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THE MULTI-FARM USE OF AGRICULTURAL MACHINERY: AN EFFECTIVE APPROACH FOR BRINGING MECHANIZATION TECHNOLOGY TO SMALLHOLDER AGRICULTURE[1/]

By

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First of all, we are pleased that FAO has again chosen a subject for discussion at this Third Session of the Panel that is both timely and useful; that it has continued (thus far) to stay away from such cliche-topics as 'appropriate' and/or 'intermediate' technology, which are currently popular among academics and international civil servants and which have pervaded much of the recent fora dealing with agricultural development within the Third World, particularly with regard to farm mechanization. Unfortunately, such slogans (appropriate technology) offer little more than a conceptual framework for generally describing the development/utilization of technology (in this case, mechanization technology) in ways that meet certain macro, socio-economic objectives; it offers few, if any, operational guidelines for applying technology. Multi-farm use of agricultural machinery, on the other hand, is not just a concept but a practical means of effectively and efficiently organizing and employing such technology, not only to the benefit of overall society but also, and more importantly and fundamentally, to those that apply to - the small, LDC farmer.

I. Introduction and Purpose

Consequently, although the general topic of appropriate technology, is not the subject of this paper it does address one of the more effective ways of putting mechanization technology to practice in support of agricultural development - namely, the mechanization of small-scale agriculture through the multi-farm use of agricultural machinery and equipment. In so doing, the paper first outlines the various systems of organizational forms by which the multi-farm use of agricultural machinery can be achieved; secondly, it identifies and examines the benefits from, the justifications for and the trade-offs among these different modes of shared-equipment use. Thirdly, the paper reviews a cross-section of country experiences involving several of the more commonly employed systems, concentrating mainly on the various organizational and institutional arrangements by which such utilization has been promoted, encouraged and/or achieved.

Thus, in analyzing and evaluating these alternative systems, the paper also identifies the major difficulties and problems of each, revealed by these experiences, as well as some of the absolute and relative advantages/disadvantages of observations and recommendations relative to employing this method (multi-farm use) of bringing agricultural mechanization to bear more effectively upon the improvement of developing-country agriculture; and, it concludes by emphasizing that 'custom hire' and 'neighborhood

hire' arrangements have not only been the most effective but offer the best choice, in most instances, for achieving this goal, especially within the small-farm sector of the majority of developing countries.

1. Defining Multi-Farm Use.

Our understanding of multi-farm use is - any means whereby more than one farmer uses the same piece of equipment, whether it be manual tools, animal draft implements, tractors, and/or associated equipment. The intent behind this general utilization arrangement being to enable the use of larger scale equipment which has been shown to be both technically more effective as well as economically more efficient, by more fully employing its greater utilization-capacity and, thus, lowering both ownership and operational costs to users as well as owners. Also, as will be further elaborated upon later, this approach (multi-farm use) actually makes mechanization services accessible, especially to the smaller farmers, in situations where it would otherwise not be possible, because of technical, financial and/or institutional deficiencies.

Under this definition, multi-farm use is already being applied in agriculture worldwide, from the simplest manual implements to the most sophisticated (agricultural aircraft) mechanical equipment. The following review also indicates that the multiple farm use of machinery has had and will continue to have an important place in increasing agricultural production, especially in the developing countries where the role it plays changes with the level of economic/technical development achieved. These experiences also reveal that in most instances implementation and operational difficulties tend to be greater than conceptual models associated with various modes of multi-farm use would indicate. This has rather important implications, which are pointed out later, for those attempting to put any of these systems into practice.

As will also be pointed out, the success of mechanization depends upn many factors; foremost of which would be the choice of a well-suited insitutional arrangement for delivering and supporting the required services, as well as for implementing this choice with reasonable economy and efficiency. Neighborhood help and farmer exchange of labor, tools and implements are traditional means of achieving multi-farm use in the rural sector; farmers and farm families help their neighbors who, in return, help them carry out various crop production and other farming operations. Thus, it can be said that the concept of multi-farm use is a customary practice that is wide spread. Moreover, in its rudimentary form, it requires little or no special planning or organization. It is not only broadly acceptable but occurs spontaneously, almost as a social function; and, in some cases, it actually has its roots in social custom. However, as we shall see, good organization and management become cruicial to its success under more advanced and complex arrangements.

2. Distinguishing Between Organizational Forms.

Broadly speaking, the alternative institutional arrangements by which the multi-farm use of agricultural machinery can be organized and provided are two types:

(a) Those supported and operated by public (government) funds; and

(b) Those developed and run as a result of private initiative and financing.

The former consists of two subcategories, including such organizational arrangements as (government-owned) Machine Tractor Stations (MTS), which provide only machine services and are separate from other types of services such as farm management, and those that usually combine several types of services (i.e., cooperatives, communes, collectives and state farms) all of which are most-often associated with more socialistic forms of government, although cooperatives are common to the free-enterprise system as well.

Under the private sector category of machine-service arrangements, neighborhood hire (farmer contractors) and custom hire (private contractors) are the two principal forms; however, cooperatives with public and private support also have potential. Variations of these basic arrangements, which also provide for multi-farm use, include the exchange of different implements and tools between private owners on a planned basis (machinery rings); the organized exchange of actual machine-services among farmers, with payment in cash or kind; and, the less-formal or ad hoc provision of one farmer helping another. Obviously, just as the latter is really only a form of custom work, it would for several reasons be a mistake to view these various alternatives and modifications as discrete or mutually exclusive options.

In the first place, the dividing line between these different systems tend to blur. Private ownership and custom work blend together and custom work is virtually identical to the simpler forms of machinery cooperatives, such as the machinery circles. Secondly, it is clear that no one system is best for all the diverse agro-economic conditions that exist, even where a distinction can be made between irrigated/rainfed, high-rainfall/low-rainfall or intensive/extensive farming systems. Thirdly, international experience demonstrates the central importance of matching the delivery system chosen to the level of development that has been reached. In fact, one is tempted to speak of a succession from one system to another as agriculture develops technically and economically. Thus, custom work tends to give way to private ownership, with a transformation of government tractor services to collective ownership, as agriculture becomes more advanced and/or integrated.

II. EXPERIENCES UNDER VARIOUS MULTI-FARM USE SYSTEMS

The success of any mechanization scheme depends on several factors, including both the choice of well-suited institutional arrangements for delivering and supporting the required mechanization services and the task of implementing this choice with reasonable efficiency. In this section, a few of the principal institutional-options available to any country wishing to promote the multi-farm use of agricultural machinery are examined by reviewing some experiences that have been documented on a country basis. This includes the identification of some of the problems that arise and which can be generally associated with these alternative organizational forms.

1. Cooperatives

The cooperative structure has been and remains a popular organizational form among developmentalists, particularly with regard to agricultural and/or rural development. In practice, unfortunately, cooperatives rarely provide the miraculous cure that many social theorists have hoped-for; and, this has been particularly true in the case of cooperatives for the provision of agricultural machinery services. Cooperative-use of farm machinery has had very limited success, and even less so within the smallholder section of developing agriculture, where it is most often prescribed.

Granted, under such a (small-scale) size structure, some type of group (cooperative) ownership of machinery may be essential, in order to raise capital to purchase farm tractors and associated equipment. However, need alone does not lead to success. In fact, the more successful cooperatives sytems seem to be organized along family lines. Cooperatives require a relatively high level of organization and management, which is often unavailable or inadequate in the smallholder agricultural sector. Lack of success also relates to the fact that many farmers are inclined to think only in terms of their personal benefits (those to be derived from the cooperative association) and are not willing to share the responsibilities and risks that must also be assumed. The following is a brief review of a couple of country experiences with mechanization though cooperatives that point out some of these difficulties and provide some insight into the problems (and benefits) associated with this type of organizational structure.

(a) The Comilla Project in Bangladesh can serve as one good example. The system was set up on a two-tiered basis, with village cooperatives as the base, with a local federation of cooperatives composed of a council of elected representatives. The cooperatives provided credit and access to mechanization services. At one level a station, complete with repair and

training facilities, sold services to the local cooperative. It operated separately from other federation activities and had a professional manager from outside the area. The principle services provided included plowing, irrigation and transport.

Generally, the undertaking was not successful for several reasons, not the least of which was the inability of the mechanization station to cover its own costs, requiring continual excessive subsidies from outside or from other cooperative activities. Trained operators willing to cooperate with local farmers were unavailable and hard to supervise once obtained. Spare parts shortages, inappropriate equipment, and repair delays were all common. Training of local operators and mechanics proved only a partial solution.

The Comilla experience illustrates other common problems with cooperatives relative to their management.

(i) It proved impossible to maintain a cooperative for several years without constant outside supervision. Despite management assistance that was generally judged to be above average (potential) many of the individual cooperatives suffered from incompetent local management; and, even the more successful cooperatives tended to slide into dormancy after two to three years. This is perhaps the most persistent problem of cooperatives, regardless of setting.

(ii) Experience in similar instances have also shown, that cooperative tend to come under the control of locally-powerful individuals, who dominate them. Whether this dominance is based on larger landholdings, community leadership or political affiliation, it frequently results in a disproportionate share of benefits going to one or a few of its members. Thus, though the cooperative may appear to be functioning smoothly, it is not fulfiling the important function of giving wide-spread access to new technology and inputs.

(iii) Where cooperatives are set-up by the government or a quasi-governmental agency such as in Comilla, coordination between the cooperative group and other agencies active in agriculture often poses severe problems. Cooperatives are generally channels for the provision of services, rather than the direct providers. Integration of cooperatives and organizations such as credit banks, importing authorities, etc., is crucial to success. Where cooperatives are set up within a semi-autonomous framework (at least from the point of view of other agencies), such as a national federation, rivalries may develop over who controls the farm equipment.

(b) The Farmers Association (FAs) in Malaysia provide another example. These associations (cooperatives) are rather new and are continuing to develop. Many of them have or are attempting to provide mechanization services to their members, services which have encountered a lot of difficulties, including:

(i) lack of organization and management experience;

(ii) lack of incentives and ability to maintain and utilize the equipment; and

(iii) inability to collect charges for services rendered (farmers do not feel the same responsibility to make payment for services rendered by cooperatives or government as they do for privately-owned services).

Farmers Association in Malaysia are indirectly subsidized (grants in kind, government employed staff, etc.), however, such experineces are not unique, but representitive of that which has taken place within the smallholder agriculture sector of many countries. Cooperatives, government services, and services of large marketing firms have all suffered similar financial and mangement problems in trying to provide mechanization services, whether in Thailand, Kenya, Uganda or other countries such as Malaysia.

(c) Benefits Claimed for the Cooperative Approach to Mechanization include:

(i) Cooperatives are seen as a way to achieve an economic scale of operation without changing the land tenure system or the fundamental organization of society. The land base necessary for efficient use of machinery can be achieved, without combining other management or agricultural operations, where economies of scale do not exist or traditional/political factors are not favorable for this change. In this way, the often severe fragmentation of small holdings can be overcome and the benefits of modern technology more easily applied.

(ii) Cooperatives encourage the adoption of innovations by sharing risk and increasing communication, both among farmers and extension agencies. Experience has shown that a group is often more willing to make a change than its individual members acting alone.

(iii) Cooperatives provide a vehicle for pooling resources to achieve the "critical mass" needed for modernizing investments such as purchase of machinery.

(iv) Cooperatives, in the eyes of the central government, help mobilize the peasantry, even outside the scope of the cooperative. A well-disciplined federation at the national level can be a valuable tool for controlling agricultural production and monitoring rural conditions.

2. Government Mechanization Services

Various forms of mechanization services provided by governments exist, including machinery pools, collectives and communes, the latter two most-often being associated with more socialistic forms of government. And, although mechanization services for soil and water conservation, and to a lesser extent for crop production, have been utilized in numerous countries, the machine tractor station (MTS), which is essentially a special form of machinery pool, has been the most widely used government system for providing mechanization services and will serve to exemplify this form of organizational structure.

Government-owned machine tractor stations are facilities whose function is the provision of machinery services for agricultural production activities. The machinery is owned by the Stations and the MTS staff (usually government or quasi government) operates and maintains it. The MTS does not own land nor is it ordinarily involved in land management decisions. Generally, the MTS contracts with the insitutions owning and/or managing the land (collectives, communes or individual farmers) to perform specific agricultural machine-operations; payment for such services may be either in cash or kind, sometimes specified as a share of the crop.

The MTS was first developed in the Soviet Union in the 1920s, as an adjunct to the Kolkhoz (collective farm) system. Subsequently, institutions direcly modelled on the Soviet MTS were set up in China as well as several other countries, including Africa. Similar insitutional arrangements for providing agricultural machinery services have also been developed in Australia, Malaysia and elsewhere. The principal, hoped-for advantage of the MTS is the realization of economies of scale in mechanization. Even where farms are quite large (as in the case of the Soviet Kolkhoz) it may be difficult to use larger machines efficiently within the context of ownership by individual farm units. A shortage of trained operators and, especially, shortages of capital availale to individual farm units are also the usually-cited reasons for adopting an MTS strategy.

The MTS also permits the direct mobilization of government resources for the purpose of improving agriculture performance, as well as increasing the ability of government to control the development of agriculture. These goals are realized through the collective MTS contract, which specifies the types and timing of operations and, therefore, determines the crop mix and the production technologies employed. In terms of control

of outout, by accepting payment in kind, a large share of the total output is paid to the state, ensuring a reliable flow of needed coomodities. Through such centralization and specialization, it is also generally hoped that the adoption of new production practices and the use of output-increasing techniques and inputs will be accelerated.

However, in practice (for the most part) the MTS has never lived up to its theoretical potential. The Soviet experience was so unsatisfactory that the MTS was abolished in 1958, with the machinery and work force turned over to the Kolkhoz. The Chinese have had a similar experience and the tractor stations have tended to evolve into selfcontained communal farm systems. In Ghana, the MTS was done way with in 1965, after only three years of operation. Tractor stations or machinery pool successes are hard to find.

(a) Four main problem areas can be identified, including technical difficulties, managerial inefficiencies, personnel problems and MTS-client relationship troubles. These are briefly reviewed and discussed below:

(i) Technical problems are the most basic but not necessarily the most difficult to overcome. The mismatching of agronomic needs and the chosen technology is a common problem and derives from insufficient agronomic information (soil type, optional plowing dates, depth, etc.). This, in turn, leads to the inefficient use of machines, high down-time rates, poor quality of work, and poorer yield results than anticipated. When plots are small and have not been consolidated and work has not been well organized, high turning-time and greater travel between plots results in high operating costs.

Location and size of the MTS relative to its users can pose a problem. The average Soviet MTS served about 16,500 ha; however, the Chinese concluded that 3,000 ha (a 3-km radius) was about the maximum that could be effectively served. Certainly, too large an area leads to a high proportion of time in unproductive travel, while too small an area may leave unused capacity in certain machines. Thus, there is the inherent problem of transforming a physical stock of goods at a specific (fixed) location into an efficient service-flow at a large number of distant and widely dispersed sites. Experience with the Tractor Hire Service (a government machinery pool) in Kenya indicated that only about 70% of the tractor hours were productive time even in a well organized smallholder system. This problem is further exacerbated by the distances involved when the former is located off-farm.

The seasonal nature of agriculture also combines with the specialized nature of MTS services to create excess capacity during part of year, both in terms of wage-labor as well as capital. This can be dealt with, in part, by mechanizing other operations or finding off-farm use for the machinery; but, these are usually partial solutions to the basic problem and not completely satisfactory.

(ii) Managerial problems further magnify the technical difficulties sketched-out above, which result in higher costs, loss of efficiency and a generally lower quality of services. In fact, despite the promise of greater economies of operation offered by MTSs, in practice government subsidies are usually required to maintain services. While such practices are not necessarily a sign of inefficiency, especially in countries where the prices of most commodities are controlled, judging from assessments made of these systems by their own country-experts, operating costs are often well-above that budgeted, and expected management efficiencies.

Other problems relate to the variety of machines that are sometimes purchased from a number of countries, this leading to spare parts shortages, training deficiencies and even more severe mismatches between agronomic conditions/requirements and the technology being used. Bureaucratic complexities in ordering, importing and obtaining replacement parts under such systems tend to be great, resulting in increased down-time and delayed/untimely field operations. Often, the chain of command between agricultural ministries and the authority controlling the MTS is confused and subject to controversy. Also, the sheer number of stations and machinery required to effectively service an entire country (the scale on which they are usually established) demands a level of organization that often exceeds the capability of the developing country.

(iii) Personnel/Staff problems are another source of difficulty. Beside the general shortages of trained people in developing countries, both technical and managerial, there is the particular lack of staff with experience and/or training in organizational and operational skills peculiar to MTS systems. Moreover, there is often a countrywide shortage of trained technicians and people willing to work in rural areas. Thus, special training programs are necessary, which add to the cost and do not guarantee that trained staff will not leave for urban jobs, once experienced; the training of local labor provides only a partial answer to the problem.

The difficulty of maintaining supervisory personnel in the field also leads to low productivity, while more comfortable, home-office jobs tend to multiply. In China, for instance, the 4.5 people (already high) required to maintain and operate a tractor in the 1950s rose to seven per tractor during the 1960s. In the Soviet Union, three to four times as many workers were used for each mechanical operation as compared to the US. Therefore, given the difficulty of factor subsitution at the level of any particular operation, this suggests that a substantial overhead is associated with the system's operations.

Worker incentives or fee rates, such as sometimes used, also lead to low-quality work with the subsequent loss of any yield advantages gained by mechanization (i.e., deep plowing). Conversely, time-based rates encourage inefficiency unless workers are well-supervised. When yield and quality of mechanized work are closely related, yield-based incentives are possible, but these have rarely been complimented.

(iv) Customer-Service problems are, for several reasons, an inherent difficulty in MTS- type operations, as well, whether their clients are communes or individual farmers. Relations between MTSs and their customers also tend to be strained. For example, even though one of the principal reasons to mechanize is increased speed; the optional period for some operations is most often quite short. With several clients for the same service, disagreements about priorities arise. Where the client is a large unit, such as collective, the MTS and commune management teams become rivals for ultimate control. Smallfarmer clients may be unable to make their needs clear to a MTS and retaliate by failing to perform necessary preparatory work.

Other related problems, in the case of small farmers, include a fear (on their part) that the MTS' is the first step to increasing government control or outright takeover. Also, an unwillingness on the part of machinery operators to 'take orders' from untrained small farmer (the end user) lead to problems. Finally, since farms vary greatly in size, the MTS may provide a disproportionate share of its services to the larger farmers during critical periods, because it is with these larger units that greater efficiency of machine-use can be attained.

Several benefits from MTSs do exist, even though the above roster of problems paints a somewhat gloomy picture regarding the suitability and/or workability of Machine Tractor Stations. Thus, they should not be

rejected entirely as a viable mode of providing machinery services to agricultural producers. In fact, many if not most of the problems cited above are as much a product of the state of underdevelopment as that of the MTS appraoch itself. Moreover, as with most of alternative modes, including custom hire, any attempt to rapidly mechanize where the needed infrastructure, trained personnel, agronomic information and other crucial inputs are lacking will likewise run into difficulties.

Similarly, the bureaucratic problems of overstaffing government insitutions, quality control and incentives are endemic to developing countries, and to most developed ones as well. Any system involving heavy government intervention in likely to suffer from a variety of difficulties; and, early recognition of such likely points of weakness are necessary, if effective counter measures are to be taken.

Finally, however, while the above cited problems associated with the MTS, have prompted governments to search for alternatives, it should be noted that the use of such system (generally in the form of cooperatives; collectives or communal farming systems) already implies some level of development and some experience with machine services, whereas the MTS appraoch does not. Thus, it can not be concluded that one of these other, (on-farm) approaches should have been applied from the start or that it would have succeeded any better.

The MTS arrangement does concentrate scarce resources (capital and labor); it does absorb the risks of innovation by producers; and it does assume/serves important educational functions during early stages of mechanization. These features, together with the greater government control it affords, will continue to make it a viable and almost inevitable choice in certain situations and circumstances.

3. Individual Ownership Arrangements and Systems.

Ownership of machines by individual farmers may extend from the simplest wooden plow to sophisticated harvesting equipment. Advocates of the market approach argue that the private profit motive will lead to the adoption of the optimal technology within this broad range of machinery and tools, if the government will only allow the market to operate freely. Such a strategy has been pursued (albeit unconsciously) in the United States and most of the western world, with generally favorable results.

The approach has several advantages. First, government expenditures are minimized; the government need only carry out its research and extension functions and ensure that rural markets, particularly those involving pricing and credit, are functioning well. It should be stressed that this is not by any means any easy task. Second, individual farmers make the decisions as to whether a given technology should be adopted (there are no private equivalents to the MTS, that do not have to meet its own

costs of operation). Third, private machinery manufacturers, importers and agents compete in the development and dissemination of new technology, reducing the need for government activity in these fields.

(a) Custom Hire (pure contractors) provide one form of individually owned systems for multi-farm use. In those developing countries with a free market economy, many entrepreneurs are discovering that providing farm mechanization services is a good business. This has been a common practice in Europe and North America for 30 years or more, most notably with the combine brigades of North America. These brigades did, and continue to, fill a need for a mechanized activity that requires a large capital investment for a very brief seasonal operation-period. A farmer with 200 hectares of wheat would have to invest $50,000 in a combine and associated harvesting equipment to harvest his crop; an activity that might last ten days. A custom operator with a fleet of combines could harvest the farmer's wheat in 3 or 4 days for perhaps $10,000. The advantage to the farmer is that not only does he not have to tie up his capital in harvesting equipment, neither does he have to be concerned with maintenance and operation of the equipment as well.

A similar situation exists in the small holder agriculture system of developing countries with regard to seedbed preparation. Seedbed preparation is not only a brief seasonal activity but also a laborious task requiring a high power-input. The typical small farmer with 1 ha wet-rice paddy land (to prepare) would require more than 10 days to plough (at least twice), puddle, and level using a draft animal. If he plans to tractorize his operations he can consider a single axle tractor costing $3,000 that would prepare the 1 ha in three days; but then he has to invest his own capital, assume the risk of ownership and operation; must develop the skills to own, operate and maintain the equipment. He also must have the managerial skills to provide sufficient service to his neighbors to defray the cost of ownership and operation. All of these are requirements far beyond the means of most small farmers.

Some would say that he should continue with more labor-intensive means of production, but perhaps he is getting old and can no longer follow a draft animal for 125 km (per ha) in difficult paddy conditions, or he is simply wants an easier way for himself and his family to prepare his land. Now, with customs hire services becoming more prevalent, the farmer can have his one hectare prepared in 3 or 4 hours at a cost of $40 to $50; an obvious bargain in comparison to the alternative of owning his own source of power. Local entrepreneurs are stepping in to fill this demand for land preparation. With a 60 to 70 hp four-wheel tractor, rotovator and perhaps a trailer, a contractor can hire

out his tractor and equipment to prepare 200 to 300 ha of land per year in a multiple cropping system. In Thailand, for example, it has been estimated that contractors operate their tractors, 1,350 hours per year serving about 260 ha; in the Philippnes, contractors operate nearly 1,500 hours per annum servicing more than 275 ha each year. Some owners manage to achieve this output with one operator, while others may use two operators, working 12 to 16 hours per day during the peak land preparation season.

(b) Neighborhood hire, whereby a farmer purchases machinery with capacity in excess to his needs and proceeds to hire out that excess capacity in his community, is another common and widely accepted form of multi-farm use. For those farmers interested in tractor ownership, who do not have a large farm, the potential for providng mechanization services to their neighbors has made it financially feasible for them to purchase technically optimum size tractors and associated equipment. This system has the advantage that the owner is often the operator and the owner feels a responsibility to his community and his neighbors; thus, this provides the essential added incentives to do a good job at a fair price.

In the Philippines, it has been estimated that 70% of the four-wheel tractors are owned by individual farmers who also work for their neighbors; 20% are owned by farmers (many sugar growers) exclusively for their own use, and, 10% are owned and operated solely for the purpose of hire (custom operators). In Thailand, more than 60% of the four-wheel tractors are owned by farmers who also do work for their neighbors. Each farmer-owned tractor may serve 35 to 40 farmers (usually limited to land preparation of part or all of their holdings).

Single axle tractors, including the power-tiller (unit with an integral rotovator for land cultivation) are also used for neighborhood hire; however, the percentage of units used exclusively for the owner would be much higher. Chancellor found in Malaysia (a country with rice farmer holdings averaging less than 1 hectare), that single axle tractors used for hire served an average area of 27 ha operating about 400 hours per year. In the Philippines, it has been estimated that a power tiller may service as much as 35 ha per year.

4. Other Organization Forms.

Obviously, many variations of the several general types of organizational forms discussed above can be cited. In addition, a few remaining distinct forms also deserve mention. Following a brief discussion of a few of these.

(a) Machinery Rings (circles) are one step removed from cooperative ownership and offer one solution to the need for a level of mechanization that a small-farm structure does not readily permit. They are excellent means of organizing multi-farm use of equipment, by pooling excess machinery capacity and making equipment (rather than the service) available to others. As a result, farmers are able to distribute the cost of ownership and operation. The Rings function as clearinghouses for the sale/purchase of available and needed machinery capacity. Where they are organized through banks or credit cooperatives, the institution frequently handles the accounting, providing automatic payment. Machinery circles provide information about machinery availability and specifications, and thus lessen the need for entrepreneurial ability on the part of the machinery provider (owner).

The use of this system appears to be unique to Northern Europe and possibly a few other countries; it, however, has not been applied in smallholder developing agriculture. The system does have limitations in that it requires:

(i) a degree of trust on the part of all members,

(ii) experienced and qualified users, and

(iii) a high level of organization and management.

Thus, it requires a degree of sophistication yet to be developed in most smallholder agriculture areas.

The Government of Pakistan provides a similar service whereby Agricultural Engineering Workshops hire out government owned tractors and associated equipment to farmers for land preparation and specialized operations such as land leveling and soil conservation. Farm machinery rental and lease (usually by farm equipment retailers) is also a common private sector business in developed countries.

(b) Informal Machinery Pools are another form of joint/private ownership wherein there is an agreement (usually informal) among a few farmers to each purchase separate types of equipment so that collectively the group has the machine capacity to handle the common needs of the group. It is a form of cooperative and yet a type of custom work, as there may be exchange of machine services as well as the common use of a privately-owned machine by the various members of the group. Payment may be strictly on an exchange basis or it may involve actual cash or in kind transactions as well. It is similar to a machinery ring but much less formal in structure and operation; however, like the 'rings', this arrangement also requires a high degree of trust among members, as well as experiences in the use of the equipment being exchanged.

(c) Collectives, Communes and State Farms are in a class of organization most-often associated with socialistic and/or centrally-controlled forms of government, but which can also facilitate the principle behind multi-farm use of agriculture machinery. However, basically, these organizational forms are established for the purpose of production rather than to provide machine services. Moreover, they are only 'multi-farm' in the sense that such an arrangement is a deliberate alternative to organizing the large number of small-holders that might otherwise exist; and thus, overcomes the associated difficulties of trying to effectively mechanize agricultural production under such a structure of small-farmers.

These three distinct forms of group-farming have many common features and, in general, differ primarily from each other in terms of the way ownership of land and other assets are handled, and the position of the farmer relative to these resources and inputs. However, with particular regard to farm machinery, in each form it is owned by the unit as a whole, with management of it, and that of the machine/equipment services provided, unified as well. Thus, in those cases where such units do own and operate their own farm equipment (as opposed to hiring it from an MTS), they usually do so in hopes of integrating machinery management with other management issues. Such units are also usually large enough to utilize large equipment at economic levels. Likewise, the potential exists for cost-savings by locating the machinery unit on the farm itself.

The Chinese have had considerable success in developing an efficient collective or commune-type farming system, including the integrated management of mechanization. This success has been made possible by compeling and urgent national interest. The system combines some of the advantages of the free enterprise and socialist commune systems by providing worker (member) incentives and operating many small farms as a collective large sale farm. Managers are elected by the members and are elected and/or re-elected on the basis of proven performance which would be beneficial to the members. Each member is paid on a points system and points are awarded for (i) hours worked, (ii) level of skills, (iii) quality of work, (iv) attitude, and (v) timeliness. If the commune is successful (has surplus earnings), a bonus is awarded to the members on the basis of their points earned each year.

(c) Others. Mexico has recently begun experimenting with a new institution; the village corporation. These are modelled on the Yugoslavian worker-ownership approach, this method involves forming a village corporation under the management of a professional farm manager. The manager makes all decisions regarding land and labor use, subject to the general approval of an elected village council. Proceeds are divided according to land and labor input. Mechanization, in the form of a village machine station with a professional

manager and mechanic of its own, forms the nucleus of the scheme. Preliminary results indicate that this method is quite effective. The problem, of course, is to obtain the agreement of the village to accept the manager's dictates and, given that, to find sufficient numbers of competent managers.

As with the MTS, the efficiencies promised by larger units do not always materialize. Especially where state farms are established in new areas, acreage targets are frequently not achieved. This results in lower usage rate for machinery, higher costs per acre and, consequently, higher costs per unit of output. It has proved far more difficult than expected to set a large unit in operation de novo, even given adequate supplies of mechanical and other inputs.

III. Summary and Conclusions

As the above review of experiences reveals, there are several mechanisms for bringing about the multi-farm use of agricultural machinery. Moreover, it is difficult to recommend any one of these organizational-forms over another, without knowing in detail the setting and situation involved; the final choice depends very much upon the social and economic system existing within the country and area in question. It also depends on the level of economic and technical development that has occured, as well as customs and cultural habits and practices. The type of agriculture, the size-structure of the production units, the extent of land fragementation and the degree of homogeneity in production-mix among farmers also bear upon the choice of institutional arrangement that will best encourage and provide for the efficient and effective utilization of agricultural machinery on a multiple farm basis.

Nonetheless, several conclusions can be drawn regarding the overall effectiveness of multi-farm use, as a way of facilitating and improving the needed mechanization of developing-country agriculture (generally) and with particular respect to the comparative strengths and weaknesses of the various organizational-forms for achieving usage. Below is a summary evaluation of the alternative approaches (by broad structural-type) discussed earlier, followed by a few conclusions and recommendations.

1. Public Financed/Controlled Systems - Only Marginally Successful

As pointed out in the previous section, under more socialistic forms of government, public financed and controlled systems of bringing about the multi-farm use of equipment may be the only acceptable organizational-form, which includes machine tractor stations, machinery pools, communes, and/or

collectives. However, as also pointed out, these systems (generally) have had limited sucess at best; and, in most instances they have failed to be effective or viable because of one or more of the following:

(a) Lack of incentatives to both users and those who operate and manage such systems;

(b) Decisions are often politically rather than technically and/or economically movitated;

(c) Difficulty of operating a ´commerical-type´ operation under government terms of service and employment;

(d) Farming is an seaasonal operation and can not be organized on a regular (40-hour week) basis or to fit bureaucratic needs;

(e) Government systems seldom achieve financial viability.

Nonetheless, government financed/controlled systems are not without some advantages, including being well-suited to introduce mechanization services where a low-level of development still exists; effective in selecting and introducing ´appropriate´ mechanization systems; and, ideal for reducing the financial risk of farmers. Larger and more specialized equipment can also usually be provided under such systems than would generally be economic under private arrangements.

At this point, perhaps it should be stressed that, even though the unregulated spread of privately-owned farm equipment would be inconsistent with the principles and doctrines of some political systems, if a country is operating under a mixed system, either permanently or even during a transitional stage, substantial control of the mechanization process may be better achieved by regulation instead of restriction or by a combination of taxes, incentives and credit controls. However, even in a mixed economy, government intervention requires institutional support, with the appropriate choice depending on government capacities as much as on idealogical criteria. In any case, the above criticisms and limitations still hold.

2. Cooperatives (both Public and Private) - Perhaps the Least Successful

While cooperatives are commonly financed and controlled by public funds and guidance, they are also organized privately under both free-enterprise and mixed economies as well. Regardless of where the control and source of financing lie, their performance relative to providing mechanization services to cooperative members has (generally) been similar - not very good. However, the reasons for this lack of success, whether private or public, are somewhat different from those (cited above) relative to other forms of public financed/controlled systems.

In this regard, although cooperatives are seen as a way to achieve an economic scale of operation as well as capturing most of the other advantages and desired benefits of (other) public financed/controlled organizational forms, they have generally proved difficult to set-up, hard to administer, and have shown a distinct tendency to wither away in the face of competition. Successful pilot projects translate only with great difficulty into healthy, functioning networks of cooperatives. Thus, while it would appear (at least theoritically) that cooperatives would offer a solution for bringing mechanization to small farmers, the very smallness of farms and the large number of them makes cooperatives more difficult to organize and manage. The problems that arise are:

(a) How do you determine who will put up how much capital?

(b) How do you share the cost of its use?

(c) How do you determine the order of use?

(d) How do you distribute the cost of repairs and maintenance? and,

(e) How do you develop responsible management and operators?

Continued attempts to implement cooperative systems in the face of this indictment stem from reasons similar to those that support the establishment of other government-controlled systems-namely, that activities undertaken in the private sector are regarded as either undesirable or viewed as being inadequate to create the necessary linkages between large numbers of small holders and what might be called agri-business. It should be noted that in comparison to machine tractor stations, cooperatives do not provide the necessary degree of centralized control. Also, while local autonomy increases the ability of the machinery service (cooperative) to respond to local needs and pressures, it conversely reduces the power of the planning agency to shape mechanization to meet nationally-determined goals.

With regard to privately-organized cooperatives (as opposed to state sponsored), because of the ´lumpiness´ of agricultural equipment and machines, one might except these factors to encourage the spontaneous organization of cooperatives around machinery use. However, while in fact there has been a certain degree of causal sharing or small partnerships in the use of machinery, generally, farmer-sponsored cooperatives have steered clear of providing machinery services. They have instead concentrated on tangible inputs, such as seed and fertilizer, etc. Though information is relative scarce on this subject, it appears that the complications of purchasing operating, and maintaining farm machinery are generally too complex for farmer sponsored cooperatives to bother with. The only exception of note is the ´machinery circles´ which have had rather good success in a few limited areas (nothern Europe).

3. Private Custom Services - The Most Successful Overall

While private ownership of agricultural equipment, by the individual farmer, has been the dominant institutional form throughout most of the developed world, supplemented by custom (contract) work by farmers or specialized firms, it is very doubtful that a purely private ownership approach is either appropriate or even feasible in many developing countries, considering their smaller holdings, greater employment needs, lack of supporting infrastructure and the (often-found), unavailability of adequate financing. Also, the wide-spread emphasis on centralized planning and the desire for smooth and rapid progress are other factors that mitigate against private ownership, as a general answer to how best to mechanize agriculture in some developing countries.

Nonetheless, private ownership of farm equipment has played and will continue to play a significant role in mechanization development in most LDCs. In fact, because custom services, through private operators, provides an institutional half-way point between purely private use/ownership and cooperatives or governmental provided services, it can offer an acceptable alternative and bridge the gap between private ownership and non-mechanization, which are often only really viable alternatives.

In fact, as noted earlier, neighborhood hire and custom hire are the most widely used and accepted systems, even though these systems also have some limitations. Their big advantage is that responsibility and authority rests with the individual owner. The system also has the following inherent advantages of flexibility:

(a) Discussions can be made on the spot to accept or reject a piece of work (both by the contractor and the recipient);

(b) If the farmer is not satisfied, he can refuse payment or, at least, refuse to use the service in the future;

(c) If the contractor does not receive payment, he can choose not to work for that individual again;

(e) The owner and operator (or operators) can arrange hours of work and days of work;

(f) The owner has direct responsibility for proper operation, maintenance and repair; and

(g) The equipment owner and the farmer-user can negotiate charges to their mutual satisfaction.

Thus, we would conclude that farm-owned ´neighborhood hire´ and pure ´custom hire´ offer the best opportunity to maximimize the number of beneficiaries of mechanization from limited capital resources.

4. Conclusions and Recommendations.

From the foregoing discussion and analysis, the following conclusions and recommendations are offered:

(a) Multi-farm Use of Machinery, as a general utilization/application approach, offers a practical and efficient way of making agricultural-equipment services readily available to smaller farmers and, thus, bring mechanization technology more effectively to bear upon agriculrure improvement efforts, especially within developing countries where increased productivity and output within their small-farm sectors is of the highest priority. Moreover, multi-farm use should be encouraged as a suitable means of extending mechanization to a maximum number of beneficiaries, as well as a proven vehicle by which increased agriculture production can be achieved.

(b) Custom Hire and Neighborhood Hire systems for achieving multi-farm use have been the most successful organizational forms, (overall), generaly offering the greatest potential, in terms of fully achieving the benefits of shared-equipment use and in bringing about the needed mechanization within developing-country agriculture, without wholesale government intervention or a major revamping of that sector's organizational and institutional structure (although this may be desirable for other reasons). Multi-farm use, through these approaches, can be accomplised while still exploiting the efficiencies, economies of scale and cost-reducing possibilities afforded by optimum machinery/equipment selection (both type and size) and its effective operation/maintenance and overall management. Furthermore, this is achieved without surrendering the flexibility, diversity and the independency of choice of the individual farmer.

(c) Debate and Concern Over Appropriate Technology, relative to agricultural mechanization, becomes a non-issue when viewed from the perspective of choosing the proper mechanism to put such technology into practice at the user-level. The type (two-wheel/four-wheel) and size of tractor and implements employed under a multi-farm use approach are relatively unimportant, in terms of farm-size or even employment-effects and capital requirements. Experience has indicated that the size of the power unit and associated equipment are relatively unimportant in relation to the size of plots or farms; and that the density of plots to be cultivated within a limited radius is far more important. Also technical constraints, quality of work, efficiency of operations and cost of operations generally favor the mid-size four-wheel tractors.

The major concern is the quality and cost of the work. Experience has indicated that purchasers and operators are the best judges of which size and type of machinery is most practical and economical; and, with small-holder mechanization continuing to be concentrated primarily on land preparation, there is little displacement of full-time labor and only minimal negative effects on part-time labor or seasonal labor requirements.

(d) National and International Forums dealing with the mechanizational aspect of agricultural development should, therefore, concentrate on meaningful solutions to bringing the small-holder sector into the mainstream of the development process, rather than endless dialogue and use of ´slogan´ phraseology. The Brandt Report (North-South: A program of Survival) places Third World, food imports at 145 million tons annually by 1990, unless greater agricultural production progress is achieved. Relieving this shortage of food by developing and exploiting the agricultural potential of the developing countries will only be possible with better management and improved technology including mechanization. The question is not whether to mechanize, but how and where to do it most effectively and efficiently. One of the biggest problems in dealing with the issue of multifarm use, and many other aspects of mechanization in developing countries, is the general lack of supporting data. Many individuals can cite examples of services they have observed and personal knowledge and experience, but these experiences are not always supported by documentation. Therefore it is suggested that FAO establish a research project (and conduct several case studies) to monitor and evaluate various types of multi-farm use in selected developing countries.

(e) Increased Energy Use in LDC Agriculture is an inevitable reality if food production needs are to be met. Fertilizers and chemicals will continue to constitute the largest single category of energy input (80% in 1972 and an estimated 90% in 1985), while during the same period the use of energy for mechanization is expected to increase more than 200%. Thus, in view of the deepening energy crisis, the relationship and problems associated with agricultural mechanization and energy demands/sources of supply/prices, including the implications of these factors on meeting food requirements, need to be thoroughly studied. The impact of increasing energy costs and related adjustments could be a topic of future sessions of the Panel.

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