CULTURAL PRACTICES AND ENVIRONMENTAL CONDITIONS AFFECTING MACHINE SELECTION IN LESS-DEVELOPED AREAS

by

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The critical problem of increasing food supplies to keep pace with the world population explosion is, it seems, finally being recognized—even among the "haves" of the world—the well fed peoples of Western Europe and North America. The rather phenomenal production increases both on a unit area and on a per capita basis which have been achieved in these areas in recent years, however, have led us to feel that developing technology and our ability to apply it will keep us well fed in the foreseeable future.

The developing countries, particularly in the Far East, Africa, and Latin America present an entirely different, and an alarming, situation. The specter of starvation has always been present in these areas. Since the Second World War, and up until recently, the food situation in terms of production per capita has been slowly but gradually improving. In the 1965-66 crop year, however, the per capita production fell by an average of between four and five per cent. Only the provision of food grains from surpluses in Western countries prevented widespread starvation.

The greatest opportunities for the vast increases in food production required to keep pace with world population increases lie in the lesser developed areas. Also, to achieve economic and political stability and world peace, these countries must become more self-sufficient in food production. The basic requirements of soil and climate are there. What is lacking is technical know-how in all aspects of production and in many cases the capital to effectively utilize this know-how. Both of these must be made available from the more highly developed areas.

It is recognized that mechanization alone is not the answer to the problem of world food supplies. It is equally true, however, that without the power and the proper tools to perform production operations in a satisfactory and timely way, much of the potential benefit of improved crop varieties, increased use of fertilizers, increased water availability, and improved cultural practices cannot be achieved. The purpose of this paper is to suggest areas where mechanization can contribute most to increasing food supplies in developing countries and to point out some basic criteria which can contribute to the success of mechanization projects.

IMPROVE DRY LAND FARMING PRACTICES

In both developed and developing countries, mechanization has progressed most rapidly and shown the greatest benefits under extensive rather than intensive farming conditions. The large dry land areas in United States, Canada, Australia, Argentina and in the Sudan, which approach a semi-arid status, are good examples of this. Tractors and larger machines can operate more efficiently in such areas, and relatively large and unfragmented blocks of land are owned by individuals who have the capital to purchase machines. Also, under dry land farming conditions with low and very seasonal rainfall, timeliness of operations and particularly of seeding is very important. Only with power equipment can this timeliness be achieved over the large areas concerned.

Although the basic cultural practices associated with dry land cereal farming – soil stirring rather than soil inversion type of tillage and ridge type seeding – originated in the Middle East, they have only recently been mechanized there to any degree. The modern chisel plow is really only a version of the traditional stirring plow which, without major change, has been the basic tillage tool for centuries in most of Africa, the Middle and Far East and in Latin America. The modern deep furrow dry land grain drill and the lister planter provide basically the same type of ridge seeding as did the Roman-type plow which is still used extensively in North Africa and in Spain.

Vast areas, particularly in North Africa and the Middle East, are now basically being used only for nomadic-type seasonal grazing—mostly goats. In the days of the Roman Empire these areas were considered to be the "bread basket" of the world. They have an ideal climate for dry land cereal production, and if modern dry land farming practices and machines were utilized they could again become one of the major cereal producing areas in the world. Modern dry land cultural practices and machines could do for these areas what they have done in the past 20 years for the western great plains wheat belt in North America.

One of the greatest possibilities for significant increases in world cereal production – and at low cost – would appear to be through the introduction of proven dry land farming practices and machines in these large under-developed semi-arid areas.

Only in a few isolated cases is ridging of land and planting the crop in the furrow between ridges practiced in row crop growing areas in developing countries. The practice of lister planting (planting in the furrow between ridges) has resulted in good yields and profitable produc-

tion, particularly of corn, grain sorghum and cotton in large areas in North America, where otherwise, due to low rainfall, these crops could not be grown economically without irrigation. I have never seen a lister planter at work outside of North America.

There are vast areas in the world where soil and climatic conditions closely parallel the regions in North America where lister planting has proved so successful. Many of these areas are now only used for marginal grazing. They offer great opportunities for very significant contributions to world food production if proven cultural practices and machines are introduced.

IMPROVE IRRIGATED FARMING PRACTICES

The advantages of planting on top of a ridge are well established in irrigated areas and in regions with a high rainfall and a relatively short growing season. This basic cultural practice, however, is virtually unknown in less developed areas – the main exceptions being Egypt and the Sudan.

There is no doubt that in many areas significant savings in irrigation water and considerable increases in yields could be achieved if this practice was adopted.

Introduction of the rather recently developed bed shapers with which sloping beds and beds with centre salt ridges can be easily and cheaply formed would also permit production of row crops on much land which, due to heavy salting, has become completely unproductive.

MAJOR FOOD CROPS FIRST PRIORITY

Rice and wheat are the world's basic food crops, together making up approximately 41% of total human food consumption. It is important, therefore, that priority be given to means of increasing the production of these crops.

Since wheat is the staple food in the developed countries, the cultural practices and machines best suited to producing high yields at low cost under varying soil and climatic conditions are well known. It only remains to apply these methods and machines to production in the less-developed areas.

Rice, on the other hand, is the predominant staple food in many of the developing countries. It is adapted well to these areas and is a very important food crop in that it approximately doubles food yield of wheat in terms of calories per acre. Its production by indigenous methods, however, requires a very great input of both manual and animal labour. It must be mechanized if the acreage is to be expanded or even maintained at the current level.

Most scientists concerned with world food problems agree that more research on cultural practices and machines for mechanization of rice production is required. Fortunately, we have some considerable experience in this area. In a number of countries, particularly Australia, Brazil, France, Italy and United States, rice production has been completely mechanized. It is worth noting also that these countries produce some of the highest yields per acre in the world. In visits with scientists working on rice production problems in the less-developed areas, however, one is impressed by the general lack of knowledge of cultural practices and machines which have been developed in those areas which have been successfully mechanized. Better co-ordination in this work would seem to be indicated.

SIZE OF FARMS

Many development programs in the past – including mechanization programs – have had as their stated objective the preservation of the "family farm" or "the improvement of the lot of the small peasant farmer". In most cases, even in developed countries, but more significantly in developing areas, these small farms of five acres or under are uneconomic units which operate only at a low subsistence level and contribute virtually nothing to marketable food supplies. They must eventually disappear and any scheme to keep them alive will, in the long run, be a losing one. They must be amalgamated into or absorbed by larger units if the land they occupy is to contribute its full food potential.

It is well recognized that the creation of larger farming units involves political issues which are difficult and slow to resolve. They must, however, eventually be resolved.

It is not feasible to try to mechanize these small farms through individual ownership of machines. The best solution would seem to have the heavy animal work done on a hire basis by local larger farmers who may not own enough land to justify the investment in a tractor and equipment for work only on their own land. This, in fact, is the way mechanization started in currently highly mechanized countries. In a number of less-developed areas, fortunately, this practice is spreading rather rapidly. It should be encouraged in every way possible.

In all developing countries, a considerable amount of the arable land is in farms in the size range suitable for economic mechanization. In India, for example, nearly 20% of the cultivable land is in holdings of 10 acres or more and the largest single group of holdings – farms of 30-50 acres – accounts for 13% of all cultivable land. This is the group which now contributes most to food production – much more than the small subsistence farms or the large estates which in many cases are operated by share cropping tenants of absentee landlords.

Farms in the 10-50 acre class are mainly owner-operated. The owners are educated people who have the intelligence, the desire and the capital to put up-to-date technological information and equipment into practice. It appears obvious that these are the farms where the most significant production increases can be achieved.

In most countries, farmers in this class are anxious to mechanize. They have failed to do so to date only because of unavailability of machines, lack of credit facilities and, most important, lack of knowledge about the selection, operation and maintenance of equipment.

In a number of developing countries, machine availability is being improved either by providing more foreign currency for importation or, where volumes permit, by starting local production. The provision of credit for machinery purchases is also being given more attention in many countries. Local governments, foreign aid agencies and machinery manufacturers are providing increased facilities for training operators and mechanics. The most important area, however, where it appears that train-

ing and advice has been neglected is in machine selection – the choice of the best type and size of machine for the size of farm and the cropping, soil and climatic conditions.

OFF-THE-FARM TRACTOR WORK

The introduction of power equipment results in a complete change in the general farm economy. Capital investment is considerably increased and a greater cash flow is required to make the investment in machines profitable. In the early stages of mechanization the returns on investment may not be sufficient to make the purchase of equipment immediately profitable if it is used only on the owner's farm.

In most areas, however, there are good opportunities for profitable off-the-farm tractor work. The most important of these are: First, heavy tillage work (work normally done by animals) on adjoining small farms. Experience has proven that the provision of tractor/tillage work by this means is much more satisfactory than by co-operatives or government machinery pools.

Second, short haul road transport work. Tractors coupled to two or four-wheeled trailers provide a very economical method for the transport of farm products, construction materials, etc. to market, processing plants or construction sites. In a number of countries, stringent road regulations seriously restrict the use of tractors on public roads–although no such regulations apply to bullock and camel carts. Every effort should be made to rationalize these regulations since as they now stand in many countries, they seriously restrict the progress of agricultural mechanization.

Third, earth moving on local land and water development projects and road and industrial construction projects. Spain shows good examples of this. In that country, one in every three farm tractors is equipped with a mounted or semi-mounted earth scraper. These are used extensively for off-season construction work on roads, dams and irrigation projects and for general land improvement. Without this off-the-farm work, many small farmers could not afford a tractor and the resulting extra productivity and lessening of heavy farm labour which it provides.

REPLACE ANIMALS– NOT PEOPLE

Most developing areas are in the tropics and sub-tropics. In these areas, animal power is much less efficient than in temperate climates. Also, a great deal of the heavy animal work–land preparation, water pumping–is required in the hottest seasons of the year. In many areas, animals, used basically only as a power source, consume up to 25% of the crop which they work to produce. This is a severe drain on available food supplies.

In most developing areas, farm work is quite clearly divided between that done with animal power and that done by human labour without the aid of any other source of power. This division is basically as follows:

Animal power

- primary tillage and soil preparation
- water pumping for irrigation
- threshing
- transport
- land development – levelling, ditching, small dam building

By hand

- seeding and planting
- weeding
- harvesting
- seed cleaning (winnowing)

Most operations which are normally done completely by hand can be done very efficiently in this manner from the standpoint of effect on quantity and quality of crops produced. In most cases they are not strenuous jobs and so women and children can and do assist in them to a large degree. Labour is plentiful and cheap and since in most cases there is little other profitable work that these people can be transferred to, there is no point in replacing them with machines – at least at the start of a mechanization program.

The exact opposite applies to work normally done with animals. Practically without exception the work done by animals is not satisfactory from the standpoint of either quality or timeliness – both of which can seriously affect crop yields. Also, the heaviest manual work is that involving the use of animals.

Work animals are of little use for either milk or meat. The objective should, therefore, be to replace them with mechanized power units. When this is done, however, equipment must be planned which will allow the replacement of animal power in *all* operations normally done by them– or the animals will still have to be retained.

A study conducted in Egypt provides a good example. This disclosed that in the Nile delta area, approximately 50% of animal work hours were used in pumping water for irrigation. Tractors could not completely replace animals, therefore, until simple, low lift, portable, tractor-driven pumps were made available.

Few farming enterprises, even in developed countries, can afford the luxury of both tractor and animal power. The success of any mechanization program depends to a very great extent on the provision of equipment which will permit tractor power to replace animal power on *all* jobs normally done by animals.

SELECTION OF EQUIPMENT

The farmer in less-developed areas, when purchasing his first tractor, faces a completely different and much more difficult problem than his more fortunate counterpart. Before purchasing his first tractor, the western farmer usually had been doing his work with at least two and more often four quite strong horses; and he had a complete set of tillage, seeding and harvesting machines to utilize the power of these animals. With his first tractor he usually purchased only one implement, most often a plow. In most cases, however, he adapted all his existing horse-drawn equipment for use with the tractor and thus with a low investment in implements he was able to use his tractor for all production operations from primary tillage right through to harvesting and transport of his crop to storage or to market.

Compare this with the position of the farmer in the lesser-developed countries. When he purchases a tractor, his existing implements are all of the two bullock or one camel size and usually consist only of a wooden plow, a wooden plank for smoothing

and a bullock cart. If he is in an irrigated area he will also have some type of animal-powered water lifting device. None of these indigenous implements are suitable for operation with a tractor. Also, remember that his wooden plow was a multi-purpose tool which he used for primary and secondary tillage, seeding and inter-row cultivation. It required no spare parts other than a locally forged point. It had no adjustments, required no lubrication and needed no tools whatsoever to maintain it.

When he purchases his first tractor, the farmer in these areas can usually afford only one implement and he wants that implement to do everything that his wooden plow did—and more and better. Also, from the standpoint of simplicity, ease of operation and maintenance, he wants it to approach the wooden plow as closely as possible. These are not easy requirements to meet but the closer an implement comes to meeting them, the greater possibility it has of success, particularly in the early stages of mechanization.

In cereal-growing areas in the less-developed countries, the implement which has been the most successful and, incidentally, which meets the requirements noted above very closely is the heavy-duty tine-type cultivator. It is probably the simplest machine one could imagine, from the standpoints both of design and operation. It has no moving parts, requires no lubrication and the wearing parts —the point or shovels—do not require frequent replacement and when they do they are low cost and usually can be fabricated within the country.

If designed on a tool bar principle, the tine spacing can be altered for different types of tillage or for row crop cultivation. The tines can also be equipped with ridging shovels to form ridges for row crop work. A number of manufacturers also provide seeding attachments for this type of tiller which, while not equalling the performance of a grain drill, do provide a very significant improvement over indigenous methods of seeding—and at a low cost.

In row crop areas, and particularly with crops such as sugar cane, corn, sorghum and cotton, where heavy stalk and root growth must be handled, offset and one-way discs have proved to be probably the most successful multipurpose tillage tools. Seeding attachments for this type of machine are also very satisfactory in many conditions.

Where row crops are grown under irrigation, the sled-type tool carrier/bed shaper/cultivator is a tool which closely meets requirements and which could do much to improve yields and economy of production in these areas.

In the harvesting field in many areas there is a place for combines. In most cases, however, they must be operated on a contract basis and, due to the multicropping pattern in a number of areas, in order to permit maximum utilization and thus economic ownership, they should be able to handle a wide variety of crops such as wheat, sorghum, rice and corn.

In many areas where it is very difficult for a combine to work there is a real need for a small tractor-mounted thresher which could be operated on a contract basis. A satisfactory machine of this type does not appear to be commercially available.

Discussion on tractors has purposely been left until last, first because the extent to which a tractor can be economically used depends entirely on the types of implements which are available for use with it. Secondly, most published material on mechanization in less-developed areas has concentrated on tractors with little consideration for the types of implements to be used with them.

The most controversial point regarding tractors for developing countries seems to be related to size. It has been suggested that a small simple tractor, stripped of all the so-called luxury features, is the answer. All major tractor manufacturers have devoted considerable time and money to this matter. Most agree that a tractor in the 30-40 hp class is the most suitable size over the widest range of conditions. Certainly a less costly machine would be desirable in both developed and developing areas —but not a lower-powered or less sturdy one.

Because of the usually greater soil resistance in tropical areas, the rougher ground conditions and the abuse that tractors are subjected to by inexperienced operators, they really should be more robust and powerful than is required in developed areas.

The cost per hp is also inherently higher for a small hp tractor than for a larger one. Also, the stripping of a tractor of the so-called non-essentials such as self-starter, comfortable seat, etc. does not significantly lower the cost. Moreover, most areas demand these features—including 3-point hitch, hydraulic depth control, and so on.

It is well known that the secret of low cost for tractors, as in most other items, is volume production. It would be difficult for any manufacturer to achieve sufficient volume in a tractor in the 10-20 hp class to allow production methods which would result in low enough costs to make such a machine economically attractive either to the manufacturer or the consumer.

SUMMARY

1. In less-developed areas, the introduction of new and proven cultural practices can contribute greatly to increased food production. Power equipment is required to put these cultural practices into effect.

2. More research on basic cultural practices is required to keep pace with and to effectively utilize developments in plant breeding, fertilization, pest and weed control, etc.

3. Mechanization can contribute most to increased and low cost food production in the following areas:

(a) semi-arrid cereal growing regions.

(b) irrigated row crops.

4. Priority should be given to mechanization of the world's major food crops — wheat and rice.

5. A need for increased research on cultural practices which permit economic mechanization of rice production is indicated.

6. Mechanize first to replace animals—not people.

7. In machine selection for newly mechanizing areas, the most important considerations are: multipurpose capabilities, simplicity of operation, lack of need for adjustments and low maintenance requirements.