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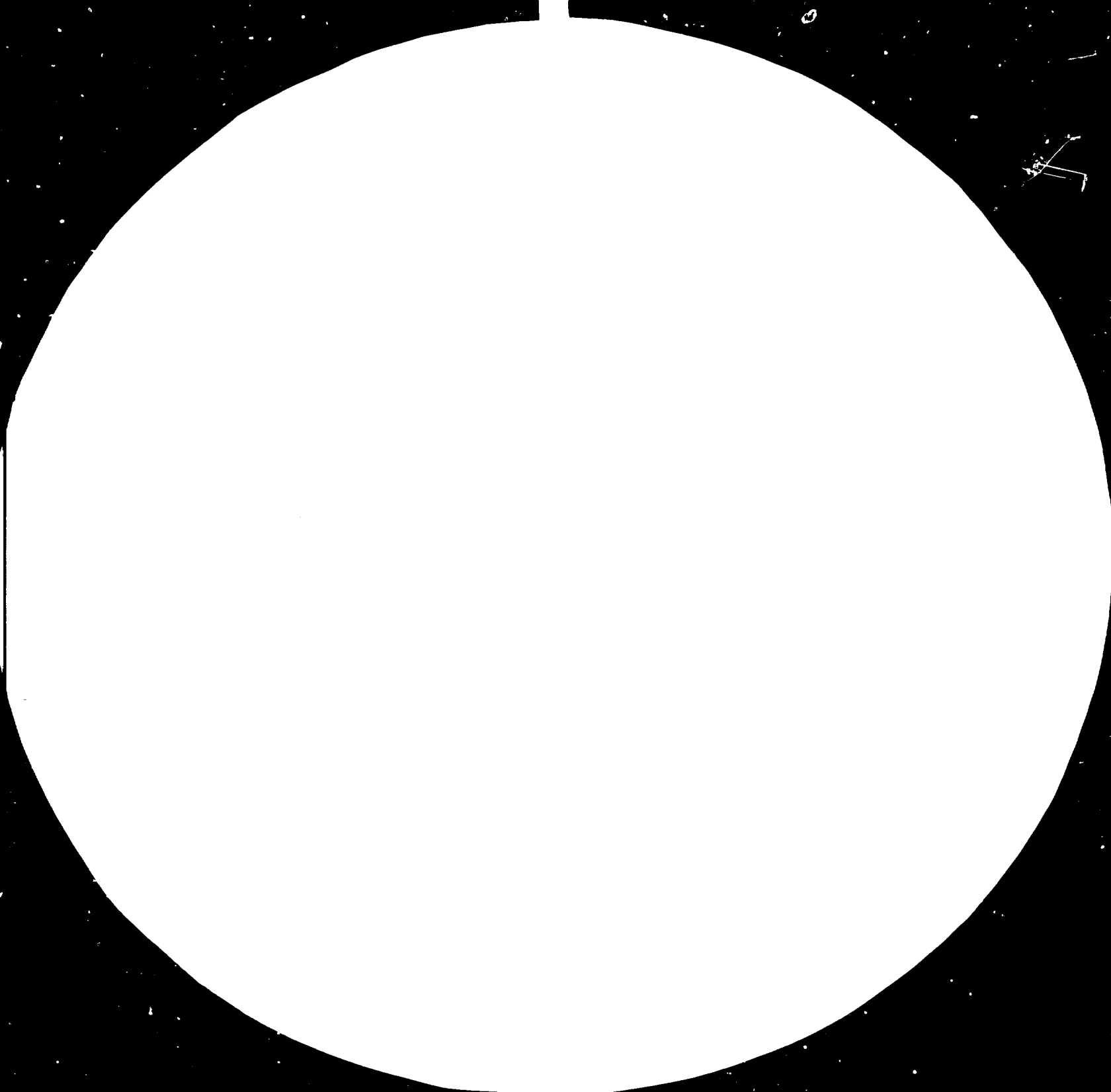
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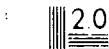
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Background Paper to Issue Paper No.II

INTEGRATED MANUFACTURE OF  
AGRICULTURAL MACHINERY AND CAPITAL GOODS PRODUCTS\*

prepared by  
the Secretariat of UNIDO

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## Introduction

1. Agriculture and industry are closely related: industry is required to produce the machinery that will optimize the use of inputs to agricultural production - seeds, water, fertilizer, pesticides, energy and soil - and to process the outputs.
2. Demand for agricultural machinery varies according to the characteristics of the "end user", the agricultural sector. In developing countries, this sector has such varied conditions - types of terrain, size of holdings, income, crops, ecological conditions, forms of production - that it can require a variety of machines and equipment, from simple hand tools to heavy, sophisticated machines. In addition, developing countries may require equipment for irrigation, storage, transport etc., as well as machinery to transform agricultural inputs into industrial products.

## Categories of products

3. Most developing countries produce only three categories of agricultural machinery (see annex for definitions): simple, intermediate and standard, as described below.

### Simple tools and equipment

4. The agricultural machinery most commonly used in developing countries is as described in category 1 (annex): simple hand tools, manually operated equipment and animal-drawn implements, which can be locally produced.
5. Raw materials for these products are primarily medium- and high-carbon steels, sheet metal for elementary forms, wood, and standard hardware. Technology incorporates metal cutting, sheet-metal forming, pipe bending, simple forging and casting, grinding, welding, and simple heat-treatment techniques. Production machinery is simple and, in most cases, universal, depending on the product specifications, design and volume of production. Technology and volume are suited to artisan and small-scale manufacturing units with batch production techniques.

6. One case that might be regarded as specialized and justify mass production techniques with forging and heat treatment as principal operations would be a sufficiently large demand for hand tools. However, these can also be produced in artisan and small-scale units.

#### Intermediate equipment

7. Tractor-drawn basic implements and simple low-cost, low-power equipment, as described in category 2 (annex), are already produced in some developing countries. If their designs were copied or adapted, many other developing countries could also produce them.

8. The raw materials for these products (excluding engines) are mainly medium- and high-carbon steel, sheet metal, some forged parts and castings, standard hardware and bearings, and a few rubber parts. Technology consists of machining, press work, welding, forging, grinding, and other standard operations. Production machinery is of a universal type that uses different types of tools, jigs, fixtures, dies and moulds. The production programme may include subcontracting for components and the local purchase of off-the-shelf parts. Technology and volume of production are suited to small- or medium-sized manufacturing units with batch-production techniques.

#### Standard equipment

9. Power-operated equipment, such as low- and medium-powered tractors, pumps and engines, as described in category 3 (annex), has been successfully produced in many developing countries, and could be produced in more developing countries in the immediate future if there were an exchange of experience and information on production and training between these two groups of countries.

10. To produce standard equipment, basic facilities (foundry, forge, gear shop, heat treatment, tool room, quality control laboratory) and ancillary industries are required, together with metal products, electrical items, components and sub-assemblies.

Needs of the agricultural sector

Production of agricultural machinery

11. Production of agricultural machinery in developing countries is varied to fulfil their needs: product range, specifications, design, complexity, cost etc. Some countries have big specialized plants, others rely on artisans, but most have small- and medium-scale urban and rural plants.

Rural and artisan units

12. Most rural units are either smithies or artisan workshops, employing few persons, in which production is carried out manually and power-operated machines are seldom used. The basic characteristics of these units are family ownership and management in the procurement of raw materials, production, marketing and financing. Production is carried on in self-contained, simple facilities, and, except for basic raw materials, very little is purchased from outside.

Small- and medium-scale units

13. Small- and medium-scale units have a mix of manually operated machine tools and simple power-operated machinery associated with a management system. They are situated mainly in urban areas or on the outskirts of towns, and employ 5-50 persons. They may be owned by a single person, be a partnership or co-operative, or be aided or owned by the Government. Production is in batches or selected items are produced on a continuous basis. Some outside jobs may be carried out and services (repair and maintenance, manufacture of spare parts etc.) provided.

Large-scale units

14. Large-scale units usually manufacture a specific product or group of products and employ 50-500 (sometimes more) persons. Their production is based on large volume, and both conventional and semi-automatic or automatic special-purpose machines are used. Basic facilities are essential. The final product is assembled from components, some of which may be imported or bought locally from ancillary industries but with the bulk manufactured in the unit.

### Imports

15. Although most developing countries could produce a wide variety of agricultural machinery, they are highly dependent upon imports. Some countries import a part of their heavy agricultural equipment and a variety of machinery of lesser technical complexity; some import all their heavy agricultural machinery and some simple equipment; and others import virtually all their machinery.

### Problems

#### Integration

16. In most developing countries the agricultural and industrial sectors are disjointed and the agricultural machinery sector is in turn separated from the capital goods sectors, with which it should be integrally linked. The lack of co-ordination between sectors is reflected, inter alia, in a lack of knowledge of the demand for agricultural machinery; this is a crucial problem that results in a chain of others: the same type of equipment is produced by different enterprises so that too many products of the same type are made; industrial plants are not used to their full capacity; parts that could and should be produced domestically are imported; and the development of basic industries, design and technology are hampered. Other problems are low demand for varied products; lack of skilled labour; limited financial resources; seasonal (changing) conditions and under-utilized installed capacity.

#### Production

##### Rural and artisan units

17. Rural and artisan units have problems with production because of lack of internal organization and because the personnel work in other agricultural activities for part of the year. These units are limited by not always being able to obtain the scrap metals they utilize and by technical difficulties with equipment other than that which has been used traditionally.



Small- and medium-scale units

18. Small- and medium-scale units have most of the following problems:

(a) Most of these units do not have enough knowledge of the real needs and demand of the agricultural sector, and in some cases even if they have the knowledge, their engineering capacity is incapable of providing realistic technological and economic solutions;

(b) Such units have a limited capacity to design machinery and equipment that is appropriate to demand, and even if they could develop a prototype, the financial and economic problems they confront would make production virtually impossible;

(c) They have difficulty in acquiring the imported inputs necessary to produce different machinery and equipment;

(d) They cannot train their personnel or establish research and development programmes because of the scarcity of resources;

(e) They are exposed to strong foreign competition because national institutions and enterprises prefer imported machinery and equipment, some of which is more expensive and of lower quality than that produced domestically.

Large-scale units

19. Large-scale units have been using their capacity at a very low level of utilization; this cannot be improved through a diversification of production because of the rigidity that exists between the technological process and the specialized product for which the plant was conceived. There is great difficulty in controlling technology used because of high external dependency on inputs, patents, trademarks etc. The installation of new plants of this type requires high investment that few developing countries can afford in the present world economic crisis.

Institutional and planning problems

20. In developing countries, there is the lack of an institutional framework and adequate planning and policies that could integrate the development of the agricultural machinery and agricultural sectors and help to overcome the problems the production units face, which consequently tend to worsen. There is also a lack of institutions that can develop and promote models of mechanization, give technical assistance to consolidate the existing

productive apparatus, and promote new investments. Credit, technology and training policies that could develop the demand and supply of agricultural machinery have either not been established or implemented effectively.

#### An approach to integration

21. The agricultural machinery sector should be integrated into the capital goods sector, both of which require similar manufacturing processes and technologies, raw materials, manufactured inputs (components, sub-assemblies etc.), skills and know-how. This communality could be used to integrate as well as diversify their production, utilizing the existing capacity of both sectors, thus permitting an increase in productivity and a decrease in costs.

22. Integrated production should be planned to produce the largest variety possible of agricultural machinery and capital goods for the industries whose products satisfy the needs of the majority of the population: food, construction and transport. It should also produce equipment for general purposes. Existing institutions should play an important role in such integration as it would require the use of resources and existing infrastructure, as follows:

- (a) product design and development;
- (b) technological advisory services;
- (c) common engineering services; and
- (d) related training.

23. The main technological alternatives to the production of agricultural machinery and capital goods are specialized manufacture or multi-purpose production units.

#### Specialized manufacture

24. Specialized manufacture has the following main characteristics:

- (a) Rigidity between product and technological process of production;
- (b) Production is based on machines that perform highly specialized operations;

(c) Production is of large quantities of the same or similar products, which are of a high technological complexity;

(d) The level of complexity of the machinery produced is determined at the production level by the technological characteristics of the different operations needed for its manufacture;

(e) The plant lay out is designed to permit repetitive operations in a sequence;

(f) Considerable technological infrastructure is needed; if it is not available, this type of enterprise tends to integrate vertically or the semi-finished products and components are imported.

#### Multi-product production approach

25. The multi-product approach has the following characteristics:

(a) Flexibility between product and technological process of production;

(b) Technological process of manufacture is based on universal machinery capable of different basic operations (cutting, welding, machining), in which labour plays a determining role;

(c) Production is of small quantities of a great variety of products of a relatively low technological complexity;

(d) Level of complexity of the products is determined at the level of production, basically by the design;

(e) Plant lay out is designed to permit the production of small quantities of different products by universal machines;

(f) Horizontal integration can be achieved with the domestic technological infrastructure.

26. The great diversity but relatively small volume of equipment required by the agricultural sector, and the need for an integrated development with the capital goods industry, make it necessary to base production, in most developing countries, in multi-product production complexes or on small- and medium-scale units. According to its technological characteristics, such production permits the manufacture of the great variety of machinery and equipment needed to develop key sectors (agricultural, food, construction, transport). Multi-product production permits a more rational utilization of existing installed capacity. Also, because of the small investment needed relative to that needed for big specialized units of production, new plants can be installed. Such production can also play an important role in promoting the development of the domestic technological infrastructure and the national engineering capacity, which can help to generate a more endogenous development.

27. The type of multi-product units or complex will depend on the characteristics of the agricultural machinery and capital goods sectors, and also on the technological infrastructure. The most important are given below.

Complexes

28. One type of complex is formed by a group of small- and medium-sized urban and rural enterprises provided with common services by a central unit. This central unit, because of the scarcity of technical resources available in developing countries and the need to reduce overhead costs, has to provide the following:

- (a) Design and technical specifications for different equipment;
- (b) Programmes of production based on foreseeable demand;
- (c) Provision of semi-finished products and components that cannot be produced in the country to different plants;
- (d) Establishment and implementation of training programmes to improve the quality of products.

29. This complex can be made implemented by stages. First, the different units may arrive at an agreement to implement on a common basis one of the above-mentioned activities. The activity can then be undertaken in one of the units. They can progressively develop other activities to a point where the level of operations justifies the creation of a central unit to provide common services to all the units.

30. The production units in this type of complex should produce the equipment mainly for the region in which they are located. With respect to the production oriented to satisfy the national demand, each unit should specialize to some extent, in order to avoid a duplication of efforts.

31. Another forms of complex consists of a central unit responsible for providing the main parts needed for assembling the different types of equipment produced by the small- and medium-scale enterprises that constitute the complex. Each unit has to establish its own programmes designs, and to determine the parts that have to be requested from the central unit.

### Units

32. In countries where complexes are not desired, the development of the agricultural machinery and capital goods sectors can be based on small- and medium-sized urban and rural multi-product units. To operate these efficiently, each of them must acquire the capacity to determine demand, designs, and organization of production that will enable them to achieve diversified production with a high productivity.

33. In countries where artisans play an important role, agricultural mechanization has to be based on artisan multi-product units. To use to the maximum the potential of this type of production, it is necessary to co-ordinate the development of the artisan units that are oriented to produce agricultural machinery with those that do maintenance and repair work, which are more modern, and also with the ones that produce simple metal products (beds, etc). This type of unit must also improve traditional designs to better suit them to the changing needs of the agricultural sector. Care should be taken in the introduction of changes or new designs because of the impact that they can have on the logic and efficiency of the agricultural productive system. These production units should operate all year long, combining the activities of maintenance and repair with those of production.

### Engineering support services

34. The concept of basic facilities, ancillary industries and support services will have to be reformulated towards this multi-product production approach. Integration of agricultural machinery with the capital goods sectors will require mobilization of resources and full use of existing infrastructure. The requirements are engineering product designs; technological advisory services; and related training.

### Engineering product design

35. Designing products and adaptations is an important part of engineering that determines production technology and influences the cost of products. In the case of multi-product manufacturing units, similar and technologically compatible products must be considered. The design or modification must

ensure good performance, easy operation, strength, reliability, technological effectiveness, durability, repairability, standardization and interchangeability of parts and components by utilizing indigenous materials and installed manufacturing facilities.

#### Technological advisory services

36. The local institutional capabilities must be improved in order to assist the promotion, transformation or establishment of multi-product production units, including plant lay out, process planning, production methods, production techniques, material control, work study and quality control.

#### Training

37. Domestic development and manufacture of capital goods cannot be achieved if appropriate training programmes are not initiated. The training programmes should be for skilled workers, technicians and engineers especially in tool engineering, production technology, machine tool utilization, engineering design and factory management as well as marketing personnel.

#### Proposed action

38. To integrate development of the agricultural machinery and capital goods sectors action is required by Governments, small- and medium-scale producers and artesans, of the sub-regional and regional institutions of the developing countries; and by enterprises in the developed countries.

#### Action by Governments

39. The Governments of the developing countries should establish institutional mechanisms to link the demand of the agricultural sector with industrial supply. They should formulate medium- and long-term plans to determine the products and new investment required, and to rationalize the existing productive apparatus. They should also adopt policies that will permit the channelling of credit to the producers and buyers; promote research and domestic engineering; and improve the qualifications of personnel, and encourage the association of producers to increase their negotiation capacity.

Co-operation between developing countries

40. There are possibilities for co-operation between developing countries in the

- (a) identification of appropriate agricultural machinery and capital goods products suitable for each country concerned;
- (b) promotion and adaptation of existing machinery;
- (c) promotion of local manufacture of appropriate products with emphasis on multi-product units;
- (d) assistance to local manufacture through information dissemination, in-plant training and co-operation between national institutions and manufacturers between the subregional countries; and
- (e) introduction of appropriate production techniques, marketing and extension services at national levels.

Co-operation between developed and developing countries

41. The co-operation between developed and developing countries should be focused on reinforcing or creating in the developing countries domestic engineering capabilities to generate their own designs and technological processes, and a technical infrastructure that could permit domestic production of parts and components.

42. For these purposes, it is necessary to adopt programmes of co-operation with the enterprises concerned, research institutions and finance organizations.

Annex

AGRICULTURAL MACHINERY PRODUCED IN DEVELOPING COUNTRIES

The term "agricultural machinery" is defined in three broad-based categories, as follows:

<u>Category</u>	<u>Definition</u>
I. (simple)	<p><u>Hand tools</u>: hoe, machete, spade, weeder, knife, sickle, axe, pick-axe, shovel etc.</p> <p><u>Manually operated equipment</u>: pedal thresher, hand sprayer, corn sheller, cassava puller and chopper, hand pump, chaff cutter, storage bins etc.</p> <p><u>Animal-drawn implements</u>: plough, cultivator, leveller, ridger, reeder and fertilizer drill, pump, sugar-cane crusher, reaper, cart etc.</p>
II. (inter-mediate)	<p><u>Tractor-drawn basic implements</u>: plough, cultivator, harrow, leveller, seed drill, reaper, trailer etc.</p> <p><u>Simple, low-cost low-power equipment</u>: power thresher, pump, chaff cutter, corn sheller, peanut decorticator, rice mill, hammer mill, power tiller, low-power engine etc.</p>
III. (standard)	<p><u>Power-operated equipment</u>: tractor, pump, harvest and post-harvest equipment (may be manufactured in a few developing countries).</p>



