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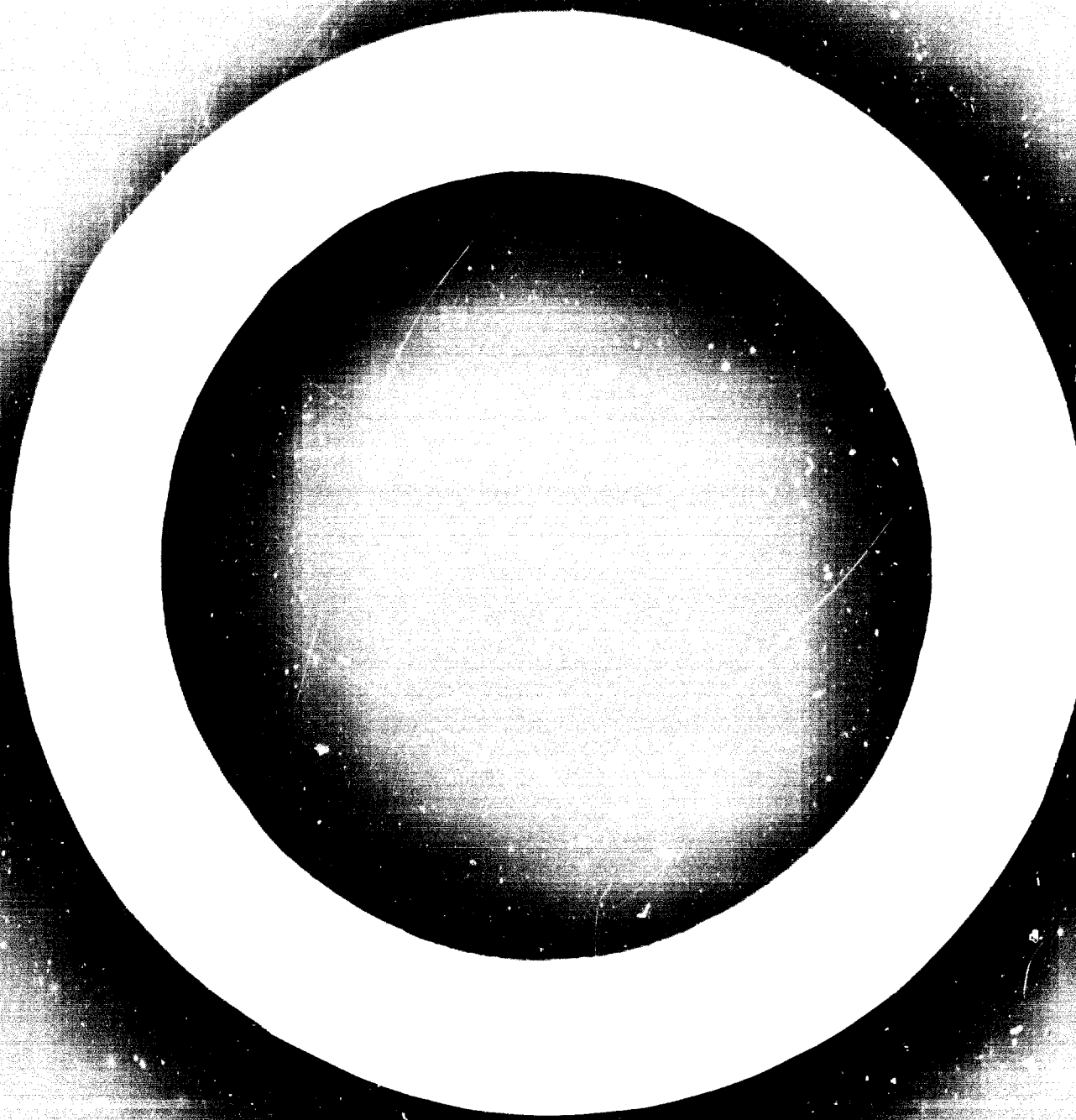
**OUTLINE RELATING TO PRESENT STATE AND PROBLEMS IN**  
**FARM MACHINERY PRODUCTION AND APPLICATION**  
**IN DEVELOPING COUNTRIES<sup>1/</sup>**

by

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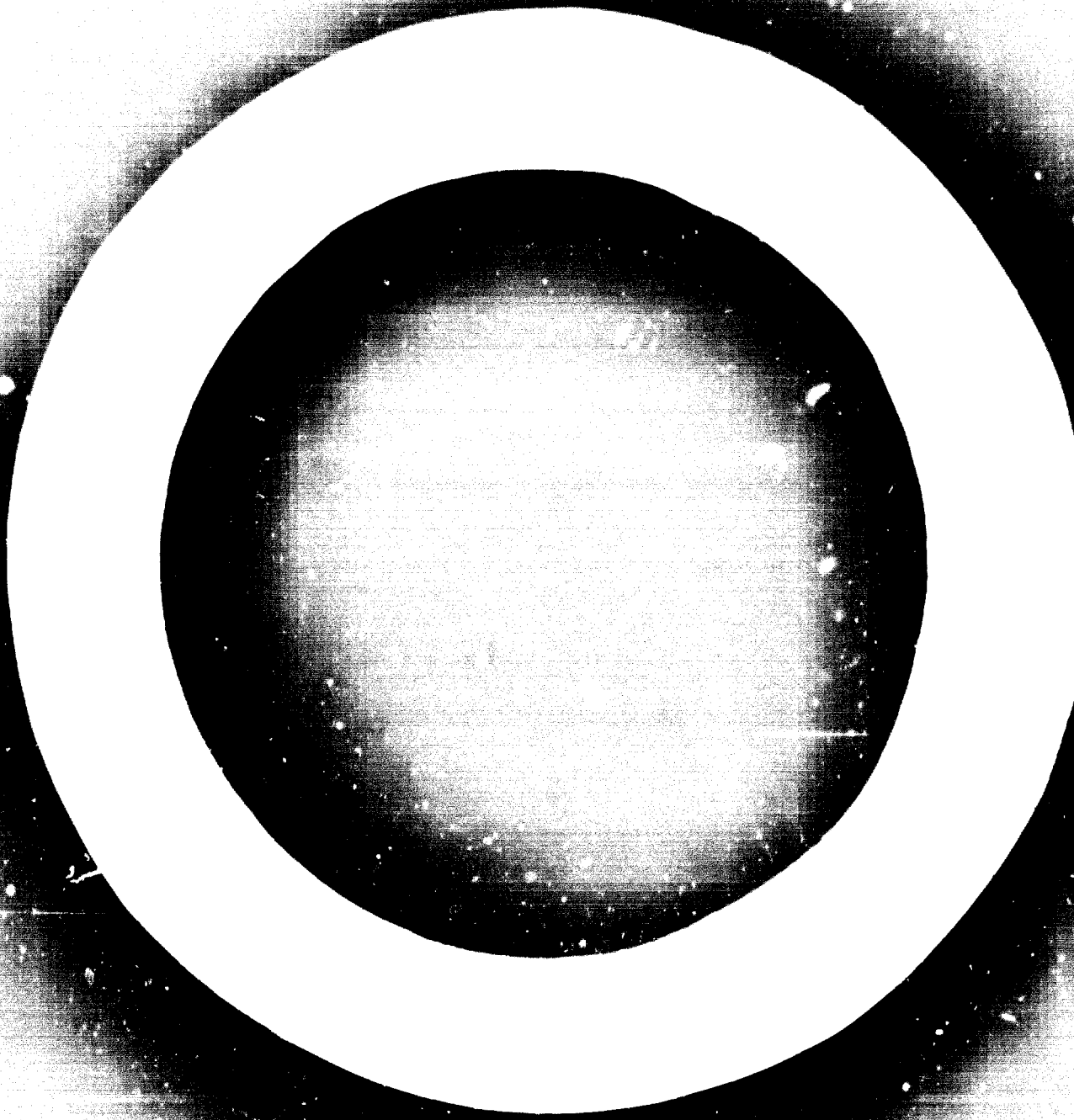
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It is conceivable that outlines like ours are not fit for direct appliance. Meanwhile, we believe that in any case they represent an alternative of possible approaches to the matter. In the case of adopting some of the standpoints exposed, an inquiry by direct contact on the spot, or by organizing missions such as the recent ECAFE one, should be provided in order to collect true data for forming definite decisions and eventual elaboration of corresponding designs.

Finally, let us remark that our concluding suggestions set down in our following introduction, might be, among others, considered as a concrete assistance, where joint interests between developing and developed countries, a fundamental principle of the UN charter proclamation, could be realized.

As our outlines raise different questions, which call for discussion, the author trusts his task will be achieved when opportunity for it is provided.

### CONCLUDING SUGGESTIONS

As our outlines carry some original suggestions relating to farm machinery production and application in developing countries, we are stating our conclusions as an introduction to it, in order to give full comprehension in advance of special approaches to the matter involved.

These are the following:

1. In order to raise their own standard of living and to normalize relations towards developed countries, the first condition for developing countries consists of improvement of their agricultural production.
2. Practice has shown that agricultural improvements either in developing or in developed countries are always subordinated to domestic farm machinery industries.
3. The introduction of modern techniques is of special importance for those developing countries, which, besides fertile land, have little other wealth.
4. The problem is not easy, but may be resolved if approached in a suitable way.
5. Our outlines show that for this purpose the minimum requirements, whether in production or in application of farm machinery, should be provided.
6. In developing countries, where industrialization has already started, respective requirements are quite special, demanding corresponding individual solutions.
7. In a number of the less developed countries, with common climate and soil conditions, especially in arid, tropical and sub-tropical areas, the improvement problems are of a common nature.
8. If these countries need and ask for urgent assistance, the priority in studying their situation should be recognized.
9. In this case, some areas and countries, such as semi-arid and paddy areas, as well as the more developed countries should be, for the moment, deferred.
10. The main concern in less developed countries should be to increase the yield and the production of their common crops, such as wheat, corn,

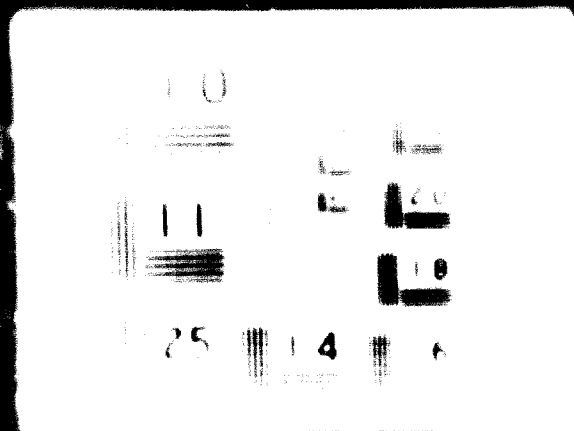


- cotton and rice (rice only in dry farming), by the use of modern standard equipment manufactured in indigenous specialized factories.
11. Standard equipment in our case means the so-called "mounted implements", carried on corresponding standard tractors, whose performance under different conditions has already been proved. Specialized factories mean indigenous small-scale plants for manufacture of farm machinery bearing several common functional and technological features.
  12. Medium and low type equipment, such as traditional manpowered tools and animal-drawn machines, which do not provide field operation improvement, should be eliminated.
  13. Our preliminary feasibility studies have shown that a successful farm mechanization can be provided in areas of a minimum of 10 ha. Larger co-operative or governmental farms, if they exist, might be also taken into consideration.
  14. Our feasibility studies have also shown that small-scale specialized factories, whose investments must be rather modest, can work with success if optimal capacities covering market demands are provided.
  15. In order to reach this goal, leading foreign manufacturing concerns should be invited to assist in the realization of the project.
  16. In this case, the governments concerned should provide their foreign partners with the status of "privileged enterprises".
  17. Government facilities should be related to the order of sharing magnitude agreed by the partners: in building the factory, in organizing the manufacture, in organizing repair and maintenance services, in assuring supply of raw material and spare parts needed, and, in some cases, in assisting field operations.
  18. One of the most important obligations of the partner should consist of enabling indigenous independent manufacture by fair transferring of necessary technical know-how.
  19. In order to achieve such far-reaching undertakings, at the same time serving the partner's interest, the governments concerned should engage all factors concerned, such as: competent administration, industrial and trade chambers, banks, private entrepreneurs and farmers.

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20. If organized on a wide scale, among countries bearing common economic interests, the project could be more easily realized, due to the enlarged market, the adequate creation of specialized factories, the broader experiences acquired, etc.
21. In order to pave the way for successful achievement in practice, a pilot project bearing the same characteristics as the main project should be set up.
22. If such a project is sanctioned in principle by UNIDO's authorities, some preliminary consultation with some developing countries, some leading foreign factories, as well as consultation with FAO and ILO should be held.

SECTION I

1 PRESENT SITUATION IN PRODUCTION AND APPLICATION OF FARM MACHINERY

1.1 Interdependence between industry and agriculture

Looking at the map of the world, we can see that nature and man have, on different continents, put in order some living and working conditions, conforming to geographical circumstances.

Particular influence has been exercised in the course of centuries on the soil itself by climate conditions, changing its structural characteristics which have still more differentiated work conditions.

Thus, protected by natural circumstances, some people have in the past improved methods and means of work, while others have fallen behind.. The differences in agriculture in this way are so pronounced that nowadays, in some areas, people live and work with most oldfashioned tools, ploughing ground to prepare the seed beds, using meagre cows to draw wooden ploughs as productive as in passed epochs, while in other areas we can see extensive surfaces where people have nearly overcome the nature, due to the irresistible influence of the machine, on a side and the lagging on the other side, we can conclude that the prime factor should be the presence of ever growing machine industry in one case and its lack in the other case.

Hence, we are coming on an important point of view: that nowadays the agricultural development, i.e. its mechanisation is chiefly influenced by the production of farm machinery, and vice versa. This production is conditioned by agricultural conditions.

1.2 Influence of natural conditions

It is understandable that natural conditions in different developing areas have contributed either directly or indirectly to the agricultural improvement.

Thus, while on American and African continents, where under arid, tropical and sub-tropical climates, agricultural conditions are rather stable, on the Asian continent in contrast especially in its south east countries such as India, Indonesia and East Pakistan, the climate with its frequent tempers is subjecting many changes in agricultural work.

In these areas since the monsoon does not come regularly, farmers await the rain, and if it starts, they must plough as early as possible to make farming practices, i.e. to proceed to timely operations. Except in Iran and West Pakistan the annual rainfall in Asia is between 1,000 and 2,400 mm during monsoons (six months). Their farming areas range from temperate to tropical, the latter affording opportunities for continuous crop production, with each

crop crowding the other. In temperate situations, conditions vary from one crop a year with a winter freeze to one major crop and a winter crop. Sub-tropical areas are between the two situations.

It is evident that in special conditions mechanization should be accommodated to the local conditions. Thus, in India, although interest for small and medium mechanization exists, the classical mechanization usually applied in arid areas is rather two to five times more used, due to its greater productivity.

In Japan, on the contrary, where the main crop, rice, is cultivated in paddy fields on the smallest economic units of 1.1 ha on average, a special so-called medium mechanization has been invented which is now mass-produced and which could serve in other countries having similar natural conditions. Hence, under the most difficult natural conditions, the machine is ever keeping its supremacy.

### 1.3 Some experiences of developed and developing countries

Let us, firstly, have a look at some European countries, rather less advanced and still less endowed by nature than the United States; for example, West Germany and Italy.

After the Second World War, having rebuilt and developed their industries, their agriculture improved in such a measure that their crop production has become sufficient for their domestic needs, and, in some cases, also for export.

Some other countries, such as Yugoslavia and Romania, due to their recent industrial development of farm machinery, have attained record grain yields enabling them to realize suitable market surpluses.

As for the developing countries, the industry, especially of farm machinery, has similar effects on agriculture. Namely, there are, among these countries, those which have earnestly approached industrialization, like Argentina, Brazil and Mexico in Latin America, India, Iran, Japan and Turkey in Asia, UAR and in some measure the Maghreb countries in Africa, and whose agriculture has subsequently also improved; while, on the other hand, numerous countries, principally small ones having only a few industries, have by no means organized their agriculture.

We shall first consider the more developed of developing countries, briefly pointing out the following:

#### Argentina, Brazil and Mexico

These three countries have, by their actual development and potential facilities

already passed the so-called critical economic threshold. Their heavy metallurgical machine and chemical industries helped them to start building other industries, among them the farm machinery industry. Argentina is leading with its 13,000 tractor production and other farm machinery amounting to \$100 million in 1965. It should be noted that this country is manufacturing all kinds of farm machinery, even wheat and corn combines. Mexico, the Latin country with a great industrial potential had, in 1965, 3,600 tractors and about seven million other farm machines, while Brazil had, in the same year, a production of 3,000 tractors and about twelve million other agricultural machines (see Appendix A).

These figures are rather convincing, taking into account the great need of farm machinery, especially on the Argentinian pampas. Meanwhile, the present acreage of one usable tractor per 260 ha. of cultivated land is rather low, compared to the UK's 17 ha., or Kenya's 95.

Meanwhile, as the yield increase of their main crops, wheat and cotton, has been, in the last decade, about 15 per cent higher than the average world yield increase of some crops, one can conclude that respective industrial policy in this field is on the right way, and will quickly progress when some credit facilities, which are the main obstacle to the agricultural expansion, are overcome.

In UAR, where some heavy machine industries, including a tractor factory with 10,000 vehicles capacity, have been erected, the consequences of the last unfortunate war, as well as some other economic difficulties do not enable at the moment a right presentation of its development in farm machinery and agricultural mechanization.

Japan, a country which, after the Second World War, reached the greatest boom, is only formally a developing country. With her 2,500,000 small tractors and tillers specially constructed and successfully working in paddy fields, Japan should be for other similar lands a promoter of new techniques in agriculture.

India, is one of the developing countries which, after the Second World War, started on a wide economic front.

There are large metallurgical plants erected, basic machine and chemical industries and others. Between the machine factories, farm machinery, engines and tractors occupy important places (see enclosed tables B1 and B3) their aim being to meet the requirements of wide agricultural spaces.

Meanwhile, the already mentioned climate conditions, as well as plenty of economic and social difficulties, which arise as consequences of an ambitious perspective plan, did not bring about the awaited expectations in the field of

#### 1.4 Some deductions resulted from the precedent examples

Although the mentioned data are rather poor, they implicate some conclusions regarding the developing lines of the countries concerned. They are the following:

- All these countries have some inherited cultures.
- All of them have a stable political and social regime.
- Some of them have started before, others after the Second World War on an intensive industrialization.
- Most of them have erected or planned metallurgical and machine building plants.
- Agricultural machinery has been included in their industrial plans assisted by foreign partners.
- Agricultural mechanisation has started assisted through Governmental facilities.
- Some of them have already increased the yields of common crops.
- Although Government assistance has been provided, their development has been hindered by different economic and social difficulties.
- Eventual further assistance from developed countries as well as from the UN should be provided individually.
- In every case their struggle to reach the aim should be considered.

As a pioneer undertaking, fit to be followed by other developing countries that is, in short, the situation of more developed developing countries. Nevertheless, our main concern is directed to the less developed countries, for they need serious assistance to break as much and early as possible their backwardness, in order to reach the present situation of more developed and still some developing countries.

Our survey is just devoted to this aim, the following paper trying to find the most suitable ways for it.

SECTION II

2. FARM MACHINERY CLASSIFICATION ACCORDING TO FUNCTIONAL AND TECHNOLOGICAL CHARACTERISTICS

In order to make a suitable choice of farm machinery for developing countries we built a classification which somewhat differs from the conventional standard classification, although it retains the same general allotment.

The idea to group farm machinery according to their functional and technological characteristics has derived from the fact, which already has been pointed out, that the production and the application of farm machinery are two independent mutually conditioned categories, which for our purpose is of capital importance. Indeed, the standard classification shows the following common characteristics (see Appendix C):

- I. group - tillage machinery;  
Main function: fundamental and auxiliary soil preparation;  
Main technology: forging
- II. group - seeding, fertilizing and grain preparation machinery;  
Main function: seeding, planting, fertilizing;  
Main technology: pressing, stamping;
- III. group: pumps and sprayers;  
Main function: irrigation and spraying;  
Main technology: casting;
- IV. group: special machines designed for paddy fields;  
Main function: different purposes;  
Main technology: various technological process;
- V. group: Harvesting, threshing and milling machines;  
Main function: grain collection and preparation;  
Main technology: assembly of organic and functional parts
- VI. group: Diesel engines and tractors;  
Main function: power providing and conversion  
Main technology: high precision machining

We do not want to prejudge any solutions, but by means of this classification we can see that at the first time the two first groups of machines are indicated for developing countries, either from functional or from technological point of view. The two following groups of machinery, III and IV, designed for irrigation i.e. for wet soil, are more complicated as the first ones, but in some cases they are indispensable in respective farm operation. For this reason their manufacture may be considered in special cases.



Machinery belonging to groups V and VI is the most complicated, both in production and application. For this reason it should come at the end.

Such gradual development of farm machinery must not be admitted as a rule, but we have seen by our previous attempts, that in due course machinery of developing countries, belonging to the last group, has started to manufacture the first. For this reason we are pleading for a gradual, but progressive development, especially where less developed countries are concerned. This attitude will be pursued further in our study.

## 2.1 Selection of suitable machinery from the technical point of view

A great variety of farm machinery which exists in the world market may be suited to the sharp competition of developed countries and not yet saturated demands. But on a rather poor market such development might be very dangerous because of the many difficulties arising from rapid manufacture, unskilled operation, bad maintenance and inadequate spare parts provision.

Here we shall list, according to the classification set down, the main conditions<sup>to</sup> which farm machinery should conform in order to satisfy their manufacture and application in less developed countries in the early stages.

These are the following:

- Adaptability - Perhaps the first consideration in selecting an agricultural machine is to determine whether it will do the desired work under certain conditions
- Cost of operation - The size, type, power, equipment, repairs and first costs should all be considered in determining the merits of a new machine as an investment
- Reliability of manufacturer - The responsibility of the manufacturer of a machine to the user is recognised. Manufacturers having such a policy give their customers excellent service and are responsible for the development of such new and useful machinery
- Design and construction - In addition to the efficient use of good material, in farm machinery due provision must be made for the adjustment and replacement of parts; the interchangeability of parts being essential.
- Ease of operation - Convenience and comfort for the operator as well as saving of time are matters to be studied in selecting i.e. in design and construction of farm machinery

- Ease of repair and adjustment -** Wear on machines cannot be wholly eliminated but a well designed machine provides for either adjustment or replacement to compensate for wear.
- Dealers' Service -** This service consists in instruction, in operation, in supplying spare parts and in overhauling machines in certain instances.
- Appearance -** No little consideration in the purchase of a machine is its appearance, for it has been established that there is a very definite relationship between pride of ownership and workmanship.
- Versatility -** There are machines available, which, although they may not perform each of a number of operations as well as machines specifically designed for each particular job, can without the need for additional equipment efficiently carry out a variety of work under different conditions.

All these general conditions mentioned are more or less realized by the internationally known leading farm machinery factories. In wide competition these factories have achieved almost the same results since they started from the same requirements, namely to eliminate as much manual work and animal power as possible to lighten the dead-weight and to reduce costs. Thus modern farm machines are no longer isolated devices; they have become integral parts of the tractor farm when they have the necessary power for their work. The tractor itself is no longer only a drawing machine, but, supplied with its "mounted implements", it has become a real working unit. Thus, different farm machinery characteristics should be considered as an integral requirement of a "system of machines".

What is the usefulness of an already prepared unit possessing the highest levels of performance, and what should be its main function for correct use in the field is indubitably a serious question. In every case, leading manufacturers have taken care to provide the best solutions for the same task, regardless of work or degree of skill. The deciding factor for their correct use in different field operations is the soil conditions which, in this case, as seen in later pages, are common in arid, tropical and sub-tropical areas.

The structural and functional features of machines manufactured by different leading manufacturers are almost the same (see enclosed App. D<sub>1</sub>-D<sub>8</sub>) For this reason it may be considered that the "system of machines" already mentioned

regardless of its origin is of a standard type. Called a "set of standard mounted implements", it will constitute the main equipment for most developing countries and will form the main manufacturing programmes in some of them in the first stages of acquiring the farm machinery.

The set of standard mounted implements will contain the following machines: 2-3 moldboard ploughs, disc harrow, smoothing harrow, fertiliser distributor, universal grain drill, grain planter, cultivator, 2-3 ton trailer. As can be seen, the set does not contain the tractor, nor the harvesting and threshing machines, which do not belong to manufacture in the first stages, but will be used in multi-farm or any kind of hired use.

The requirements which these machines should provide, whether in production or in application, will be dealt with in the next chapter.

SECTION III

3. MINIMUM ECONOMIC CRITERIA FOR PROMOTION AND APPLICATION OF FARM MACHINERY

As stated in the foregoing chapter relating to the classification of farm machinery, there are common technical elements in each machine group, whether from the production or from the application standpoint. Although these considerations have led to several criteria in choosing suitable farm machinery, a serious economic survey should be done in order to set down a sound basis for a progressive development of farm machinery use and manufacture in developing countries.

Minimum criteria should, in either case, be provided at the first stages of development in order to meet the market demands as well as to engage the people of developing countries in a new industrial way.

3.1 Minimum economic requirements from the agricultural standpoint

Requirements for agricultural mechanization in different developing countries may be different according to their specific standpoints and real needs, but, owing to the same technical means and methods applied in similar conditions in different countries, minimum economic requirements should be provided in each of them from the agricultural point of view.

Before passing to the economic requirements concerned, let us first consider some general conditions which may serve as a basis for them. To this end we have compiled the enclosed Appendix E, listing general human, natural, mechanical and financial conditions, in countries of arid or tropical areas. We can see that all natural conditions regarding soil, water and sun are mostly satisfactory; that mechanical requirements regarding the facilities of techniques, power machine adjustment, repair and maintenance ought to be satisfactory under certain conditions. With regard to human requirements, the skill and the wealth of farmers at present are unsatisfactory causing a great falling behind of these countries. But, starting from the universal working influence of machinery, we can soon expect results in this field.

Meanwhile, it appears that the greatest concern should be in the field of financial assistance. While questions relating to the prices and technical assistance may be solved in certain ways, especially through government regulations and possible foreign partnership, the financial problem will stay open until some radical undertakings have been set down. In the last chapter we shall deal with this question.

Let us come back to the minimum economic requirements relating to the agricultural mechanization in developing countries. From this as well as

from the industrial standpoint, i.e. from their common standpoint, let us suppose a standard area in which "common crops" are growing, cultivated by means of "standard machinery". Such a selection does not represent any special requirements. "Standard area" means in our case an area located in an arid or tropical region - semi-arid and paddy areas should be excluded. "Common crop" in our case means cultures such as wheat, corn, cotton and dry-land rice. In other words, crops which are habitually grown in these regions. "Standard machinery" in our case means the already selected "set of standard mounted implements" with their tractor of 35-65 hp.

With this assumption, most areas of developing countries should be covered, and our considerations would be in a certain measure general.

Now we can pass to the question of minimum economic requirements. For this, let us imagine farms of 10-20 ha. set apart, which we shall call "typical farms", where the following conditions should be fulfilled:

1. average monoculture yields of wheat, corn, cotton or rice (rice only in dry farming);
2. main agricultural operations as ploughing, harrowing, fertilizer distribution, drilling or planting, harvesting, threshing and transportation;
3. for these main operations, a set of mounted implements should be provided as well as a corresponding tractor of 35 to 65 h.p. and harvesting machine should be hired.

In our enclosed surveys relating to five typical farms (see Appendix F, Fr) growing respectively: wheat, corn, cotton or rice on areas of 10 - 20 ha. provided with corresponding standard equipment, we can see that the minimum economic conditions are satisfied, as the total grain production calculated on world rates is in all calculated cases much higher than total costs including the investment, operation and maintenance costs, as well as the costs of sustenance of the farmer's family of three members.

Such an average result, meeting the normal requirements, may be a firm economic approbation of the introduction of organized farm mechanization in developing countries - even the less developed ones.

### 3.2 Minimum economic requirement from the industrial standpoint

In our previous item 3.1 we have seen that main agricultural crops may be economically produced in developing countries on small surfaces from 10-20 ha. by means of standard equipment. This equipment consists of sets

of mounted implements supplemented by tractors of 35-65 h.p., constructed for developed and for developing countries. These are: molboard or disc ploughs, disc harrow, fertilizer distributors, smoothing harrows, universal grain drills, planters, cultivators and small 2-3 ton trailers. The suitability of such machinery for developing countries which has been noted in item 2.1 relating to the choice of machinery, as well as the checked experience of foreign manufacturers offer sufficient certainty.

Before passing to the minimum economic requirements for building farm machinery factories, let us view the general conditions for it in developing countries. Our enclosed survey (see Appendix G) relating to the manufacture of standard machinery above-mentioned, shows that conditions of natural environment are satisfactory and that human and technical conditions ought to be satisfactory under certain circumstances. The most important problem lies in the financial area. Either private or governmental, the financial assistance may be engaged only through a wide scale arrangement in which the Government and a leading foreign manufacturer can find a common interest for building the local factory. We must at once point out that it is not a question of assembly plants and the like, which have in practice shown precisely the opposite effect to that expected, nor is it a question of small scale industries manufacturing and improving small field machinery and hand tools. The question is to build typical modern factories specialized in the manufacture of the above-mentioned standard machinery, with a capacity enabling them to satisfy the market demand, the quality and the prices alike being the world ones. It is true that such a task is not easy to perform. But if the supplies of manufacturing costs is compensated by lower overhead costs and wages, as well as by protective duty and other governmental facilities, we presume that in a short time the factory will be operating successfully.

The term "typical factory" has been used for the following reasons: 1. they should be specialized for the manufacture of a rather small assortment; 2. their main technology (such as forging, pressing, casting, etc.) should be thoroughly expressed; 3. they should work in one shift sufficient to cover the production costs; 4. they should make use of technical organizational and financial assistance, whether from leading foreign manufacturers or from the government; 5. their management in the first stages should be the responsibility of the foreign partner whose important duty should be to raise the local staff standards so that it can become autonomous within a fixed period; 6. another obligation should be to provide the factory with

all necessary equipment, tools, instruments, technical documentation, know-how and sufficient raw material for normal manufacture; 7. the role of the foreign partner should extend to problems of trade, repair and maintenance, and, in some cases, of field operation assistance; 8. for all these obligations, the foreign partner should make use of facilities provided by the government in order to enable the correct function as a whole, as well as to protect the interests of the foreign partner.

An important point is the question of improvement. The factory should progress according to the market demand - and inversely, bearing in mind the potential influence of the machinery in the qualitative change of inherited field methods. For these reasons the one-shift capacity should provide the passing over to the second and to the third shift without noticeable investments.

It is difficult, within our small framework, to embrace all details which accompany the building and the organization of a factory. Nevertheless, to express the minimum economic requirements for such factories, we have used the document "Profiles of manufacturing establishments" issued by UNIDO. In order to give the possibility of comparing different data important for a relevant judgement of the investment concerned, we have compiled six profiles as follows:

1. A small factory for primary and secondary tillage machinery;
2. A small factory for seeding, planting and fertilizer distributing;
3. A medium factory for pumps and sprayers;
4. A medium factory for paddy field machinery;
5. A large factory for harvesting, threshing and milling machines;
6. A large factory for diesel engines and tractors.

These six profiles of farm machinery factories correspond exactly to the previous classification made for suitable choice of machinery, whether for production or for agricultural mechanization. (See Appendix  $A_1 - H_6$ )

Considering the kind, the size and the technological process, as well as the original use of the products concerned, we may divide the factory profiles into three parts:

- the first one corresponding to immediate building, namely the two first factories;
- the second one corresponding to the building in case of specific needs: these are the third and the fourth factories; and
- the third one concerning the fifth and sixth factories which may come into consideration afterwards, depending on their real development.

Such a programme can be started according to the data summarized in the enclosed tabulation, which shows the following:

gross data:	a. total fixed assets
	b. total employees
	c. total annual output
selected coefficients	d. fixed capital assets per employee
	e. fixed capital assets per 1 T product
	f. annual output per employee.

In order to compare these data for a relevant decision, we have arranged a comparative sheet (see enclosed Appendix I) which evidently point out the above mentioned factory classification, whether from the standpoint of the gross data or of the selected coefficients. These data surely show the possibility of relatively small investment for the two first factories, as well as the importance of their productivity, despite their relatively modest investments. Other factories, especially the two last ones, involve much more investment as well as numerous types of workmanship. Their weight of product per one employee is necessarily low according to the higher working degree.

A similar differentiation can be seen by comparing the factory products, i.e. their representatives according to one tone machinery prices (see enclosed Appendix K).

Whether one or another comparison provides the same data enabling the setting up of the priority in building farm machinery factories in developing countries.

### 3.3 Some deductions concerning the preceding requirements

The foregoing minimum economic as well as technical requirements being of fundamental importance for setting the industry and the agriculture in developing countries under way, we shall present them in their mutual connection. In order to get a general estimation of the problem concerned, one must point out that simultaneous fulfilment of different requirements, whenever mutually bound and conditioned, represents equations with many variables.

For this reason, we introduced in our final considerations some limitative factors as follows:

1. regarding the land:

dry, tropical and sub-tropical areas;  
paddy fields to be treated in special cases  
semi-arid areas should be excluded.



2. **Regarding minimum sizes of farms:** Minimum economic units from 10-20 ha suitable for farm mechanisation on private sector; eventual co-operative or governmental estates should be specially studied.
3. **Regarding kind of crops:** main crops such as wheat, corn, cotton and rice common in the countries concerned; rice only under dry farming with subsequent irrigation.
4. **regarding system of cropping:** dry land monoculture, one harvest-time; whenever possible double or triple cropping.
5. **Regarding field operations:** whole cycle of main operations, from soil preparation to harvesting and transportation; seed-bed preparation, harrowing, fertilizers, seeding, planting, cultivation should be done with indigenous mounted implements, while harvesting, threshing and tractor use should be performed in multi-farm use or by hiring.
6. **Regarding the choice of machinery:** powered equipment consisting of mounted implements such as plough, disc harrow, fertilizer distributor, smooth harrow, universal drill, corn and cotton planter, cultivatory trailer all of standard type mounted on tractors of 35 - 65 h.p.; tractor as well as harvester and thresher should be imported or hired.
7. **Regarding the manufacture:** optimal technological process in specialised plants such as forging, pressing, and casting with less machining; high machining should be foreseen for further development stages.

**8. Regarding the partnerships:**

obligatory foreign manufacturers sharing in building and organizing indigenous manufacture, providing equipment, tools and other facilities, such as technical documentation and know-how; importing raw materials, semi-products and adjustments; organization of repair and maintenance; also assistance in field operation.

**9. Regarding the cadres training:**

although this concern belongs to the Government, the education and the training of industrial skilled and semi-skilled, as well as the qualifying of foremen in an accurate technological way should be carefully organized by the partner.

**10. Regarding the financing:**

financial sharing between the partner, the Government and eventually the private contractor should refer to all of the above-mentioned requirements. A joint venture should be desirable; the assistance of the World Bank for industrial development also.

**11. Regarding the Government's share:**

maximum assistance and facilities for manufacturing or purchasing the components should be provided by the Government, as the result of a sound economic policy.

**12. Regarding UN assistance:**

common UNIDO, FAO and ILO endeavours to implement the project in the best manner from the industrial, agricultural and educational point of view.

At first sight, the above-mentioned conditions may appear as numerous as they are difficult to realize. Nevertheless, they represent a minimum of technical, economic, financial and organizational requirements for an undisturbed farm machinery production and application, which still exists in developed countries.

Moreover, it should be said that a large project requires an organized activity of all interested factors and authorities, in other words, it should be carried out on a wide scale, as stated in our next chapters.

SECTION IV

4. TWO FUNDAMENTAL DEVELOPMENT WAYS FOR BUILDING FARM MACHINERY  
INDUSTRIES IN DEVELOPING COUNTRIES

Almost in all countries especially in developing ones, agriculture appears as one of the most difficult problems. While in developed countries this problem is solved in accordance with the developed industry, by the presence of which agriculture finds its place in the country's economy as a whole; in developing countries without industry, agriculture is taxed beyond its possibilities and does not find its way for its affirmation. One of the circumstances raising difficulties in developing countries is the increase of the agricultural production in developed countries after the war and its competitive appearance on the world market which confirms even more the handicap of developing countries.

Even in some potentially rich Latin American countries, the agricultural production is in latent stagnation due to the deficiencies of the present underdeveloped structure of their economy, the vicissitudes of foreign trade, and the lack of energetic national development programmes.

The situation is still more difficult in developing countries where besides fertile land there is no other natural wealth. These countries will for ever remain backward if their agriculture will not be organised on a modern basis, i.e. by means of modern techniques which will enable their people to benefit from the civilisation, the creation of a modern and progressive attitude of mind, and consequently, the approach to the results of economy scale.

There are two different fundamental ways of development for it: the evolutive and the progressive way of development.

4. 1. Evolutive way of development

In fact, both the evolutive and the progressive way of development may lead to the same goal, but the ways to reach it are rather different.

When starting from the existing situation i.e. from established habits and home techniques, trying to improve them without particular changes, it would take a long time until the farmer renounces to his experience acquired due to his inherited habits. For this reason the minimum requirements for an agricultural improvement exposed in our foregoing chapter should not have much chances to come to a positive result in the near future.

One may be still afraid that the rectification of existing rather primitive animal drawn and handtools <sup>implements</sup> will tend more to regression than to improvement.

But as the course of "less resistance" is prevailing in some developing countries, and unfortunately by some protagonists of the West, we shall try to overcome the inertness habitual to evolutive development in order to be, in a near future, in a position to build farm machinery factories in developing countries.

Such a way should be the following:-

1. Organize marketing of farm machinery,
2. Organize services for repair and maintenance,
3. Organize instruction for a fair handling of machinery,
4. Organize a bureau for agricultural engineering,
5. Organize assembly plants for some farm machinery
6. Organize the construction of a small-scale factory to meet with the demands of the market in machinery and hand tools,
7. Form manpower for this manufacture
8. Build a development service that will take care to pass from simple to more complicated machinery.

It is our opinion that this programme will suit the followers of the evolutive development, and that some foreign manufacturers could have interest in it if some of the developing countries should agree to such a way.

#### 4.2. Progressive Development

The term "progressive" is used to characterize the endeavour for a project conception which may be more or less extended. Namely, if in some developing countries objective potential conditions for the production and the application of modern farm machinery exist, and if, therefore, a firm decision for it exists among authoritative governmental and private factors, one may expect a relatively rapid expansion of the project.

Measures which in such a case should be set, must not take a revolutionary form like the land reform in India, for this experiment, besides basically hopeful expectations, is running several risks by a lot of interrelated non-farming employment opportunities.

The developing countries like Argentina, Brazil, Mexico, India, Iran, Turkey and UAR - as we have seen in chapter 1 - should get started industrially for a period of time and assistance should be rendered individually, according to their needs, for which we should devote ourselves particularly.

Meanwhile, some developing countries have no other wealth besides fertile land and therefore assistance to a large extent is necessary.

In these countries the improvement of the yield, thanks to the excellent natural fertility, compared to the world average as a whole is rather weak. Thus the meagre increase in the average yield obtained over the past decade must be attributed to the scant technical progress made during that period.

We are not followers of omnipotent techniques, but we are eye-witness of their firm effect when properly used. Take as an example Yugoslavia, whose pre-war average yield in spite of favourable natural conditions was under world yields, while in post-war periods they have increased 2 - 3 times, due to the endeavours for organizing the farm machinery production which has played an important role. Their machinery manufactured in half a score specialized modern factories provide not only the Yugoslav market, but also some developing and even developed countries.

There is no doubt that similar results could be obtained in developing countries where natural conditions are better than in the above-mentioned country, under the condition that the afore-mentioned minimum requirement should be taken, i.e. their realization should be done in a progressive way, fulfilling the limitative factors mentioned above in item 3.3 "Some deductions concerning the preceding requirements".

#### 4.3 Suitability of a Pilot Project

As the mentioned progressive development involves difficulties which cannot be discovered sufficiently in advance, we propose to proceed gradually by experience on a smaller scale following the pilot project carefully prepared, in order to be able to expect satisfactory results.

Such a pilot project should be elaborated and realized in the following order:

Among developing countries select three or four belonging to the arid or tropical areas where common crops such as wheat, corn, cotton or rice are growing, whose Governments are willing to approach the experiment elaborated by United Nations.

**Elaborate feasibility studies:**

for a progressive agricultural mechanisation  
for building specialized small scale farm machinery factories  
as mentioned above.

- Invite leading foreign companies to take part in building farm machinery factories according to a tender elaborated by the Government concerned with UNIDO's assistance;
- Proceed the development of the Project under UNIDO assistance;
- Follow the process of laying out the project from the very beginning: the building, the equipment, the running, the management, the inspection and control, the marketing, as well as the use and the behaviour of machines in the field. Special care should be provided to the manpower training.
- Compare results realized in the countries concerned to the Pilot project, and bring concluding remarks, in order to enable further extension.

The above mentioned items are stipulated in principle form, and should be completed for practical use.

According to our estimations for some typical specialized factories (see App.H1 and H2), the investment costs should amount in average to about 300,000\$. The selected coefficients as well as the value added show this investment as feasible. Compared with the indirect advantages in acquiring experience in a rather short time, these investments should be considered as moderate.

For these reasons one may expect a real interest among developing countries, especially the less developed ones; among foreign factories, especially the world-known ones as well as broad assistance of the UN.

SECTION V

5. NECESSITY OF EXTENSION ON A WIDE SCALE

We have seen that the necessity of production and suitable application of farm machinery in less developed countries exists as well as the possibility to perform it in a certain manner. For this reason we proposed to start with a pilot project. If this project succeeds one might go further on a wide scale extending the experience acquired. "Wide scale" in our case means not only the extension on a wide region, but also the embrace of all relevant factors. For this reason such an undertaking should have the significance of a great project. On the following pages we shall expose our meaning in the matter concerned.

5.1 Possibility to organise farm machinery production on a regional basis

As known, economic agreements between different countries on a regional basis are the characteristic of post-war practice. These agreements as useful for developed countries, are necessary for developing ones. Unfortunately, a certain selfsatisfaction, as consequence of their political independence acquired, followed by a certain unsteadiness, did not produce much results in the matter of economic regional agreements. Nevertheless, taking into account the usefulness of regional agreements, either existing ones as: RCD Magreb, LA, or eventual new ones which will be reached especially between the less developed countries, one might believe that by extension of their common market, the possibility of organising farm machinery production should be much easier than on a limited market and isolated indigenous forces.

The proposed specialized factories should by all means achieve the expected optimal capacities when working for three or four countries, than for one solely. In this case the foreign partner should also achieve better experience through direct contacts with different fields, or different problems, such as suitability, maintenance and spare parts provision for this machinery.

This experience should lead to the idea of eventually organizing common centres for general repair, stocks of machinery and spare parts and last but not least, a centre for research, for the improvement both in production and in agricultural mechanisation.

Our proposal to start a pilot project could be much supported, if three or four countries taking part in it could be mutually bound on a regional basis.

## 5.2 Eventual further industrial development

As the introduction of new techniques in developing countries is not a target for itself but an intention to have more products with less efforts, in some cases, market surplus of crops could be used for manufacture. Common crops which have been foreseen in our production programme could lead to the building of flour mills, equipment for food preparing, cotton dragglers, rice husking equipment and others.

Such industrial development as a logical forthcoming of farm production improvement and the market surplus might be expected in all developing countries where the indigenous industry is at the beginning.

## 5.3 Particular countries' interest for a wide scale improvement

As a matter of fact, the machine industry provides market surplus and changes manpower structure. The farm machinery has in this way in developing countries a double role: providing surplus products either in industry or in agriculture. For this reason the initiative of some developing countries which have already started with it, although the difficulties which have necessarily been provoked in their economy, should be appreciated.

As for the less developed countries, starting directly without a previous development of the heavy machine industry, they should give proof that the farm machinery industry is able to put a fundament for their industrialization - in other words, that this industry should provoke the country's potential forces in that way. Thus, a wide scale improvement of the farm machinery industry and the agricultural mechanization moving all relevant factors should be of great interest to the governments concerned.

## 5.4 Leading manufacturers' assistance in the project

There is no doubt that a great project as mentioned cannot be realized without a firm assistance of a leading foreign factory. The interest of leading factories for co-operation with some developing countries has increased after World War II. Their trade policy, compared to the pre-war period, has rather changed due to the growing demands on one hand, and the increased competition of farm machinery factories on the other hand. Still in all countries in Europe and in some developing countries, there are farm machinery and tractor factories, working in co-operation with leading factories on the base of licenses, technical documentation and know-how.



Working on all continents, leading factories have acquired a large experience either in production or in application of suitable farm machinery models, and are the most competent in the matter involved. That is the reason why we consider their co-operation in realizing a great project as obligatory.

It is understandable that they could co-operate only in the limit of facilities which should be created for them. But the essential element of their assistance consists of leaving the former attitude, treating the developing countries as being unable for industrial work, only fit to be taken into consideration for small artesanal work and traditional farm operations. Their attitude towards their indigenous partners should be a fair play statement of highly experimented leading factories, pledged to transfer their experience in the best manner, in order to make their indigenous partners as independent as possible in their work. The post-war experience shows that leading so called mother factories keep their role and their interest in this kind of share ~~was~~ better than working through simple trade. On the other side, governments having a partner with all necessary qualities, assure all kind of facilities. It is difficult, and not the moment to enumerate mutual obligations between governments and foreign partners concerned. But one has to point out: the expected results in such a co-operation might be measured by the open minded and constructive partnership.

#### 5. Scientific and technical assistance

There are many research and development institutes, testing organisations and laboratories, specialized in farm machinery either in production or in application. In our case less interest lies in fundamental but in applied forms of scientific and technical assistance. Both, performing laboratories and field operating tests must have a practical mind: to determine technical and functional characteristics of a machine, its organ, or part.

For developing countries the main request should be the optimal choice of farm machinery. Although the so called "set of standard mounted implements" has to serve as technical ground for agricultural mechanization in any tropical area, in some specific cases it might be some request for constructive or functional changes. Beside these exceptional requests the main assistance of these institutions should consist of checking the effect of mechanised work, due to its technical and functional performances, as well as to the agricultural mechanization organisation. In this way relevant institutions should closely co-operate with the factory and the government authorities.

### 5.6 Economic aspects

In our precedent studies we tried to reconcile the interests of some developing countries with those of several foreign partners.

Although this aim is bearing far reaching advantages, in order to be practically realized the account should be direct, i.e. the machinery in the field should cover all operative and investment costs, as well as the costs of life of the farmers family. On the other side, the factory project should be bankable i.e. its manufacture should be realized on world economic and qualitative rates.

In our studies we have already stated that such a situation might be created under several conditions, which require a fair partnership between the countries concerned and the foreign factories interested, based on reciprocal obligations and benefits.

Our firm opinion is that machines whenever they work must give equal results under similar conditions. The error of judgment that production and application of farm machinery should belong only to developed countries has been demented long ago. The weakness of developing countrise, even the less developed ones, does not lie in their inability to approach technical problems but to the lack of capital, as well as to fair technical assistance in our case a fair-minded partnership with a foreign leading factory.

### 5.7 UNIDO's assistance

Hence, the initiative for a project such as the study of possibilities to manufacture farm machinery in developing countries represents undoubtedly a great endeavour.

UNIDO has had many proofs for its contribution to the development of developing countries. Meanwhile, an embracing action which should contribute to a real renaissance in the industrial and the agricultural field might be an important point in its success up to now.

It is important to note the necessity of unanimous endeavour of all participants in this project, both the governments concerned and the foreign partner, whose role has been pointed out in our report, and whose impartial co-operation would be in this case put under proof.

It is up to UNIDO, FAO and ILO to assure, each of them in corresponding function, the indispensable co-operation which has been pointed out many times in our previous elaborations.

SECTION VI

6. SCOPE FOR CO-OPERATION

All the above mentioned presupposes - without saying - the corresponding interest of developing countries concerned, i.e. their agreement. Although this interest might be justified, we believe that with some of the developing countries preliminary meetings should be held before giving the project broader publicity. In this case the following questions should be discussed:-

- 1) Importance which the country attaches to the project.
- 2) Manner of approach for its realization.
- 3) Readiness of the country to take over certain obligations.
- 4) Possibility of some investments.
- 5) Priority of the choice of foreign partners.
- 6) Eventual common access in regional frame.
- 7) Eventual joint venture with the partner.
- 8) Eventual realization of a pilot project.
- 9) Miscellaneous suggestions.

In case this action should get a broader regional importance, opportunity should be given to expose it on a regular or special regional meeting.

As to the country's meeting, at which representatives of different governmental, financial and other administrations should participate as well as some private persons and farmers, it would be advisable that UNIDO exchanges some correspondence before taking part in the meeting.

6.2  
7. Consultations with some foreign leading factories

After the consultations held with several developing countries i.e. after having cleared most of the questions relating to the project, the situation would be sufficiently explicit to have meetings with some of the leading foreign factories.

Their choice could not be difficult as only outstanding manufacturers like Massey Harris Ferguson, Deere and Co., International Harvester, Deutz and eventually Jteyer should take part in the first competition.

The meetings should be organized in UNIDO's residence with following terms of reference:

- 1) Agreement in principle to take part in the project
- 2) Manner of approaching the project
- 3) Order of their eventual participation in the project
- 4) Order of eventual investment
- 5) Conditions of eventual participation in the pilot project
- 6) Priority of countries concerned
- 7) Miscellaneous suggestions

In case the leading companies should not be interested in the project an international competition of different interested factories should be recommended.

### 6.3 Consultations with FAO and ILO

Consultations with FAO and ILO might be held before having meetings with developing countries and foreign factories; but we believe that the procedure should be reversed.

This is due to the fact that the developing countries concerned would be somewhat surprised to be set on an alternative course which interferes with their situation, without being previously consulted. Normally the "fait accompli" method is psychologically condemned to failure; which might be the case if consultations were held behind their backs.

Consultations with factories regarding training of cadres, repair and maintenance and others in which the factories have to take an active part, if not a leading part, should also be held before having a meeting on these questions with FAO and ILO. In this way some controversies on these matters could be avoided.

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- A Annual Supply of Agricultural Machinery in the Developing Countries
- B1 - B3
- C Farm machinery classification according to function and technology
- D1 - D8 General features of some mounted implements manufactured by foreign leading concerns.
- E General farm mechanisation requirements.
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- I Comparative sheet of capital assets and production output for the typical specialised factories
- K Average world selling prices of 1 ton agricultural machinery.

APPENDIX A

Annual Supply of Agricultural Machinery in the Developing Countries  
by Regions  
1964 and 1965

	<u>Total</u>	<u>South and Central America</u>	<u>South and Southeast Asia</u>	<u>Near East and Turkey; Africa excluding South Africa</u>
(In million dollars)				
<u>1964</u>				
Production	177.3	128.3	45.0	4.0
Imports	<u>701.5</u>	<u>221.8</u>	<u>100.1</u>	<u>179.9</u>
Total	678.8	350.1	145.1	183.9
<u>1965</u>				
Production	184.9	129.1	51.8	4.0
Imports	<u>511.7</u>	<u>225.0</u>	<u>117.1</u>	<u>211.6</u>
Total	735.6	354.1	168.9	215.6
<u>In Percentage</u>				
<u>1964</u>				
Production	26.1	36.6	31.0	2.2
Imports	<u>71.9</u>	<u>63.4</u>	<u>69.0</u>	<u>97.8</u>
Total	100.0	100.0	100.0	100.0
<u>1965</u>				
Production	25.0	36.5	30.7	1.9
Imports	<u>71.0</u>	<u>63.5</u>	<u>69.3</u>	<u>98.1</u>
Total	100.0	100.0	100.0	100.0

Source: UNIDO

AGRICULTURAL MACHINERY PRODUCTION - South and Central America

SITC Number	Item	1964		1965		1966		1967		1968		1969		1970	
		Year	Value \$1,000	Year	Value \$1,000	Year	Value \$1,000	Year	Value \$1,000	Year	Value \$1,000	Year	Value \$1,000	Year	Value \$1,000
72-5	Tractors, other than hand	1964	13,004	1965	13,448	1966	100,000	1967	100,000	1968	11,961	1969	11,961	1970	11,961
72-6	Spraying Machinery Sprayers Masters	1964	37	1965	1,453	1966	1,453	1967	1,453	1968	7,285	1969	7,285	1970	7,285
72-21	Pumps for liquids Power driven Hand water pumps	1964	11,526	1965	8,120	1966	11,526	1967	11,526	1968	11,526	1969	11,526	1970	11,526
72-1	Agricultural Machinery - Soil preparation Cultivators Disc harrows Land levellers Seeders seed, V. machines	1964	100,000	1965	100,000	1966	100,000	1967	100,000	1968	100,000	1969	100,000	1970	100,000
72-2	Agricultural Machinery - Harvesting Reapers Cutters Thrashers	1964	1,408	1965	1,408	1966	1,408	1967	1,408	1968	1,408	1969	1,408	1970	1,408
Total Agricultural Machinery		1965	100,000	1966	100,000	1967	100,000	1968	100,000	1969	11,961	1970	11,961	1971	11,961
72-5	Tractors, other than hand	1965	16,000 <sup>d</sup>	1966	16,000 <sup>d</sup>	1967	16,000 <sup>d</sup>	1968	16,000 <sup>d</sup>	1969	16,000 <sup>d</sup>	1970	16,000 <sup>d</sup>	1971	16,000 <sup>d</sup>
72-6	Spraying machines	1965	1,453	1966	1,453	1967	1,453	1968	1,453	1969	7,285	1970	7,285	1971	7,285
72-21	Pumps for liquids Power driven Hand	1965	11,526	1966	11,526	1967	11,526	1968	11,526	1969	11,526	1970	11,526	1971	11,526
72-1	Agricultural Machinery - Soil preparation	1965	100,000	1966	100,000	1967	100,000	1968	100,000	1969	100,000	1970	100,000	1971	100,000
72-2	Agricultural Machinery - Harvesting	1965	1,408	1966	1,408	1967	1,408	1968	1,408	1969	1,408	1970	1,408	1971	1,408
Total Agricultural Machinery		1965	100,000	1966	100,000	1967	100,000	1968	100,000	1969	11,961	1970	11,961	1971	11,961

a/ Includes hand tractors  
 b/ All pumps and compressors, including industrial  
 c/ Production was started in 1969.  
 d/ Estimated







Appendix C

Farm machinery classification  
according to function and technology

- Group I Tilling and soil preparing machinery  
Ploughs, harrows, rollers, pulverisers, cultivators.
- Group II Seeding, fertilising, cleansing and hay handling machinery  
Seeders, planters, separators, cleaners, graders, fertilisers.
- Group III Pumps, spraying and dusting machinery  
Water and manure pumps, sprayers, atomisers, dusters.
- Group IV Special machinery for paddy fields  
Watering and other machinery Japanese type.
- Group V Harvesting, threshing and milling machines  
Harvesters, threshers, presses, combines, milling machines.
- Group VI Diesel engines and tractors

Appendix D1

General features of some mounted implements  
manufactured by foreign leading concerns

2 - 3 moldboard ploughs

Uses: Ploughing, as the basic operation in tilling of soil sowing the most important ones to secure good growth and development of crop in the course of vegetating period. In order to provide for it, ploughing is required to pulverize and granulate the soil and invert the furrows as much as possible. In addition to it, for the homogenization of the ploughing up of the spread fertilizers are essential.

Main characteristics

- Attachment - Standard method of hitching in three spots provides for easy and quick attaching to the tractor.
- Design - Up-to-date design executed to switch quickly from 3-furrow plough to 2-furrow plough and vice versa.
- Regulation - Regulation and maintenance of the working depth as well as lowering and lifting of the plough is made from the operator's seat by means of the hydraulic lifting mechanism.
- Adjustment - Easily and quickly performed, being reduced to two single operations.
- Ploughing head - Made in three types of bases: standard base, cylindrical base with share, and moldboard of two parts with point for cultivation of hard and rocky soil.
- Maintenance - Reduced merely to occasional lubrication of the appropriate spots and regular grinding of share.

Appendix D2

Disc Ploughs

Uses: These ploughs are designed for work in dry and compacted soils, but they can be used with success for ploughing purposes in wet and sticky soils, where mouldboard ploughs could not be used successfully enough. Unlike the plough borer, discs are not subject to rapid wear because of their rotation during work, what is especially favourable in stony and abrasive soil ploughing.

Main characteristics:

- The 3-point hitching hydraulic power lift system enables quick and easy attachments of the implement to the tractor, as well as very satisfactory operation. The additional weight transference to the rear wheels during the work acts through this system as the pulling force increases what means at the same time an increase of economy.
- Raising, lowering and depth altering during the work is controlled by the single hydraulic control lever which is located beside the driver's seat.
- The proper tractor steering and driving in furrow direction is provided by the furrow wheel.
- Bevel faced discs and proper position of them enable good penetration even in toughest soil conditions (stony, weedy soils) so that these ploughs are an ideal implement for land reclamation.
- If the soils are too hard and the ploughs do not penetrate satisfactorily, both the 2/3 and the 3/4 furrow ploughs can be reduced to 2 and 3-furrow ploughs, respectively.

Appendix D3

Offset disc harrows

Uses: Mounted direct to the tractor 3-point hydraulic linkage, these harrows represent a well balanced compact unit, giving a first class performance in seed bed preparation, as well as in orchards, vineyards and forest plantations. The discs penetrate into the soil exposing and destroying weed roots whilst stubble and top growth are cut down and mixed with the top soil leaving the surface in ideal conditions to hold moisture and withstand top soil erosion.

Main characteristics

- Attached to the 3-point hydraulic power lift linkage so that raising into transport position, lowering into working position and penetrating depth is easily and simply controlled by the hydraulic control levers.
- Both front and rear harrow gang can be independently offset in either side by about 60 cm along their frames, so that a maximum adjustment of 120 cm can be achieved, or both together shifted on the headstock to bring gangs as close to the crop
- Rear gang angling adjustable in three positions.
- Frame inside outer disc means that cultivation can be carried out close to growing crops; fruit trees, etc.
- Rear gang depths' setting by means of a levelling lever.
- Each disc is furnished with a special adjustable cropper fitted on a common scraper bar.

Appendix III

Heavy duty spike tooth harrow

Uses: The heavy duty spike tooth harrow is an implement with very wide using possibilities. It can be successfully used in accomplishing many operations such as deep ploughed soil harrowing and seedbed preparation in order to break the clods, level the ground unevenness and prepare the ground for drilling; covering of fertilizers spread on the cultivated surface; killing of weeds developed before starting the drilling; pasture, grassland, clover and alfalfa fields aeration.

Main characteristics

- The harrow handling is very simple.
- The 3-point power lift hitching system enables the implement to be attached by only one man in a short time.
- Raising in transport and lowering in the working position can be easily made by the hydraulic power lift control lever.
- For troublefree and easy transport the harrow wings can be hinged up and in this position fastened.

Appendix B

Fertiliser distribution

Usage: This distributor is classified for distribution of inorganic fertilizers prior to basic tillage and in feeding of winter crops. In either case, its features have proved to full advantage, such as high efficiency and uniform distribution. Although designed for operation with granular fertilizers a satisfactory accuracy in operation is obtained also with powdered fertilizers, providing that they possess the allowed moisture content.

Main characteristics

- The fertiliser distributor is characterized by a simple construction and small number of operating components removed to the aggressive effect of inorganic fertilizers.
- With the application of it, a swath up to 14 m wide is reached with granular and 10 m wide with powdered fertilizers.
- Owing to the wide swath, the frequency of passage of the tractor in operation is reduced, and consequently trampling which has a negative influence on all crops fed in early spring.
- Distribution of various standard amounts of fertilizers is made possible, contingent upon the requirements of crops.
- Operation is simple, without involving any particular skill in handling or maintenance.
- Conforming to the wide swath, a high operating efficiency is achieved with a great reliability in service, having a favourable effect on economy of work.

Appendix 2.1

Multi purpose seed drill

Uses: The multi purpose seed drills for 13, 15 and 20 rows are universal implements for sowing purposes. They can be used in drilling of various crops as cereals, grass, industrial plants, vegetables, forage crops and others. The very large row spacing adjustment possibilities and easy setting of the necessary number of outlets enables that each crop could be planted to the desired width, and thus in various quantities p.ha. in regard to certain conditions.

Main characteristics:

- Both the seeding mechanism and fertilizer attachment are driven by the pneumatic tyred ground wheels through gears and chains.
- The seeding and fertilizer attachments are lowered and put into operation by the hydraulic power lift control lever. The action of raising automatically shuts off the seed and fertilizer flows ensuring no waste of seed and fertilizer.
- Seeding and fertilizer ratings are very simply controlled by lever adjustments.
- Complete operation control from the tractor seat
- Removable fertilizer attachment ensures good cleaning possibilities.
- The seed hopper wheel is designed to tip back and removable feeding mechanisms facilitate cleaning.



**Appendix I**

**TILLAGE**

**Uses:** The tiller is an ideal multi-purpose farm implement designed for sub-soiling, stubble-mulching, weeding. In many cases the tiller may be the only implement needed in preparing a seedbed. In some soils it replaces the plough entirely. This tiller is an excellent implement for breaking root-filled, or rocky soil, where ploughing is impractical or where it is not desirable to disturb soil structure.

**Main characteristics:**

- There are three models: with nine, eleven and thirteen tines. The nine tine model is suitable for cultivating orchards and vineyards, whereas the eleven and thirteen tine models provide a much wider coverage.
- All three models are made of light weight, high strength steel angle bar with bolt holes provided at 25 cm, which enables both front and rear tines to be spaced as desired.
- If an obstruction is encountered, only that tine which makes contact points back against spring tension until the obstruction is cleared, and then returns to working position.
- If the tiller is to be used for row crop cultivation, it will be found that a wide setting of the tractor wheels may be used to advantage. For this work, it must be taken care of arranging the setting of tines equally on each side of the tiller.
- Constant and adjustable working depth can be controlled from the tractor seat.

Appendix D 8

1-ton unloading or tipping trailer

Usage: It is designed to be used for transport of all kinds of agricultural products and other materials used in farming. Special extensions are used when transporting the maize, sugar beet, cabbage and others, which are added to the lades. By taking off the lades and putting on the platform extensions and special lades it becomes possible to transport hay, straw and other such bulky materials. It is also possible to mount on the transport box to take and transport silage.

Main characteristics:

- Unloading: tipping rear at an angle of 500 i.e. 400 on the left and right side, operated from the operation seat.
- Lades: Made of pressed thick metal sheet. The front lade is immobile, secured with bolts and other lades are hinged and detachable. The lade corners are specially reinforced.
- Trailerbeam: Made of thick pressed metal sheet and specially reinforced, having an adaptor for attachment to the tractor.
- Brakes: There are two, one from the other independent breaking system; manual independent brake at operator's hand and pneumatic brake which is synchronised with the tractor brake, acting simultaneously.

**Appendix E**

**General for mechanization requirements**

CRP: small grains, grass, corn, beet, cotton etc.

Requirements	- agricultural operations			
	tillage: preparation of a seed bed for planting			
	ploughing	harrowing	cultivation	
human	1. will	(+)	(+)	(+)
	2. skill	-	-	-
	3. size of land	(+)	(+)	(+)
	4. permission	(+)	(+)	(+)
	5. wealth	-	-	-
natural	6. soil	♦	♦	♦
	7. water	♦	♦	♦
	8. sun	♦	♦	♦
mechanical	9. techniques	(+)	(+)	(+)
	10. power	(+)	(+)	(+)
	11. size of machine	(+)	(+)	(+)
	12. adjustments	(+)	(+)	(+)
	13. repair and maintenance	(+)	(+)	(+)
14. costs	(+)	(+)	(+)	
facilities	15. technical assistance	(+)	(+)	(+)
	16. financial assistance	-	-	-
	17. governmental regul.	(+)	(+)	(+)

**Legends**

- ♦ the requirements are satisfactory
- (+) " " under certain conditions ought to be satisfactory
- " " are unsatisfactory

Appendix F,

Summary of Typical Farm

Typical Farm 1

<u>Size</u>	10 ha
<u>Main crop</u>	Wheat
<u>Field operations</u>	ploughing, manure harrowing, seeding, harvesting, transportation
<u>Equipment</u>	<ul style="list-style-type: none"><li>• 20 h.p. wheel tractor 1</li><li>2 b. mol board plough 1</li><li>disc harrow 1</li><li>fertilizer distributor 1</li><li>smoothing harrow 1</li><li>universal grain drill 1</li><li>2 T trailer 1</li><li>• wheat harvester 1</li></ul>
<u>Fertilizer</u>	Universal fertilizer 3 tpa/ha
<u>Manpower</u>	Operator 1
<u>Trial crop production</u>	13 tpa/ha : Total 13 tons

- The tractor and the harvester should be provided under multi-farm use, or hired.

Appendix P<sub>2</sub>

Trical farm 2

<u>Size</u>	20 ha
<u>Main crop</u>	wheat
<u>Field operations</u>	ploughing, manure, harrowing, seeding harvesting, transportation
<u>Machinery</u>	35 h.p. wheel tractor 1 2-3 b. moldboard plough 1 disc harrow 1 fertilizer distributor 1 smoothing harrow 1 universal grain drill 1 3 W trailer unloader 1 * wheat harvester 1
<u>Manure</u>	mineral fertilizer 3 tpa/ha
<u>Manpower</u>	operator 1
<u>Total crop production</u>	13 tpa/ha x 20 = <u>26 tpa</u>

\* The tractor and the harvester should be provided under multi-farm use, or hired.

Appendix F

Tractor Farm

<u>Size</u>	20 ha
<u>Main crop</u>	corn
<u>Field operations</u>	ploughing, harrowing, manure, planting, 2 cultivations, harvesting, transportation
<u>Machinery</u>	<ul style="list-style-type: none"><li>• 35 h.p. wheel tractor 1</li><li>2-3 wolboard or disc plough 1</li><li>fertiliser distributor 1</li><li>disc harrow 1</li><li>smoothing harrow 1</li><li>planter 1</li><li>cultivator 1</li><li>3 T trailer unloader 1</li><li>• corn harvester 1</li></ul>
<u>Seedling material</u>	grain 20 kg/ha
<u>Manure</u>	mineral fertiliser 20kg/ha
<u>Labour</u>	operator 1
<u>Yield</u>	grain 30 tpa/ha
<u>Total area production</u>	grain 60 tpa

- The tractor and the harvester should be provided by multi-farm use, or hired

Appendix 7

UNITED STATES

<u>Size</u>	20 ha
<u>Main crop</u>	cotton
<u>Field operations</u>	ploughing, sowing, 2-time harvesting, planting, thinning, 2-time cultivation, harvesting, transportation
<u>Machinery</u>	<ul style="list-style-type: none"><li>• 35 h.p. wheel tractor 1</li><li>2-3 b. moldboard plough 1</li><li>fertiliser distributor 1</li><li>disc harrow 1</li><li>smoothing harrow 1</li><li>planter 1</li><li>row cultivator 1</li><li>3 T trailer unloader 1</li><li>• cotton harvester 1</li></ul>
<u>Seedling material</u>	grain 60 kg/ha
<u>Inputs</u>	fertiliser (N + P + K) 6 t/ha
<u>Laborer</u>	operator 1
<u>Yield</u>	grain 13 t/ha
<u>Total gross production</u>	grain 13 t/ha

• The tractor and the harvester should be provided under multi-farm use, or hired.

Appendix 7<sub>3</sub>

Original form 2

Area

10 ha

Main crop

rice

Field operations in dry farming

ploughing up to 22 cm, sowing, disc harrowing, smooth harrowing, seeding, irrigation by gravitation, water draining, harvesting, grain and straw transportation

Equipment

- 35 h.p. wheel tractor 1
- 2-3 subsoil plough 1
- disc harrow 1
- fertilizer distributor 1
- siphon tubes any
- universal grain drill 1
- 2 T tractor trailer 1
- rice husking implement 1
- thresher 1

Seedling material

grain 120 kg/ha

Inputs

mineral fertilizer 8 kg/ha

Manpower

operator 1

Yield

grain 25 tpa/ha

Total crop production

grain 25 tpa

- The tractor and the thresher should be provided under multi-farm use, or hired.



Appendix C

General farm machinery manufacturing requirements

CROPS: grains, small and grass, corn, beet, cotton etc.

Requirements		agricultural operations; tillage: preparation of seed bed for planting		
		ploughs	harrows, rollers pulverisers	culti- vators
human	1. will	(+)	(+)	(+)
	2. skill	(+)	(+)	(+)
	3. education	(+)	(+)	(+)
natural environment	4. climate	+	+	+
	5. staidness	+	+	+
technical	6. choice of machine	(+)	(+)	(+)
	7. construction and design	(+)	(+)	(+)
	8. ty, isation	(+)	(+)	(+)
	9. standardisation	(+)	(+)	(+)
	10. technological process	(+)	(+)	(+)
	11. inspection and control	(+)	(+)	(+)
	12. technical know-how	(+)	(+)	(+)
Financial	13. private capital	-	-	-
	14. government capital	-	-	-
	15. foreign partnership	(+)	(+)	(+)

Legend: + the requirements are satisfactory  
 (+) " " under certain conditions should be satisfactory  
 - " " are unsatisfactory



17 . 12 . 13

## PREFACE

Many problems related to farm machinery production, particularly in their application to developing countries, have been studied by many capable experts. However, for varied reasons in different developing countries, the problems have not been entirely solved. One reason for this delay lies probably in the insufficient data available.

Some countries which have more or less approached industrialization, and in major cases have started with farm machinery production, do possess statistical data concerning the importation and the production of agricultural machines. These serve to form several conclusions and to emit some suggestions. One of them is assuredly the specific character of problems concerning the matter in these countries, which consequently should be treated apart for each of them. This fact indeed separates the more developed from the less developed countries, where, for the latter, more or less common requirements do exist.

In less developed countries, where industries do not yet, or barely, exist, and where the social and governmental situation is rather stable, the main potential wealth resides in fertile soil and clever farmers. Countries like those in the Mediterranean, equatorial and south-east African regions, as well as meridional Latin American and some Asian ones, which are grouped by natural similarity or by regional economic agreements bearing common requirements are fit for building farm machinery industries and selling corresponding agricultural mechanization.

Our outlines have been oriented in this way by approaching the problem systematically, if necessary through a pilot project. Although the lack of financial indigenous resources for such an undertaking might sink this idea at its start, we believe that this fundamental problem could be solved by the interest which leading foreign concerns carry in getting stable economic positions in some of these overseas countries.

Starting from this possibility, and before all the urgent needs which the less developed countries have in solving their acute economic problems, we believe that our primary attention should be devoted to them without neglecting urgent assistance for specific problems raised by more developed countries.

APPENDIX H<sub>1</sub>

TYPICAL EXAMPLES OF SPECIALIZED FACTORIES

Typical specialized small scale factory for primary and secondary tillage machinery

Annual capacity - one shift operation 1000tons

Major products - tractor ploughs, harrows, rollers  
pulverizers, cultivators, trailers

Total employees - one shift operation 100 persons

Fixed capital assets

Buildings	2500 m <sup>2</sup>	\$100,000	
Machinery, tools, instruments		\$200,000	
Total assets (without land)			\$300,000

Detail of machinery departments

Blacksmith	sowing, cutting, heating, forging, pressing, grinding, welding, packing	)	about 30 machines and equipment as well as tools and instruments modestly mechanized.
Foundry	moulding in sand	)	
Machine processing	turning, planing, drilling, milling, grinding, polishing	)	
Toolmaking	preparing tools and instruments most imported	)	
Heat treating		)	
Assembly		)	

Selected coefficients

Buildings, machinery, equipment, tools and instruments all per one employee	\$3,000
Annual product per one employee	10 tons
Fixed capital assets (without land) per one ton product	\$300/1 ton

APPENDIX H<sub>2</sub>

Typical specialized small scale factory for seeding,  
planting and fertilizer distribution machinery

<u>Annual capacity</u>	-	one shift operation	750 tons
<u>Major products</u>	-	universal grain drills, corn and cotton planters, machines for fertilizer distribution	
<u>Total employees</u>	-	one shift operation	100 persons
<u>Fixed capital assets</u>			
Buildings		\$50,000	
Machinery, tools, instruments		\$150,000	
Total fixed assets (without land)			\$200,000

Detail of machinery departments

Pressing and forging	sawing, cutting, pressing, forging, grinding, welding	)	about 25 machines and equipment, tools and instruments modestly mechanized
Machine processing	turning, drilling, milling polishing	)	
Tool making	preparing tools and instruments most imported	)	
Assembly	painting	)	

Selected coefficients

Buildings, machinery, equipment, tools and instruments, per one employee	\$2,250
Annual product per one employee	10 tons
Fixed capital assets (without land)	\$300/1 ton

APPENDIX H<sub>3</sub>

Typical specialised small scale factory for paddy fields

farm machinery

Annual capacity - one shift operation 1,000 tons  
Major products - paddy field tillers, weeders,  
rotors and rakes of Japanese type  
Total employees - one shift operation 100 persons

Fixed capital assets

Buildings - \$ 50,000  
Machinery, tools, instruments - \$ 250,000  
Total fixed assets (without land) \$ 300,000

Detail of machinery and equipment

Forging  
Pressing  
Machine processing  
Welding  
Heat treatment  
Assembly, painting

} about 40 different  
machines and  
equipment, tools  
and instruments  
modestly  
mechanised

Selected coefficients

Buildings, machinery, equipment, tools and instruments  
per 1 employee \$ 3,000  
Annual product per 1 employee 10 tons  
Fixed capital assets per 1 ton product \$ 300  
(without land)

APPENDIX H<sub>4</sub>

Typical specialized medium scale factory for agricultural

PUMPS AND SPRAYERS

<u>Annual capacity</u>	- one shift operation	2,000 tons
<u>Major products</u>	- Power driven pumps with horizontal and vertical spindles, sprayers and similar machinery	
<u>Total employees</u>	- one shift operation	400 persons
<u>Fixed capital assets</u>		
Buildings	- \$ 200,000	
Machinery, tools, instruments	- \$ 600,000	
Total assets (without land)		\$ 800,000

Detail of machinery departments

Foundry	}	about 100 machines and equipment tools and instruments fairly mechanised
Forging and pressing		
Machine processing		
Welding and assembly		
Tool making		

Selected coefficients

Buildings, machinery, tools and instruments	per 1 employee	\$ 2,000
Annual output	per 1 employee	5 tons
Fixed capital assets (without land)	per 1 ton product	\$ 160

APPENDIX H<sub>3</sub>

Typical specialised large scale factory for harvesting

threshing and milling machinery

<u>Annual capacity</u>	- two shift operation	13,300 tons
<u>Major products</u>	- wheat and corn combines, threshers, straw press, grain cleaning, milling machines	
<u>Total employees</u>	- two shift operation	2,650 persons

Fixed capital assets

Buildings	- 2500 m <sup>2</sup>	\$ 1,400,000
Machinery, equipment, tools, investments	-	\$ 3,600,000
Total assets (without land)		\$ 6,000,000

Major machinery crucial for determining overall capacity

Universal machine tools of medium capacity for  
forging pressing and processing of metals  
Some assembly lines for large capacity highly  
mechanized

Selected coefficients

Buildings, machinery, equipment, tools and instruments		
	per 1 employee	\$ 2,200
Annual product	per 1 employee	4,8 tons
Fixed capital assets (without land)	per 1 ton product	\$ 450



APPENDIX H<sub>6</sub>

Typical specialized largescale factory for Diesel engines and tractors

<u>Annual capacity</u>	-	two shift operation	25,725 tons
<u>Major products</u>	-	agricultural Diesel engines and wheel tractors	
<u>Total employees</u>	-	two shift operation	5,500 persons
<u>Fixed capital assets</u>			
Buildings	-	\$ 4,000,000	
Machinery, equipment, tools and instruments	-	\$ 9,200,000	
Total assets (without land)			\$ 13,200,000

Major machinery crucial for determining the overall production capacity

- Engines:** Universal and special machine tools conveyor of small capacity automated
- Tractors:** Semi-automatic universal and special machines. Tools for processing castings and making gears.
- Pig iron:** Semi-automatic machines for sand moulders of medium and large capacity, electric ovens, mechanized preparations of moulds and conveyor system for melting and pouring castings.  
Mechanization 80 %, automation 40 %

Selected coefficients

Buildings, equipment, tools and investments	per 1 employee	\$ 2,400
Annual product	per 1 employee	4,65 tons
Fixed capital assets (without land)	per 1 ton product	\$ 513

**Comparative sheet of capital assets and production output for the  
typical specialized factories**

**Appendix J**

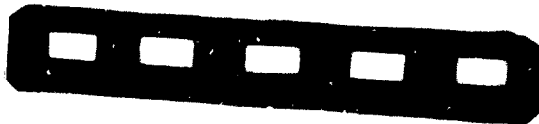
	gross data			selected coefficients			Remarks
	a) Total fixed assets	b) Total employees	c) Total annual output	d) Fixed assets/employee	e) Fixed assets/1 employee	f) Annual output/1 employee	
H 1 Tillage machinery	300,000	100	1000	3,000	300	10	
H 2 Seeding machinery	225,000	100	750	2,250	300	7,5	
H 3 Paddy fields machinery	300,000	100	1000	3,000	300	10	
H 4 Pumps	800,000	400	2400	2,000	335	6	
H 5 Harvesting machinery	6,000,000	2,770	13,300	2,200	450	4,8	
H 6 Engines and tractors	13,200,000	5,500	25,725	2,400	513	4,6	


All assets are expressed in US \$  
employees in persons; output in tons

**Appendix I**

**Average world selling prices**  
**of 1 ton agricultural machinery**

Group I	plows, harrows, cultivators	\$ 800
" II	universal grain drills, planters, fertiliser distributors	\$ 900
" III	pumps, sprayers, atomisers	\$ 1,100
" IV	paddy field machinery	\$ 1,250
" V	harvesters threshers	\$ 1,600
" VI	tractors	\$ 1,800
	Diesel engines	\$ 2,400





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