justify the introduction of mechanised methods in agriculture unless these methods are directed toward the production of an export crop which can find an outlet on the international market and unless it can be shown that the increased production could not be obtained by other methods more labour and less capital-intensive.

10. Lack of Markets.

The difficulty about developing the food producting sector, which in turn limits introduction of mechanised techniques, is the lack of markets. However, as the non-agricultural sector expands there has generally been enough slack in the domestic food sector to meet increased demand. Mechanisation would, in somes cases, facilitate acceleration of physical production, but it is difficult to see where the output could be marketed. There is negligible scope at the moment, because of the high proportion of the population involved in agriculture, for trade between countries in domestic staple foods and the food surpluses in developed countries promises little scope for future exports in this direction.

Export crops also face a difficult future market. Although smallscale production of tea, coffee and tobacco in East or West Africa has expanded rapidly, coffee expansion is now limited by a quota agreement and the other two crops also face serious marketing difficulties. Cotton, groundnuts and pyrethrum are all grown as part of the small-scale agricultural systems but, on the whole, the international market prospects are also somewhat dismal.

In the case of plantations financed by private overseas capital the arguments against mechanisation are perhaps weaker. Management will introduce mechanisation only where financially profitable, although there is a case for import tariffs on machinery to encourage the use of local labour by offsetting the effects of rising wage (*) rates so long as this does not discourage overseas investment which is at least providing the foreign exchange to purchase machinery.

(*) The effect of union pressures has been to force unskilled wage rates even higher in situations where there is a high level of unemployment. Employers have often been stimulated to mechanise in order to avoid wage escalation and accompanying workers' benefits, job restrictions and regulations etc.

11. Alternative Opportunities for Capital.

Most of the developments in the introduction of mechanical power in African agriculture have been associated with government schemes of one kind or another. Could this capital be used more profitably either in the agricultural sector or in developing the rest of the economy? In practice, if the export crop sector is excluded, it is often difficult to find schemes in agriculture which will give as high, or as reliable, a return on capital as investment outside the agricultural sector. Governments should nevertheless consider investing capital in building roads and bridges or in marketing facilities which might stimulate agricultural production more than direct investment in mechanisation. These alternative methods should at least provide employment rather than substitute for labour. At the same time government has to consider how far a greater impact would be achieved in the agricultural sector by investments which diversify the economy and increase the purchases of food by the non-agricultural sector bringing a greater proportion of the subsistence sector into the cash market.

12. The Foreign Exchange Problem.

The shortage of foreign exchange is becoming even more serious a constraint on development than is capital. The rate of development in the poor countries of Africa depends very much on the success of government planning programs as a necessary adjunct to the development impact of investment in the private sector. Most countries are already running into serious balance of payments problems, partly because of the immense debt burden and foreign exchange required to finance loans. Recent surveys by the World Bank showed the cost of annual interest and amortisation on debt payments to be rising very rapidly. Indeed, this return flow of capital to the industrialised countries has swallowed up virtually the whole of the increase in aid over recent years. This has occurred at a time when the capacity of the poorer countries to finance essential imports as well as to increase debt service payments on past borrowing has been seriously curtailed by falling prices for their major exports — mainly agricultural exports. It is vital for governments to earn and conserve foreign exchange in such a situation and to use scarce exchange only in areas of genuine development potential. It is doubtful if foreign exchange for mechanisation is efficiently used in the food production sector. Even the efficiently organised and mechanised former European farms in East Africa involved a very heavy drain on foreign exchange resources through the imports of machinery and raw materials. Indeed, Clayton (14) has suggested that in the former mixed farming highlands of Kenya, one of the most intensively mechanised food producing areas in Africa, the contribution to foreign exchange made by this sector through exports was of the order of £ 4 million per annum whereas the imports of farm inputs alone came to almost £ 3.5 million per annum. Such estimates are difficult to calculate, but as yet no better figures have been produced to contradict even the order of magnitude of these estimates. The development contribution in terms of net foreign exchange earnings of an agricultural sector which involves substantial mechanisation may, therefore, be relatively small due to high costs of machinery and fuel and other imported items, plus the effect of the consumption patterns of farmers devoting a high proportion of income to imported items.

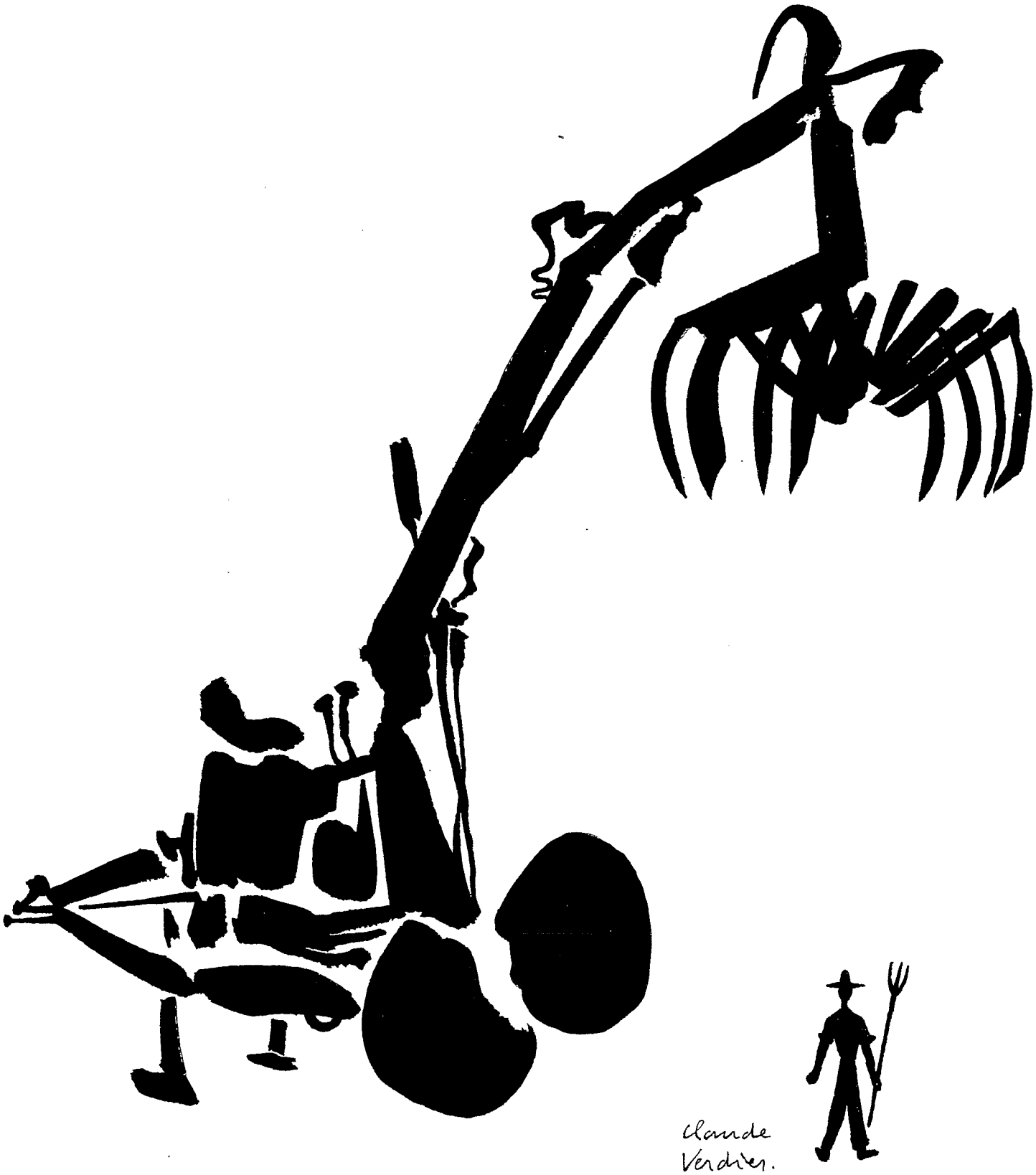
13. Subsidising Agriculture in an Underdeveloped Economy.

Encouraged by the experience of the developed countries which subsidise agriculture, some argue that agricultural development in the underdeveloped areas of the world should be subsidised. Consequently, where farmers cannot afford to hire tractors, government should provide the tractors at a subsidised cost. However, the developed countries of the world with less than 10 per cent of their population in agriculture can afford to subsidise the relatively small agriculture sector for social and political reasons. In an undeveloped economy, however, agriculture has to provide a surplus of capital which can be channelled into development of the rest of the economy. But Cairncross 15) observes,

> " The situation confronting agriculture in a underdeveloped tropical country is thus essentially different from the situation faced in countries settled from Europe during the 19th century. The latter were all, or nearly all, in temperate latitudes and could supply the industrial centres of Europe with foodstuffs as a replacement of higher cost feeding stuffs produced there. The specialisation between the old world and the new was on the basis that brought low-cost farmers overseas into competition with highcost farmers in Europe and gave to the development of the newer countries all the leverage of a large cost differential. The new countries were in a very real sense the frontiers of the older economy. But the underdeveloped countries of today are selling in a much more inelastic market. "

Consequently, it is difficult for the developing countries to produce a capital surplus from agriculture in present conditions.

There is a further argument that mechanised methods of cultivation will ultimately be adopted and should therefore, be subsidised to encourage farmers



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to use them, thereby increasing sales, spreading overheads and reducing costs. An opposing argument suggests that farmers should be discouraged from using mechanical methods where labour intensive methods would maximize employment and give a better income distribution. Furthermore, there is no evidence that mechanical cultivation techniques will not be used profitably just as soon as the proportion of the labour force involved in the agricultural sector of the economy is small enough to justify them. There are, of course, research problems, physical and technical, which make the application of advanced techniques difficult in the tropics. Research has to continue to ensure that when mechanisation is in the national interest, appropriate machines and methods are available. Unfortunately most research has concentrated on technical problems and little is documented on economic issues, for example the conflict between mechanisation and employment creation.

14. Evaluating Mechanisation Schemes.

A great deal of progress has indeed been made toward the development of mechanised equipment and cultivation techniques suited to the conditions found in many parts of tropical Africa (16). The experience of many schemes has also led to the evolution of superior methods of organisation and administration, although these advances usually involve an even greater need for scarce, skilled manpower. As a consequence, there are now examples of mechanisation projects for which an accounting profit is claimed. Some, such as the wheat growing schemes in the highlands of Kenya and Tanzania and the Mwea Tebere irrigated rice scheme in Central Province, Kenya, are dependent on a high product price enforced on consumers subsidising producers through the medium of tariffs on imported substitutes. Other schemes are difficult to assess, as the basis for accounting is not clear and some concealed costs may be absorbed by central government services, but a Michigan State University Report (7) indicates that certain schemes are currently financially successful.

Subsidised hire services, the allocation of relatively large holdings on costly, irrigated or cleared land, and protected marketing arrangements, extension advice etc., ensure that the few participants in some mechanisation schemes become better-off. The resources needed to ensure this, however, have been diverted from small scale farming. Consequently income distribution becomes more uneven and in effect, the majority of poorer smallholders are subsidising a minority of fortunate scheme participants, since all potentially share a slowly expanding market.

It may be even more unfortunate in future if mechanisation schemes become more successful, judged at the level of the individual farmer or the individual project. From the national economic viewpoint this situation is dangerous as the previous technical and scheme level failures, shielded the economy the extension of trial projects and the effects of resource misallocation. Given the possible technical and financial success of mechanisation projects, evaluation which analyses projects from the viewpoint of the national economy becomes essential.

The primary motive of the private investor is to obtain a sufficient return on the capital invested. He is not directly concerned with benefits such as the ability to earn or conserve foreign exchange or creating employment. The private investor is interested only in using market prices in measuring the profitability of a project (17), while government must employ prices which reflect the relative national scarcity of inputs.

Projects may be assessed in terms of net returns to foreign exchange or by employing other ratios of output to input of scarce factors of production. One example of these social economic criteria is the employment created per unit of capital invested. The most commonly employed measure of social profitability is, however, the ratio of social benefits to social costs. When this ratio is calculated using prices of goods and services which reflect the real costs incurred by society and the benefits flowing to it, the ratio is known as the social benefit: cost ratio (18).

The social benefit: cost ratio will automatically favour projects in Africa with high absorbtion of unskilled labour, relatively low demand for high-evel manpower (the value of which may well exceed current salary levels) and high net foreign exchange earnings.

It is well known that social investment criteria involve quantification problems but their adoption is essential for an understanding of the contribution of an individual project to the economy as a whole. To measure the profitability of a mechanisation project by using market prices and private accounting procedures is dangerous. As Little and Mirrlees stated in their manual of project analysis (18, p. 59).

> " ... hunches have no general value. The direction of advance of a particular economy can be determined only by close analysis of that economy. Furthermore, non-quantitative analysis, even if shrewd, is dangerous. It tends to lead to exaggeration. Excessive emphasis on one sector and neglect of another is not uncommon. The best balance between sectors can be achieved only by quantitative analysis. All the arguments which lead some to advocate more for agriculture, and others more for light, or for heavy industry, can be given due weight. The arguments on both sides usually have some validity ; in practice, though, everything depends on how much validity — and this can be determined only by a proper system of cost-benefit analysis. "

Social investment criteria have barely been applied, either *ex post* or *ex ante*, to any mechanisation scheme in tropical Africa. The use of such criteria seems long overdue.

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