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ID/WG.40/23

ID/47

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REPORT OF THE EXPERT GROUP MEETING ON AGRICULTURAL MACHINERY INDUSTRY IN DEVELOPING COUNTRIES

Vienna, 18 - 22 August 1969

UNITED NATIONS

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EXPLANATORY NOTES

"Dollars" refers to United States dollars (US$) unless otherwise indicated.
"Tons" refers to metric tons unless otherwise indicated.

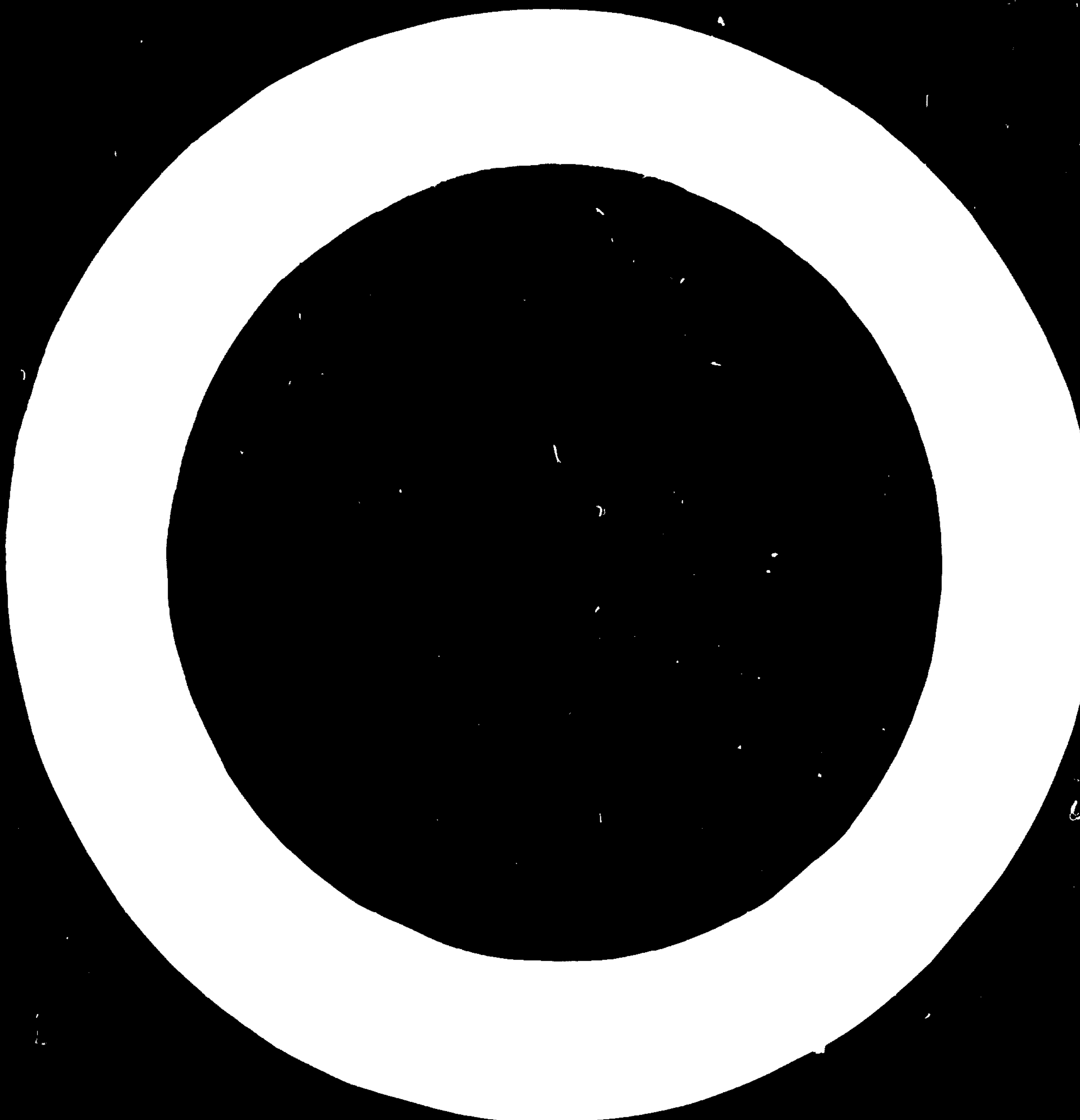
ABBREVIATIONS

United Nations Organizations

ECA	United Nations Economic Commission for Africa
ECAFE	United Nations Economic Commission for Asia and the Far East
ECE	United Nations Economic Commission for Europe
ILO	International Labour Organisation
FAO	Food and Agriculture Organization of the United Nations

Other organizations

AIDC	Asian Industrial Development Council
ISO	International Standards Organization
CEMA	European Committee of Associations for Agricultural Machinery Manufacturers
BIRPI	International Union for the Protection of Industrial Property
JCRR	Joint Commission for Rural Reconstruction, China (Taiwan)
PDAF	Provincial Department of Agriculture and Forestry, China (Taiwan)



Letter of transmittal to the Executive Director of UNIDO

We have the honour of presenting to you the Report on the Expert Group Meeting on Agricultural Machinery Industry in Developing Countries organized by the United Nations Industrial Development Organization (UNIDO) and held in Vienna from 18 to 22 August 1969.

It has been recognized by all the developing countries that agricultural machinery and implements – integrated with other allied inputs – are among the most important means for increasing production, and there has been an emphasis on the importance of self-reliance in agricultural machinery manufacture integrated with indigenous engineering industries. We are happy to note that UNIDO proposes to provide technical assistance to those countries which express a desire to establish their own industry capable of producing agricultural machinery and implements.

The Report is divided into three parts, Part I consisting of recommendations, Part II dealing with the consensus of the meeting towards formulation of recommendations and Part III consisting of the report on agricultural machinery industry in developing countries, based on the background documents, discussions at the meeting and various notes submitted by the participants.

We sincerely hope that our recommendations will provide you with a sound basis for your future work programme. In order to implement this programme, we recommend that UNIDO concentrate on field action-oriented projects in the manufacturing of agricultural machinery, and we strongly urge the developing countries to assess their needs and to assist you in establishing an order of priority.

We wish to express our deep appreciation to the UNIDO Secretariat for organizing this meeting so effectively, and for all its assistance and hospitality.

Yours truly,

F.R. Moasser (Chairman)
M.J. Wanjigi (Vice Chairman)
J.R. O'Callaghan (Rapporteur)

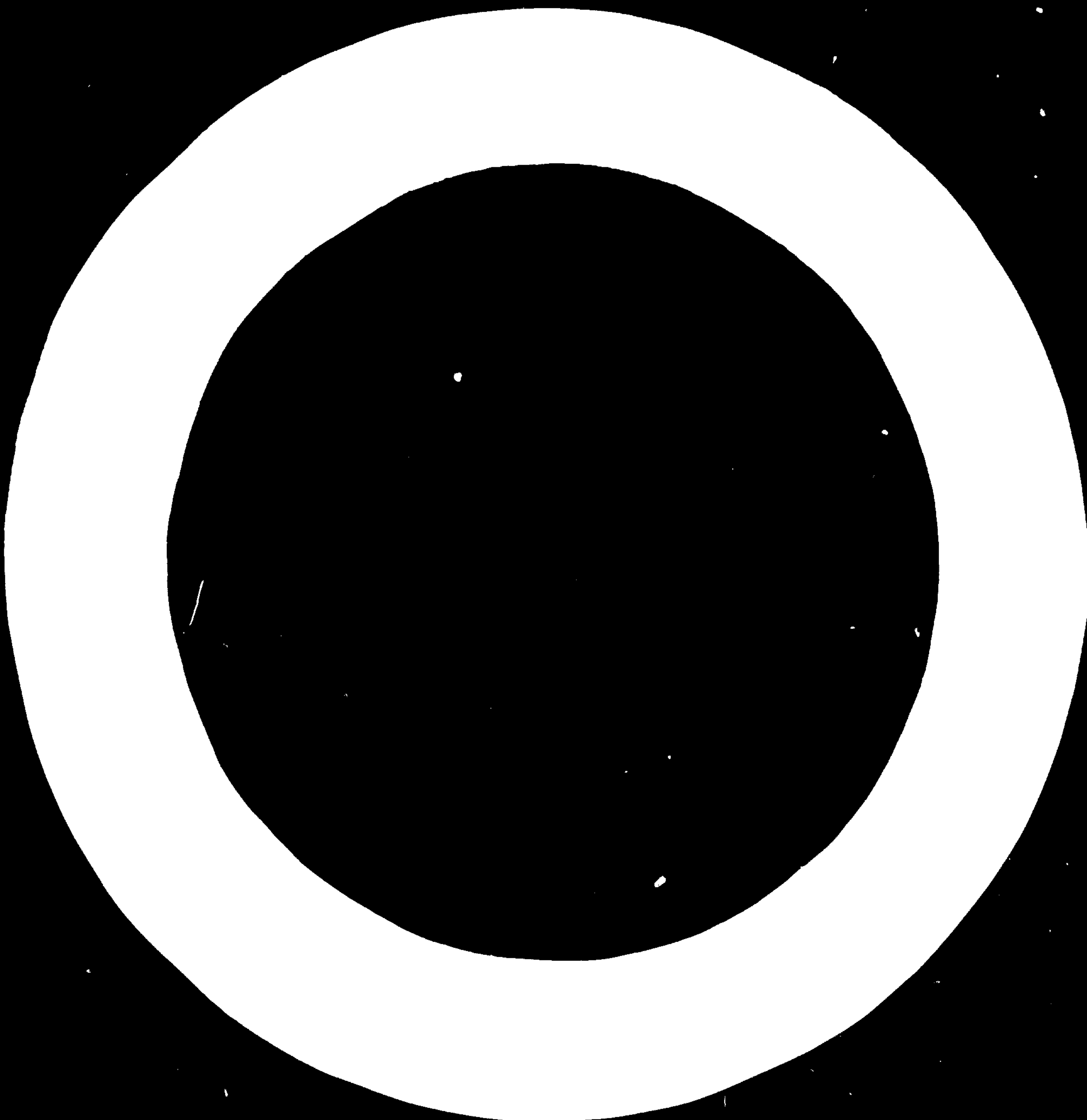
Introduction

1. An Expert Group Meeting on Agricultural Machinery Industry in the Developing Countries was organized by the United Nations Industrial Development Organization (UNIDO) in fulfilment of its mandate to help member countries by identifying industries which might usefully be developed. The meeting was held in Vienna from 18 to 22 August 1969. Forty-six participants representing international organizations as well as government agencies, private industry and research institutions in thirty-one developed and developing countries discussed how developing countries can both increase their agricultural production and stimulate the transfer of technology by manufacturing their own agricultural machinery and implements.

2. Background papers dealing with such subjects as the use of tractors in developing countries, design of tillage, plant protection and harvesting equipment, manufacturing, marketing, service and maintenance, had been prepared by experts and distributed to the participants before the meeting.

3. The meeting agreed that the time is ripe to expand rapidly the facilities for the manufacture, distribution, repair and maintenance of agricultural machinery and implements in the developing countries. An indigenous agricultural machinery industry can help in the mechanization of agriculture, provide a nucleus of industrialization and assist in the creation of technological and business skills through the countryside.

4. It is urgent that UNIDO prepare guide-lines to assist developing countries in formulating long-term plans for the development and utilization of agricultural machinery. UNIDO should be prepared to assist at all stages in the setting up and operation of an agricultural machinery and implement industry. Immediate field action-oriented projects are recommended.



Part I

RECOMMENDATIONS

Introduction

5. The Expert Group Meeting on Agricultural Machinery Industry recognized that the developing countries should step up their activities in the field of agricultural machinery and implements[1] directed towards the "Total Manufacturing Sector", including adaptation, design, development, manufacture, quality control, cost control, testing, research, marketing, repair and maintenance etc. It is urgent that UNIDO prepare guide-lines to assist developing countries in formulating long-term plans for the development and utilization of agricultural machinery. UNIDO should be prepared to assist at all stages in the setting up and operation of an agricultural machinery and implement industry in order to ensure the success of the industry as a growth point for industrialization within the country.

6. Close liaison between UN agencies and other national and international organizations is recommended in dealing with the multidisciplinary problems of the agricultural machinery industry and its application as an input in agriculture.

7. The over-all objective is a planned action programme stimulating self-reliance in accelerated growth of agricultural machinery and associated industries.

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[1] Agricultural machinery and implements is a term used for the machines used in the production, processing and distribution of food and agricultural products. The term includes such items as hand tools, animal drawn equipment, tractors, engines and power units, power tillers, land development equipment, irrigation equipment and pumps, tillage, seeding, fertilizer, plant protection, transport, harvesting and processing equipment.

Recommendations

Immediate field action-oriented programme

8. In order to implement the programme of work, UNIDO should concentrate on field action-oriented projects in manufacturing agricultural machinery and implements, with emphasis on improving existing manufacturing facilities in developing countries. The meeting calls upon Governments to submit projects to UNIDO.

9. As a follow-up action to the United Nations Industrial Development Organization (UNIDO), the Asian Industrial Development Council (AIDC) and the Economic Commission for Asia and the Far East (ECAFE) through the "ECAFE/AIDC/UNIDO Fact Finding Team on Industries Manufacturing Agricultural Machinery" in 12 ECAFE countries, UNIDO should now concentrate on investigating the establishment of manufacturing plants for agricultural machinery and implements in selected countries of the region.

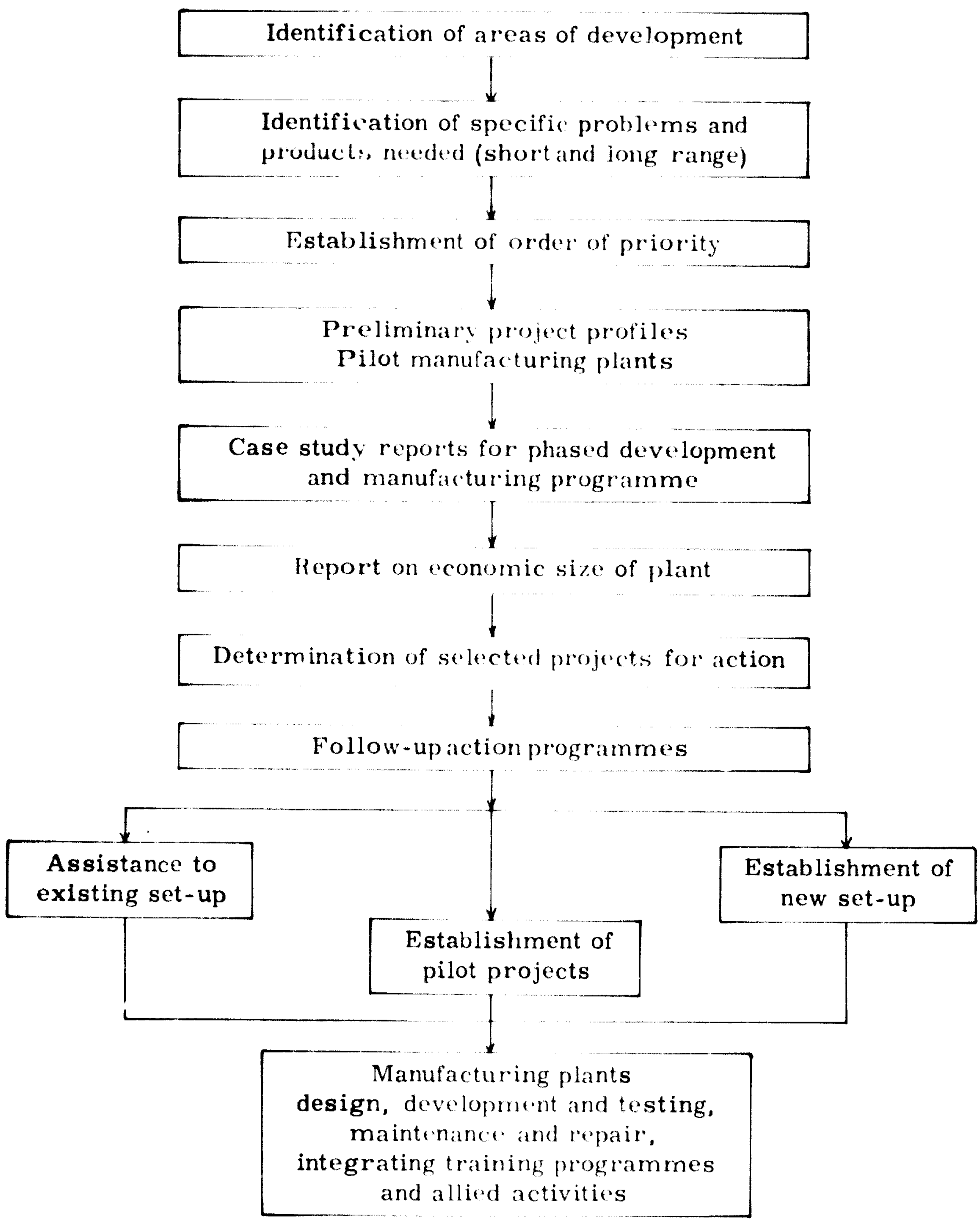
Long-term programmes
(A guide-line for action is shown in Figure 1)

10. One of the most pressing problems facing the developing nations is to obtain a definition of what is required in the way of agricultural machinery and implements that will contribute greatly to an increase in agricultural production and whose manufacture will be a nucleus of industrialization. The meeting calls on Governments to assist UNIDO in carrying out a detailed study in order to supplement the available data on the existing usage of and demand for agricultural machinery and implements in the developing countries of Africa, Latin America and the Middle East; the primary objective of the study is to identify promising projects for manufacturing agricultural machinery and implements. The activities of all organizations of the UN family concerned in this field should be co-ordinated.

11. UNIDO, in co-operation with FAO, ECE and other Regional Economic Commissions should assist the developing countries to carry out systems analyses to plan, on a national long-term basis, the optimum levels of

Figure 1

A guide-line for action



mechanization and of agricultural machinery and implements required to be manufactured for three major groups – small, medium and large-sized, holdings – taking into account the role of contract farmers and co-operative usage.

12. UNIDO, in co-operation with FAO, should evolve a work programme of agricultural machinery and implement manufacture integrated with the production and utilization of other inputs in agriculture – especially fertilizers, pesticides, insecticides and other agricultural chemicals, fuels and lubricants, seeds and water resources – in order to facilitate the development of appropriate machinery and implements. It may also be advantageous to organize a meeting of both input and agricultural machinery and implement manufacturers to discuss these problems.

13. Considering that existing manufacturing facilities for agricultural machinery and implements in some developing countries are working below capacity, it is recommended that Governments call on UNIDO to advise, on a priority basis, the appropriate manufacturers, in order to improve production capacity and to provide for rational expansion and diversification of product mix. In the opinion of the meeting, regional co-operation should be explored as a solution.

14. UNIDO should develop guide-lines for formulating the economic size of plants in developing countries for manufacturing agricultural machinery and implements. The analysis should work out such details as capacity, capital requirement, plant, building, organization, employment, sales, costs, gross annual profit, foreign exchange necessary, value added and capital output ratio using the existing economic indicators. It would seem desirable also to include the manufacturing programmes, ancillary industry development, subcontract, quality control and various supplies necessary to operate the plant efficiently. These guide-lines could then be presented to the developing countries to assist them in formulating a manufacturing programme.

15. In order to highlight the different manufacturing problems faced in developing countries and to formulate a guide-line for manufacture, case

studies should be undertaken by UNIDO on selected items of agricultural machinery and implements based on existing selected industrial enterprises, preferably from developing countries, where solutions to the overall problems have been evolved successfully.

16. UNIDO, in co-operation with BIRPI, should be prepared to advise the Governments of developing countries on patent and licence agreements for the manufacture of agricultural machinery and implements.

17. UNIDO, at the request of Governments of developing countries, may assist in the development of pilot manufacturing plants for agricultural machinery and implements, in order to stimulate growth as a means of pre-investment analysis and for the purposes of training and demonstration.

18. UNIDO, at the request of Governments, should assist the developing countries in carrying out programmes of market research before introducing a new product, using also the services of other UN organizations, especially the Market Research Centre of UNCTAD and the Regional Economic Commissions.

19. UNIDO should assist the developing countries in setting up and reinforcing development and testing centres where local manufacturers can seek guidance and technical knowledge on plant lay-out, implement design, development and production techniques including quality control. Co-operation between such centres is advocated.

20. Considering the metallurgical, engineering and technological impact of agricultural machinery and implement manufacture, a technical document should be prepared by UNIDO using all available documentation on the metallurgical aspects — the selection of correct material, standardization, import substitution, heat treatment, manufacturing techniques and quality control. Some of the problems faced and solutions developed by industrialized countries and also by relatively advanced countries such as India, Pakistan, Brazil, Argentina and Mexico may be studied to formulate suitable techniques for the developing countries. Such activities as are necessary to impart technical knowledge on a continuous basis on metallurgical aspects of farm

machinery through expert group meetings, surveys, training etc., could also be beneficially undertaken.

21. UNIDO, at the request of the Governments of the developing countries, should assist in the local manufacture of quality spare parts for agricultural machinery and implements. UNIDO and member Governments should work in liaison with manufacturers to ensure an effective after-sales service.

22. UNIDO, in collaboration with other UN organizations, should pay particular attention to the problems of proper operation, service and repair of agricultural machinery and implements in the developing countries and be prepared to assist Governments in the development of solutions to these problems.

23. UNIDO, in co-operation with Regional Economic Commissions, should assist developing countries in exploring possible areas of regional co-operation towards agricultural machinery manufacture, ancillary manufactures, market sharing and establishment of manufacturer's associations.

24. UNIDO should assist developing countries by instituting fellowships in the various manufacturing aspects of agricultural machinery and implements; the fellowships to be tenable in both industrialized countries and other developing countries.

25. UNIDO should assist the agricultural machinery and implement industries in the developing countries by programmes of industrial training and management development.

26. It is recommended that – in order to promote growth of the agricultural machinery industry in developing countries – UNIDO should make available at an early date the services of regional and interregional advisers for the agricultural machinery industry.

27. UNIDO should investigate the possibilities available to developing countries for obtaining financial assistance both in manufacturing investment and credit to farmers for the purchase of agricultural machinery and implements, together with the necessary spare parts.

28. UNIDO should assist Member Governments to promote the development of small scale industries which are regarded as a very important intermediate step towards industrialization in the field of agricultural machinery and implements.

29. The general economic aspects in the field of agricultural machinery should be studied by other UN agencies, especially Regional Economic Commissions and brought to the attention of UNIDO.

30. The meeting requested the UN and its specialized agencies to prepare and to distribute to UNIDO members a working schedule of activities in the field of agricultural machinery and implement manufacture.

Appendix 1

REPORTS REQUIRED TO BE UNDERTAKEN

(a) Project profiles (preliminary) on the manufacturing aspects of tractors, power tillers, engines, pumps, plant protection equipment, agricultural implements, agricultural hand tools.

(b) Project profile on agricultural machinery and implement development, adaptation and technical service centres for developing countries.

(c) Project profile on agricultural machinery and implement-testing stations in developing countries.

(d) Project profile on industrial fellowship, group in-plant training in agricultural machinery industry in industrialized countries.

(e) Project profile on agricultural machinery mobile workshops and central workshops for developing countries.

(f) Study reports by country on the status of agricultural machinery industries in each of the developing countries.

(g) Report on the economic sizes of plants of selected agricultural machinery – tractors, power tillers, engines, pumps, plant protection equipment, agricultural implements and hand tools – for developing countries.

(h) Report on the metallurgical aspects of material for agricultural machinery manufacture in developing countries.

(i) Case study reports on under-utilization of existing metal working industries in selected developing countries and possibilities of diversification of agricultural machinery products.

(j) Case study reports on the phased development of manufacturing industries – tractors, power tillers, engines, pumps and plant protection equipment – in successful industrial enterprises in selected developing countries.

(k) Case study on indigenous substitution of material, quality control and heat treatment for agricultural machinery and implements in selected developing countries.

(l) Case study reports on successful agricultural machinery repair and maintenance workshops in selected developing countries.

(m) Analysis of status agricultural machinery industry in developing countries.

Appendix 2

AREAS OF EXPLORATORY ACTIVITIES RECOMMENDED

Technical assistance investigation mission: To visit selected countries to outline specific areas of assistance which UNIDO could render in the field of agricultural machinery manufacture.

Case study team: On indigenous substitution and phased manufacturing programme of successful selected industries in selected developing countries.

Case study team: On metallurgical aspects of agricultural machinery manufacture in selected developing countries.

Case study team: On agricultural machinery and equipment workshops in selected developing countries.

Case study team: To visit a selected limited number of countries (2-3) to conduct case studies with main focus on: the assessment of under-utilized or unused industrial facilities towards manufacture of agricultural equipment; the expansion of existing units; recommendations on diversification and product mix; exploring the extent and substance of product design changes to utilize existing machinery equipment and focusing on the necessity of re-inforcing production through design and development centres; and pilot manufacturing plants.

Manufacturing technique study team: To be in conjunction with international and national professional agricultural engineering institutions and well known manufacturing organizations. Members from developing countries to make a group study in selected industrialized countries.

Symposium on agricultural machinery industries: To be attended by participants from developing countries and industrialized nations to discuss various aspects of agricultural machinery manufacture.

Part II

THE CONSENSUS OF THE MEETING - RAPPORTEUR'S ADDRESS

National planning

31. Industrialization is an obvious way of increasing activity in developing countries. It is logical as a first step to consider the manufacture of agricultural machinery and implements because these are the items for which there is a local market. Traditionally, the metal-working industries in Europe have grown out of agriculture, mining and textiles. The agricultural machinery industry should have a very special place in a developing country since it diffuses technology throughout the countryside and involves a large sector of the working population in its activities.

32. In its implications, the decision to set up an industry is a long-range one. It is important that the industry should develop, expand and grow. At the pre-investment stage it must be possible to envisage in the long term what the needs of an agricultural machinery and implement industry in capital, labour, training are going to be and its effects on the national economy, together with its relative relationship with the agricultural and industrial sectors. The government of a developing country will wish to see a cost-benefit analysis of a proposed agricultural machinery and implement industry before making its decisions.

33. UNIDO must be prepared to help the governments of developing countries in deciding what options are open to them in the establishment of agricultural machinery and implement industries. UNIDO should prepare to act as an unbiased independent consultant possessing enormous available resources in the UN family. It should be able to advise the governments of developing countries on long-term comprehensive industrial development and on the particular problems associated with the establishment, development and growth of agricultural machinery and implement manufacturing, with special reference to its effects on the metalworking and agricultural sectors as industrialization proceeds.

The agricultural constraints

34. The need for agricultural machines and implements to fulfil their agricultural functions correctly is an important constraint in the agricultural machinery industry. Agricultural machinery and implements form an input to agricultural production comparable in importance with high-yielding varieties, fertilizers and water. In fact, in order to exploit the opportunities for increased production offered by high-yielding varieties, fertilizers and water, there is need for better and more reliable tillage, harvesting and processing machines because the timeliness of the different operations becomes very critical. The livelihood of those who work in agriculture is dependent on the satisfactory performance of the agricultural machines and implements available to them.

35. It is difficult to specify within close limits the conditions within which an agricultural machine will be required to work. Soil conditions vary from light sandy soils which are easy to rupture by tillage implements, to wet clay soils which require very large forces to break tehm. The crop density presented to a harvesting machine can vary within limits that are almost as wide. The skill of the operators of agricultural machines is usually low, as is the general standard of maintenance. A characteristic feature of agricultural production is that it is seasonal; as a result many machines stand idle for long periods. An indigenous agricultural machinery industry should strive to satisfy its own local conditions and even exploit them as far as possible.

36. There is an extremely wide range of agricultural machinery and implements, from hand tools and animal-drawn implements to sophisticated tractors, harvesting and processing machines. The whole range is involved in any long-term plan, and UNIDO must be prepared to concern itself in the manufacture of items in the whole range. The development of land to make mechanized farming both practical and economic as well as to increase yields should have the highest priority in national planning in developing countries. The manufacture of plant protection equipment is also in urgent need of attention. It is conceivable that the decision to set up an agricultural

machinery and implement manufacturing industry may be based on grounds of the greatest benefit to the country as a whole rather than to its agricultural sector. However, on marketing grounds alone, the machines must be satisfactory in function in order to satisfy the customer and generate demand through increased purchasing power in the agricultural sector.

37. Agriculture is a traditional and conservative industry in which it is difficult to achieve changes. Even in industrialized countries change in agriculture is slow; it took almost ten years to absorb both the combine harvester and the forage harvester into agricultural practice in western Europe.

Dynamics of an agricultural machinery and implement industry

38. Two different approaches to industrial development can be represented by the "big bang" approach and the "evolutionary" approach.

39. The "big bang" approach is found in the setting up of a large new plant which has an impressive effect on the industrialization of a developing country. These plants come in big units, the technology is well developed, the product uniform and a base demand already exists in the country. Examples of "big bang" industrialization are fertilizer plants and oil refineries.

40. The "evolutionary" approach to industrialization is met in a manufacturing industry which is serving a demand that is in itself expanding. The agricultural machinery and implement industry is an example of the "evolutionary" approach since the practices and demands of agricultural production are in themselves slow and evolutionary. However, this does not mean that the agricultural machinery and implement industry is a static one, especially in developing countries where there must be a very high rate of change in order to close the gap between these and the industrialized countries.

41. The "evolutionary" approach to the siting of plants for manufacturing agricultural machinery and implements means that the machines produced must satisfy a function that is agriculturally correct, preferably forward-looking, yet acceptable to a large body of farmers. In this way a market for the machines is reasonably assured. An agricultural machinery and

implement industry is likely to grow from an existing manufacturing plant that meets a local need.

42. Due to the rapid rates of change in both industrial and agricultural development and the rates of growth which are possible in developing countries, the life of a manufacturing plant for agricultural machinery and implements is likely to be short. These plants will either have to be written off over a short period of time, or they must have the possibility of change built into them. It is worthy of note that in the USSR the amortization period of a plant for manufacturing agricultural machinery is four years. In a developing country a greater rate of change may be expected than in the USSR, and an amortization period preferably less than four years should be used.

43. The agricultural machinery and implement industry is one with a high ratio of investment to turnover. The minimum size of an implement factory under European conditions was found to be one producing 16,000 - 20,000 tons per annum.

44. There is obviously great need for market research before investing in manufacturing facilities, in order to find out what agricultural machines and implements are required in the country, the quantities, the likely rate of growth of the market, the demand for spares and the standard of after-sales service that is expected.

45. The manufacture of tractors and engines is a highly sophisticated industry in which there are apparently advantages of scale. In industrialized countries the production of the majority of tractors is concentrated in relatively few firms. Local assembly of tractors with progressive substitution of indigenously produced parts is viewed as an aid to industrialization in developing countries.

46. It may be possible to develop and manufacture a local product that already exists and satisfies a local requirement. More usually a licence agreement with an existing supplier from an industrialized country is the quickest way to acquire technological information. However, there must be local design and development in order to exploit local opportunities and

deal with the problems that arise as the fraction of indigenously produced components and materials in the machine increases.

47. A valuable by-product of a successful agricultural machinery and implement manufacturing plant is the transfer of technology from the plant in two distinct areas. There should be a close working relationship between the manufacturer and the ancillary industries that supply components. It is envisaged that there should be close collaboration in forming specifications and in deciding on standards of quality control. A more widely-diffused transfer of technology is that which occurs in providing an adequate service for launching the equipment to the farmers and for its proper repair and maintenance. Many of the plants at present manufacturing agricultural machinery and implements in the developing countries are operating well below full capacity. It is urgent that such plants should be advised on how to reduce slack by such means as an expansion of the market, improvement in product mix, regional co-operation and improvements in design and quality control in order to make the product more acceptable

Design, development, adaptation and testing

48. One way of estimating the amount that should be invested in design development and testing is to relate it to the rate of change. In industrialized countries there is a significantly higher rate of investment in industries where there is a high rate of change than in industries that are comparatively static. In Europe the electronic industry invests 22 per cent of the added value in design and development, whilst the agricultural machinery and implement industry invests one per cent.

49. The rate of development of the agricultural machinery industry in developing countries must be higher than in the industrialized countries in order to close the gap between them. A high rate of change calls for high investment in design and development. Even such simple problems as the breakage of cultivator tines calls for metallurgical facilities to control the steel, soil mechanics and stress analysis facilities to estimate the loads and design facilities to modify the structure.

50. The substitution of indigenous materials nearly always raises special problems of modification and quality control. As agriculture develops it will need new machines better suited to local conditions. A requirement already exists for machines to harvest the crops grown in many of the developing countries. These are local problems which should be solved locally. Maintenance can be simplified by good design and attention to such features as the adoption of one grade of lubricating oil. There is plenty of scope for industrial engineering in plants manufacturing agricultural machinery. An industry should not stand still; it should expand by exploiting all the opportunities that are offered to it.

51. Quality control is of great importance both from the manufacturer's and the farmer's point of view. It ensures that the parts of the machines reach the minimum standards that provide reasonable reliability.

52. In the absence of such simple facilities within a manufacturing plant, the setting up of a design centre could provide a service on a group basis.

53. One of the aims of a local manufacturing plant must be to foster the development of technological and technical competence within the country.

54. Field testing of agricultural machinery and implements may be regarded as an extension of manufacturer's quality control to field conditions. It does not seem to offer the farmers any sounder advice than could be obtained by observation of a sample of the machines working under field conditions.

Service, repair and maintenance

55. Timeliness in carrying out critical operations in the production of crops is one of the principal expectations of the farmer from mechanization. On this account the reliability of machines is of great importance. It is felt that the manufacturer has extensive responsibilities in introducing the farmer to the operation of the equipment, in providing adequate supplies of spares at reasonable prices and in training dealers and their service personnel. Manufacturers are expected to invest in providing a good after-sales

service in all countries. However, it is unrealistic to expect to buy agricultural machinery and implements cheaply in the first instance, and then to expect good service and cheap spares.

56. Mobile workshops were advocated for use in developing countries as well as indigenous production of spare parts. Local production of spare parts was regarded as a step towards a manufacturing programme while at the same time providing a cheaper source of supply for the farmers.

Education

57. The manufacture of agricultural machinery and implements in developing countries makes very great demands beyond the existing urgent need for education and training at all levels.

58. There is a need to train the field operators in the use and care of the agricultural machinery and implements and to educate farmers in the elements of farm management so that they can make proper use of the equipment and obtain an adequate return on their investment in machinery.

59. A very extensive and expanding programme of technical training is necessary for those engaged in manufacture and for those in the repair and maintenance of machinery, both at the manufacturing plant and in after-sales service. Commercial and marketing training will be needed for the sales staff.

60. There will be a growing need for education of technologists and managers who will provide leadership both for the agricultural machinery and implement industry itself and for the industries which are expected to grow around the nucleus of industrial growth that an expanding agricultural machinery and implement industry is expected to provide.

Guide-line for UNIDO activities

61. There has been broad general agreement that the time is already ripe to start manufacturing agricultural machinery and implements in many of the developing countries. This is an exciting venture which must be properly

planned so that it is a dynamic activity from which further industrialization and the diffusion of technology through the countryside will grow. There will be an accelerating rate of change and one must plan to take account of this and to encourage it. Our planning must be good because the disappointments of failure are too saddening to contemplate.

62. UNIDO must formulate guide-lines which help the governments of developing countries to make long-term plans for integrated expansion from the very beginning. There is no single answer to the problem of setting up manufacturing facilities for agricultural machinery and implements. Every situation has to be exploited to the best possible advantage, taking into account the particular set of constraints and the particular set of opportunities prevailing at that particular time.

63. It is imperative that UNIDO should immediately start field action-oriented pilot projects for manufacturing agricultural machinery and implements. Such projects would provide the most convincing demonstration of what can be achieved and would be a most fruitful way of making a synthesis, at selected points, of all the expertize available in UNIDO. Through field action-oriented projects in manufacturing agricultural machinery and implements, UNIDO could help in the fulfilment of the aspirations of countries towards self-reliance and at the same time provide nuclei for the integrated transfer of technology in developing countries, with special emphasis on adaptations of large-scale technology to the medium scale sector.

Part III

AGRICULTURAL MACHINERY INDUSTRY IN DEVELOPING COUNTRIES

I. THE ROLE OF AGRICULTURAL MACHINERY AND ITS USAGE

Machinery as an input in agricultural production

64. It is recognized that agricultural production – which commands top priority in developing countries – is the proper management of the application of inputs. The efficiency of inputs is, in turn, a combination of the mode of application and the availability of power and techniques. Agricultural machinery and implements are among the most important media for enhancing agricultural production through efficient and economic application of inputs. Power is an essential input, along with equipment, fertilizer, seed, pesticides and water, for modernizing agriculture. Since the problem of the developing countries is one of increasing the production of food, power and the skill to use it should be of the amount and kind that will contribute to increased yields.

65. One of the main requirements of farming is timeliness of operations. In many areas, particularly in subtropical regions, ploughing can only commence before the first rains if mechanical power is available. Timeliness of planting is all-important as it can have a big influence on yields, particularly where it allows crops to take full advantage of any early rain. Where multicropping can be practised, there is usually too little time to get one crop off and prepare the ground for the next. At peak periods there is always demand for additional power, whether provided by animals or by tractors. Power mechanization enables the farmer to get on with his work quickly when the weather and climatic conditions are right and, furthermore, it is often his salvation when they are not.

66. Power mechanization can also help to increase yields by doing the job more effectively than is possible by hand or with animal power. Tractor power enables a better job of land levelling, terracing, bunding and the application of effective soil and water conservation methods. In medium and heavy soils it allows a better tillage job in deep ploughing, chisel ploughing, sub-soiling discing and in mulching operations to maintain productivity and many other operations. The accurate placing of seeds at regular spacing and at regular depth also has an important influence on yields. This is particularly true for the new high-yielding varieties.

67. Other important functions are the pumping of water for irrigation, and crop protection, including aerial spraying. Weed control too is mainly carried out by mechanical means. Alternatively, sprayers are required for the application of chemicals for weed control. Diseases, moulds and insect pests normally have to be controlled by chemical means and this too requires the use of mechanical sprayers or dusters.

68. Harvesting often causes a bottleneck in farming operations. If crops are not harvested at the right time there can be considerable losses from shattering, from birds and rodents and from weather hazards. The combine harvester not only ensures the safe collection of the harvest from the field, but it has furthermore been estimated that a combine will reduce harvest losses by at least 10 per cent over conventional methods where the crop is cut by hand or by other mechanical means and then has to be stooked, carted and subsequently threshed.

69. Transport forms an important link in farm mechanization. Tractors and trailers or animal-drawn carts are essential for getting crops off the field. Equally important is the availability of transport for getting produce from the farm to market. This may best be served by rail or by trucks rather than by tractors, although tractors are widely used for this purpose.

70. Power in agriculture may be provided by two-whee., four-wheel and crawler tractors. It may also be provided by engines mounted on self-propelled implements, particularly self-propelled combine harvesters.

Power for pumping for irrigation may be provided by tractors, internal combustion engines (mainly diesel) or by electric motors. Tractors, petrol, diesel and electric motors are also used for providing power for grinding, mixing, lifting, conveying and similar farmstead operations and, finally, tractors may also provide the motive power required for farm transport.

71. At one time crawler tractors were extensively used for ploughing and other tillage operations requiring considerable power. They are, however, relatively expensive to purchase, complicated and expensive to maintain and lack flexibility. They are at present used mainly for land clearance and reclamation and for very heavy work under certain soil conditions, but they are not to be recommended for general agricultural use.

72. The two-wheel single axle tractor or motor cultivator is best suited for market garden and vineyard work and for paddy cultivation. It may be fitted with a petrol or with a diesel engine. Owing to its lower capital cost and easy maintenance, it gained some acceptance in the developed countries in the early days of mechanization. Normally, however, it has a shorter working life than the four-wheel tractor and the working costs per hectare, including depreciation, are somewhat higher. In most countries it has been very largely superseded by the four-wheel tractor. The widespread acceptance and use of two-wheel tractors in Japan is largely due to socio-economic reasons which are not paralleled elsewhere. The two-wheel tractor could play a more important role in some of the paddy areas of Asia where the farms are predominantly small and access is difficult. Moreover, it lends itself more easily to local manufacture as for example in China (Taiwan), India and Iran.

73. The most popular and commonly used tractors for agricultural purposes today are the four-wheel models, usually fitted with diesel engines. They have the most versatile application in that they can be used for a wide range of activities, including land preparation, primary and secondary tillage, seeding, inter-row cultivating, spraying, harvesting and transport and they can also provide power for pumping and other operations. Furthermore,

the operating costs of a medium to large diesel engine four-wheel tractor, including depreciation and maintenance, is lower than for any other type of tractor.

74. There is another, although indirect way in which tractors contribute to increased food production: increasing the size of the fields and consequently the net amount of land under production. It is estimated that in developing countries nearly three per cent is lost on one acre plots and eight per cent on one-half acre plots due to intermediate bunds. Tractors, engines and power driven implements also release productive land which would otherwise be used for feeding the draft animals which the engines replace.

75. Improved and additional power contributes to a reduction of labour, the elimination of peak labour loads and to convenience. Mechanical power is a catalyst for changing the attitudes and raising the social status and dignity of those who work in agriculture. Mechanical power provides a challenge for the designing and use of a whole new array of modern implements — implements that perform their functions better and faster for increased yields and production. Obviously, the development of agricultural machinery and implements manufacturing sector, integrated with the domestic engineering industry, will give a more meaningful solution to the over-all industrial growth of the developing countries.

76. Owing to the importance of agriculture in the economies of developing countries, improvements in agricultural income increase the community's purchasing power and farm mechanization diffuses technology throughout the countryside, involving a large section of the population in its activities.

New techniques in agriculture

77. The introduction of high-yielding rice and other crop varieties has raised exciting possibilities for tropical farmers and the need for mechanical cultivation has acquired new significance. The shorter growing season of the improved varieties, together with their higher yields, provide incentives for multiple cropping. If the rice farmer is to keep the land in near-continuous production, power equipment suited for lowland conditions must be made

available. Equipment is needed to enable the tropical farmer to cope with the high labour-consuming operations of land preparation, transplanting, weeding, harvesting and threshing. In addition, recent increases in rice yield have created problems of drying and processing which require engineering attention. It must also be pointed out that most of the developing countries have now started manufacturing facilities for fertilizers and insecticides and the use of these is gradually increasing. There has been a growing awareness in allied industries, especially agricultural chemicals, fuels and lubricants, about the utilization of their products in the agro-industrial sector.

78. In view of the importance of irrigation for increased yields and profit, attention should be given to the mechanical forms of irrigation, including supply, control and distribution, as well as its efficient management.

79. The development of land in order to make mechanized farming practical and economic, as well as to increase yields per hectare per season and per year, should command the highest priority in national planning for the manufacture of equipment. Clearing land, shaping and sizing the fields, grading the surface to maximize the efficiency of water utilization, the construction and maintenance of drainage ditches and of irrigation conveyances and controls were also referred to, as well as the development of adequate rural road systems.

80. Among other developments mentioned were:

(a) Placement of fertilizer into rows;

(b) Many working operations are being combined into one drive, such as harrowing, row fertilizing, sowing and rolling, giving better yields with less labour and less soil compaction;

(c) The use of plastics in general for machines, greenhouses, pipes in irrigation and drainage etc.;

(d) Harvesting of vegetables and fruits is developing from hand methods to mechanical. The methods of growing these crops are being made more suitable for mechanical harvesting;

(e) Part of the most important mechanization development in the near future must be in the animal husbandry mechanization, which has as yet hardly begun. It must be remembered that the size of enterprise in animal husbandry, horticulture etc., is more or less independent of farm size and therefore easy to enlarge, mechanize and automate;

(f) Storing fodder grain at relatively high moisture content by cooling, using chemicals etc.;

(g) In fodder harvesting, rotary mowers, grass drying, packing of fodder in anaerobic state in the field, fodder-pellets or wafers of grass;

(h) Stock feeding: fixed conveyors with tower silos and mobile feeding equipment with horizontal silos; for pigs, dry feeding or liquid pipeline feeding;

(i) Environmental control in (a) stock buildings: ventilation, temperature and humidity; (b) glasshouses also CO_2-content, light and watering; (c) storage for potatoes, vegetables, fruits etc.;

81. The main general trends in development of machines are:

- Increasing the unit output;
- Increasing the driving speed;
- Specialization of the implements – self-propelled;
- Automation of the driving, adjustment and maintenance;
- Co-operation between manufacturers in designing implements which are used together in the same work chain;
- Increasing the safety and comfort.

82. One condition for economical mechanization is continuous growth in the size of agricultural and forestry units and thereby a decrease in their number as well as co-operation between the individual units. Simplification of production, regional specialization and also, in the case of smaller farms, possibilities to earn regular secondary incomes will be necessary in many cases. By co-operation the farmers can, from a professional viewpoint, specialize without the production on the farms becoming limited to too few products. This co-operation not only applies between farms (horizontal integration) but also between farms and other branches of commerce (vertical integration).

83. Foodstuff production in developing countries should, when possible, also be partly organized on the same principles as industrial production. These principles should be applied at field level by aiming at large production units wherever possible.

84. In most industrialized countries, at least in the initial stages of development, the agricultural machinery sector developed on its own, with almost no interrelationship among the manufacturers of agricultural chemicals, fuels and lubricants, seeds and agricultural machinery. The same also applies to irrigation and drainage schemes and the development of water management and the manufacture of irrigation equipment such as pumps etc.; but due to modern technology in agriculture, there is now very significant intercommunication between the manufacturers of agricultural machinery and other allied input manufacturers.

85. Taking into account the accelerated manufacture of other allied inputs, especially agricultural chemicals (fertilizers, pesticides, insecticides), fuel and lubricants, hybrid seed and development in water resources, it is necessary to evolve a work programme of agricultural machinery and equipment integrated with the production and utilization sector of agricultural chemicals, fuels, seeds and water resources in developing countries. This will call for integrated planning from all aspects and co-ordinated action programmes in order to render the agro-industrial and agricultural machinery manufacturing plans of the developing countries fruitful and meaningful.

<u>Factors contributing to higher farm income</u>

86. Agricultural production and the sectoral development of agriculture have been given great emphasis in all developing countries. The manufacture and utilization of selected inputs have been awarded a relatively high priority. There has been a marked improvement in agricultural management techniques. Hence, in every developing country, there is a significant percentage of farmers who are enjoying a higher farm income as a result of the effective application of agricultural technology to crop production. As a nation raises its standards of living, the cost of manual labour will also increase and, of course, the reluctance to perform undesirable and unexciting jobs, regardless of the amount of pay.

87. The importance of establishing competence in farm management as a prerequisite for successful mechanization was stressed. The introduction

of machines on farms increases capital investment in the farms. The management of the equipment usually affects economic returns to the farmer more than normal variations in the cost prices of machines. The agricultural practices in a country determine the type of mechanization which is acceptable. Successful machines must be based on a sound and progressive system of agriculture.

88. National leaders have the problem of allocating resources in the matter of the kind, type and amount of equipment to manufacture and to export. A systems analysis will help indicate the equipment needed to maximize the production of those crops to which a country will give a high priority. It was pointed out that with basic tillage there will be one operation that will require the maximum power input and that this, in the final analysis, will determine the minimum size of power unit.

89. There is need to improve the kinds of animal-drawn equipment that will increase yields and complement the use of mechanical power. The cold fact is that agriculture is short of total power and animals will be used in many countries for a long time. Examples of the kinds of equipment in need of manufacture are the grain drill and the seed planter. It was pointed out that previous research indicates the limited opportunities and questionable success of attempting to increase animal power through harness design. Improved, light-weight steel ploughs could reduce the number of ploughings required in many cases, while improved seeding and tillage techniques could substantially increase yields. It will be necessary, however, for such improved equipment to be produced in quantity and at prices that the small farmer can afford, and that credit facilities are readily available for their purchase. At present their relatively high cost puts them well beyond the reach of most of the small subsistence farmers in developing countries.

Acceleration of the rate of agricultural development

90. Two aspects of agricultural mechanization were emphasized: first, meeting the present needs of mechanization of agriculture in the developing countries and second, working out prospective approaches providing the maximum productivity of agriculture in these countries.

91. It would be a mistake to orientate the developing countries to pass through the stages which were taken by the developed countries of the world. This would cause an unjustified delay in development of new nations. It seems more reasonable to encourage the developing countries to use the most productive types of agricultural machinery, based on the experience of the industrial countries.

92. The use of such machines is possible provided there is solution of such problems as:

> Training of personnel for the manufacture, use and repair of machines;
>
> Creation of large holdings possessing sufficiently large areas of fields on the basis of co-operation among small farms, creation of state-run farms and so on.

93. The alternative, involving the enlarging of farms as a result of farmers going bankrupt, is too long and painful.

94. In developing countries a sort of vicious circle can now be observed, with limited productivity restricting the possibility of buying the machinery while lack of machines prevents an increase in productivity. Even if a farmer can afford to buy a sophisticated machine he often does not know how to use it.

95. Such problems were confronted in USSR 30 years ago at the beginning of intensive mechanisation of agriculture. The only solution which was found involved setting up state run machine tractor stations staffed with skilled personnel and provided with good repair facilities. These stations operated on the basis of agreements with nearby farms.

96. There may be other ways and means of using highly productive agricultural machinery.

97. Unless a search for such forms of agricultural machines utilization is made, the mechanisation of agriculture will be delayed for many years, limited productivity machines only will tend to be introduced and productivity will grow very slowly; labour consumption will be high, the number of agricultural workers great and this would delay the whole process of industrial development of developing countries.

98. It appears that manufacture of agricultural machines and tractors in the developing countries can only be organised on the basis of co-operative efforts of a group of neighbouring countries, including the use of local raw materials.

Power to optimize yields

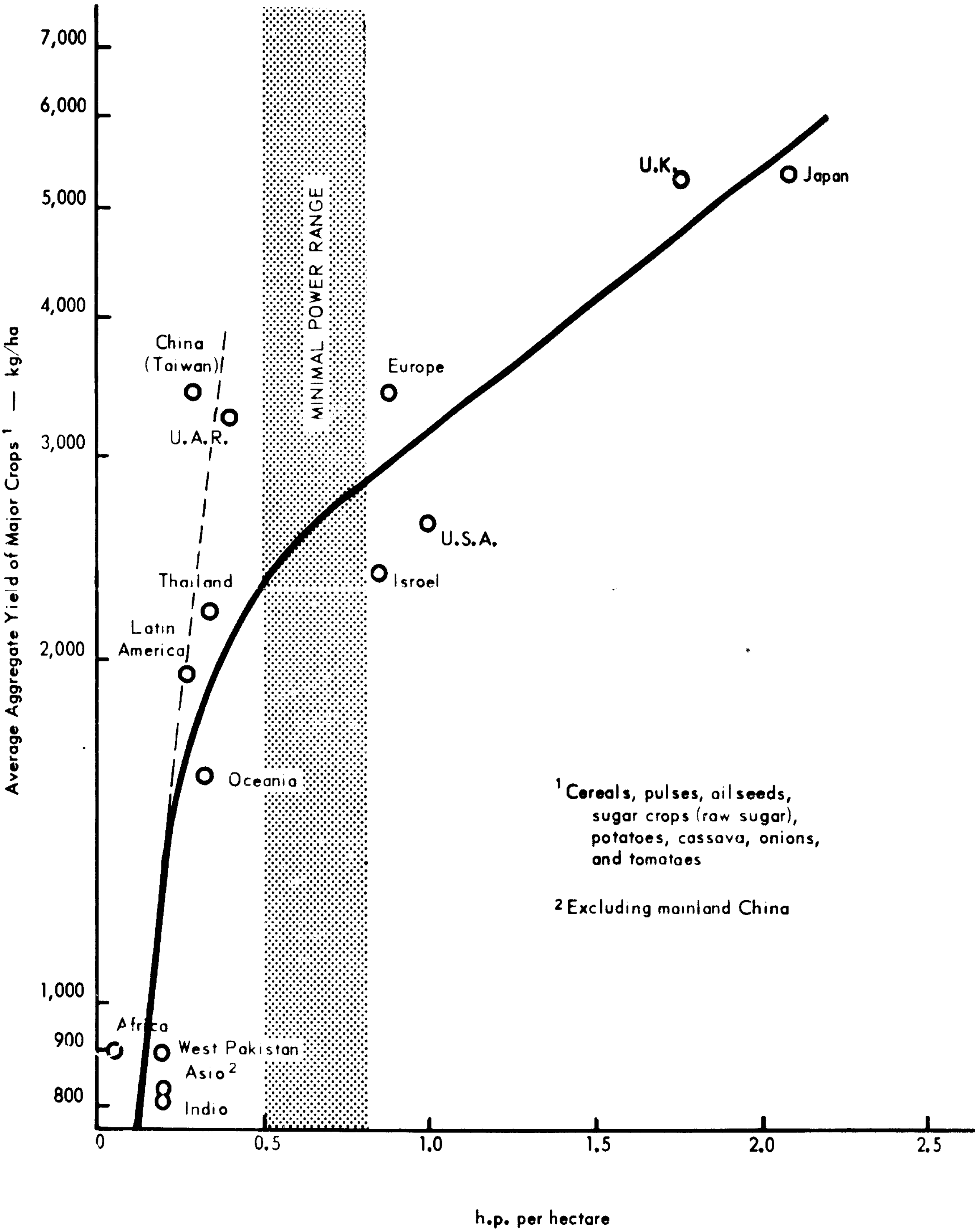
99. A most important question is: What is the minimum amount of power per hectare needed to optimize yields? In an attempt to arrive at an objective answer, horsepower per hectare was plotted against the average yields per hectare of all major crops for countries, regions and continents, as shown in Figure 2, based on values in FAO Production Yearbook 1965. Figure 2 indicates that the minimal power per hectare for developing countries should fall within a range of 0.5 to 0.8 h.p. The logarithmic scale for yields helps to emphasize that 0.5 horsepower/hectare is a marked inflection point in the slope of the curve. For calculating estimates of minimal power required, 0.5 h.p./ha should be a reasonable goal. The United States of America, Europe, the United Kingdom and Japan, where production commands the main attention, are probably over-powered for the optimum. These countries of high production and high standards of living now regard labour efficiency and convenience as the dominating criteria. It will be noted that the greatest gains in yields are obtainable more rapidly up to a power input of 0.5 h.p./ha. Placing greater emphasis on increasing the number of tractors in early stages of development is a matter of considerable urgency. Much more than the 0.5 h.p. would, of course, be required to maximize production.

100. Data on additional countries is obviously needed to make such an analysis more reliable. In particular, data is needed on countries that fall within the 0.4 to 1 h.p. class, since this appears to be the critical portion of the curve. To assess the power more accurately, more precise data on quantities of human labour, animals and tractors used in agriculture and estimates of their h.p. capacity is required. Power for irrigation and stationary machine utilization directly related to food crop production and preservation should also be included. An index of yields per hectare that

Figure 2

Relationship between yields in kg/ha and power in h.p./ha

(Major food crops)



assesses the data according to crop areas, tonnage and relative production energy requirements should be used. The yield-value index as developed and used by FAO should be tested for this purpose.

101. It must be borne in mind that the curve in Figure 2 does not necessarily prove that greater power application to agricultural operations in the developing countries will contribute to increased yields, but it adds to the confidence in supporting the thesis, and provides a more scientific base for programming the needs at this stage than would otherwise be possible.

102. The question might be posed why Africa, Latin America and Asia cannot do as well as China (Taiwan) and the United Arab Republic, both of which have proportionally large inputs of human power. A partial answer may be found in looking at some of their characteristics as compared with India. This comparison is made in Table 1.

Table 1

Some comparative characteristics of three countries

	Ratio of irrigated to cultivated land	Quality of potentially arable land	Health rating	Calorie level percent	Educational rating
China (Taiwan)	61.8	1	1	102	2
India	19.9	2	3	84	3
The United Arab Republic	100.0	1	3	108	3

103. Most important in Table 1 is the ratio of irrigated to cultivated land. Where a dependable source of irrigation water is available, timeliness is not critical in seed or plant bed preparation, except in a three-crop/year system. The time to prepare a good bed adequately can be spread with little loss, if any, of yields.

104. Generally, the farmers of the developing countries want the latest in tractors because they do a better job, enhance convenience and increase status. It is a mistake for a nation to force upon its farmers the tractor types discarded or outdated in other countries. The latest models should be used but caution should be exercised in adding unnecessary accessories.

Relationship of size of holding to mechanization pattern

105. 'The average size of the holding', an existing statistical number, indicates that the average size in most of the developing countries is small, usually less than 2 ha. However, a detailed analysis of the existing distribution pattern of the size of the holdings in each country indicates that "small holdings" (0-3 ha) constitute a high percentage of the total number of holdings, the medium and large size holdings constituting a very significant percentage of total area cultivated. Land tenancy reforms which are being implemented in most of the countries are aiming at making the tiller the owner of the land and at giving him fair treatment under land tenancy acts. However, there is still the major problem of fragmentation of land holdings in all the developing countries. On the other hand, due to relatively higher farm income enjoyed by a section of farmers, the use of "selected" farm equipment is becoming popular on relatively small holdings.

Role of contract farmers/operators in the use of agricultural machinery

106. Again, as contract farming is becoming popular in certain countries, especially in the usage of tractors and threshers and combine harvesters, the classic "size of the holding - farm machinery" relationship no longer holds good in absolute terms. Although many attempts have been made towards the introduction of co-operative usage of agricultural machinery and implements, there has not been any significant development and co-operation in agricultural machinery usage has been limited.

107. In general it is necessary to identify the probable levels of mechanization and agricultural machinery required for the three major size groups of holdings - small, medium and large - with reference to developing

countries. It is desirable to take into account the prevailing effect of contract farming and community usage on agricultural machinery development.

108. The requirements of farm machinery based on the size of holdings may be indicated as follows:

(a) Small holdings which practise subsistence farming in which hand tools are widely used. There appears to be considerable scope for a reduction in the number of designs of hand tools. With standardization there are economies in large scale production, e.g. hand tools, improved animal drawn implements, hand operated crop protection equipment, small engines, hand power pumps, pedal operated threshers.

(b) Medium holdings characterized by small progressive farmers who possess rudimentary standards of farm management. The source of power may be animal or small tractors. Considerable progress has been made in the development of animal drawn equipment and it has had a stimulating effect on farming practices. It is probable that in many areas animals are transitional between hand tools and engines. A better understanding of the principle of action of the implement and its place in the production system should help to establish implements well suited to local conditions and worthy of local manufacture, e.g. hand tools, power tiller and matching full range of implements, hand operated power crop protection equipment, engines, power pumps, trailers, power threshers.

(c) Large holdings practising cash farming which use full size conventional tractors. In most cases there are opportunities either for modifying existing equipment or for developing new equipment in order to satisfy more fully local needs, e.g. riding, wheel-tractors and matching implements including levellers, power crop protection equipment, engines, power pumps, trailers, power threshers, power harvesting machinery, seed cleaning and handling equipment and milking machines.

II. CLASSIFICATION, DEMAND AND TRENDS IN DESIGNS

Classification of agricultural machinery and implements

109. A universal classification system is badly needed. All agencies involved should work together in developing an international classification index that will be accepted and used throughout the world to improve communication and understanding. UNIDO has a co-operative responsibility to

play in this matter. From the viewpoing of the manufacturer, the classification index should reveal specifications and not necessarily end usage.

110. The statistical classification of agreed nomenclatures adopted by CEMA (The European Committee of Associations of Agricultural Machinery Manufacturers) was discussed. It is based on fifteen class headings:

Class	I	Agricultural power units
"	II	Equipment for working the soil
"	III	Equipment for sowing, planting and distributing manures
"	IV	Equipment for crop protection
"	V	Equipment for irrigation
"	VI	Equipment for harvesting
"	VII	Equipment for threshing, selection and conditioning of agricultural products after harvest
"	VIII	Equipment for livestock husbandry (excluding equipment for handling feed and manure)
"	IX	Equipment for the processing of agricultural products on a farm scale (e.g. wine making, cider making etc.)
"	X	Equipment for dairy work on a farm scale
"	XI	Equipment for farm handling and transport
"	XII	Equipment for land reclamation and soil conservation
"	XIII	Construction of components and accessories
"	XIV	Miscellaneous agricultural equipment
"	XV	Replacement parts.

The codification system has been agreed with ISO and is shown in Appendix I.

Existing usage of agricultural machinery

111. There is no readily available comprehensive data on the existing usage and demand of agricultural machinery for all developing countries. The Report of ECAFE/AIDC-UNIDO Fact Finding Team on industries manufacturing agricultural machinery in 12 ECAFE countries appears to be the first of its kind. The report states that hand implements are used on most of the farms. In the majority of cases, draft animals with wooden ploughs, harrows, land levellers and puddlers are common. There has been no significant widespread usage of improved implements except in selected areas of certain countries. Power tillers are mainly limited to paddy cultivation, and used in China (Taiwan) and the Republic of Korea; they are being introduced in almost all of the other countries of Asia. Four-wheel riding tractors are used in all the countries; a thorough usage is significant in India, Pakistan,

Iran, Thailand and Ceylon. The common tractor-drawn implements were mould-board and disc ploughs, cultivators and disc harrows. Seed drills, planters and fertilizer distributors have been recently introduced. Except in Iran no machinery for harvesting is used. Hand sprayers, pumps, engines and threshers are commonly used, although knapsack sprayers are now being introduced

112. Agricultural machinery is more widely used in the major countries of Latin America than in Asia. Sufficient comprehensive data is not available on the over-all agricultural machinery and implement position for Africa, the Middle East and Latin America. It is necessary for studies on the lines of ECAFE/UNIDO Fact Finding Team to be undertaken in these major geographical areas.

Priority order of agricultural machinery to be considered

113. The order of priority towards consideration and manufacture differ from country to country. The following order of priority may be considered as a general guide-line:

(i) Power machinery such as tractors, power tillers and engines
(ii) Tillage implements
(iii) Crop protection machinery
(iv) Irrigation machinery
(v) Seeding and fertilizer equipment
(vi) Threshers
(vii) Hand and animal drawn implements
(viii) Harvesting machinery
(ix) Processing equipment
(x) Grain handling items
(xi) Transport equipment
(xii) Machinery for special crops

Future demand for agricultural machinery and implements

114. The report of ECAFE/AIDC-UNIDO Fact Finding Team has analysed the probable demand for agricultural machinery and implements for the twelve countries visited. Again it is necessary for information on these aspects to be compiled in three other geographical areas, namely Africa,

the Middle East and Latin America. The following are the highlights of the ECAFE-UNIDO Fact Finding Team with respect to twelve Asian countries:

ECAFE Group of Countries: China (Taiwan), the Republic of Korea, the Philippines, Indonesia, Singapore, Malaysia, Ceylon, Thailand, Iran, Pakistan (East and West), India and Nepal.

Four-wheel riding tractors

115. The level of consumption of tractors was high in Ceylon, India, Iran, Malaysia, Pakistan, the Philippines and Thailand. The total sales for 1968 were around 33,000, of which tractors within the range of 35 - 45 h.p. were highest. It was expected that in 1970 the annual sales as compared to 1968 would increase by 70 per cent and in 1975 by 250 per cent. In 1968 the number of tractors manufactured was 22,000, of which about 12,000 were manufactured in India under a progressive scheme for substituting imported tractors by those locally made. Another 6,700 were assembled but with limited local parts in India, Iran, Pakistan and Thailand. The rest were assembled in Ceylon, the Philippines and Thailand from parts which were almost totally imported in the form of CKD components. Manufacturing machinery was being installed to produce 30,000 tractors by 1970 and 74,500 by 1975. The number of assembled units estimated for 1970 was around 15,000.

116. It was estimated that the output of tractor manufacturing plants which would be installed and/or expanded in the near future would not be able to cope with the projected consumption requirements by 1975. A regional production deficiency would therefore justify the economic manufacture of tractors of various sizes. For tractors within the 35 - 50 h.p. range, the collective demand was expected to be around 32,000, of which India and Pakistan would absorb about 80 per cent. The manufacturing capacities of both countries for 1970 in the given range of tractor sizes were expected to be approximately adequate. For tractors within the 55 - 65 h.p. range, the collective demand was expected to be around 15,000, of which 13,600 represented the combined demand in India, Iran, the Philippines, and

Thailand. In Iran, there was a plan to install a tractor manufacturing plant with an annual installed capacity of about 4,000 units.

Power tillers (hand tractors)

117. In 1968, the total number of power tillers in the twelve countries visited was reported to be around 70,000. The total annual consumption was around 21,500. The annual demand was expected to increase to 38,000 by 1970 and to around 100,000 by 1975. Out of an installed combined annual capacity of 20,600, about 14,000 power tillers were manufactured with various amounts of local parts in Ceylon, China (Taiwan), India, Iran and the Republic of Korea. In most of these countries, a substantial proportion of the components were made locally, except for the engines and transmissions or their main parts which were still imported, principally from Japan. Plans were under way in the countries visited to increase the combined annual installed capacity to about 34,000 by 1970.

118. It was expected that the aggregate annual demand for power tillers in the countries visited would increase by about 65 per cent in 1970 as compared to 1968. The number of manufacturing plants available by that time would be adequate for producing approximately 90 per cent of the aggregate demand. Owing to the increasing demand for power tillers, however, it was necessary to expand the manufacturing plants available. Furthermore, it appeared that there would be a bigger market in the future should a less expensive, more rugged and simpler power tiller be developed and mass produced for the needs of developing ECAFE countries where agricultural conditions, especially in rice-producing areas, are almost identical.

Small riding paddy tractor

119. In many rice-producing countries the need was expressed for a small compact and economical riding paddy tractor with a suitable matching wet land tillage system, preferably with a rotary tiller, in the 20 h.p. range. The production of such a tractor, especially if it could be offered at a lower price than those normally available, would increase the demand for

such tractors particularly for wet land cultivation. Considering the interest in such a tractor expressed by the parties in the rice-growing countries, the possibilities of manufacturing such a paddy tractor should be investigated.

Small engines for agricultural use

120. Manufacturing plants to produce small engines were found in China (Taiwan), India, Indonesia, Iran, Pakistan and the Republic of Korea. The production of small engines of various types (including the engines for tractors and power tillers) in the twelve ECAFE countries visited was about 277,000 in 1968, of which India produced about 90 per cent. However, small engines for agricultural purposes, of various sizes and makes, needed to be categorized, according to the purpose of their specialized manufacture, as follows:

(a) 1 - 2 h.p. gasoline-fed micro-engines for knapsack sprayers and dusters: In India where such engines were manufactured, the production in 1968 was around 18,000 from a plant with an installed capacity of around 36,000. The demand for 1970 of such engines in the twelve ECAFE developing countries visited was estimated to be 90,000 and was likely to increase two-fold by 1975. It was therefore necessary to explore the possibilities of setting up a mass production manufacturing plant to supply, at a competitive price, all the requirements of the countries within the Far Eastern sub-region. At the same time, India should find ways of utilizing more of its installed unused manufacturing capacity.

(b) 3 - 5 h.p. gasoline-fed engine for light agricultural applications: The aggregate production in 1968 was around 24,000. The increasing demand for 1970 was estimated to be about 80,000 and for 1975 about 160,000. Those estimates took into consideration the competition from diesel engines for similar agricultural applications. To meet the demand, it seemed necessary to explore the possibilities of setting up a new plant in the Far East.

(c) 3 - 15 h.p. diesel engines for power tiller and stationary agricultural applications: In 1968, the combined production of such a category of small engines from plants in China (Taiwan), India, Iran, South Korea and Pakistan was around 140,000. The demand was increasing rapidly and would reach an estimated annual volume of 330,000 by 1970, in pace with the increasing demand for power tillers and pumps. In plants located in China (Taiwan), India, Iran, the Republic of Korea and Pakistan, the respective productions would have to be increased to cope with the proportionate demands. Steps would have to be taken by countries such as Ceylon, Indonesia, Malaysia, the Philippines and Thailand to manufacture such engines.

(d) 12 - 30 h.p. diesel-fed engines for medium duty agricultural applications: Except in India and Pakistan, the demand for such engines, mostly of the horizontal types, was relatively small. With the increasing rural electrification, the need for such engines was decreasing, except for irrigation purposes and deep well installations at places where electricity was not economical. There were manufacturing plants for such engines in Iran, the Republic of Korea, and Pakistan; the quality of production needed to be further improved.

(e) 30 - 75 h.p. diesel engines for riding tractors: In 1968, about 18,000 such engines were manufactured in India. It was estimated that the collective annual demand for 1970 of the twelve ECAFE countries visited would be 57,000.

Power-operated pumps

121. Centrifugal pumps were widely used for agriculture in the twelve ECAFE countries visited. Propeller paddy pumps employed to transfer water between low head areas, such as between irrigation canals and paddy fields, were used mostly in the Philippines and Thailand. Deep well water pumps were used quite extensively in India, Iran, Nepal and West Pakistan. The total demand for 1970 of all types of pumps in the countries visited was estimated to be 440,000. All the countries were almost able to produce their respective requirements of conventional pumps for agricultural purposes. The technology requirements for the manufacture of such pumps were relatively simple, although there was a need to improve the manufacturing techniques, particularly in foundry practices. The aggregate production of power-operated pumps, which was estimated to be around 375,000 in 1968, needed to be rapidly increased to cope with the demand which was roughly estimated to be about 950,000 by 1975.

Plant protection equipment — sprayers and dusters

122. In all the countries visited there was a growing awareness of the need to protect crops from pests and other forms of plant diseases. Hand-

operated sprayers were already used substantially while power-operated knapsack dusters and sprayers were still in the introductory stages. The estimated demand for 1970 of hand-operated sprayers and dusters was 330,000, while the production for 1968 was around 240,000. In the case of power-operated knapsack sprayers and dusters, the aggregate production for 1968 was around 24,000, whereas the estimated demand for 1970 was 80,000. Hand-operated knapsack sprayers, being relatively simple to manufacture at low cost, could be manufactured in every country. However, small 1 - 2 h.p. gasoline-fed engines for knapsack sprayers needed to be procured initially as, to be economical, they would have to be manufactured on a large scale. On account of increasing national demands, countries such as Indonesia, Iran, Malaysia, the Philippines and Thailand would be justified in going ahead with the full scale manufacture of power knapsack sprayers, excluding initially the small engines that would have to be imported, together perhaps with the nozzles.

Paddy threshers

123. The demand estimated for 1970 of pedal-operated paddy threshers of the simple type was about 65,000. The total production in 1968 was around 30,000. Pedal threshers could easily be produced in all ECAFE countries, since they were simple to manufacture and the amount of investment necessary was small. The demand estimated for 1970 of power-operated paddy threshers of the simple type was about 50,000 and for 1975 about 150,000. In none of the countries was there found any organized effort to produce an efficient type of power paddy thresher. However, appreciable efforts were being made to design and evolve improved models. Efforts were being made in the Philippines by the International Rice Research Institute and in Thailand by the Engineering Division of the Rice Department.

Power wheat threshers

124. With the introduction of high-yielding varieties of wheat and multi-cropping patterns, the demand for power wheat threshers in wheat-producing

countries such as India, Iran and Pakistan was expected to increase. The demand for power wheat threshers for 1970 was estimated to be about 26,000. In 1968 the production was only 11,000. In many major wheat-producing countries, combine harvesters, mainly of the self-propelled type, were widely used, although their introduction in Asian countries such as Iran and West Pakistan was only recent. Until recently, no significant attempts to introduce them had been made in India. The local designs of wheat threshers found in the Asian wheat-producing countries needed considerable engineering improvements. However, those introduced and manufactured in West Pakistan appeared to be the best suited for the requirements of the region.

Hand tools and bullock drawn implements

125. There was a need to improve the techniques of manufacture of hand tools and bullock-drawn implements as well as their design and quality. No country seemed to have given much attention to their manufacture. Besides the drawbacks in the implements, the low capability of bullocks to produce adequate draft power had hindered production. Other factors were the diversity of models of tools and implements in use within the region, the current dearth of quality manufacture in small shops and, above all, the difficulty of making available quality implements at economical prices. State run plants in Ceylon and Nepal were producing hand tools and bullock-drawn implements at outputs below the rated manufacturing capacities.

Tractor and power tiller implements

126. Small-scale producers or tractor/power tiller manufacturers and assemblers themselves fabricate the matching basic implements in accordance with the original specifications. Although accepted and widely used in the countries visited, the implements manufactured needed to be improved both as regards their material composition and the techniques of manufacture. Disc ploughs, mouldboard ploughs, tillers, seeding and fertilizer distributors, crop protection equipment, and in particular, specialized components such

as tines, discs, bearings, shares, mouldboards and bar points needed to be manufactured with regional collaboration in mind.

Rice-processing machinery

127. The introduction of new high-yielding varieties of rice pointed to the need for improved machinery and techniques for rice processing. Improved drying, hulling, milling, storage and transport facilities should be adopted to avoid the substantial losses resulting from the traditional harvesting methods. Technical solutions were available, but a judicious choice should be made of the size and type of equipment to be promoted, taking into consideration all the factors involved, such as location, facilities etc.

African countries

128. It is very heartening to note that the Economic Commission for Africa (ECA) – through various activities in engineering industries with special reference to regional industrial development and harmonization – has carried out valuable preliminary studies on the future demand of agricultural machinery and implements in Africa. Following are the highlights of various reports with respect to estimated demand by 1980.

Hand tools for agriculture

(a) West Africa

129. The estimated consumption of tools for use by hand and with machines (group 697) in 1980 is about 25,000 tons, of which between 40 and 50 per cent will consist of hand tools used in agriculture and forestry, i.e. spades, forks, hoes etc., and 50 - 60 per cent of other tools for use by hand or with machines, i.e. hammers, pliers, pincers, spanners, metal cutting shears etc. It will be assumed that about 80 per cent is produced in the sub-region and the rest, mainly tools for use with machines are imported. The present production in the sub-region is about 1,540 tons – mainly in the UAR (1,300 tons). Estimated productions in 1980 are:

UAR	-	2,000 tons of agricultural hand tools per annum and 3,000 tons per annum capacity for other tools for local use and partly for export;
Sudan	-	1,000 tons of agricultural hand tools;
Libya	-	4,000 tons of tools other than agricultural, for local use and partly for export;
Tunisia	-	1,300 tons of agricultural hand tools;
Algeria	-	3,000 tons of agricultural hand tools and 3,000 tons of other tools for local use and for export;
Morocco	-	2,000 tons of agricultural hand tools

(b) East Africa

130. The estimated consumption of group 695 (tools for use by hand or with machines) in 1980 is about 40,000 tons, of which between 80 and 85 per cent will consist of hand tools used in agriculture and forestry, i.e. spades, forks, hoes etc.

Engines

(a) West Africa

131. The first group in the machinery division is power generating machinery (711) for which the demand in 1980 will amount to 60,000 tons. Of this, 60 per cent will consist of internal combustion engines and 20 to 25 per cent of steam generating boilers.

132. If it is assumed that about half the requirements for internal combustion engines can be met by local production, say up to units of 50 h.p., there is room for two factories each with an output of about 10,000 tons per annum or 15,000 to 20,000 engines. The main markets for these engines will be Nigeria, Sierra Leone and Ghana, in order of importance.

(b) North Africa

133. The first group in the non-electrical machinery division is the manufacture of power generating machinery (711) for which the demand in 1980 will amount to 116,000 tons in the sub-region and about 53,000 tons in

Maghreb countries. Of this, 60 per cent will consist of internal combustion engines and 20 to 25 per cent of steam generating boilers.

134. If it is assumed that about half of requirements for internal combustion engines can be met by local production, say up to units of 50 h.p., there is room for new capacities of about 30,000 tons per annum or 45,000 to 50,000 engines.

135. The main markets for these engines will be the UAR with 50 per cent of total consumption in the sub-region, which is also at present the only producer of internal combustion engines (about 1,000 tons per annum), and Algeria, which will consume almost 45 per cent of the demand of the Maghreb countries.

(c) East Africa

136. The first group in the machinery division is the manufacture of power generating machinery (711) for which the demand in 1980 will amount to 35,000 to 40,000 tons. Of this 60 per cent will consist of internal combustion engines and 20 to 25 per cent of steam generating boilers.

137. If it is assumed that about half the requirements for internal combustion engines can be met by local production, say up to units of 50 h.p., then there is room for one large factory with an output of 10,000 tons per annum of 15,000 to 20,000 engines. The main markets for these engines will be Zambia and Kenya.

Agricultural machinery and implements

(a) West Africa

138. The consumption of the next group, agricultural machinery etc., is estimated at about 110,000 tons in 1980. Important categories are agricultural tractors and accessories accounting for between 50 and 60 per cent of consumption, i.e. 55,000 tons per annum, and agricultural machinery, and applicances for preparing and cultivating the soil, for harvesting etc., accounting for 20 per cent, or about 20,000 tons per annum. The total

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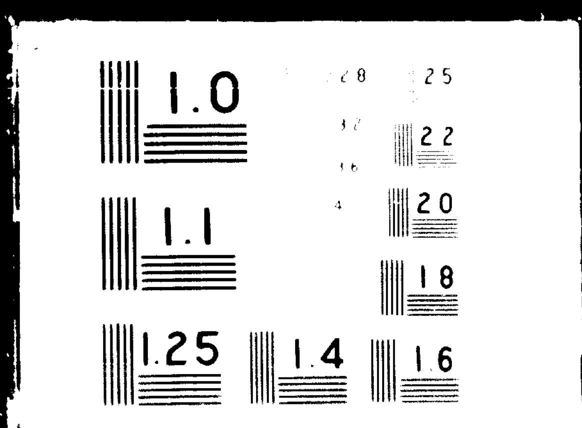


consumption of tractors is estimated at between 30,000 and 40,000 units and between 27,000 and 32,000 of up to about 50 h.p. might be produced and the remainder imported. In this case a sub-regional market is necessary.

139. Of the market for agricultural machinery, about 6,000 to 8,000 tons per annum (about 6 to 7 per cent of the total consumption of the group 712), will consist of ploughs, for use both with tractors and animals. The present capacities in Senegal and Niger, accounting for about 600 to 700 tons, will be sufficient to supply the domestic demand of these countries and the demands of Mauritania, Mali and the Upper Volta. Important markets are Nigeria, with a demand of about 3,500 to 4,000 tons per annum, and Ghana and Liberia, each with about 1,000 tons.

(b) North Africa

140. The consumption of agricultural machinery etc. (712), is estimated at about 124,000 tons, of which almost 90 per cent (109,000 tons) will be in the Maghreb. However this estimate does not take account of agricultural consequences of the Aswan dam in the UAR.

141. Important categories are agricultural tractors and accessories, accounting for between 50 and 60 per cent of consumption, i.e. 60,000 tons per annum, and agricultural machinery and appliances for preparing and cultivating the soil, for harvesting etc., accounting for 20 per cent or about 25,000 tons per annum. The total consumption of tractors is estimated at between 30,000 and 40,000 units; between 25,000 and 30,000 units of up to about 100 h.p. should be produced and the remainder imported. A sub-regional market is necessary. It would be desirable to have close co-operation and co-ordination with the producers in the UAR (present production about 2,000 tons per annum), Algeria and Morocco as far as the types and accessories for locally produced tractors are concerned.

142. Of the market for agricultural machinery, about 7,000 to 9,000 tons per annum (about 6 to 7 per cent of the total consumption of the group 712) will consist of ploughs, for use both with tractors and animals. New capacities additional to those existing could be established.

(c) East Africa

143. The consumption of agricultural machinery etc. (712), is estimated at about 54,000 tons in 1980. Important categories are tractors and accessories accounting for between 50 and 60 per cent of consumption, i.e. 28,000 tons per annum, and agricultural machinery, i.e. cultivating and harvesting machines accounting for 20 per cent, or about 10,000 per annum.

144. The total consumption of tractors is estimated at between 18,000 and 20,000 units, and between 14,000 and 16,000 up to about 25 h.p. should be produced and the others imported. A sub-regional market is necessary.

145. Of the market for agricultural machinery, about 3,000 to 4,000 tons per annum will consist of ploughs. Important markets are Zambia, Kenya, Tanzania, Ethiopia and Madagascar.

Pumps

146. The market for machinery and appliances (719) is the largest machinery group.

(a) West Africa

147. The demand is expected to exceed 200,000 tons per annum in 1980 manufactures and will include the following main types of machines:

10 - 15 per cent pumps and centrifuges;
5 per cent valves and similar appliances;
20 per cent lifting and loading machinery;
10 per cent weighing machines.

148. It will be possible to construct plants for each of these types and to cover about a half the total demand. For the manufacture of valves, cocks etc. (from bronze and other copper alloys), a sub-regional plant is proposed with a capacity of 3,000 to 5,000 tons per annum. For light pumps and centrifuges two or three plants with 2,000 to 3,000 tons capacity and for medium pumps two or three of 3,000 to 4,000 tons. Two or three plants of 3,000 to 4,000 tons annual capacity would meet requirements for weighing machines, two of 4,000 to 5,000 tons could provide winches and hoisting

equipment and four or six of 1,500 to 2,000 tons could produce belt and lath conveyors. These plants would be located in the principal consuming countries.

(b) North Africa

149. The demand is expected to exceed 360,000 tons per annum in 1980 and will include the following main types of machines:

15 - 20 per cent pumps and centrifuges;
10 - 15 per cent valves, taps, cocks, and similar appliances;
20 per cent lifting and loading machinery;
10 per cent weighing machines.

150. The present production of these goods is about 15,000 tons, of which about 13,000 tons is in the UAR – mainly weighing machines – and covers about 19 per cent of the present total demand in the sub-region.

151. It will be possible to construct plants for each of the types mentioned above and to cover about a half of the total demand. The rest, consisting of heavy, specialized high pressure pumps and appliances, will have to be imported.

152. For the manufacture of valves, cocks etc. (mainly used in the construction and petroleum industries), two sub-regional plants are possible, each with a capacity of about 9,000 - 10,000 tons per annum.

153. There will be room for new capacities of about 30,000 - 35,000 tons in pumps and centrifuges, of which about 15,000 - 20,000 will be of small size and the rest of medium size.

154. For the light pumps and centrifuges, three plants, each with a capacity of about 3,000 tons, could be established; for the medium pumps and centrifuges two new capacities, each with about 10,000 - 12,000 tons per annum, which would also include the rest of the light pumps, could be located in the region.

(c) East Africa

155. The market for machinery and appliances will also exceed 100,000 tons per annum, and will include the following main types of machines:

10 per cent air conditioning machinery;
35 per cent pumps and centrifuges;
5 per cent valves and similar appliances;
20 per cent lifting and loading machinery;
10 per cent weighing machines;

156. It will be possible to construct plants for each of these types. For the manufacture of valves etc., (from bronze and other copper alloys), a sub-regional plant is proposed with a capacity of 3,000 to 5,000 tons per annum. For light pumps, four or five plants with 2,000 to 3,000 tons capacity and for medium pumps four or five of 3,000 - 4,000 tons annual capacity would meet requirements.

Agricultural trailers

(a) West Africa

157. The total quantity of trailers for agricultural use could be produced in the sub-region and five factories are proposed, each producing some 15,000 - 20,000 units per annum and located in Nigeria, Ivory Coast, Ghana, the Upper Volta and Senegal.

(b) North Africa

158. The total quantity of trailers for agricultural use could be produced in the sub-region and the following new capacities are proposed: in the UAR about 6,000 tons per annum, Morocco 4,000 tons and Algeria 3,000 tons.

(c) East Africa

159. Only one factory catering for the whole sub-region and producing some 15-20,000 units per annum is justified.

Europe and the Middle East

160. It is noted that the Economic Commission of Europe (ECE) – through its Committee on Agricultural Problems and Working Party on Mechanization of Agriculture – has conducted a series of studies in this field. It may be necessary to conduct studies on the demand and scope for agricultural machinery manufacture in the developing countries of Europe and the Middle East.

Latin America

161. It appears that sufficient comprehensive data is not readily available on the needs and scope of agricultural machinery manufacture in selected Latin American countries.

Long term requirements for tractor power

162. The growth rate of tractors in Asia, Africa and Latin America for 1955 to 1965 is given in Figure 3. Assuming a minimal level 0.5 h.p./ha and assuming that the labour force will double by the time these regions meet the minimal level, the following table gives estimated existing power and amount needed to meet the minimum goal.

Table 2

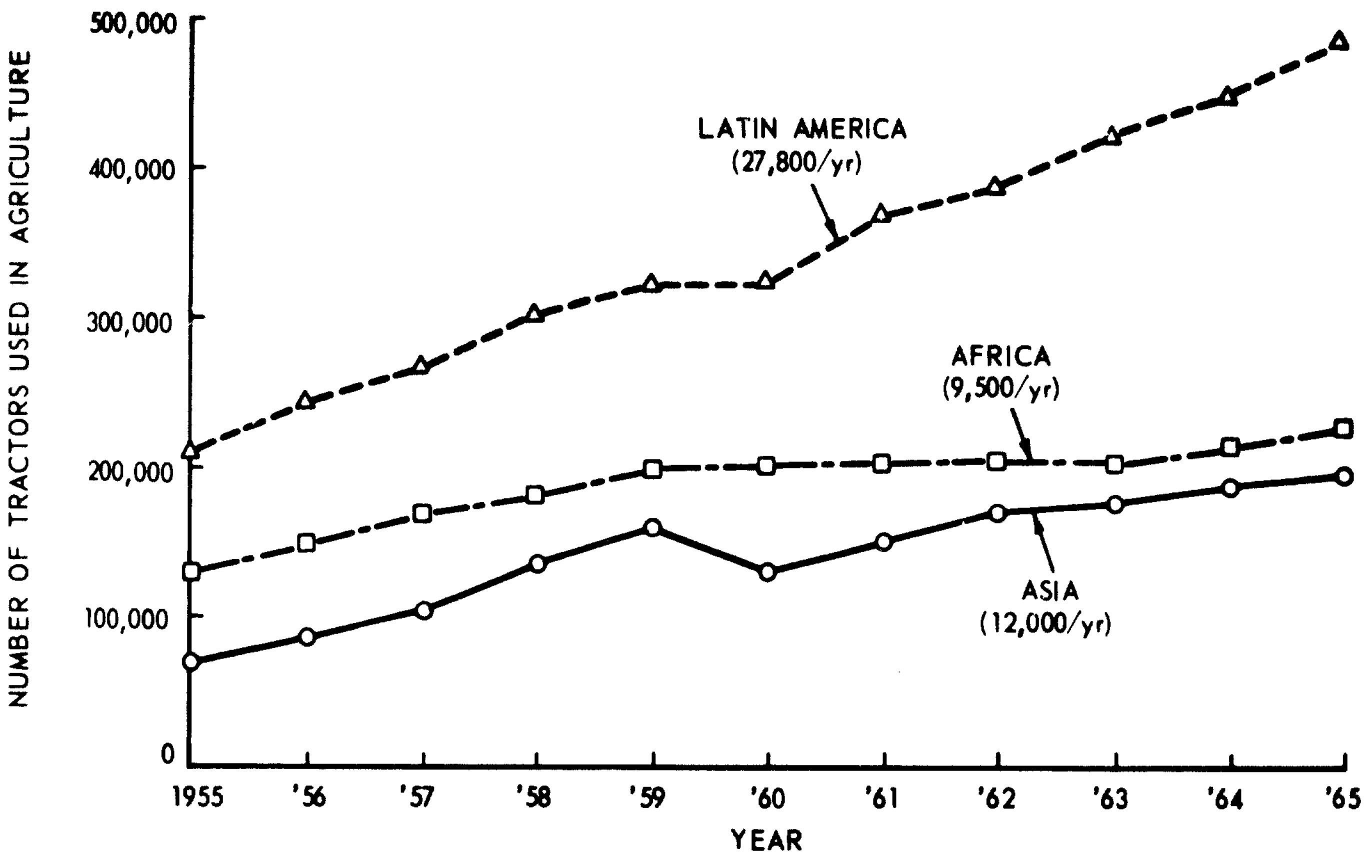
Existing power (h.p./ha) and amount needed to meet minimum goal of 0.5 h.p./ha

	h.p. per ha		
	Latin America	Asia	Africa
Existing			
Human	0.02	0.05	0.01
Animal	0.07	0.10	0.01
Tractor – including garden types	0.18	0.05	0.03
Additional Needs			
Human (assume labour force will double)	0.02	0.05	0.01
Tractor	0.21	0.25	0.44
Total	0.5	0.5	0.5

Figure 3

Number of tractors used in agriculture

(Wheel and crawler)



163. Table 3 gives the quantities required by the end of successive four, six, ten and twelve-year periods, using the six per cent compound tractor production growth and seven per cent on-the-farm depreciation rate.

Table 3

Number of tractors averaging 30 h.p. * to be manufactured during the periods indicated

(6 per cent compound factory production growth rate)

Period	Number of tractors (30 h.p.)		
	Latin America	Asia	Africa
1. 4-year period ending 1970	145,000	123,000	119,000
2. 6-year period ending 1976	291,000	248,000	239,000
3. 10-year period ending 1986	761,000 minimal power achieved in 1986	665,000	641,000
4. 12-year period ending 1998		1,523,000	1,468,000
Analysis			
1. Total number of tractors to be manufactured	1,200,000 (in 20 years)	2,560,000 (in 32 years)	2,467,000 (in 32 years)
2. Net on farms (existing population + new tractors - depreciation losses)			
Numbers - total	828,000 (in 1986)	1,318,000 (in 1998)	1,274,000 (in 1998)
3. Net h.p./ha	0.26	0.113	0.15
4. Percentage of the total additional h.p./ha tractor power needed (table 2)	124%	45%	34%

* Includes all sizes and types, from the small garden type to the largest crawler and wheel. Does not include power tillers recommended for wet land operations. Estimates for power tillers appear later and are in addition to the above tractors.

164. The tractor production in the numbers appearing in Table 3 was computed using an average size of 30 h.p. This does not mean that this is the only size to be imported and/or manufactured. On the contrary, a country should manufacture a range of sizes, perhaps from 6 or 7 h.p. garden type to the 50 - 75 and even 100 h.p. sizes, both wheel and crawler types. The product mix will need to be determined at the national level.

165. In Figure 4 the number of tractors (averaging 30 h.p.) on farms in Latin America, Asia and Africa have been plotted for 1955 through 1965, and projected beyond to 1998. For the future, these curves have been constructed using a six per cent factory production growth rate and the seven per cent depreciation rate, as mentioned previously. Latin America is plotted only to the year 1986, the date it will meet its minimal total need of 0.5 h.p./ha. These growth rates are considered realistic and attainable.

166. The total number of tractors to be added to each of the regions and for the time period indicated, appear in Table 4. To this table power tillers have been added, since they are an important power unit in the product mix of the developing nations. Paddy is an important crop in these countries, and the power tiller is an effective unit for wet land production. The contribution of power tillers to the net horse-power per hectare will not significantly change the figures appearing in Table 3. The estimates for power tillers are programmed on the basis of their use only for one half of the land area in paddy. The remainder of the area in paddy is left for tillage by the conventional type of tractor and animal power, together with appropriate equipment. Not all paddy is produced under wet land conditions.

Table 4

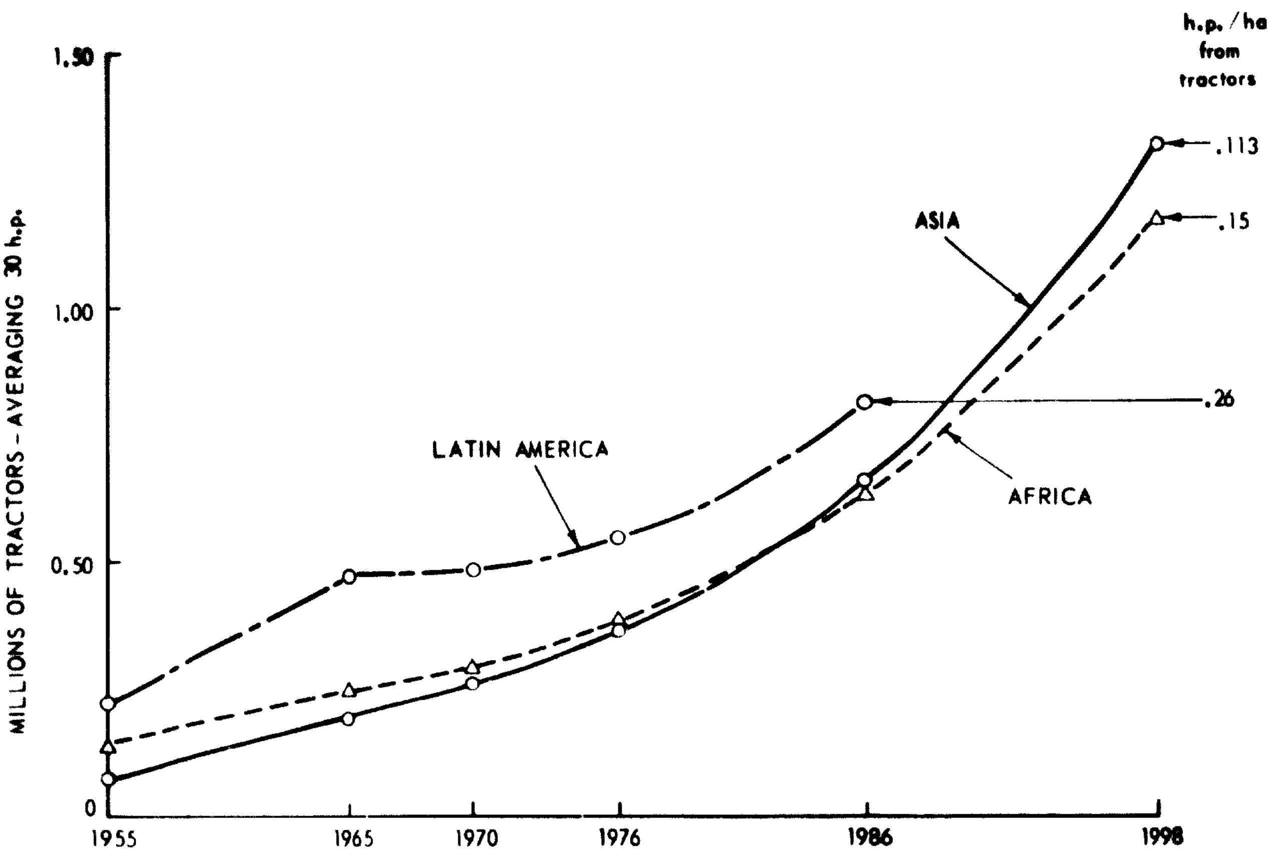
Summary of tractors and power tillers needed, by region and time period

Number needed	Latin America (20-year period)	Asia (32-year period)	Africa (32-year period)
	(millions)	(millions)	(millions)
Tractors average 30 h.p.	1.20	2.56	2.47
Power tillers	0.27	1.9	0.047

Figure 4

Tractors on farms

(6 per cent factory production growth rate
and 7 per cent depreciation rate)



Need for crop protection equipment

167. According to the statements of French researchers, plant diseases, weeds and insects destroy a quantity of products suitable for human nourishment to an annual value of 80 billion dollars[2]. Table 5 gives an idea of the distribution of the above damage.

Table 5

Loss of crop yield per cent

	Insects	Plant diseases	Weeds	Total	Yield, part remaining for human consumption
North and Central America	9.4	11.3	8.0	28.7	71.3
South America	10.0	15.2	7.8	33.0	67.0
Europe	5.1	13.1	6.8	25.0	75.0
Africa	13.0	12.9	15.7	41.6	58.4
Asia	20.7	11.3	11.3	43.3	56.7
Oceania	7.0	12.6	8.3	27.9	72.1
Soviet Union and China (mainland)	10.5	9.1	10.1	29.7	70.3
Average	12.3	11.8	9.7	33.8	66.2

168. The greatest damage occurs in the developing countries, where significant progress could be obtained by relatively less expensive investments using modern methods of plant protection and intensive agricultural production. Hence it is necessary for a group of selected experts of UNIDO to carry out surveys and prepare detailed suggestions in order to introduce the assembly and manufacture of plant protection and allied agricultural machines into the developing countries.

[2] billion = a thousand million

III. MANUFACTURE AND INDIGENOUS PRODUCTION

Pattern of manufacture

169. The manufacture of agricultural machinery and implements has a foothold in the industrial sector of almost all developing countries. Only tractors, power tillers, engines and pumps are manufactured or assembled in plants of medium size with reasonable levels of quality control and of technical co-operation with ancillary and supporting industries. Implements and hand tools are produced in relatively small units and in many cases without regard to quality.

170. Large growth is expected in the market for agricultural machinery and implements in all developing countries during the next decade. This expansion offers an opportunity to expand existing manufacture and the basic engineering industries, casting, forging, machine shops etc. Expansion of the agricultural machinery industry is viewed as an effective way of combining the application of large scale technology to small scale industries with savings in foreign exchange.

171. In expanding existing manufacturing plants and establishing new ones it is well to remember that the rate of change in both agricultural practices and in machinery and implements is likely to be rapid, so that the manufacturing plants must either be written off over a short period or have capacity for change built into them. The ECE study "The Engineering Industry and Industrialization" proposes 16,000 - 20,000 tons per annum as the minimum profitable size for a plant producing soil cultivation machinery, 2,000 - 3,000 tons for one producing pumps and 4,000 - 6,000 tons for one producing harvesting machines. An amortization period of four years was used in the USSR for appraising investment in agricultural machinery plants during 1966 - 1970.

172. The following are the highlights of the existing manufacturing facilities in ECAFE group of countries:

Tractors

173. There are five tractor manufacturing plants, all located in India. All the plants were producing tractors built with about 75 per cent of local content. There are twelve companies engaged in assembling tractors, in Ceylon, Iran, Pakistan, Thailand and the Philippines.

Power tillers

174. In Ceylon, China (Taiwan), the Republic of Korea, India, Iran and Malaysia, power tillers are being produced. The local contents varied from 30 - 40 per cent and might reach 70 per cent in the near future. In Ceylon and Pakistan (East), licences for establishing power tiller factories had already been issued. Indonesia and Malaysia had plans to start power tiller factories.

Small engines

175. Low-speed diesel engines are mainly manufactured in India and in Pakistan. High-speed diesel engines are manufactured in China (Taiwan), India, Pakistan and the Republic of Korea. Small gasoline engines are manufactured in China (Taiwan), India, Indonesia and the Republic of Korea. Micro-gasoline engines are manufactured only in India. Iran, Thailand, Pakistan and the Philippines had plans to manufacture diesel engines. In Thailand there are plans to manufacture gasoline engines. The diesel engines produced are predominantly of the low-speed type. Very few countries had manufacturing programmes for high-speed compact diesel engines of 5 - 12 h.p. suitable for automotive purpose and applications in agriculture.

Pumps

176. Ceylon, China (Taiwan), India, Indonesia, Pakistan, the Philippines, the Republic of Korea and Thailand are manufacturing centrifugal pumps. The Philippines and Thailand are also manufacturing power paddy propeller pumps. China, India, the Republic of Korea and Pakistan are manufacturing deep well pumps. Iran, Malaysia and Thailand had no significant production

of power pumps for irrigation but, however, had plans to manufacture. Iran had already laid down a programme to manufacture 10,000 pumps by 1978. In Thailand, two firms had plans to manufacture pumps. Nepal and Singapore had no manufacturing programmes. Hand pumps are manufactured in most of the countries. It appeared that in nearly all the countries foundry techniques and quality control needed to be improved.

Knapsack sprayers and dusters

177. There are plants producing power sprayers in China (Taiwan), the Republic of Korea and Pakistan. In Ceylon, China (Taiwan), India, Indonesia, the Republic of Korea and Pakistan, there are plants manufacturing hand sprayers. In Ceylon, Pakistan and Thailand there are plans to expand the production capacity for sprayers. No substantial facilities for manufacturing sprayers exist in Iran, Malaysia, Nepal, the Philippines, Thailand and Singapore.

Threshers

178. In China (Taiwan), India, the Philippines and the Republic of Korea, there are plants manufacturing pedal-operated paddy threshers. Ceylon, China (Taiwan), India, Iran and the Republic of Korea, have plants manufacturing power paddy threshers. The Philippines and Indonesia had plans to manufacture power paddy threshers. Power wheat threshers are manufactured in India and Pakistan. There was a great need for all countries to manufacture power threshers.

Rice processing machinery

179. With the exception of Japan, there is no country in Asia manufacturing a full range of rice processing machinery on a significant scale. Rice hullers are manufactured in Ceylon, China (Taiwan), India, the Republic of Korea, the Philippines and Thailand. In Ceylon and Indonesia there are plans to manufacture rice hullers. Indonesia, Iran, Malaysia, Nepal, Pakistan and Singapore have no programmes at the moment.

Implements

180. Hand tools are manufactured in most of the countries. Bullock-drawn tillage implements are also manufactured by the small-scale sector in most of the countries visited. With regard to tractor-drawn implements, primary tillage implements only are made in India, Pakistan and Thailand. Iran and Thailand have plans to manufacture more tillage implements. Power tiller accessory equipment such as cage wheels are manufactured in Ceylon, China (Taiwan), India, Malaysia, Pakistan and the Republic of Korea. It is necessary to manufacture a wider range of farm implements and equipment, especially sowing, fertilizing and harvesting equipment.

181. Details of manufacturing programmes demand estimates, and a proposed expansion programme is given in the following tables. The comprehensiveness of the available data on these aspects clearly indicates the nec· ·ity of collecting such information in the three other major geographical regions.

182. Much more data is needed concerning the most economical size of plants for different products in different areas. Feasibility studies of this type should be conducted with the assistance of UNIDO.

183. At the present time there is underutilization of the existing manufacturing facilities for agricultural machinery in developing countries; hence it is necessary that assistance is rendered on a priority basis to such industries in order to reach the manufacturing capacity whithin the near future. However, the projected demand shows that in the longer term there is a need to expand existing manufacturing facilities. It is also necessary to diversify the product mix, and assistance is needed in both of these areas. In this regard it is necessary to explore the possibilities in allied engineering sectors towards co-ordinated industrial expansion.

184. It was pointed out that sales of machines are related to the purchasing power of the farmers; hence adequate credit facilities to farmers are a necessary part of the expansion of the manufacturing programme.

185. It must be pointed out that most of the simple agricultural machinery, such as hand tools, animal drawn equipment, hand operated pumps, sprayers

Table 6

Summary of selected types of farm machinery, quantity, sales, demand and manufacturing schedules in the twelve countries visited*

(Number of units)

Item	Quantity 1968	Annual Sales 1968		Projected annual demand		Manufacturing capacity			
						1968		1970	1975
		Total	Imported [b]	1970	1975	Production	Installed capacity		(known plans)
Tractors	176,300	33,130	11,430	59,225	118,125	21,900	26,950	45,200	74,450
Power tillers	69,525	21,450	6,850	38,550	101,800	14,400	20,600	33,900	71,000
Small engines, all types	1,298,300 [a]	228,025 [a]	5,100 [a]	590,550	1,002,000	277,000	387,500	404,400 [a]	441,050 [a]
gasoline, 1-2 h.p.	77,250 [a]	20,000 [a]	(...)	90,150	185,800	18,000	36,000	36,000	40,000
gasoline, 3-5 h.p.	93,050	20,000 [a]	(...)	81,100	160,900	24,100	35,000	35,100	42,000 [a]
diesel, 3-15 h.p.	728,150 [a]	150,000 [a]	(...)	327,750	472,500	138,500	170,000	180,250	181,250
diesel, 12-30 h.p.	201,050 [a]	75,000 [a]	400	31,600	62,750	77,200	104,500	105,050 [a]	110,050 [a]
diesel, 25-75 h.p.	75,000	15,000	(...)	57,225	117,125	18,500	33,500	33,500	50,000 [a]
Pumps, all types									
hand pumps	290,500 [a]	8,000 [a]	8,500 [a]	162,500	418,000	6,200	(...)	(...)	(...)
power pumps, 3-15 h.p.	1,682,600 [a]	313,500 [a]	15,100 [a]	384,700	820,000	340,700	351,000	358,800 [a]	392,300 [a]
deep-well pumps	74,000 [a]	(...)	(...)	57,050 [a]	135,100 [a]	33,950	33,200 [a]	35,500 [a]	4,000

a Excluding estimates from certain countries.

b Representing the annual sales of agricultural machinery imported in the form of fully-built units.

* China (Taiwan), the Republic of Korea, the Philippines, Indonesia, Singapore, Malaysia, Ceylon, Thailand, Iran, Pakistan (East and West), India and Nepal.

Table 6 (continued)

Item	Quantity 1968	Annual Sales 1968		Projected annual demand		Manufacturing capacity			
						1968		1970	1975
		Total	Imported [b]	1970	1975	Production	Installed capacity		(known plans)
Sprayers & dusters, all types									
hand sprayers	781,500	178,000 [a]	28,100 [a]	328,200	640,500	241,500	253,000	273,000	(...)
knapsack	209,600 [a]	19,000 [a]	9,000 [a]	80,150	204,500	23,500	56,500	65,800	(...)
Threshers, all types									
paddy thresher, pedal-operated	1,357,000 [a]	8,000 [a]	(...)	65,000	203,000	30,500	46,000 [a]	66,000 [a]	(...)
paddy thresher, power-operated	155,670	3,200	836	50,550	147,500	17,400	20,000	(...)	(...)
wheat thresher, power-operated	27,000	(...)	(...)	25,550	65,200	11,000	13,700	(...)	(...)

a Excluding estimates from certain countries.
b Representing the annual sales of agricultural machinery imported in the form of fully-built units.

and dusters, threshers and a few tractor implements, including sowing and fertilizer distributors, can be completely manufactured in each country, in some cases by using imported raw materials, mainly mild steel and sheet metal. However, in the case of tractors, power tillers, engines and pumps, local manufacture has to be part of a phased programme based upon the level of machine shop, forging, foundry and tool room facilities and the level of ancillary industries. Assistance to developing countries is needed to analyse these aspects critically and advise on a rational manufacturing programme.

Ancillary and supporting industries

186. It is very essential that ancillary and supporting industries should be developed along with a phased manufacturing programme of agricultural machinery and equipment. For their sustenance and growth, the ancillary industries need a large variety of steel raw materials, copper and copper products, long staple asbestos, alloy steels, nickel, chromium and other alloying metals, special steels, tin, lead, special steel rolled sections and cold rolled sheets etc. Most of these are to be imported, though some may be available in limited quantities from indigenous production. The tractor and power tiller industries are bound to draw heavily from the ancillary industries in the years to come. In developed countries, the ancillary industries supply most of the needs of the equipment manufacturers. In India, however, a number of the equipment manufacturers had initially to manufacture some of the ancillary items under their own roofs due to the non-existence of certain industries; the present trend is to off-load those items to the ancillary industries.

187. Table 7 gives details of ancillary products available in the ECAFE group of countries.

188. Sufficient data are not available on the status of ancillary and supporting industries in most of the developing countries. In order to increase the local content, it is necessary for full utilization to be made of local subcontractors towards supplying ancillary components. It was emphasized that major manufacturers should collaborate with their subcontractors

Table 7

Existing ancillary industries in 12 ECAFE countries

Country	Tyres and tubes	Battery	Radiator	Other items
Ceylon	for automobiles	automotive	manufactured	
China (Taiwan)	for power tillers	automotive	-	gaskets, brake linings, clutches
India	for tractors and automobiles	available from local sources	available from local sources	all items for tractors and machinery manufacture available except for a few
Indonesia	for automobiles	automotive	nil	-
Iran	for automobiles	automotive	information not available	nozzles, filters, leaf springs, silencers etc.; limited facility for hydraulic components
Korea, Republic of	for automobiles	automotive	limited	limited electrical and rubber components, limited facility for pistons, piston-rings, nozzles etc.
Malaysia	for automobiles	automotive	information not available	M.S. hardware, few electrical components
Nepal	nil	nil	nil	-
Pakistan	for automobiles	automotive	limited facility	piston rings, piston liners etc. on small scale, other ancillary items licenced for, pistons
Philippines	for automobiles	automotive	information not available	information not available
Singapore	nil	nil	"	"
Thailand	for automobiles	automotive	"	"

in forming specifications and in advising on standards of quality control. This was seen as an important way of transferring technology.

Raw material and semi-finished components

189. Table 8 provides a brief description on the availability of castings, forgings and other ancillaries necessary to support industries for the manufacture of agricultural machinery in 12 ECAFE countries

Table 8

Raw material and semi-finished availability in 12 ECAFE countries

Country	Castings	Forging	Other items
Ceylon	limited facilities	plans existed	plans existed to make other tractor parts
China (Taiwan)	fairly good facilities	limited facilities	-
India	good facilities available including malleable castings	good facilities available	machining, fabrication, tooling and other facilities available
Indonesia	public sector projects	for defence	-
Iran	public sector projects on cast iron castings; no facility for malleable castings	public sector projects	-
Korea, Republic of	limited facility for castings including malleable	limited facility	-
Malaysia	small foundries	very limited facilities	-
Nepal	limited facility	Government implement factory	-
Pakistan	public sector projects steel castings	public sector project under plan	-
Philippines	limited facilities	limited facilities	-
Singapore	grey cast iron and steel castings production on a small scale	small prototype facility	-
Thailand	limited facilities	limited facilities	-

190. Table 9 gives a brief description of the availability of steel products necessary to support industries in the manufacture of agricultural machinery in 12 ECAFE countries.

Material for tractors

191. The raw material needs of the agricultural machinery and implement industries are mainly metallurgical. For tractor production, hot rolled carbon steel, not rolled alloy steel, cold drawn carbon steel, cold drawn alloy steel, hot rolled plates, sheets and strips, cold rolled sheets, as well as grey iron malleable, steel, and non-ferrous castings and steel forgings are

Table 9

Existing availability of steel products in 12 ECAFE countries

Country	Steel products
Ceylon	all steel to be imported; new integral steel plant under construction
China (Taiwan)	imported
India	except for some kinds of carbon steel other kind available
Indonesia	limited steel-making facilities
Iran	all steel imported; re-rolling facility max 60,000 t/yr; new steel plant to produce 1 - 2 million tons/yr
Korea, Republic of	all steel to be imported, limited re-rolling facility
Malaysia	all steel to be imported; M.S. steel section from integral steel plant and one re-rolling mill
Nepal	all steel to be imported; one small re-rolling mill
Pakistan	all steel to be imported; Pakistan Steel Mills planning to set up a steel mill
Philippines	crude steel would be available as soon as the country's first integrated iron and steel mill starts production by the end of 1969
Singapore	there was a plant manufacturing mild steel billets and bars; all steel was imported
Thailand	all steel to be imported; recently G.S. Steel Mills started; Siam Iron and Steel Co. would expand and plans were under way for Thai-Japanese steel plants and also construction of second plant

necessary. Availability of steels such as En-1A, EN-3, EN-8, EN-9, EN-42 and EN-45, which are normally used on tractors, as well as special steels such as EN-16, EN-18, SAE-5140, EN-43, EN-34, SAE-8620 and other steels required for gears, shafts, axles and other critical components should be taken into account.

Steel for agricultural discs

192. The gauge of steel required for harrow discs are 11/64", 5/32" and 3/16" and for plough discs 3/16" and 7/32" and 1/4" for heavy duty discs. These discs are normally made in EN-42 or equivalent sheet steel which is cross rolled.

Steel for agricultural implements

193. High carbon steels equivalent of EN-42, EN-16, EN-45A etc., are required for soil working tools. For mouldboards of ploughs the steel normally recommended is soft centre high carbon steel, i.e. SAE 1095 over 1024. However, this is not available in India, and mild steel plates are used. Medium carbon steels such as EN-8, EN-9 etc., are required for beams, tines etc. Normally, the frames of the equipment are manufactured from mild steel. However, the present trend of farm equipment manufacturers in other countries is to use medium carbon structural steel for a reduction of weight and for additional strength.

Need for study of metallurgical engineering aspects

194. As agricultural machinery and implements are mostly steel oriented, the problems of manufacture in developing countries is to be viewed from the following aspects:

(a) Selection of correct raw material and standardization;

(b) Import substitution;

(c) Heat treatment towards achieving desired final properties;

(d) Techniques in manufacture, especially welding;

(e) Inbuilt quality control through proper metallurgical processes.

195. These factors clearly indicate the necessity of making information on metallurgical aspects of agricultural machinery manufacture available to developing countries. Some of the problems faced and solutions developed in countries such as India, Pakistan, Brazil, Mexico and other relatively industrialized developing countries may be studied as a guide-line, with special reference to import substitution, heat treatment and quality control.

IV. PROGRAMME TOWARDS MANUFACTURE

Patents and licencing

196. The problems of the manufacture of agricultural machinery and implements are two-fold. Firstly, there is the lack of technical skill in certain areas and, secondly, there are the legal problems involved in patents and licencing. Simple items such as hand and bullock-drawn implements, hand sprayers, threshers etc., can be manufactured locally without collaboration. In India, Pakistan, China (Taiwan) etc., engines, pumps and even power tillers are being manufactured without collaboration. However, in most cases of the manufacture of tractors, engines and power tillers, in order to bridge the gap between technologically advanced nations and developing countries it is necessary to enter into collaboration in order to produce quality and dependable products. Two of the drawbacks of licencing are the problems involved in local manufacture of patented components such as hydraulic pumps, electrical items etc., which are manufactured by ancillary industries abroad, and the normal reluctance of the collaborators to allow changes of design to suit local conditions and to explore export potential. Sometimes there may be difficulty in securing imported components due to changes in design or to new models abroad. While taking all these factors into consideration, it is nevertheless necessary to enter into collaboration with established manufacturers in order to produce quality agricultural machinery – especially tractors, power tillers and engines – locally. Assistance to developing countries to formulate fair and sound licencing agreement is necessary.

197. Developing countries should not allow monopolies to develop by restricting competition too closely. A limited market can naturally only support a limited number of manufacturers of a product. The farmer customer, however, is the ultimate benefitor from a reasonable amount of healthy competition. Technical advancement, the highest quality, satisfactory performance and fair prices are the natural result of good competition.

Possibilities of mobilization of local auxiliary resources

198. The developing countries can obtain tractors and agricultural machines by one of the following methods:

(a) Import of assembled and finished machines, notably tractors and more complicated implements and machines;

(b) Assembling of machines from imported parts in local assembly plants;

(c) Local industry, manufacturing either simple manual and animal-drawn implements or more complex machines.

199. Each of these methods provides opportunities for local auxiliary industries. Developing countries with a partially developed industry can supply from local sources some of the following materials as a start for manufacture:

(a) Materials, such as rolled carbon steel or refined steel, metal sheets, sectional steel, drawn steel, wires, non-ferrous metals, wood, oils, diesel oil, graphites, diluents etc.;

(b) Castings of grey cast iron, or cast steel, malleable cast iron and non-ferrous metals;

(c) Simple parts of local origin, for example screws, nuts, plates or washers, split pins, pins, pegs, rivets, springs, bearings, rims, discs, piston rings etc.;

(d) Some manufacturing equipment and machine tools.

200. Following are the highlights of a project to manufacture a small two-wheel tractor, two PTO driven implements and two small implements developed by Czechoslovakia for India in 1965. The requirements for local materials in an average range of agricultural machines were as follows:

Metallurgical materials, comprising both carbon and refined steel (rolled steel, sheets, hoop steel, pipes, drawn steel, wires) and non-ferrous metals	44.3%
Castings of grey cast iron, of malleable cast iron, or cast steel and non-ferrous metals	30.0%
Forgings	7.9%
Other materials (products of plastics, welding and soldering materials, wood, oils, diesel oil, graphites, enamels, diluents)	3.6%
	85.8%

201. It is evident from the above survey that the manufacture of agricultural machines makes considerable demands on local sources, notably in semi-products of steel, castings and forgings. A more detailed analysis of the individual items indicates which of the local subsidiary sources can be especially important for the manufacturers of agricultural machines. With metallurgical materials, one of the main groups of materials, the specification of the steel semi-products in the described case would be as follows:

Rolled carbon steel	12.0%
Carbon steel sheets	10.4%
Rolled refined steel	8.9%
Pipes of carbon steel	5.2%
Sheets of refined steel	3.3%
Drawn carbon steel	3.2%
Carbon hoop steel, pipes of refined steel, refined drawn steel, steel wires and non-ferrous metals	1.3%
	44.3%

202. From the above pro-forma calculations of the consumption of materials from local sources for a certain manufacture of a representative range of agricultural implements it is evident that local subsidiary industries in the developing country (in this case India) can participate with deliveries in the following sequence: castings of grey cast iron (in the case described 26.3 per cent of the total consumption of material), metallurgical rolled material of carbon steel (12.0 per cent), sheets of carbon steel (10.4 per cent) and rolled material of refined steel (8.9 per cent). From the above analysis, on which no general conclusions could be based, it is evident that, in the main, grey iron foundries and metallurgical industry with steel rolling mills, especially of carbon steel, will be needed.

203. Similar conclusions can be reached from an analysis of the requirement of finished parts from local sources. Here it is a question mainly of the connecting parts, i.e. screws, nuts, washers, pegs, split pins, rivets etc., as well as antifriction bearings, rims and discs, piston rings, shaft sealings etc. The more complex the machine, the more of these parts are

needed for the manufacture, as evident from the estimated annual consumption with the individual machines of the projects described:

Table 10

Requirements of finished parts from local sources, estimated annual consumption with individual machines

Machine	Annual production units	Finished parts from local sources (in tons)	Finished parts from local sources per 1000 of machines (in tons)
Two-wheel tractor	5,000	453.0	80.6
Cutter bar	1,000	18.9	18.9
Rotary hoe	5,000	51.0	10.2
Disc harrows	3,000	7.8	1.6
Turn-about plough	2,500	3.5	1.4

204. This example of a project for establishing the manufacture of a small two-wheel tractors, of two p.t.o. driven implements and of two simple implements has been used to demonstrate the possibilities of utilizing local ancillary industrial sources in a developing country for the supply of the principal materials and of simple parts. Although we believe that in certain aspects this is a typical example, enabling conclusions to be reached, as mentioned above, it can be considered of general validity only in so far as it complies with local economic conditions. The actual conditions may require the share of the home ancillary industry to be smaller and a share of simpler parts (such as bearings, sealing rings etc.) or for a part of the material (such as rolled refined steel, sheets etc.) to be imported from abroad, or vice versa, for some more complex parts of the design (such as couplings, air cleaners etc.) also to be manufactured in local plants, in so far as these are available. Step by step, as the industry in the developing countries develops, the manufacture will become more self-dependent and will be governed by the economic laws valid in the economies of developed countries.

Estimated capital requirement for tractor manufacturing plants

205. Plants for manufacturing tractors of the types and sizes important for increasing agricultural production are varied and complex, so that it is impossible to plan for them in general terms. An approximation on a regional basis has been attempted. The approach used was to estimate capital cost on the basis of the annual average value of sales that are projected in Table 11.

Table 11

A summary of retail costs by type of power, area and period

	Millions of US dollars*		
	Latin America	Asia	Africa
4-year period ending 1970			
tractors	550	470	450
power tillers	50	220	10
total	600	690	460
6-year period ending 1976			
tractors	1,110	940	910
power tillers	70	320	10
total	1,180	1,260	920
10-year period ending 1986			
tractors	2,900	2,530	2,440
power tillers	120	530	10
total	3,020	3,060	2,450
12-year period ending 1998			
tractors		5,790	5,580
power tillers		640	20
		6,430	5,600
Total for Period	4,800	11,440	9,430
Grand Total = 56,290			
Investment/ha	$50	$33	$38

* Figures are rounded to the nearest ten million

206. Although the total retail cost of these inputs seems large, the amount per hectare of land is reasonable. The last two lines in Table 11 give the total investment over a period of 32 years (20 years for Latin America) per hectare. It averages out at about US $37.00 per hectare, or slightly more than US $1.00 per hectare per year; US $50.00 for Latin America; US $33.00 for Asia and US $38.00 for Africa. The capital costs for Latin America, Asia and Africa for manufacturing plants for tractors and power tillers are shown in Table 12.

Table 12

Capital requirements for tractor manufacturing plants

	Millions of US dollars*			
	Latin America	Asia	Africa	Total
Tractors	228	304	293	825
Power tillers	12	54	2	68
Total	240	358	295	893

* Calculated at 100 per cent of annual average sales over the 32 year period for Asia and Africa and 20 year period for Latin America.

207. The capital costs of manufacturing plants appearing in Table 12 can be pro-rated for each region among the 4, 6, 10 and 12 year periods as indicated in the previous table summarizing retail costs. If this is done, a reasonable distribution of the total capital investment that will be required over the 32 years ending in 1998 for Asia and Africa and the 20 years ending in 1986 for Latin America is obtained. The four year period ending in 1970, as indicated in the above table, is rapidly nearing its end. Some of the existing factories for the production of agricultural machines in some of the developing nations are handicapped in achieving high productive efficiency and the rated capacity of the plant owing to inadequate imports of critical components or materials. These components are not now being manufactured in the country for various reasons, such as the inadequacy of specialized

materials, tooling or skills. Imports usually amount to 10 - 20 per cent of the cost of the tractor. It is recommended that, in the initial stages of building up plant capacities in the developing nations, increased imports of critical components should command the highest priority. Plants to produce these critical components can follow later. In other words, prior attention should be given to increasing the capacity and efficiency of plants already in existence.

Transfer technology – example of two developing countries – India and China (Taiwan)

208. The production programme in industrialized countries is normally based on high volume, low manpower requirement, automation, highly developed process planning, industrial engineering and advanced production techniques. The aim is towards lower cost of production and high quality. In developing countries quality is of equally high importance. However, due to lower market demand, the volume of production may be relatively small. Low volume, together with other factors such as import duty, high cost of raw material and lower efficiency in manufacturing techniques, tend to make products manufactured more costly. Hence, manufacturing techniques suitable to a lower volume of production and indigenous conditions should be introduced to lower the cost without adverse effects on quality. Some of the problems involved in transfer of technology in two relatively industrialized developing countries are discussed below.

Case study: India

Tractors

209. The modest achievement made by the tractor industry so far, despite the difficulties that had to be surmounted, is noteworthy. It is significant that the indigenous contents are on average about 75 per cent by value. Since they commenced production, the tractor manufacturers in India have maintained a good quality of workmanship by giving importance to quality control

at all stages in the manufacture. In order to cater for demand which has been in excess of indigenous production, imports of tractors have been allowed, care being taken to import only those models of tractors which are likely to be taken up for indigenous production in the near future. The tractor industry has been de-licenced to enable the existing units to expand and new units to be set up to meet the anticipated demand.

Power tillers

210. In addition to four-wheel tractors, the need for two-wheel tractors (power tillers) has also been recognised, particularly in rice growing and hilly areas. The annual demand for these power tillers is expected to rise to about 25,000 by 1975 from its present level of 800. On the basis of this assessment, a number of proposals for power tillers have so far been approved for manufacture. (The most popular type of power tiller seems to be the one with a diesel engine, developing 8 - 10 h.p. at a speed of 1,500 r.p.m.). The 'Krishi' tiller, at present manufactured in India, although originally of imported design, has over 90 per cent indigenous content. The only components being imported are some bearings, roller chains, tyres and tubes, and tiller blades, which are under development in India. Most of the raw materials required for production of the power tillers are available in India.

Agricultural implements

211. It is significant to note that most of the implement industries were established without foreign collaboration. The most popular of these implements are the tine tillers, disc harrows, off-set disc harrows, disc ploughs and mouldboard ploughs. With the availability of steel and the necessary fabricating machinery, this industry has grown in size and has supplied the growing needs without recourse to imports. The springs, cutting edges, hardware and discs are now available from indigenous production. Some special roller bearings are required to be imported at present for the production of disc ploughs etc. In recent years, the units in the medium scale

sector have also taken up the production of attachments to tillers for seeding and fertilizer distribution. They have also initiated action in the development and production of tractor-drawn reapers, harvesting machinery such as threshers, cleaners, driers etc. Since the implements industry is largely steel oriented, its future requirements in the form of mild steel section, castings, forgings and high carbon steel plates will rise steeply in the next four to five years. The steel, foundry and forging industries are well established and can meet this demand; the supplies from the steel plants are being organized so as to ensure a regular and adequate availability of steel raw-materials, particularly high carbon steel plates, to the implements industries. The import of conventional implements similar to those produced by the indigenous industry is not being allowed. Special types of implements not yet developed in India are being allowed in for purposes of development and for actual use.

Engines

212. The type of diesel engines produced in that sector are generally of the horse-power range up to 10 h.p. and include both vertical and horizontal engines. The main requirements of raw materials for the manufacture of diesel engines are: pig iron, forging steel, alloy steel, special steels, ancillary components. Efforts are being made to meet the growing requirements of the diesel engine industry both for meeting the internal demand and for exports. A gasoline engine industry relating to applications other than automobiles has been in existence for the past 10 or 12 years. The production in this field has been confined to engines of horsepowers from 1-7. Engines, of both four-stroke and two-stroke varieties and in air-cooled versions, are now being produced. Engines of 12 h.p. two-stroke air-cooled variety have also been developed. Efforts are being made to cover the gap between 7 - 12 h.p. also with air-cooled engines. Special importance is being given to enlarging the production of 1 - 2 h.p. engines for sprayers, the demand for which is expected to grow substantially during the next few years. One of the manufacturing units of these engines is

already capable of producing 2,000 engines per month and can step this up further, depending on the demand. Additional capacity in this field may also be created in the near future.

Pumps and motors

213. A large range of power driven pumps, such as centrifugal, rotary, reciprocating, turbine, axial flow, propeller, and submersible pumps are being produced in India. While the major portion of the total production in the country is from the organised sector, a sizeable production of some 100,000 pumps is estimated from the small scale sector.

Ancillary industry

214. The following is a brief outline of the products the automobile ancillary industries have developed and supplied to the tractor, engine and implement industries: pistons, pins, rings, cylinder liners, gaskets, engine valves, fuel injection equipment, filter and filter elements for fuel, oil and air, fuel and oil liners, hoses, roller chains, flywheel ring gears, water pumps and parts, radiators, bimetal bearings and sintered bearings, fan belts, starter motors, dynamos, alternators, voltage regulators, ignition coils, spark plugs, breaker points, clutch assemblies and driven plates, clutch facings and brake linings, brake equipment and parts, ball joints, steering linkages, steering wheels, axle shafts, ball and roller bearings, oil seals, king pins, valve springs, laminated springs and miscellaneous springs, wheels and rims, head and tail lights, electric horns, switches, panel instruments, sheet metal parts, high tensile hardware, jacks, servicing equipment and tools, especial automotive castings and forgings, high carbon discs for agricultural implements, batteries, tyres and tubes, cables and wires, grey iron and S.G. and malleable castings, forgings, steering wheels and gears.

215. The ancillary industries would have to expand in the following fields particularly in order to cater to the rising demand: pistons, pins, rings and cylinder liner, fuel injection equipment and parts, electrical equipment

such as starters, dynamos etc., clutch assemblies and driven plates and parts thereof, ball and roller bearings, engine valves, springs etc., wheels and rims, gaskets, high tensile hardware, automotive castings, automotive forgings and their heat treatment and machining, gears and shafts, steering gears, hydraulic equipment.

216. For both ferrous and non-ferrous casting, the techniques of moulding used in India are: sand casting, permanent mould casting, shell moulding, gravity die casting, precision casting by various processes, investment casting.

217. For the past few years, about 10 units of medium sized capacities capable of handling closed die forgings and ferrous alloy steels have been established. The die-making capacity to feed the recurring requirements of the forging units has also been created to a major extent. Non-ferrous forgings are also needed in the manufacture of internal combustion engines, tractors and other machinery. A small but good beginning has been made in this direction and some of the smaller sized non-ferrous forgings are being manufactured. Against the total capacity of 120-130 thousand tons of steel forgings per annum installed in the country, the quality forgings are about 30 - 35 thousand tons per annum. The capacity to manufacture various types of aluminium, copper, and other non-ferrous based alloys is well developed in the country.

Case study: China (Taiwan)

Power tillers

218. As an attempt to solve the problem of an anticipated labour shortage, seven different makes and models of garden tractors in the power range of 1.5 - 10 h.p. were introduced into Taiwan by the Joint Commission for Rural Reconstruction (JCRR) from the United States in 1954. In the following year, a 5 h.p. rotary type and a 2.5 h.p. tiller-type single-axle two-wheel tractor, now called "power tiller", were purchased from Japan. They were tested at various agricultural research and improvement stations and agri-

cultural schools, thus marking the beginning of power tiller extension in Taiwan. In 1956, JCRR again imported a quantity of small power tillers of the same type for testing and demonstration at the agricultural stations. The local farmers showed their interest in the machine from the onset, and their demand for it became so great that the local machine manufacturers began to produce the machine by copying the imported models. Several small farm machine shops added this machine to their stocks. A number of factories formerly making motorcycles or small oil engines produced power tillers as a sideline production. Up to 1959, a total of 22 small manufacturers came into being and began producing locally-made power tillers. Most of them concentrated on the tractive-type power tiller, and only two plants produced the driven-type rotary tillers. In the meantime, imported power tillers increased to 16 different brands, providing strong competition to the local manufacturers.

219. However, the small manufacturers, whose products were of doubtful quality, soon found themselves in financial straits. Thus, owing to insufficient operating funds and lack of proper manufacturing techniques, all the local manufacturers except three either went bankrupt or changed to making other products at the end of 1960. The three remaining manufacturers have managed to turn out a small number of power tillers each year. On the other hand, two groups of China (Taiwan) industrialists, in co-operation with Japanese agricultural machinery companies, set up two factories to produce power tillers with some parts imported. From then onwards the import of power tillers, except spare parts, stopped altogether.

Grain driers

220. In order to save a sizeable amount of rice from spoilage by rain or high humidity, several types of rice driers were purchased from the United States by JCRR for trial use during the past decade. However, all these driers are either too bulky or too expensive for the individual farmer to use or to own. A lighter drying bin with a motor blower and burner for artificial drying of rice was developed by the PDAF experiment stations in co-operation

with the China Agricultural Machinery Co. Ltd. in 1966. About 650 units of the drier have been offered to local farmers for adoption during the past two years. Meanwhile, some 300 units of Japanese-made driers of similar design were also imported.

Rice transplanter

221. Since 1966, JCRR has assisted the Taipei District Agricultural Improvement Station in modifying two Japanese rice transplanters – a motor-driven type and a hand-pushed one – according to needs and agricultural conditions. The preliminary results obtained from the experiment conducted in 1967 for evaluating the effect of the newly improved machine on transplanting is very encouraging, as the transplanter can save two thirds of the labour required for seedling nursery and is four times quicker in transplanting than hand transplanting. In addition, the yield in the mechanically-transplanted plots was higher than that of the hand-transplanted crops. In order to accelerate the general adoption, as well as to show the advantages of using the transplanter in rice culture, JCRR and PDAF jointly helped the China Agricultural Machinery Company to produce the machine. In 1968, several units were built and sent to agricultural stations for field tests. Beginning in this year, some 50 units of the machine have been constructed and sent to five Township Farm Mechanization Promotion Centres for demonstration and training. Judging from the good results of using the transplanter, mechanized transplanting of rice will be widely adopted by the local rice farmers.

Rice harvesting machine

222. In Taiwan, the paddy is still harvested with a small, lightweight hand sickle. Pedal threshers with a threshing cylinder mounted on skids are pulled around the field to follow the reapers. One man can cut about one half of an acre per day with a sickle, and two men with a pedal thresher can thresh two or three tons of paddy in a day. After threshing, the grain is carried to the courtyard for drying, winnowing and cleaning on concrete grounds. A thresher driven by a small gasoline engine instead of a pedal

has been developed and widely adopted by local farmers in recent years. In the meantime, a small number of Japanese-type power threshers are available for trial use. In 1967, two kinds of hand reapers, pushing and pulling, modified from Japanese designs, were manufactured locally for extension trials. They have not however been extensively used so far, due to higher grain loss and other drawbacks.

Grain cleaning equipment

223. After drying, paddy grains have to go through a winnower once or twice before sending to the market. The winnower is generally made of wood, but some factories are producing winnowers made of sheet metal. Plain bearings are usually used in the revolving mechanism. Only in recent years have ball bearings been adopted by the manufacturers. Since electricity is available in most of the rural areas, some winnower manufacturers have developed an electric motor-driven winnower to replace the handcranked one. Some of them are even equipped with an auger elevator to transport the grain into the hopper of a winnower at higher speed with less labour.

Problems in manufacture

224. The problems in the manufacture of agricultural machinery and implements in developing countries are manifold. The product selection, product mix, technical ability, raw material, import substitution, sub-contracting, quality control, production techniques, marketing, finance, organization and management are some of the interrelated factors. In order to draw attention to these factors, in the correct perspective, and to formulate a guide-line for manufactnre in developing countries, it may be desirable to prepare project profiles of selected items, such as tractors, power tillers, engines, pumps, crop protection equipment and agricultural implements, based on the existing selected industrial enterprises, preferably from developing countries where the solutions to the above mentioned factors have been successfully worked out on a rational basis.

Table 13

Annual supplies of major items for selected agricultural machinery industries having the capacities shown

1. Agricultural hand tools	
a. Direct materials	
- steel	325 tons
- lumber	to the value of US $2,500
- lacquer	to the value of US $4,500
b. Supplies	Normal plus dies to the value of US $4,000
c. Electric power	300,000 kWh
d. Fuels	1,700 gallons for production and other purposes
e. Water	1.2 million gallons
2. Centrifugal pump and valves	
a. Direct materials	
- grey iron castings	380 tons
- bronze fittings	30 tons
- steel rods	76 tons
- bolts, nuts and washers	to the value of US $3,000
- paint	to the value of US $3,000
- skids and crating material	to the value of US $6,000
b. Supplies	normal
c. Electric power	connected load about 190 h.p.
d. Fuel	heating only if any
e. Water	normal
3. Agricultural implements	
a. Direct materials	
- tubes, shaftings, sheet plate, spring, stock, strip and castings	255 tons
- grey iron castings	75 tons
- bearing material	to the value of US $600
- ball bearings	to the value of US $1,000
- paint etc.	to the value of US $300
b. Supplies	normal
c. Electric power	connected load 100 h.p.
d. Fuel	600 gallons furnace fuel
e. Water	500,000 gallons for production, sanitation and fire protection

Table 13 (continued)

4. Ploughs		
a.	Direct materials	
	- castings	625 tons
	- paint	to the value of US $6,500
	- steel brace	to the value of US $3,000
	- bolts, nuts, washers	to the value of US $1,500
	- lumber	to the value of US $37,000
b.	Supplies – casting supplies	to the value of US $4,000
c.	Electric power	connected load 50 h.p.
d.	Fuel (apart from coke as direct for coke material oven)	10,000 gallons
e.	Water	1.5 million gallons
5. 10 h.p. utility tractor		
a.	Direct material	
	- engines	10,000 units
	- sheet steel etc.	500 tons
	- H.R. rounds and flats	250 tons
	- differential gears	10,000 assemblies
	- general hardware	to the value of US $60,000
	- tyres and tubes (pneumatic)	20,000 each
	- tyres (solid)	20,000
	- packaging	to the value of US $3,000
b.	Supplies	
	- cutting tools, solvents, paints	to the value of US $15,000
	- finishes	to the value of US $12,000
	- welding supplies	to the value of US $1,500
c.	Electric power	1,350,000 kWh
d.	Fuel	200,000 gallons bunker oil
e.	Water	25 million gallons

Table 14(a)

Economic size of plants for various agricultural machinery and implements products

(based on average European conditions of 1965)

Item	Hand tools and agricultural hand implements	I.C. engines (up to 50 h.p.)	Agricultural machinery for soil preparation	Agricultural machinery for threshing and harvesting	Agricultural centrifugal pumps
	A	B	C	D	E
1. Minimum economic capacity (1,000 tons per annum)	1 - 1.5	6 - 10	16 - 20	4 - 6	2 - 3
2. Maximum wt of piece to be lifted (kg)	30	150	-	-	2,000
3. Fixed capital per unity of production ($ per ton)	160	140	45	42	180
4. Fixed capital buildings as % of total (per cent)	28	40	44	47	31
5. Working hours total/unit of production (hours/ton)	220	110	23	57	150
6. Working hours/max. hours % of total (per cent)	80	63	65	72	56
7. Output p.a. per prod. workman (tons/wkr)	8.5	17	82	33	13
8. Output p.a. per m^2 of prod. area (tons/m^2)	0.95	1.0	3.0	2.2	1.0
9. Total floor area per worker (m^2)	24	40	66	33	30
10. Prod. workman as % of total workman (per cent)	93	75	75	80	80
11. Prod. workman as % of total employees (per cent)	88	65	66	76	72
12. Energy consumed per unit of production (kWh/ton)	400	280	230	250	320

Table 14(b)

Data related to agricultural machinery industries with possibilities for developing countries

(based on USA conditions 1959/60 one shift operation)

		Farm hand tools	Pumps	Agricultural implements	Ploughs	10 h.p. utility tractor
1. Capacity	Annual	250,000 units	(820 pumps 1.5 - 10 inch) (1900 valves 4 - 16 inch)	1,800 units	12,500 units	10,000 units
2. Capital requirement 1000 US $	Fixed capital	202	618	260	92	234
	Working capital	67	120	46	50	232
	Total capital	269	738	306	142	466
	Foreign currency	187	576	206	66	238
	Local currency	82	162	100	76	228
3. Employment (Nos)	Direct labour	27	33	31	23	38
	Indirect labour	9	5	5	6	8
	Total	36	38	36	29	46
4. Investment	Fixed investment per employee $	5,600	16,300	7,200	3,200	5,100
5. Sales	Total annual gross sales (1000 US $)	411	667	336	350	1,450
6. Cost	Total annual costs (1000 US $)	322	510	268	278	1,252
7. Gross annual profit profit	Total (1000 US $)	89	157	68	72	198
	As % of total capital	33	21	22	51	42
	As % of gross sales	22	24	20	21	14
8. Foreign currency	Annual needs (1000 US $)	93	219	107	83	977
	Annual savings (1000 US $)	318	448	242	267	473
9. Value added	per annum (1000 US $)	324	464	242	233	444
	As % of gross sales	79	70	72	67	31
10. Capital output	Capital output ratio	0.83	1.59	1.27	0.61	1.05

Table 14(c)

Data related to agricultural machinery industries with possibilities for developing countries

(based on African conditions in 1965 - one shift operation)

		Farm hand tools	Pumps	Agricultural implements	Ploughs	10 h.p. utility tractor
1. Capacity	Annual	250,000 units	(820 pumps 1.5-10 inch) (1900 valves 4-16 inch)	1,800 units	12,500 units	10,000 units
2. Capital requirement 1000 US $	Fixed capital	255	770	320	110	285
	Working capital	95	130	80	90	335
	Total capital	350	900	400	200	620
	Foreign currency	240	760	290	115	480
	Local currency	110	140	110	85	140
3. Employment (Nos)	Direct labour	50	55	60	50	90
	Indirect labour	20	10	10	13	15
	Total	70	65	70	62	105
4. Investment	Fixed investment per employee $	3,700	11,800	4,700	1,800	2,700
5. Sales	Total annual gross sales (1000 US $)	410	660	330	350	1,450
6. Cost	Total annual costs (1000 US $)	240	440	220	230	1,220
7. Gross profit	Total 1000 $	170	220	110	120	230
	As % of total capital	49	24	28	60	37
	As % of gross sales	41	33	33	34	16
8. Foreign currency	Annual needs (1000 $)	70	225	120	100	1,145
	Annual savings (1000 $)	340	435	210	250	305
9. Value added	per annum (1000 $)	315	465	220	220	300
	As % of gross sales	77	70	67	63	21
10. Capital output	Capital output ratio	1.10	1.95	1.80	0.91	2.05

Economic size of plants

225. As discussed earlier, the economic size of plants in developing countries differs from that of highly industrialized nations. No detailed analysis is available regarding the economic size of plants for agricultural machinery and implements. It is, however, interesting to note that a preliminary analysis has been carried out by the Economic Commission for Africa.

226. The details of the economic size of plants for developing countries and for Africa are given in Tables 13 and 14 (a-c). Based on these, the various supplies needed for the selected agricultural machinery are also worked out.

227. From the information available it appears that it is necessary to study the aspect of economic size of plants for developing countries in detail.

"Prototype" demonstration manufacturing plants

228. Due to technological, financial and organizational limitations, it has not been possible in most of the developing countries to establish integrated manufacturing plants in agricultural machinery industry. The existing growth pattern appears to be based on unplanned, unco-ordinated and non-interrelated evolution. In order to establish a correct manufacturing patterns, it is very desirable that "prototype" demonstration manufacturing plants for agricultural machinery should be established in selected developing countries. These would act as mode plants incorporating the rational manufacturing and organizational techniques, supporting and utilizing the local resources and talents to a maximum.

V. DESIGN, DEVELOPMENT AND TESTING

229. Apart from the specific agrotechnical, economic and social conditions of the mechanization, other factors existing in the developing countries limit the possible application of machines used in the developed countries. One of these factors, especially important for the design and manufacture of more complicated machines, is the effect of tropical climate on the machines. This effect has also to be considered when deciding on the possibilities of utilizing subsidiary industries in the developing countries either for home production or for the adaptation of imported machines.

230. Tractors and agricultural machines have been designed in developed countries to meet the requirements and conditions of agriculture in the temperate zone. These conditions (as far as the quality of labour in agriculture is concerned) are frequently very strict and difficult to meet, whereas working conditions tend to be relatively easy. In the developing countries, however, the situation is quite different. The requirements on the quality of labour are considerably lower, while greater value is placed on reliability and low maintenance and repairs requirements. Working conditions are, however, much more difficult. Tractors and agricultural machines devaluate during their life due to a number of unfavourable climatic conditions, the effects of which come apparent not only in operation but as early as in the manufacturing process (at the surface finish) or before being taken over by the customer (during transport and storing). The devaluation may become evident in different ways, the most apparent of which being impaired functional and technical reliability, an increased consumption of spare parts and an increase in service and maintenance requirements. The main reasons for the deterioration of agricultural machines and implements are atmospheric corrosion, biological deterioration and wear. The restriction of these deteriorations in order to prevent the impairment of the technical characteristics is one of the aims of design in the developing countries themselves.

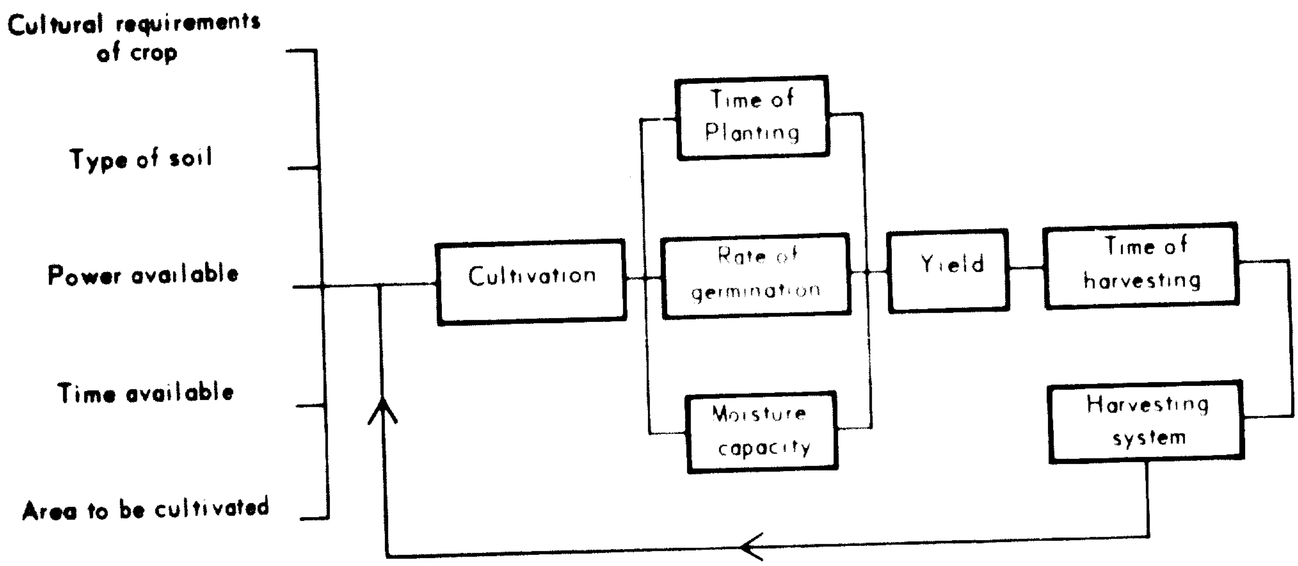
The soil-crop system

231. Agricultural machinery provides considerable scope for the designer to produce features which exploit the opportunities offered by local agricultural conditions. Mechanical design is one of the design problems of farm machinery. A more important problem is to decide how best to relate the specification for the machine to the whole system of which it forms a part. The machine is one link in an agricultural production system and the performance of the machine within the over-all system is more decisive than the way it functions in the sub-system in which it operated.

232. Some of the factors which help to specify the system performance of a cultivator are shown in Figure 5. The function of a cultivator may be described as the creation of a satisfactory environment in the soil for the development of the crop.

Figure 5

Soil – crop system



233. The systems approach to design uses the satisfactory operation of the total project as the design criterion rather than the independent considera-tion of the efficiency of the component parts of the system. The attention of the designer is directed to the complete project and he is provided with a framework for examining it. It is the approach of the agricultural engineer to farm machine design, because he is able to view both the agricultural production process and the mechanical design of the components in a similar quantitative way. The systems approach to design directs the attention of the designer to the total project, which is complimentary to that of mechanical design which directs his attention towards an analysis of the component parts of a machine.

The design criterion

234. In any systems approach to design it is necessary to compare different arrangements of subsystems in order to reach a decision. The most practical common denominator is an economic comparison of different solutions. The criterion of selection can be either the lowest cost solution or the maximum profit solution.

235. By means of economic comparisons of different agricultural production systems it is possible to decide between manual labour and power machinery systems. Even if a manual labour system appears cheap in terms of capital investment, it incurs penalties in terms of the losses which arise through inability to plant at the correct time, low water storage and late harvest.

Lack of suitable equipment

236. In tropical countries, the mechanization of areas growing lowland paddy has been relatively slower than that of dry land cereal crops. A good example is seen in East and West Pakistan. While some progress has been made in the mechanization of the dry land crop areas of West Pakistan, lowland rice cultivation in East Pakistan is almost completely non-mechanized. This disparity is, to some extent, due to the greater shortage of suitable agricultural equipment for lowland rice cultivation.

237. The equipment developed in the temperate countries for dry land cultivation is often not suited for lowland cultivation in the tropics. Some of the equipment developed for lowland work in Italy, California, and the southern United States are also not suited to the scale of farming generally found in the tropics. Japanese farm machinery manufacturers lead in the development of equipment for small-scale lowland rice cultivation. However, due to the demands of the Japanese home market, such equipment is increasingly becoming too sophisticated for the tropical farmers. The Japanese equipment also encounters problems with the heavy, deep clay soils and other conditions in the tropics. It is essential, therefore, that a major research effort be directed toward the development of suitable agricultural equipment to mechanize lowland rice cultivation in the developing countries.

238. In Asia, 5 to 25 acre landholdings constitute a major portion of the total arable land and support a large section of the rural households. This large group of holdings has sufficient means to support agricultural mechanization at an intermediate level. Ironically, however, this group has the least access to suitable farm equipment.

239. The development of simple power-operated equipment for 5 to 25 acre holdings offers the greatest potential for mechanization and is a great challenge to equipment-development engineers. This is particularly so because development research in the advanced countries is principally concerned with sophisticated equipment for larger farm holdings. The development of relatively labour-intensive agricultural equipment for an intermediate level of mechanization also will not create rural labour surpluses and unemployment problems as predicted by some authorities.

Development and evaluation needed at local levels

240. There is need for more accelerated programmes in the development and evaluation in each country of equipment to meet local requirements and which should be manufactured indigenously. Emphasis should be placed on evaluating known machine principles from all over the world and adapting those proven satisfactory before entering into a new complete development programme. Evaluation will enhance the development of local design capability.

241. Local design and development is regarded as an opportunity to foster the competence of the engineers and technicians of the developing country. Even where a country enters into a licencing agreement, it cannot avoid an element of local design. A licencing agreement is viewed as a short cut to technological sophistication, but conditions differ between countries both in the demands of the users and the facilities offered for manufacture. As the indigenous content in manufacturing is increased, redesign and adaptation is usually necessary and desirable.

242. The reasons for which developing countries wish to mechanize and to produce the necessary agricultural machinery are not largely economic, although all too often those people bent on discouraging too rapid an industrialization programme in developing countries tend to look for their arguments in economics. The developing countries' desire to mechanize their agriculture – which in many countries is a way of life – is interwoven with their general aspirations to catch up in technology as well as to relieve

their rural populations of some of the burdensome methods of work now practised.

243. The kind of approach that is strongly advocated towards the fulfilment of these goals is:

(a) The encouragement of machinery and implements manufacture as a first step;

(b) The stepping up of manufacture and utilization of water pumps; water is a very basic commodity in the rural communities and if ways and means could be found to procure it more easily, life in the rural areas would be much more attractive;

(c) Assisting in the manufacture of as large an assortment of spare parts as local technology will permit;

(d) Assisting in the developing of tractor assembly and eventual manufacture.

Future design trends and preference of farm machinery

244. It was assumed that the trends shown in the 12 ECAFE group of countries represent a fair indication of the likely trends in most of the developing countries. Based on ECAFE/UNIDO Fact Finding Teams Report the following machines were discussed:

Four-wheel riding tractors

245. In the conditions prevailing in developing countries, it is particularly important to select from the very beginning types of tractors and agricultural machines which can be used immediately with the highest degree of efficiency in agriculture, but which can also be subsequently modified at minimum expense to satisfy the future requirements of a developing economy.

246. The term "type range" of tractors or agricultural machines means the set of types, sizes and models which, considered from a technical and economic point of view, can be assembled under the heading of a single application yet possess progressive features which take into account both existing and future requirements of the economy.

247. Out of the large number of parameters for the mobile unit, the tractor and the agricultural machine may be selected as those which, while

fully characterizing the unit and providing the basic parameters for the tractors and machines, at the same time do not restrict the design possibilities for these units. Such parameters are the following:

(a) Type and design of tractor – T (track laying, wheeled tractors with two driving wheels, four-wheel-drive tractors etc.);

(b) Power of tractor engine – N;

(c) Weight of tractor – G_T, its tractive capacity and its class;

(d) Type and design of the agricultural machine – M_M (knife coulter plough, disc coulter plough, rotary plough, etc.);

(e) Working width of agricultural machine – B;

(f) Speed of movement of the unit – V

248. A machine and tractor unit is not just a tractor mechanically linked to an agricultural machine, but a unitary whole with new properties. The parameters of tractors and machines must therefore be determined simultaneously, in a single process, and the methods of determining them must be such as to make possible the simultaneous determination of the above mentioned optimum parameters of the units.

249. The calculation and justification of the type range of tractors and agricultural machines is a complex task, involving a whole series of problems connected with the manufacture and operating conditions of tractors and the agricultural machines to which they are coupled.

250. The determination of tractor weight and power, the working width of agricultural machines and the speed of advance of the machine/tractor unit is an essential element in the selection of type ranges.

251. The most popular models used in the ECAFE countries are in the range of 35-45 h.p., known as light medium tractors, with unit weights of around 1,600 kg. A few specific technical features were required in the original designs before the tractors were used successfully. They needed to be very strong in the rear axle, the front axle and the steering mechanism because of the use of cage wheels in wet or dry paddy fields. Hydraulic lift should be very powerful and good draft control was necessary. For work in paddy fields, a good protection against water and mud was needed for all

parts, but mainly for the braking system and for the oil seals in the front and rear axle. Air cleaners had to be highly efficient, likewise fuel filters because of probable use of polluted fuel oil and tropical-proof electrical equipment was also necessary.

252. It would be advantageous to manufacture a riding paddy tractor in the small horsepower range. A two cylinder diesel engine of 20/25 h.p. would perhaps be suitable. A one cylinder engine with its usual cylinder capacity and speed would be limited to a maximum of 15 h.p. and that would be too small for the requirements of rotary tillage. In order to make a significant difference with the big power tillers, 25 h.p. would be needed. Other characteristics desired would be a simple mechanical transmission with 6 gears and a differential lock. A low gear at around 1.5 km/hr was necessary for rotary tillage. Other desirable features were:

- Small wheel base for short turning radius (around 1.6 metres);
- Light weight, around 800 kg with more than 40% of weight upon front axle;
- Simple and powerful hydraulic lift;
- Specially designed rear hitch and driving mechanism for rotary tillers;
- High ground clearance (more than 40 cm);
- Sturdy rear and front axle.

Power tillers

253. The power tiller is ideal for land preparation on water-logged soil since it adds traction to the propelling unit rather than retarding. It is well established in the paddy fields.

254. The most popular models of power tillers found in the ECAFE countries were in the range of 6 to 12 h.p. Considering the performance of the existing models of power tillers marketed within the ECAFE countries and their cost, it would be good to develop a model that would be simpler in structure, lower in cost and stronger in design and performance. Such a model might incorporate the following basic parameters of design:

- One cylinder, four-cycle, air-cooled diesel engine rated at around 8 - 10 h.p.;
- Weight, less than 300 kg including engine;
- Simple mechanical transmission with 4 gears: 3 gears forward and one reverse;
- Power take-off: belt drive;
- Tyres: 6 × 12 or 6 × 14, high road clearance;
- Tilling width and depth: 600 - 650 mm, 150 - 200 mm;
- Few accessories; tubular frame body and simple design.

Engines

255. The various types of small engines used in agriculture were as follows:

(a) Micro gasoline-fed engines: from 1 - 2.5 h.p. for knapsack sprayers and dusters;

(b) Small gasoline-fed engines: from 2 - 6 h.p. engine equipped normally with one vertical cylinder, used for stationary applications;

(c) Small diesel engines: from 5 - 15 h.p. used for power tillers and for stationary purposes were used mostly for driving irrigation pumps, threshers, rice processing equipment, electrical generating sets etc.; there was a tendency towards the use of lighter, high-speed (2,000 r.p.m.), one vertical cylinder, air-cooled engines;

(d) Medium diesel engines: those engines in the range of 12 - 30 h.p. were used for driving big irrigation pumps, tractors and electric generating sets; they were with one or two horizontal cylinders, water-cooled, operated at low speeds from 350 to 600 r.p.m., heavy in weight and especially designed for stationary uses; there was a tendency to use lighter weight engines operating at higher speeds (from 1,500 to 2,500 r.p.m.);

(e) Diesel engines for tractors: air-cooled diesel engines had not been successfully used in tractors within the ECAFE countries because of the difficulty in obtaining the desired cooling effect; almost all tractor engines were water-cooled, using direct fuel injection with a speed of from 2,000 to 2,500 r.p.m. and with 2 to 4 cylinders depending upon the horse-power ratings.

Pumps

256. The centrifugal-type of pump from 2 - 10 inches in size was popular. Low-propeller types of pumps, consisting of a turbine or a propeller pump driven by a long shaft connected to an engine, were also used for lifting water at low heads.

257. Water supply is one of the most widespread and uniform demands in rural areas. It can be viewed as an aid to living conditions in rural communities, as one of the requirements of livestock and as a means of increasing production of arable crops by irrigation. The costs of pumping water are relatively low and simple water supply systems are convincing examples of the benefits of mechanization. The capacity of even small pumps is so great that communal ownership is possible without conflicting demands, especially if buffer storage is provided in the system. Such a water supply scheme can lead to co-operative ownership of other agricultural machines.

258. The most versatile pump for rural use is the jet-assisted, centrifugal pump. As an ordinary centrifugal pump it can be used for low head duties, viz lift 4 metres, delivery 10 cu.m/min. Applications are pumping drinking water from shallow wells or irrigation water from canals. The lift can be increased to 20 metres by by-passing some of the water from the delivery side of the pump back to a jet-injector, which is placed in the well on the suction pipe of the pump. In this way the pump and driving motor can be kept on the surface where they are accessible for maintenance and there are no difficult requirements in regard to sealing.

259. The pump could be driven by a small air-cooled petrol engine. A one horsepower engine would be capable of pumping about 100 litres per minute.

260. The manufacture of pumps requires good casting and machining facilities, simple assembly and close attention to quality control.

Weed control and plant protection

261. The control of weeds, disease and pests is a sure way to increase yields in the developing nations. Probably the most effective way of distributing chemicals, confirmed by the experience of farmers in India, is

by a knapsack or lightweight portable unit powered by a high speed internal combustion engine of less than 5 h.p.

262. Hand sprayers – the Hudson and the Japanese types – were commonly used in all the countries. Knapsack power sprayers were becoming popular and were of the mist type operated by micro-engines. Another type of duster being used was the portable trolley and boom type, consisting of a small 2 - 3 h.p. engine with a mist fan and a powder tank mounted upon a frame.

263. The interest and expertize possessed by manufacturers of agricultural chemicals in the field application of their products was stressed. It was proposed that UNIDO should investigate this problem in detail, from deciding the types of machinery suitable for a selected region, to design, organization of manufacture and development of marketing.

Tillage implements

264. The preparation of seedbeds is the operation which requires more energy than any other in the production of a crop. It is usually decisive in forming tractor specifications. Rapid soil preparation is essential in multi-cropping systems. It has been pointed out that it is usually more economical to increase food supplies through increased production per year per unit area rather than to bring new land into production. Many of the developing countries can produce two or even three crops per annum from the same area.

265. In countries such as Japan, China (Taiwan) and the Republic of Korea, rotary cultivators were almost generally used as an attachment to the power tiller. Ploughing with the mouldboard was occasionally carried out after harvesting. For soil preparation, one pass of the rotary cultivator was made in the soft or dry field. Some 10 - 15 cm of water was allowed into the paddy field and a few days afterwards a second pass of the rotary tiller took the place of puddling. Levelling was carried out with a levelling wooden board just before transplanting.

266. Tractors were used in India, Ceylon and Thailand; the tillage was performed by disc ploughs in Thailand, tine cultivators in Ceylon, and cage wheels and disc harrows in India. Tillage was normally carried out at the beginning of the rainy season with the aid of tractors equipped with cage wheels. The working conditions during tillage operations in wet paddy fields were the most severe that could be encountered by the power tiller or the tractor. Power tillers made in Japan, numbering more than three million and now in use, had been proven to perform quite successfully. They were light, well-protected against water intrusion and were especially designed for power transmission to the rotary tiller. Rotary tillers had been known for more than forty years and the Japanese engineers had improved and redesigned them to make them suitable for wet land cultivation. Rotary tillers were very suitable and convenient for small farms. Four-wheel riding tractors, were relatively few and were concentrated in Ceylon, India and Thailand. In Thailand, contractors who owned most of the tractors used them to plough dry or semi-dry fields using implements such as disc ploughs and cultivators. In general tractors were very difficult to use because the paddy fields in most countries (except Thailand and some parts of India) were very small in size and were very swampy. Owing to the conditions of wet paddy cultivation and the small size of the paddy fields, tractors were not really suitable and much development work was needed in that respect.

267. Tine cultivators are capable of working to depths of 0.25 m and single tines may be used for sub-soiling to depths of 1 m. Tine cultivators are simple to design and manufacture. They appear to be very suitable for tropical conditions for the following reasons:

(a) They do not remove plant residues completely from the surface, nor do they produce a fine tilth which might be easily eroded away;

(b) They are capable of working deeply in the soil, which improves the permeability, reduces run-off at the surface and increases the amount of water which can be stored in the soil;

(c) They are able to work in a wide range of conditions.

268. Small shallow-tined cultivators may be designed for use with animals. Full size tractors, however, are needed to provide the draft necessary to work deep tines.

Harvesting

269. Harvesting of grain crops is highly developed, whereas the methods used for other crops are very primative.

270. The grain crop types produced in different regions expressed as a percentage of the whole area under grain are:

(a) In the countries of Africa: millet and sorghum 52 per cent; corn 26 per cent; wheat 10 per cent; barley 6.4 per cent; and rice 5 per cent;

(b) In the countries of Latin America: corn 57 per cent; wheat 19 per cent; rice 12.7 per cent; millet and sorghum 5.5 per cent; barley 3 per cent; oats 1.6 per cent; and rye 1 per cent;

(c) In the countries of south Asia (Pakistan, India, Afghanistan, Burma): rice 42 per cent; millet and sorghum 33.5 per cent (mainly in India and Pakistan); wheat 17 per cent, corn 5.2 per cent; and barley 2.3 per cent;

(d) In the countries of the Near East (Iran, Irak): wheat 67 per cent; Barley 26.7 per cent; rice 5.8 per cent; millet and sorghum 0.3 per cent; and corn 0.2 per cent;

(e) In the USA: corn 37.8 per cent; wheat 33 per cent; oats 11.8 per cent; millet and sorghum 8.5 per cent; barley 6.8 per cent; rice 1.3 per cent; and rye 0.8 per cent;

(f) In Canada: wheat 63.7 per cent; oats 17 per cent; barley 16 per cent; corn 1.7 per cent; and rye 1.6 per cent;

(g) In Denmark: barley 74.8 per cent; oats 15.8 per cent; wheat 6.3 per cent; and rye 3.1 per cent;

(h) In the USSR: wheat 60 per cent; barley 16.5 per cent; rye 11.6 per cent; oats 6.1 per cent; corn 2.8 per cent; millet and sorghum 2.8 per cent; and rice 0.2 per cent.

271. All the experience accumulated up to the present time indicates that the perspective in the development of grain harvesting techniques is the wide application and continuous improvement of the combine harvesting method, and the developing countries should take up the use of the most perfect and productive combines.

272. For the transportation from the combines, cleaning, drying (where necessary) and processing of grain it is expedient to use industrial methods and trucks of high-capacity, with direct delivery of grain to the industrial combination plants. Experience shows that new, most advanced methods are easily introduced in the areas where mechanization has just started and there are no established traditions.

273. In order to choose the most efficient machines for use in developing countries and to work out detailed, well-grounded recommendations it is necessary:

(a) To study the concrete conditions typical for the harvesting of grain in these countries and to obtain the data characterizing the sizes of lands under crops to be harvested, the features of ground contour, variations in the properties and condition of crops and of the soil at the harvest time;

(b) To conduct tests of combines and other harvesting machines under the conditions typical for developing countries and to elaborate a tentative procedure for carrying out these tests on the basis of generalization of the experience gained.

274. In the ECAFE countries, harvesting is mainly carried out by hand and mainly by women using knives or sickles. Reapers, as simple attachments for power tillers, could be introduced as a first stage of mechanizing harvesting in many Asian countries. Binders, as further attachments to power tillers, may be integrated to the harvesting machines.

Japanese combine harvesters

275. The harvesters were very small machines especially designed for the combined operation of harvesting and threshing paddy in the typically small and wet paddy fields. They could harvest two rows (depending upon the model) up to an accumulated weight of paddy of around 600 kg - 1,300 kg. The harvesting rate was about 3 - 5 ha per hour. However, the relatively high cost of such combines and the differences in agricultural conditions in the Asian countries where they were to be introduced were considerations which needed to be further examined before such combines were manufactured on a large scale.

Western-type combine harvesters

276. Such combines were basically of the same models as those used for processing wheat or other cereals. The only differences were in the threshing drum (peg type instead of standard rasp bar type), in the carriage system (half tracks replacing the front wheels) and in minor changes in size. The combines proved very successful in all western countries, even in Italy, France and the United States of America, where they were used for processing paddy. Apart from their high cost, they appeared to be too bulky and too heavy for use in small and wet paddy fields. The smaller models with 1.6 - 2.0 metres harvesting width were being tested in Asia by western makers on a very small scale. Such machines needed to be improved to fit the conditions encountered in Asian countries in wet paddy fields.

Rice-processing machinery

277. Conditions for rice milling varied from country to country. Rice mills were found to be mostly privately owned. The number of small mills, some of which were provided merely with hulling machines, had increased in rural areas. The capacities of those mills range from 0.5 to 5 tons of paddy per day, based on one shift operation. Depending upon the type of milling equipment used, the recovery rate varied from 55 - 70 per cent. New types of milling equipment increased the yield by about 10 per cent. Except for China (Taiwan) and the Republic of Korea, the other countries of the region required technical assistance for the improvement of rice milling and the storage of paddy.

278. The various types of farm equipment employed in the twelve developing ECAFE countries visited, their level of use and the improvement areas that are necessary, are given in Table 15.

Current research and development activities

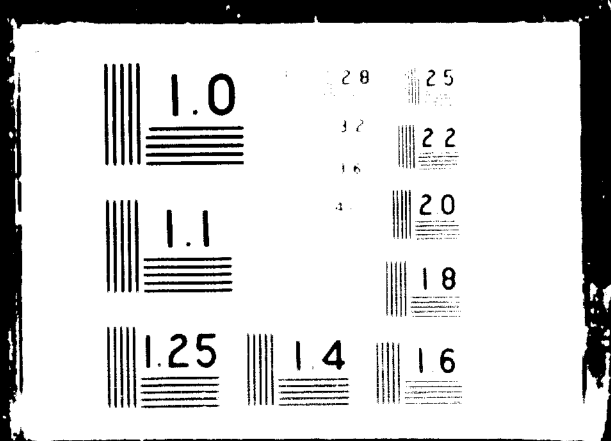
279. Many developing countries have established agricultural engineering research centres in their universities and departments of agriculture. These centres are often well-equipped and are staffed by highly qualified

Table 15

Various types of farm equipment employed in the 12 ECAFE countries, level of use and improvement areas necessary

Implements	Used normally	Necessity for: Wider usage	Standardization	Improvement
Tillage				
(a) Tractor mounted				
Disc plough	x			
Mouldboard plough standard	x			
reversible		x		
Harrow disc	x			
peg tooth		x		
Tine tiller	x			
Rotary cultivator	x	x		
(b) Draft animal				
Ploughs	x		x	x
Harrows	x		x	x
Planting and seeding				
Paddy transplanter		x		x
Seed drill/fertilizer distributor		x		x
Corn planter		x		
Pest control				
Hand sprayer			x	
Knapsack power sprayer		x		
Portable		x		
Harvesting and threshing				
Paddy Reaper		x		
Binder		x		x
Combine		x		
Pedal thresher	x		x	
Power thresher		x		x
Winnower		x	x	
Wheat Reaper		x		x
Binder		x		
Combine		x		
Thresher				
Winnower		x	x	x
Processing				
Hullers etc.		x	x	x
Other implements				
Tractor trailer	x			
Tractor front loader		x		

14. 3. 74


1.0
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engineers. A few such centres have been functioning for periods of 15 to 20 years. It is unfortunate, however, that the research efforts of these centres have not generally resulted in any significant impact on the mechanization of agriculture in farmers' fields. It is also interesting to note that the existing locally developed types of agricultural equipment which are popular are generally the result of work by technicians, farmers, and small manufacturers. There are many publicly owned research centres in the developing countries engaged in the improvement of manual and animal-drawn implements. Relatively less attention is being directed to the development of suitable small and medium sized power-operated equipment. Due to the limitations of available power per man or per animal, only marginal improvements in output can be expected from improved manual or animal equipment. The extension of marginally improved equipment in the field is a very difficult problem. The research on power-operated agricultural equipment at a few centres is generally limited to equipment surveys and test, evaluation and theoretical function analysis type of studies.

280. The factors inhibiting rapid progress in increasing the extent and use of modern power and equipment in the agricultural input-mix are selection, adaptation and evaluation. The problem is not that of inventing new equipment and principles. Rather, it consists in selecting kinds of equipment that have been proven elsewhere and adapting them to the situation in a particular country. To select and adapt requires evaluation. It is not difficult to select and adapt from among the world's collection. The more difficult problem is to conduct evaluations that are meaningful and valid. This, then, is the real key to advancement in power and equipment systems for agricultural production.

281. In most instances we are failing to make our evaluations factual, complete and comprehensive, and we are failing to analyze the data statistically, to determine its validity and to show how to improve field tests. Too many of our evaluations are based upon opinions formed by simply observing the machine in operation for a relatively short period. Too many of our evaluations are based upon measuring only one or two factors — for example,

the draft, and when we do collect data, too few and scattered readings are taken and the trials are not replicated.

282. Most machine systems can and should be evaluated on the basis of four major performance components as follows:

(a) Machine performance; e.g. acres per hour;

(b) Power performance; e.g. horse-power hours per acre;

(c) Labour performance; e.g. man-hours per acre;

(d) Economic performance; e.g. the over-all economic analysis giving the total input costs and resulting value to the product and process.

283. There is urgent need for an assessment of machinery research objectives and the formation of fresh guide-lines for the agricultural engineering research and development establishments in the developing countries. The extension of machinery research is mainly accomplished by incorporating the results into the designs of new agricultural machines, which can be made available to the farmers through normal commercial channels.

284. It is difficult to visualize a country in a position to mechanize its agriculture with imported equipment only. A study of some of the smaller but agriculturally mechanized countries indicates that the major portion of their agricultural machinery requirements are produced locally. The shortage of foreign exchange and the strong desire for industrial development are bound to encourage the local manufacture not only of the simple but also of some of the sophisticated agricultural machines. It is regrettable that too often there is a lack of dialogue between those who are conducting agricultural machinery research in the developing countries and the manufacturers who can utilize the results of such research. The research engineers from the public institutions will have to acquire skills in the development of new agricultural machines for commercial manufacture and sale. The manufacturers, for their part, will have to co-operate by supporting the development of agricultural machinery for commercial production at the public research institutions. A co-operative research programme between the public institutions and the manufacturers would be more effective than the

present independent approach to machinery research found in some developing countries.

Need for development and adaptation centres

285. Future design needs and preference for agricultural machinery and current level of research and development activities indicate the need for establishment of action-orientated development and adaptation centres for agricultural machinery. Such centres should mainly engage in such matters as the adaptation of existing machinery to local agricultural conditions, the availability of material and manufacturing techniques. They should also develop machinery to meet specific needs of the country. They should be capable of rendering technical service to the existing local manufacturers towards diversification, quality control, import substitution and new production techniques and cost reduction systems. In general these centres should act as catalytic agents, assisting the existing manufacturers and potential industrialists and government towards identification, adaptation and manufacture of agricultural machinery. There is a need to render technical assistance to the developing countries to establish such institutions. Although there are already general design and development centres in a few of the developing countries, they are mainly devoted to other fields and it may be necessary to reinforce and reorientate their activities towards agricultural machinery. Such existing organizations may be utilized towards enhancing design capabilities and encouraging local talent.

286. Considerable emphasis was placed on the importance of quality control in manufacture and the necessity for reliability in the field. There should be a feed-back of information from users. Ideally such information should be acted upon by the manufacturer's own design and development section, but where a manufacturer does not have the comprehensive service to deal with problems, he should be able to call on a design and adaptation centre for assistance. The need to increase the content of indigenous material, to devise standards of quality control, to modify designs to suit manufacturing facilities and to meet more fully the needs of local farming places demands

on design and development facilities. It is expected that rapid rates of change will be achieved in the developing countries; in this situation the processes of manufacture and utilization will alter quickly, demanding continual adaptation.

287. By combining in the same place development, testing and education in agricultural engineering, great savings can be reached. The same personnel, buildings, laboratories, instruments, experiment farms, service arrangement etc., can be used more or less for all these purposes. The whole agricultural (forestry) centre must be under the same direction.

Need for agricultural machinery testing stations

288. The ECAFE/UNIDO Fact Finding Team found that agricultural machinery testing in most of the countries is undertaken by agricultural educational institutions and in some cases by government departments. The testing facilities were limited, testing techniques questionable, and level of technical personnel in need of reinforcement. The problem of standardization, quality control and testing of agricultural machinery in developing countries is two-fold; local products which may be manufactured by many small scale manufacturers need quality control and technical assistance, while new products suitable for the local manufacture need to be identified. It is necessary that such institutions have sufficient equipment and technical man-power to carry out the work successfully. Hence it is desirable that assistance is rendered to the developing countries towards establishment of agricultural machinery and implement testing stations and also towards the reinforcement of existing institutions.

289. Two different functions for testing stations were discussed; an aid to extension in the establishment of machines on farms, and field quality control for the manufacturer.

290. In extension, testing is directed towards the needs of the consumer. Emphasis is placed on operation and how well the machines perform on a range of farms. It is important that information should be collected at the

points of use and over as wide a range of conditions as possible. Surveys of the performance of machines on several farms probably gives more useful information than can be obtained in a single test of limited duration. Side-by-side demonstrations of their own machines by several manufacturers is valuable in showing farmers what can be achieved by mechanization. A primary aim of extension testing is wide dissemination among farmers of information on machines and their utilization.

291. While manufacturers can obtain valuable information from extension testing it is the policy of manufacturers to see that their machines function properly before they are offered to farmers and to evaluate new machines and principles. The work of a manufacturers' test centre, which could be associated with an extension centre, should be largely confidential. Such centres could be watchdogs of quality control of the equipment manufactured or to be taken up for manufacture, suggest improvements in the equipment and bring to the notice of all concerned the defects, if any, in the equipment so tested. UNIDO could advise on the test procedures to be adopted.

Agricultural engineering education

292. With emphasis on self-reliance on manufacture of agricultural machinery in developing countries, there is a need to analyse the status of mechanical engineering and agricultural engineering education. It is necessary that the curriculum should be orientated towards making available competent personnel to fit into the growing industrial sector.

293. In agricultural production, agricultural engineers are concerned with improving systems of farm mechanization, management of machinery, drainage, land development, buildings, crop conservation and storage. Training is concerned with agricultural production, engineering and farm management. As industrialization proceeds, agricultural engineers become concerned with machinery manufacture, food processing, marketing, design, development industrial engineering and industrial management. Emphasis in training is placed on engineering, economics and management.

294. A very extensive and expanding programme of technical training is required for those engaged in manufacture and in repair and maintenance. Operators need training in the proper use of the machinery and farmers must be made aware of the need for management of the investment in machinery. A manufacturing programme must be accompanied by education and training of all those affected by it.

VI. MARKETING SERVICE, MAINTENANCE AND REPAIR

Marketing and service

295. The ECAFE/UNIDO Fact-Finding Team reports that so-called marketing organizations had been created in an organized way in most of the countries, although there was scope for improvement.

296. These organizations appear to be really sales organizations and must be expanded to include all other facets of marketing.

297. The marketing of farm machinery was carried out through private distributors and in some cases through state trading agencies. General organizations incorporating all aspects of marketing such as detailed market analysis, machinery usage, product analysis, sales forecasting, sales, communication, extension etc., did not really exist.

298. It is in this field of basic study of the individual characteristics of each market that UNIDO could make a vital contribution to the effective mechanizing of agriculture in developing countries. Lack of research into the basic needs of each country will seriously hamper the possibility of introducing an economically viable solution. Once the needs of a developing country are fully assessed and understood, a programme can be prepared for the phased long-term development of that market.

299. The government and industry should find ways of making available the stock of crucial spare parts, which should be priced reasonably for consumers to be able to purchase them conveniently. The retail selling prices of farm machines varied from country to country. It had not been possible to investigate the detailed cost structure breakdown.

300. The establishment of adequate service arrangements for agricultural machinery is essential. This will require:

(a) Consumable items such as fuels, lubricants and spare parts;

(b) Training facilities for instructing operators, service mechanics, advisors and other government officials;

(c) Personnel to achieve this training.

301. The setting up of an autonomous service organization largely extended over a country, which can be assumed as "the basic module" of any well conceived farm mechanization plan, can be indicated as follows for a fleet of 1000 tractors with implements, a small proportion employed in earth-moving applications, plus 500 lorries and off-the-road vehicles; the whole fleet scattered over a number of separate localities requires:

(a) Considerable expenditure in relation to the capital invested to acquire the farm machines;

(b) Even bigger expenditure in relation to the annual cost of depreciation plus capital interest.

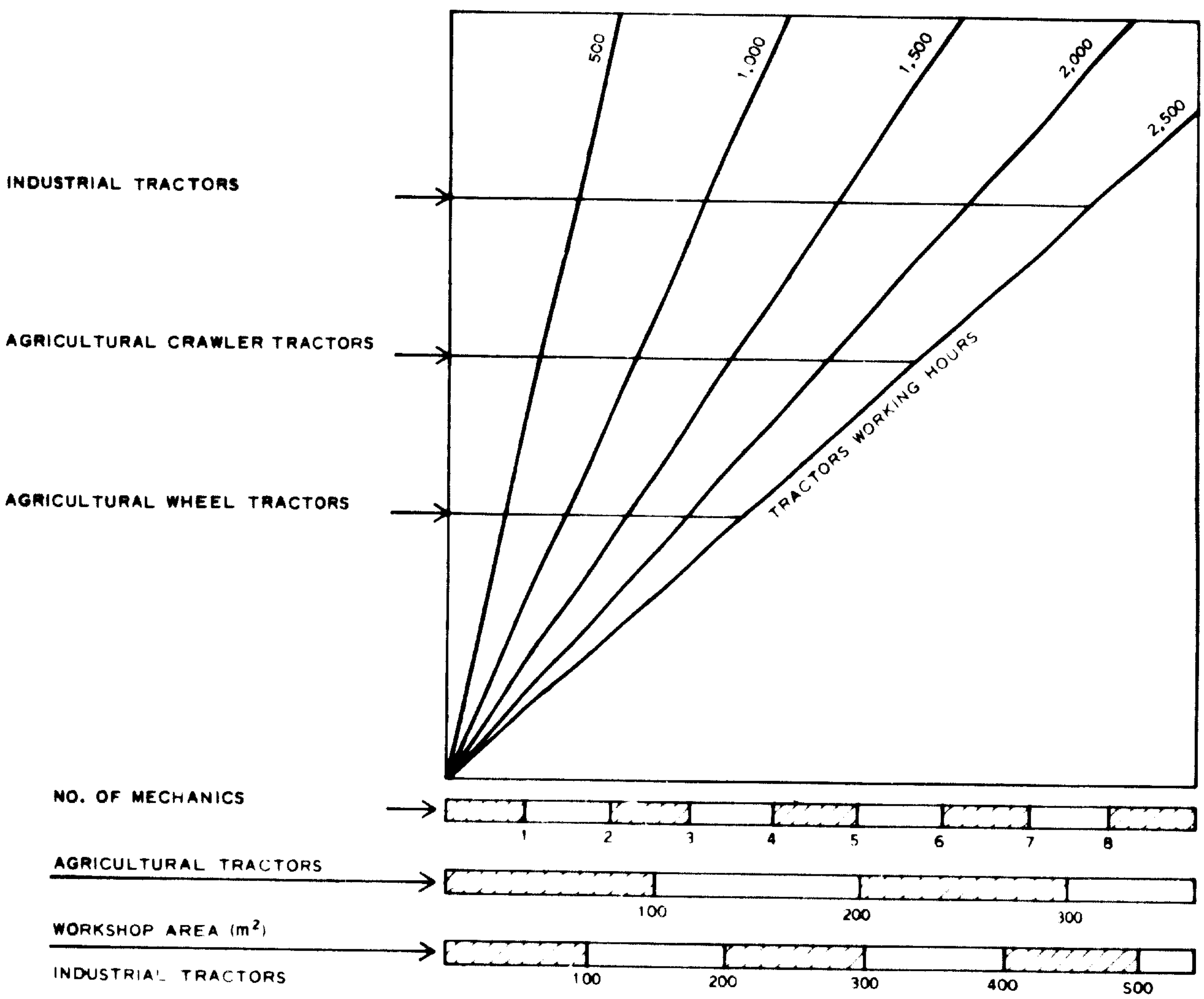
302. Therefore, under these particular conditions: capital investment expenditure may approach the shipment price of machinery; in fact, the expenditure required to secure an adequate service for the first lot of one thousand tranctors etc., may vary from one tenth of the capital investment for machinery (this in case of local distributor already running a sound business) to a maximum expense corresponding to the full investment allocated for the machines.

303. The operation of an effective agricultural service organization involves the employment of workers, technicians and executives with highly specialized skills in economic sectors which the developing countries have every interest to strengthen. The man-power employed by an effective service organization caring for a basic fleet of machines including 1,000 tractors with implements etc., may vary from 200 to 500 persons, excluding tractor drivers, depending upon the organizational solution adopted. Thus, man-power skills, highly valuable for a weak economy are created already in the early stages of operation.

304. A workshop organization digram is shown in Figure 6.

Figure 6

A workshop organization diagram
(100 working tractors)



305. The most important problem in effective service policy is probably communications: farmers and operators are often spread over large areas, in some cases a matter of more than a hundred miles from their nearest dealer and any sort of workshop. Social situations also often make the dissemination of information to operators more difficult. In particular, the levels of education too frequently make the instruction and training of machinery operators a much more laborious and repetitive process than it would be in more developed countries. The difficulties stemming from

these two main problems are further aggravated by the unique conditions under which most farm machinery is operated in developing countries. Since, as one expert estimated, machines commonly work 1,500 to 2,000 hours a year, the effects of rough handling and rigorous soil and climatic conditions tend to lead to more frequent servicing and maintenance requirements. It has been shown that there are three main problems involved in the servicing and maintenance of farm machinery in developing countries: inadequate supplies of spare parts, a lack of efficient maintenance and repair services and, in many countries, a complete absence of facilities for training operators and maintenance technicians.

306. Service to farmers should be (a) comprehensive, (b) farmer oriented, and (c) managed by modern practices and techniques. An outline of the kind of assistance discussed here and recommended for rapid advancement of agricultural mechanization, along with a designation of the agency most responsible for each type of service, appears in Table 16.

Table 16

Outline of comprehensive service

Category	Description of type of service to provide to the farmer	Agency most responsible
Before sales	Knowledge, particularly cost/benefit of the tractor and associated equipment, and how the equipment should be used and cared for	a. Government extension educational services b. Manufacturers c. Local dealers
Sales	Supply tractors and related equipment initially, and better and improved replacements over the long term	a. Manufacturers b. Local dealers
	Provide credit so that farmers can purchase equipment	c. Government credit agencies
After sales	Provide spare parts, oils and fuels, and maintenance service during the lifetime of the tractor and equipment	a. Manufacturers b. Local dealers

Spare parts supply

307. The shortage of spares for farm machinery in many developing countries can be divided into two sections: national and local. National shortages can generally be blamed in the first instance on the manufacturers supplying the machinery and, secondly, a lack of responsible attitude on the part of the government department whose responsibility it should be to ensure that imports of machinery are adequately backed up by the correct quantity of the right type of spares. As a rough guide it was suggested that, where tractors and machinery are imported, 20 per cent of the capital invested in imports should be in spare parts.

308. There has been no study involved to estimate the specific spare parts requirements for agricultural machinery on a rational basis. It is necessary to determine the estimated replacement turnover of components during the effective life period of a machine and project the requirement on a time basis. For example, the estimated replacement turn-over factor (RTF) estimated by experts in India for tractors is given in Table 17.

309. The factors in Table 17 indicate that there is a need on the part of the governments to analyse rationally the import policies of spare parts and to take steps to produce them locally with a high degree of quality control.

Maintenance and repair

310. Maintenance of farm machinery should be a simple operation that can be carried out quickly and without special tools. While manufacturers go to considerable trouble to place the fuel filter caps in an accessible place, the filter for the hydraulic oil system is frequently located in such a position that it is necessary to have a special shaped funnel available before it is possible to add oil to this system. Similarly, drain plugs have to be removed by spannering a rough cast square or hexagon that may not always conform to a known spanner size. These plugs soon become rounded by the repeated use of pipe wrenches or adjustable spanners with the result that the plug becomes difficult to remove and the farmer loses interest in changing the oil.

Table 17

Estimated replacement turn-over factor (RTF)

(Frequency of replacement of a component during tractors effective life period)

As estimated for India

S/No.	Item	RTF	S/No.	Item	RTF
1	Pistons	2	25	Generator	½
2	Piston pins	2	26	Voltage regulator	4
3	Piston rings	4	27	Steering wheel	1/100
4	Gaskets	10	28	Steering gear	1
5	Inlet and exhaust valve	4	29	Tie rod end	3
6	Valve guides	2	30	Drag link	3
7	Valve spring	1	31	King pins	2
8	Valve tappets	1	32	Wheels	1/100
9	Push rods	1	33	Clutch assembly	2
10	Timing chain	4	34	Clutch plate	2
11	Fuel injection pump	1/20	35	Clutch lining	4
12	Fuel injection pump nozzle	6	36	Gear	1
13	Fuel injection pump nozzle holder	1/20	37	Crown wheel and pinion	1
14	Fuel injection pump elements	4	38	Rear axle shaft	1
15	Fuel injection pump delivery valve	4	39	Oil seals	4
16	Filter	1/100	40	Brake lining	6
17	Filter elements	15	41	Brake drum	1/20
18	Fly wheel ring gear	1	42	Hubs	1/100
19	Water pump	1	43	Electric horn	1/100
20	Water pump repair kit	4	44	Head lamp	1/10
21	Radiator and core	1	45	Control cable	2
22	Silencer muffler	3	46	Panel instruments	1/10
23	Thin wall bearings	3	47	Battery	4
24	Starter motor	½	48	Tyres	4

311. It should be relatively simple to modify the design of the drain, filling and level plugs and adopt one standard size hexagon (or square) head. The nuts and bolts on filters that have to be undone to change filter elements should also be standardized. A suitable spanner of robust construction could then be incorporated in the tool kit. Reference to the servicing chart in the operator's handbook presents a further problem, particularly when different manufacturers,equipment is being serviced side by side. Several independent bodies allied to farm machinery have realized this problem and have drawn up a proposed standardized lubrication chart for use by agricultural machinery manufacturers. Manufacturers appear reluctant to adopt these charts. This is unfortunate, since the use of standard colours or characters, combined with a chart having a standard layout would be of considerable value, particularly in developing countries.

312. Manufacturers could further assist maintenance by rationalizing the grades of lubricant recommended, for example the use of universal oils, which go a long way towards meeting this requirement. In the experience of many experts it is possible to lubricate the majority of farm machinery with two grades of oil: a universal oil for engines, transmissions and hydraulic systems, and an EP gear oil for use in heavily loaded read axles and final reduction gears. With the introduction into Europe of more sophisticated tractors incorporating semi-automatic transmission and brakes immersed in the rear-axle oil, it will be necessary to introduce a third grade for these special requirements. It may however be some time before these machines find their way into developing countries where two grades of lubricant should suffice for many years to come.

313. In most machinery operation situations in developing countries it can be assumed that the distances involved in the wide dispersal of the machines and the lack of operating skill on the part of owners and drivers are the major obstacles to the efficient service and maintenance of machinery. Economic and communications factors are making the servicing of individually-owned machines difficult, and it is therefore likely that real improvement in the standard of operation and day to day maintenance can only come from

government operation of machinery with full co-operation from manufacturers and dealers.

314. Unfortunately, as existing schemes in several countries have made clear, government operation is not likely to aid the smaller peasant farmers to any great extent. The development of extension aid and instruction is likely to be the only effective attack on this problem unless governments are prepared to subsidise the provision of machinery, service and maintenance facilities to remote areas. Government-controlled machinery units should, however, be set up whenever possible because of the effect they must have on the long-term development of agricultural mechanization. Unfortunately, owing to difficulties of staffing and obtaining supplies in developing countries, they are seldom likely to be run profitably and will inevitably demand subsidies from governments. However, provided they are properly set up with sufficient emphasis on training operators and mechanics, they can provide relatively large numbers of trained personnel and set a standard by which all other machinery operation can be measured.

315. Considering:

(a) The wide range in degree of mechanical complexity (engine component, transmission, final drive, steering etc.);

(b) The wide range in equipment needed for repair and maintenance (welding, grinding, machining, tool room etc.);

(c) The variety in the size and bulk of the equipment;

(d) The wide dispersion pattern of the equipment around the countryside; and

(e) The need for immediate attention to the equipment in the field etc.;

there is a necessity of introducing:

A. Centralized repair and maintenance workshops

316. Taking into account the distribution pattern and type of equipment around the countryside, such shops may have centralized facility providing for:

- Testing and repairing of engines, and other complicated components, such as transmission, final drive etc.;
- Tool room, machine shop, welding, forging etc.;
- A competent organization and personnel with an education programme towards training, extension of m. intenance and repair awareness to individual farmers and service mechanics.

B. Mobile workshops

317. Taking into account the pattern of distribution and the need to provide immediate attention to the farmer in the field, such a mobile shop will be equipped with fast moving spare parts, equipment and facilities for repair in situ and staffed by capable personnel.

318. Considering these various aspects, it is necessary that all possible assistance is rendered to developing countries towards the establishment of pilot projects in the field of repair and maintenance of agricultural machinery which will act as a model to other countries. This may be either central mainenance and repair shops and/or mobile workshops.

319. Governments may well be advised to set up training facilities at trade school level for agricultural contractors, extension service workers, factory staff, demonstrators and supervisors. For farmers, the training should not only cover machinery usage and management, but be presented in a way to interest farm labour remaining on the land. It is recommended that UNIDO set up regional training centres in order to train instructors and other supervisory personnel who, on return, will train local talent for instructional purposes in rural areas.

320. Such an over-all training programme should be essentially linked to the recommendations concerning analysis and technical assistance.

321. It is also necessary that seminars on workshops for maintenance and repair of agricultural machinery and equipment in developing countries are conducted to discuss in detail the various aspects, such as:

(a) Levels of maintenance and repair programmes;

(b) Equipment and personnel needed;

(c) Training;

(d) Organization;

(e) Spare parts manufacture;

(f) Maintenance;

(g) Programme to create maintenance and repair consciousness and other factors.

VII. DEVELOPMENT OF AGRICULTURAL MACHINERY INDUSTRY

Role of developing countries

322. It is necessary that developing countries form short-term and long-term plans for maximization of production of agricultural machinery and implements. The plans should foster the diffusion of technological information by means of an action programme directed towards stimulating self-reliance through the accelerated growth of engineering industries in the agricultural mechanization sector. To achieve this result the following are the broad guide-lines:

(a) Identification of areas of development;

(b) Identification of specific problems and products needed;

(c) Market survey, industrial research and demand projection;

(d) Establishment of orders of priority;

(e) Analysis of existing industrial development and preparation of preliminary project profiles;

(f) Re-orientation of policies with respect to capital, investment, import and local manufacture;

(g) Establishment of pilot projects;

(h) Large scale manufacture;

(i) Strengthening of allied fields such as design, development, testing, quality control, production, marketing, repairs and maintenance etc.

323. In order to bridge the technological gap, it is necessary to secure all possible assistance from developing countries and international organizations, together with maximum reinforcement of domestic talent and resources.

Regional co-operation

324. Although there is growing awareness of self-reliance in agricultural machinery manufacture in developing countries, an accelerated production programme is hindered by low volume, lack of finance and technical skill. Towards meeting this challenge it is necessary for developing countries to explore the possibilities of regional co-operation in the field of selected agricultural machinery manufacture. The possibilities and merits of establishing manufacturing industries, ancillary industry development, regional manufacturing associations to exchange information, market sharing on a regional basis may be explored.

Assistance from industrialized countries

325. Joint ventures between developing and developed countries are a successful way of uniting the industrial capacity of the developed countries with the demands of developing countries and to raise the economy of the latter.

326. In order to bridge the technological gap, it is desirable that there is assistance through the exchange of technological information, industrial scholarships in agricultural machinery industry and in plant training facilities to groups of technicians from developing countries.

Assistance from international organizations

Long range planning

327. One of the major problems facing the developing countries regarding rational development of the agricultural machinery manufacturing sector consists in the inadequacies in long range planning.

Channels of information and assistance

328. In order to assist the developing countries in achieving an accelerated growth of the agricultural machinery manufacturing sector, it is necessary that, with the help of international organizations, there is continuous flow of information between developing and industrialized countries. Possible areas for action by UNIDO in developing countries are:

(a) To bridge the technological gap, to secure assistance from developing countries and international organizations and to reinforce domestic talent and resources;

(b) To promote regional co-operation among the developing countries in order that, in selected industries, the problems of low volume of production, lack of finance and technical skills could be overcome;

(c) To promote establishment of industries in the region to reduce imbalances and promote the sharing of information on marketing, development and production;

(d) To organize and institute industrial scholarships and fellowships to enable developing countries to send their chosen personnel to study the industries in the industrialized as well as in the relatively unindustrialized countries;

(e) To make a study and advise some selected countries in the region on long range planning, product identification, product mix to make maximum utilization of existing facilities particularly in the fields of tractors, power tillers, pumps and engines, and to advise on quality control and exports;

(f) To assist in the establishment of pilot manufacturing units, development and testing centres, and maintenance workshops in selected areas in the region;

(g) To achieve effective dissemination of information, organize surveys, seminars and group meetings and also make available experts for solving specific problems in the agricultural machinery industry;

(h) To have an effective liaison with the international organizations in order to draw up an integrated action programme for the region;

(i) To assist developing countries, through regional co-operation, in the manufacture of machinery and necessary ancillary items and also in the marketing of such products;

(j) To co-ordinate the activities of the machinery manufacturing industries with those of the manufacturers of other inputs in agriculture such as fertilizers, pesticides and chemicals, fuels, seeds etc., and thus facilitate the development and production of necessary machinery for the utilization of such inputs;

(k) To prepare a document on the metallurgical requirements in the manufacture of agricultural implements, highlighting the correct selection of materials, heat treatment, manufacturing techniques and quality control.

(l) To advise on the feasibility or otherwise regarding the establishment of plants for tractors, engines and other complex items of machinery in the developing countries; the manufacturing programmes could be suggested on the basis of availability of auxiliary products locally or within the region;

(m) To organize demonstrations of new types of equipment, to promote new ideas in manufacture and utilization of agricultural equipment;

(n) To render assistance to developing countries in the establishment of market research units and in promoting the manufacture of spare parts to meet the demand on the agricultural machinery sector;

(o) To advise on the establishment of mobile and base workshops, equipment and man-power needed for the same and the inventory of spares and materials to be held by such units for rendering effective service to the machinery in use in the field;

(p) To conduct case studies on existing workshops in selected areas, to identify the problems and deficiencies and suggest their solutions;

(q) To advise on inspection techniques, quality control, cost reduction, standardization of techniques and processes, and on the modernization of existing plants;

(r) Publication of technical documents of interest to machinery manufacturers.

Integrated action by international organizations

329. The industrial growth of developing countries is based on many interrelated socio-economic factors, the development of agricultural machinery is more complex, since it depends on the industrial sector on the one hand, and agricultural sector on the other. Hence, in order to assist the developing countries towards increasing agricultural machinery manufacturing facilities and development of other related activities there is a need for integrated action programmes by all international organizations concerned.

Appendix 1

I. PRINCIPLES OF CODIFICATION

1. **First six digits:**	Agreed with ISO as follows:
- **first two digits**	main classes of agricultural equipment (according to type of work). e.g. 06: Equipment for harvesting.
- **third digit**	sub-classes of agricultural equipment. e.g. 061: Equipment for harvesting forage.
- **fourth digit**	specific machines. e.g. 0611: Mowers.
- **fifth digit**	method of movement. e.g. 06113: Mower for animal draft.
- **sixth digit**	source of power for driving the working parts. e.g. 061136: Mower for animal draft, with auxiliary engine.
2. **Last three digits:**	As agreed with ISO, these are used for the more detailed description of machines according to successive technical differences. e.g. Mounted, semi-mounted or trailed; reversible or non-reversible (ploughs); indications of size or capacity (number of furrows of a plough; power of a tractor; output of a cream separator etc. . . .).
N.B. (1)	See table on next page for details of the allocation of the fifth and subsequent digits.
(2)	The figure '8', at positions beyond the second digit, always indicates "others".
(3)	The figure '9', at positions beyond the second digit, always indicates "replacement parts".
(4)	An abbreviated codification may be achieved, for example, by replacing the '0's indicating "not utilized" by a full stop or an apostrophe. In this way the code number need never exceed 5 or 6 digits. e.g. 01110003 becomes 0111.3. Application of this abbreviated system is left to the choice of each individual association.

Allocation of the last five digits

(for the first four digits, see preceding page)

Number	5th DIGIT	6th DIGIT	7th DIGIT	8th DIGIT	9th DIGIT
	Method of movement in work	Source of power for driving the working parts	Location in work (0 to 2) or first basic technical distinction (3 to 9)	Second basic technical distinction	Third basic technical distinction
0	Not used, or whatever the source of power for movement	Not used, or whatever the source of power for driving the working parts	Not used	Not used	Not used
1	Stationary	None	Mounted or semi-mounted		
2	By man	Man	Trailed		
3	By animal or by winch	Animal			
4	By tractor	Groundwheel drive			
5	By walking tractor	Power - take-off drive			
6	Self-propelled	I.C. engine or electric motor			
7		Hydraulic			
8	Other methods	Other sources			
9					

II. APPLICATION OF THE CODIFICATION SYSTEM TO THE CEMA CLASSIFICATION

CEMA.	CLASS I
01	Agricultural power units
011	- tractors
0111	- wheeled tractors
011100003	- up to and including 24 h.p.
011100004	- over 24 h.p. up to and including 34 h.p.
011100005	- over 34 h.p. up to and including 50 h.p.
011100006	- over 50 h.p. up to and including 65 h.p.
011100007	- over 65 h.p. up to and including 80 h.p.
011100008	- over 80 h.p.
0112	- tracklaying tractors
011200001	- up to and including 25 h.p.
011200002	- over 25 h.p. up to and including 40 h.p.
011200003	- over 40 h.p. up to and including 80 h.p.
011200004	- over 80 h.p.
0113	- walking tractors
01130001	- up to and including 5 h.p.
01130002	- over 5 h.p.
012	- Other single-axle motor-driven machines
0121	- motor mowers (single-purpose)
0122	- motor hoes (single-purpose)
0123	- motor winches
019	- Replacement parts for equipment in Class I

	CLASS II
02	Equipment for working soil (excluding equipment for land reclamation and soil conservation – covered in Class XII)
021	- Equipment for ploughing
0211	- mouldboard ploughs (including vineyard ploughs and stubble ploughs)
02113	- for animal draft and winches
02114	- for tractor draft
0211411	- mounted and semi-mounted
0211412	- trailed
02115	- for walking tractors
0212	- disc ploughs (including vineyard ploughs and disc tillers)
02123	- for animal draft and winches
02124	- for tractor draft
0212411	- mounted and semi-mounted
0212412	- trailed

CEMA	CLASS II (cont)
02125	- for walking tractors
02128	- other equipment for ploughing
022	- Equipment for soil preparation (excluding ploughing)
0221	- cultivators
022101	- with fixed tines (rigid or sprung)
022145	- with moving tines or blades (p.t.o. driven)
0222	- harrows
02220101	- with tines or teeth
02220102	- with discs (disc harrows)
02220103	- rotary (without p.t.o. drive) including rotary hoes
0223	- rolls
02230101	- flat
02230102	- special
0224	- blade type smoothers for seed beds (floats)
0228	- other equipment for soil preparation (excluding ploughing)
023	- Equipment for cultivation in row crops
0231	- hoes
02313101	- for animal draft, single row
02313102	- for animal draft, multi-row (including toolbars)
02314	- for tractor draft (including toolbars)
0232	- root thinners
0233	- ridgers and bedders
0238	- other equipment for cultivation in row crops
029	- Replacement parts for equipment in Class II

	CLASS III
03	Equipment for sowing, planting and distributing manures
031	- Equipment for sowing
0311	- drills, including combine drills (excluding spacing drills)
03120001	- spacing drills – without fertilizer attachments (individual units)
03120002	- spacing drills – combined with fertilizer attachments
0318	- other equipment for sowing
032	- Equipment for planting
0321	- potato planters
0322	- transplanters
0328	- other equipment for planting

CEMA	CLASS III (cont)
033	- Equipment for distributing manures
03310001	- fertilizer distributors
03310002	- liquid-fertilizer distributors
0332	- farmyard manure spreaders
0338	- other equipment for distributing manures
039	- Replacement parts for equipment in Class III

	CLASS IV
04	Equipment for crop protection
041	- Equipment for applying chemical sprays and dusts to crops
0410	- sprayers, dusters and dual purpose sprayers and dusters
041004	- for animal or tractor draft – ground wheel drive
041006	- for animal or tractor draft – with auxiliary engine
041022	- carried by man – hand-operated
041026	- carried by man – engine driven
041045	- for tractor draft – p.t.o. driven
04106	- self-propelled
0411	- sprayers
041122	- carried by man – hand-operated
041126	- carried by man – engine driven
041134	- for animal draft – ground wheel drive
041136	- for animal draft – engine driven
041144	- for tractor draft – ground wheel drive
041145	- for tractor draft – p.t.o. driven
041146	- for tractor draft – with auxiliary engine
04116	- self-propelled
0412	- dusters
041222	- carried by man – hand-operated
041226	- carried by man – engine driven
041234	- for animal draft – ground wheel drive
041236	- for animal draft – engine driven
041244	- for tractor draft – ground wheel drive
041245	- for tractor draft – p.t.o. driven
041246	- for tractor draft – with auxiliary engine
04126	- self-propelled
042	- Equipment for fumigating crops
043	- Equipment for soil treatment
048	- Other equipment for crop protection
049	- Replacement parts for equipment in Class IV

CEMA	CLASS V
05	Equipment for irrigation
0501	- complete installations (including pumps forming part of such installations)
0502	- components of irrigation installations (pipes, rainers, unions etc.)
058	- Other equipment for irrigation
059	- Replacement parts for equipment in Class V

	CLASS VI
06	Equipment for harvesting
061	- Equipment for harvesting forage
0611	- mowers
06113	- for animal draft (with or without auxiliary engine)
0611401	- for tractor draft – mounted and semi-mounted
0611402	- for tractor draft – trailed (with or without auxiliary engine)
0612	- tedders, swath aerators, windrow scatterers, forage crushers
06120001	- tedders
06120002	- swath aerators
06124501	- windrow scatterers
06124502	- swath turners
06124503	- forage crimpers and crushers
0613	- rakes, side delivery rakes etc.
06130001	- rakes (single-purpose hay rakes)
06130002	- rakes (combined; side delivery, tedder and swath turner)
0614	- sweeps and buckrakes
0615	- green crop and hay loaders
0616	- forage harvesters (all types)
0618	- other equipment for harvesting forage
062	- Equipment for harvesting grain and seed
0621	- binders
06213	- for animal draft
06214	- for tractor draft
0622	- combine harvesters
06224	- for tractor draft
06226	- self-propelled
0623	- maize harvesters (for grain, all types)
0628	- other equipment for harvesting grain and seed

CEMA	CLASS VI (cont)
063	- Dual purpose equipment for harvesting grain and seed
0631	- swathers (windrowers)
0632	- pick-up balers (all densities)
0638	- other dual purpose equipment for harvesting grain and seed or forage
064	- Equipment for harvesting potatoes
0641	- potato lifting ploughs
06413	- for animal draft
06414	- for tractor draft
0642	- potato diggers (spinners, elevator diggers etc.)
06423	- for animal draft
06424	- for tractor draft
0643	- potato harvesters
0644	- haulm pulverizers
065	- Equipment for harvesting sugar beet
0651	- sugar beet toppers
0652	- sugar beet lifters
0653	- sugar beet harvesters
0654	- pick-up loaders for tops or roots
066	- Equipment for harvesting olives
067	- Equipment for harvesting other crops
068	- Other equipment for harvesting
069	- Replacement parts for equipment in Class VI

CLASS VII

07	Equipment for threshing, selection and conditioning of agricultural products after harvest
071	- Equipment for threshing and baling
0711	- threshers
07111001	- standard (including threshers for pre-chopped straw)
07111002	- special (for maize, rice, clover etc.)
0712	- stationary balers (all densities)
072	- Equipment for cleaning, grading or dressing
0721	- grain and seed cleaners
0722	- grain and seed graders
0723	- grain and seed cleaners and graders (combined)
0724	- grain and seed dressers

CEMA	CLASS VII (cont)
0725	- potato sorters or graders
0726	- cleaners, graders or dressers for other products (eggs, fruit etc.)
073	- Equipment for storage
0731	- silos (all types)
0732	- silo unloaders
074	- Equipment for drying forage
075	- Equipment for drying grain and seed
078	- Other equipment for threshing, selection and conditioning of agricultural products after harvest
079	- Replacement parts for equipment in Class VII

CLASS VIII

08	Equipment for livestock husbandry (excluding equipment for handling feed and manure)
081	- Equipment for the preparation of grain for feed
0811	- mills and crushers (single-purpose)
0812	- mixers (for dry feeds)
0813	- combined mills, crushers, mixers
0818	- other equipment for the preparation of grain for feed
082	- Equipment for the preparation of fodder crops for feed
0821	- root and chaff cutters
0822	- pulpers and shredders (single-purpose or combined)
0823	- choppers
0828	- other equipment for the preparation of fodder crops for feed
083	- Equipment suitable for the combined preparation of grain, seed and fodder crops for feed
0831	- multi-purpose feed preparation machines
0832	- mincers
0833	- mixers (suitable for wet feeds)
0838	- other equipment suitable for the combined preparation of grain, seed and fodder crops for feed
084	- Other equipment for feed preparation
0841	- washers
0842	- steamers
0843	- cubers
0848	- other machines for feed preparation (germinators, green feed cabinets etc.)

CEMA	CLASS VIII (cont)
085	- Equipment for feeding and watering stock (except for poultry and other small animals)
0851	- automatic drinking troughs
0852	- automatic feeders
0858	- other equipment for feeding and watering stock
086	- Equipment for poultry and for the rearing and feeding of other small animals
087	- Equipment for electric fencing
0871	- electric fencers
088	- Other equipment for livestock husbandry
089	- Replacement parts for equipment in Class VIII

CLASS IX

09	Equipment for the processing of agricultural products on a farm scale (e.g. wine-making, cider making etc)
091	- Equipment for wine-making
0911	- crushers and stalk separators (single purpose or combined)
0912	- presses
091216	- mechanical
091217	- hydraulic
091218	- pneumatic
0913	- filters
0918	- other equipment for wine making
092	- Equipment for making cider and similar products
0921	- crushers, decorticators
0922	- presses and other machines for extraction of juice
0928	- other equipment for making cider and similar products
093	- Equipment for oil production
0931	- machines for preliminary work (crushers, decorticators etc.)
0932	- mills
0933	- moulders (moulder-dosers)
0934	- presses
0935	- separators
0938	- other equipment for oil production

CEMA	CLASS IX (cont)
094	- Equipment for the processing of other agricultural products
098	- Other equipment for the processing of agricultural products on a farm scale
099	- Replacement parts for equipment in Class IX

CLASS X

10	Equipment for dairy work on a farm scale
101	- Equipment for mechanical milking
1011	- machine milking installations (complete)
10111601	- milking units, comprised in complete installations (1011)
1012	- components and accessories to form complete milking installations (excluding those comprised in 1011)
10121601	- milking units, comprised in components (1012)
102	- Equipment for conditioning milk
1021	- coolers (all types)
1022	- filters with a capacity under 220 galls/hr (1,000 litres/hr)
103	- Equipment for processing milk
10311001	- cream separators, with a capacity under 77 galls/hr (350 litres/hr)
	- cream separators, with a capacity from 77 galls/hr to 220 galls/hr (350 litres/hr to 1,000 litres/hr)
1032	- butter churns (simple and combined butter making machines) with a capacity under 88 galls (400 litres)
1033	- butter treatment machines, with a capacity under 1000 lbs (50 kg) butter
108	- Other equipment for farm dairy work (including equipment for cheese making)
109	- Replacement parts for equipment in Class X

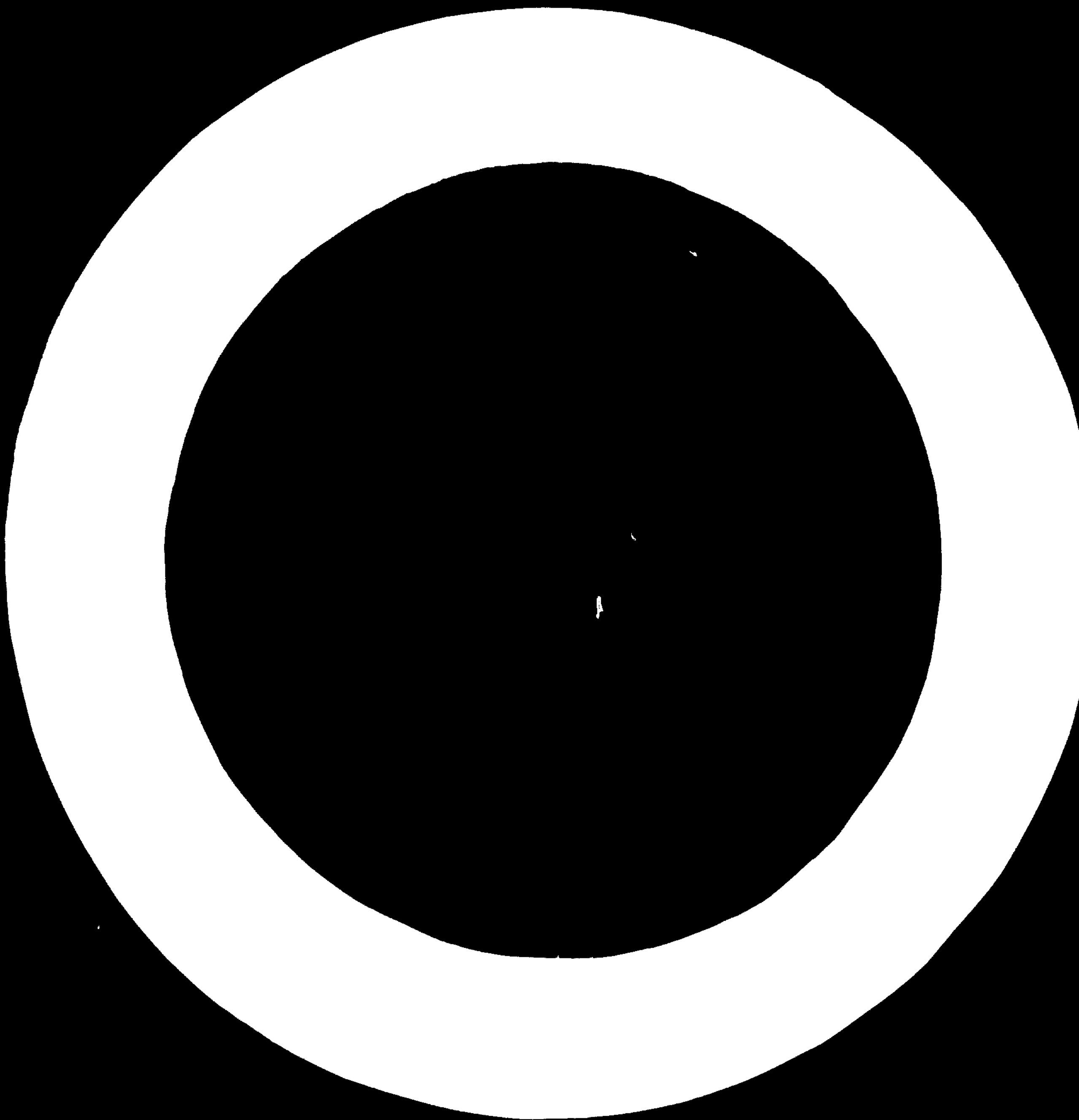
CLASS XI

11	Equipment for farm handling and transport
111	- Equipment for handling
1111	- grain blowers
1112	- blowers for other products (including cutter-blowers)
1113	- elevators and conveyors, with belts, chains or augers (continuous-acting, mechanical)

CEMA	CLASS XI (cont)
1114	- automatic feeding conveyors (bunk feeders)
1115	- automatic cowshed cleaners
1116	- hoists (not continuous acting)
11161001	- stationary fixtures
11161002	- mobile
11164	- for tractors
1117	- tractor-mounted hydraulic loaders
11174701	- front loaders
11174702	- others
1118	- other equipment for handling
112	- Equipment for transport
1121	- trailers, for solids (pneumatic tyred, for tractor draft)
11214001	- with two or more axles
11214002	- with single axle
112245	- moving floor trailers for solids (including forage boxes)
1128	- other equipment for farm transport (trailers for animal draft; with steel wheels; for liquid manure; water carts etc.)
119	- Replacement parts for equipment in Class XI

	CLASS XII
12	Equipment for land reclamation and soil conservation
121	- Equipment for land clearing
1211	- brush cutters and bracken breakers
1212	- rippers
1218	- other equipment for land clearing (e.g. tree dozers, bush pullers, stone pickers, stumpers, forestry winches etc.)
122	- Equipment for drainage and for the formation of ditches and trenches for irrigation
1221	- sub soilers
1222	- mole ploughs
1228	- other equipment for drainage and for the formation of ditches and trenches for irrigation (e.g. drainage ploughs, ditchers, ditch cleaners, trenchers, pipe layers etc.)
123	- Equipment for earth moving
1231	- graders, for agricultural use
1232	- earth scoops and scrapers
1238	- other equipment for earth moving (e.g. bulldozers, angledozers, excavators etc.)
129	- Replacement parts for equipment in Class XII

CEMA	
	CLASS LXX
70	Construction of components and accessories
	CLASS LXXX
80	Miscellaneous agricultural equipment
809	- Replacement parts for equipment in Class LXXX
	CLASS XC
90	Replacement parts (Sum total of items with designation '9' in the various classes)



Annex 1

INAUGURAL ADDRESS

by Mr. N. Grigoriev
Director, Industrial-Technology Division,
on behalf of Executive Director of UNIDO

I welcome you to this expert group meeting on the Agricultural Machinery Industry in Developing Countries. I do not need to stress to you that agricultural machinery and implements are among the most important media for increasing agricultural production. This has long been recognized in all developed and developing countries. There is now, however, a new awareness in developing countries that the indigenous manufacture of agricultural machinery must be introduced, with new facilities being fully integrated into the domestic engineering industry. In recognition of this trend, UNIDO proposes to provide technical assistance to those countries which would like to establish their own industry capable of producing agricultural machinery and implements. This, however, is a major task involving major problems in yet unexplored areas and environments, and we are looking to this meeting to provide us with the necessary guide-lines.

The term "agricultural machinery" covers a wide range of machinery and implements. Their manufacture calls for a variety of new requirements and local availabilities, such as raw and semi-finished materials, as well as management and skilled-labour resources. I am happy to note from the provisional agenda that many of these aspects of agricultural machinery industries will be covered. To facilitate your work, we have made available to you in advance – as background documentation – several papers by experts in this field. To assist you in your deliberations, we have prepared an advance draft report covering the major aspects of the agenda.

In order to study self-reliance in its correct perspective, it is essential to explore and discuss various aspects of development, design, production, marketing, maintenance, financing and other allied elements. In this respect, the Industrial Development Board has stressed the importance of the design and manufacture of agricultural machinery in developing countries. Projects relating to the establishment of engineering and design centres, to improving quality control, and to lending attention to the repair and maintenance service have also been suggested by several delegates.

Initial steps have been taken through the ECAFE/UNIDO Fact Finding Team on Industries Manufacturing Agricultural Machinery in selected countries of the ECAFE group. The over-all farm machinery sector of this region has been surveyed, and areas which require assistance from UNIDO have been identified. We are planning such a survey for other regions.

Based upon your deliberations and recommendations, UNIDO will prepare a programme of assistance in furthering production of farm machinery integrated with the domestic engineering industry. The programme is expected to focus on the identification of product types and on promoting collaboration between the developing and industrialized countries. We are confident that your meeting will be successful, ultimately leading to the increased production of farm machinery and equipment in the developing countries. We eagerly await the outcome of your discussions.

In conclusion, I want to extend to you my best wishes for the task ahead of you, which, I am sure, will be a most fruitful one. I also wish you a pleasant stay in Vienna.

PRESENTATION OF THE EXPERT GROUP MEETING ON AGRICULTURAL MACHINERY INDUSTRY

by Mr. O.V. Soskuty
Chief, Engineering Industries Section, UNIDO

I wish to second Mr. Grigoriev in welcoming you all to this opening session of UNIDO's Expert Group Meeting on Agricultural Machinery Industry.

This expert group meeting has been organized by the Engineering Industries Section of the Division of Industrial Technology of UNIDO, with the primary purpose of discussing various aspects of agricultural machinery manufacture and of recommending future activities of UNIDO with emphasis on technical assistance in agricultural machinery manufacturing in developing countries.

The Industrial Development Board, the governing body of UNIDO, has requested that the Executive Director, among others, help in the formulation of industrial development plans and programmes, identify those industries which should be developed, assist in developing countries in the efficient utilization of new and existing manufacturing capacity, promote co-operation among developing countries, assist in the dissemination of technological innovations, and organize appropriate seminars and other meetings on specific aspects and problems of industrial development. This meeting was organized according to these terms of reference.

We are happy to note that the response to this meeting has been good — from developing countries as well as from industrialized nations. As of the present time we have 46 participants from 31 countries throughout the world. Fifteen out of this number are each from a different developing country. There are 20 participants representing industry, 11 from Research and Development Institutions, 10 from government agricultural machinery agencies and 5 from international organizations.

It would perhaps be useful at this point to outline what we hope to accomplish during the course of this expert group meeting.

The Agenda which you have been given contains fifteen specific items. Each item is supported by a list of subject matter which falls within the scope of the item. Not all, of course, carry equal weight, and there may be additional items which occur to you. Please feel free to request their inclusion if you so desire.

A prior report has been prepared which attempts to be a framework on which to construct the final report. This prior report has been derived from the studies which many of you have submitted and which are most valuable contributions to the sum of knowledge and expert advice which is being brought together in this meeting. You will also, I am sure, wish to expand and develop this framework in fulfilling the purpose of the meeting. A total of 29 documents has been submitted, including study reports, by country, on the status of agricultural machinery, and expert papers on scope and demand, design, development and manufacture, marketing, and maintenance and repair.

As a consequence of reviewing and discussing all these areas of importance, there will be recommendations which you will wish to make to developing countries, to industrialized countries, and to UNIDO. These recommendations are perhaps the most important aspect of your work, representing as they do a cross section of authority from the more limited experience of the developing countries to the vast experience and know-how of experts from industrialized nations. As the discoveries made in the course of your discussions will be of great value, your final report must not fail to record this aspect of your work.

The report will be prepared by your rapporteur in co-operation with the discussion leaders at the end of each session. Toward the end of the week, a final report will be prepared and submitted to the meeting, and with your approval will afterwards be transmitted to the Executive Director of UNIDO.

The task before us is not an easy one; but we hope that, with the help of many recognized authors and by the presence and contributions of so many distinguished experts, a fruitful exchange of views will emerge and sound recommendations result.

OPENING STATEMENT

by the Chairman, Mr. F.R. Moasser
Arak Machine Building Plant, Teheran, Iran

On behalf of all the experts present here and on my own behalf, I would like to express my appreciation to the United Nations Industrial Development Organization for organizing this Expert Group Meeting on Agricultural Machinery Industry in Developing Countries. The number of countries represented here and the presence of outstanding experts in various fields of agricultural machinery clearly indicate the interest both by developing countries and industrialized nations in agricultural mechanization and agricultural machinery industries.

We are happy to be in Vienna, the music city of the world. However, I must point out, Austria, although a small country has set an example in the field of agricultural production and its interest in the developing countries is rapidly expanding. As a matter of fact, Austrian agricultural machinery is being manufactured on a progressive local manufacturing phase as in Thailand.

We are pleased to note that UNIDO has made all possible efforts to make this Expert Group Meeting effective and meaningful. The background documents prepared by various experts are of great value.

Considering the various aspects of agricultural machinery manufacture and the problems involved, we are happy to note that the agenda is comprehensive. I am confident that this expert group will discuss the various aspects in detail and fulfil the objectives of this meeting. I am also confident that the deliberation of this meeting will result in meaningful recommendations specifically outlining the future activities of UNIDO in the field of agricultural machinery manufacture in the developing countries.

I am pleased to note that UNIDO has now stepped up its activities in this important aspect. It is needless to state that, since agricultural machinery is interrelated both to the agricultural and the industrial sector, the problems are complex in nature. It is very essential that developing countries reach a significant level of self sufficiency in the manufacturing field. In this aspect, assistance from industrialized countries as well as from international organizations is very essential. I am sure that UNIDO's activities will enhance the design, development, manufacture and all other aspects of agricultural machinery industry in developing countries.

CLOSING STATEMENTS

Closing statement by Mr. O.V. Soskuty

At the close of this Expert Group Meeting, may I tell you how pleased we are that, thanks to the great effort and untiring work of the participating experts, the work which we set out to do has been accomplished. We are particularly pleased with the resulting recommendations, which should direct the future activities of UNIDO, and point the way to the assistance which it can most beneficially render.

We have seldom seen an expert group that has worked so diligently. The outcome of your industrious efforts is that UNIDO will be able to channel its energy to the areas in which it will be most effective.

Our resources are limited, and we must therefore apply them at the point of greatest common need. With this in mind, our aim is to support the quantitative and qualitative increase of agricultural machinery implements in the developing countries, and in this way contribute to improving the living conditions of the peoples of the world.

We would hope that, as a result of this brief gathering, we will all have gained new contacts among the participants which will not subsequently be lost, but which will develop into lasting friendships as we continue to work together for our common good. We should very much like to stay in touch with you, so please feel free to contact us whenever you think that we can assist you, we would likewise wish to call upon you to help us.

I think I can express everybody's feeling if I ask our Chairman to accept our deep appreciation and thanks for conducting this meeting in such an able and devoted manner. We have also appreciated Mr. O'Callaghan's diligence as rapporteur.

Closing statement by Mr. F.R. Moasser, Chairman

On behalf of all participants and on my own behalf I would like to again thank UNIDO for organizing this Expert Group Meeting on Agricultural Machinery Industry in Developing Countries and specially thank Mr. Grigoriev and Mr. Soskuty and particularly Mr. Swamy-Rao for all their effort and interest to make this meeting successful.

I would also like to thank all participants of this meeting for their contribution and detailed discussions which has proved so valuable and have made the meeting so fruitful and meaningful.

Special appreciation must be expressed here to members of drafting committee and particularly Mr. O'Callaghan for the hard work and a fine job which he has done in bringing all the discussions and views expressed during the five day meeting to a form of final recommendations which is approved by the meeting.

I hope these recommendations will prove to be useful and bear fruitful results.

Annex 2

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LEVITSKY, J.
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HOFSTAETTER, Johanna, Mrs.
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Annex 3

AGENDA. 1.

(with provisional schedule of work and plan of the meeting)

Monday, 18 August 1969

8.30 a.m.	Registration
10.00 a.m.	FIRST MEETING (Inaugural Session)
2.00 p.m.	SECOND MEETING - DISCUSSIONS Item 1 - Role of agricultural machinery and usage Item 2 - Classification, demand and trend in design

Tuesday, 19 August 1969

9.00 a.m.	THIRD MEETING - DISCUSSIONS Item 3 - Manufacture and indigenous production Item 4 - Programme towards manufacture
2.00 p.m.	FOURTH MEETING - DISCUSSIONS Item 5 - Design and development Item 6 - Testing and standardization Item 7 - Agricultural engineering education

Wednesday, 20 August 1969

9.00 a.m.	FIFTH MEETING - DISCUSSIONS Item 8 - Marketing, repair and maintenance Item 9 - Large-scale technology to small-scale sector Item 10 - Regional co-operation and assistance
2.00 p.m.	SIXTH MEETING - DISCUSSIONS Item 11 - Guide towards UNIDO activities Item 12 - Conclusions

Thursday, 21 August 1969

9.00 a.m.	SEVENTH MEETING Item 13 - Recommendations
2.00 p.m.	EIGHTH MEETING Item 14 - Review of report

Friday, 22 August 1969

9.00 a.m.	NINTH MEETING Item 15 - Approval of report
2.00 p.m.	TENTH MEETING (Closing Session)

ANNOTATED PROVISIONAL AGENDA

Monday, 18 August 1969

Registration 8.30 a.m.

FIRST MEETING (INAUGURAL SESSION) 10.00 a.m. - 1.00 p.m.

Address of welcome
Presentation of the seminar
Inaugural address
Election of chairman
Election of vice chairman
Election of rapporteur
Chairman's address
Approval of agenda
Introduction of participants
Appointment of drafting committee (5 members)
Presentation of synopsis of papers

SECOND MEETING - 2.00 p.m. - 5.30 p.m.

Appointment of 3 members drafting subcommittee - II session

Item-1: Role of agricultural machinery and usage

(a) Role of agricultural machinery and equipment in the industrial and economic growth of developing countries
(b) New techniques in agriculture
(c) Factors contributing to higher farm income
(d) Relationship of size of holding to mechanization pattern
(e) Role of contract farmers/operators in usage of agricultural machinery and their needs

Item-2: Classification, demand and trend in design

(a) Identification of agricultural machinery and types
(b) Classification of agricultural machinery
(c) Existing usage and demand of machinery
(d) Possible areas where machinery can be used
(d) Priority order of agricultural machinery to be considered for investigation
(f) Future demand for agricultural machinery
(g) Trend in requirements and design and factors affecting the same
(h) Requirement of machinery for special crops - paddy cultivation
(i) Requirement of machinery for other special crops

Background papers:

- Tractors and their use in the developing areas of the world - Mr. G.W. Giles
- FAO's activities in agricultural mechanization in developing countries

Tuesday, 19 August 1969

THIRD MEETING - 9.00 a.m. - 12.30 p.m.

Appointment of 3 members drafting subcommittee - III session

Item-3: Manufacture and indigenous production

(a) Existing manufacture

(i) Analysis of industrial manufacturing facilities

(ii) Analysis of existing agricultural machinery manufacturing facilities

(iii) Utilization of unused industrial capacity towards manufacture of agricultural machinery

(iv) Extent of usage of existing productive capacity in relation to projected demand

(v) Expansion of existing agricultural machinery industries capacity

(vi) Level of local content desirable fo simple implements

(vii) Level of local content for less sophisticated equipment

(viii) Level of local content for tractors, and combines etc.

(ix) Some thoughts on rationalization of local content

(b) Ancillary and supporting industries

(i) Status of ancillary industries

(ii) Status of supporting industries

(iii) Promotion of ancillary and supporting industries

(iv) Utilization of sub-contractors towards effective local manufacture

(v) Identification of components that can be locally manufactured and nature of assistance required

(vi) Problems faced by ancillary and supporting industries

(c) Spare parts manufacture

(i) Status of spare parts manufacture

(ii) Utilization of existing industrial capacity towards spare parts manufacture

(iii) Spare parts manufacture in small scale sector

(d) Raw material, machine tools and import regulations

(i) Availability of raw material

(ii) Availability of machine tools

(iii) Existing import policies

Item-4: Programme towards manufacture

(a) Patents and licencing

(i) Legal problems involved in patents and licences in developing countries

(ii) Virtues and drawbacks of foreign collaboration for manufacture

(iii) Reflections on importance of transfer of technology and problems involved

(b) Problems in manufacture

(i) Product and product mix

(ii) Technical ability

(iii) Organization and management

(iv) Raw material and import substitution

(v) Finance

(vi) Quality control

(vii) Production techniques

(viii) Other factors

(ix) Reflections on ways and means of expansion of agricultural machinery manufacturing programme

(c) "Prototype" manufacturing plant

- analysis of a typical plant for limited production of agricultural implements, involving the following aspects:

(i) Product mix

(ii) Production capacity

(iii) Expansion schedule

(iv) Size of investment

(v) Production schedule

(vi) Sub-contract purchase

(vii) Plant location and layout

(viii) Organization

(ix) Selling price

(x) Marketing organization

(xi) Diversification

(xii) Other factors

Background papers:

- Analysis of criteria for farm mechanization and for the manufacture of agricultural machines and implements in developing countries - Mr. D. Hutla
- The development and manufacture of mechanized rice growing equipment in Taiwan - Mr. Tien-Song Peng
- Development of the supplying auxiliary industries for agricultural machinery production in a developing country - India - Mr. K. Prabhakar
- Report of ECAFE/UNIDO Fact Finding Team on industries manufacturing agricultural machinery in the ECAFE group of countries

FOURTH MEETING - 2.00 p.m. - 5.30 p.m.

Appointment of 3 members drafting subcommittee - IV session

Item-5: Design and development

(a) Requirement of machinery for paddy cultivation - design and development aspects
(b) Requirement of machinery suitable for local conditions
(c) Current status of the design and technical capabilities for agricultural machinery in the developing countries
(d) Virtues and shortcomings of present tractors and equipment as used in the developing countries and principal changes desired
(e) Necessity of instituting national and regional design and development centres on agricultural machinery and equipment
(f) Some reflections on the set-up and organization of such centres

Item-6: Testing and standardization

(a) Status of machinery testing facilities
(b) Need for agricultural machinery testing stations
(c) Reflections on need for standardization
(d) Necessity of instituting national and regional testing centres on farm machinery and equipment
(e) Some reflections on the set-up and organization of such testing stations

Item-7: Agricultural engineering education

(a) Status of agricultural engineering education and training

(b) Need for reorientation in curriculum towards effective participation in industrial activities
(c) Some reflections on ways and means of achieving the above

Background papers:

- Design features of agricultural machinery for developing countries - Mr. J.R. O'Callaghan
- Some aspects for designing machines for grain harvesting - Mr. A.A. Pustygin
- Determination of parameters for tractor/machine assemblies - criteria for the preparation of tractor and agricultural machinery design - Mr. N.M. Orlov

Wednesday, 20 August 1969

FIFTH MEETING - 9.00 a.m. - 12.30 p.m.

Appointment of 3 members drafting subcommittee - V session

Item-8: Marketing, repair and maintenance

(a) Analysis of marketing problems
(b) Problems of repair and maintenance
(c) Problems of fuel and lubricants
(d) Operator level (preventive) maintenance
(e) Manufacturers representative - dealers level maintenance
(f) Education of service personnel
(g) Warranty policies
(h) Reflections on the effective repair and maintenance system
(i) Need for prototype mobile repair and maintenance workshop
(j) Need for prototype demonstration repair and maintenance workshop

Item-9: Application of large-scale technology to small-scale industries

(a) Study of manufacturing facilities in some developing countries
(b) Assessment of need and formation of policies at a national level
(c) Assessment of needs and formation of optimum policies at production level
(d) Technological problems - personnel production and quality control
(e) Import substitution
(f) Manufacturing cost
(g) Manufacturing techniques

Item-10: Regional co-operation and assistance

(a) Possibilities and merits in establishing manufacturing industries on regional basis

(b) Possibilities and merits in establishing manufacturing associations on regional basis to exchange views on common problems

(c) Possibilities of market sharing on regional basis

(d) Industrial scholarships in agricultural machinery factories in developing countries for candidates from less developed countries

(e) Possible areas of assistance among developing countries

- (i) Schedule of indigenous tractor manufacture
- (ii) Development of ancillary industry
- (iii) Quality control
- (iv) Marketing
- (v) Other areas

(f) Assistance from industrialized countries

- (i) Phases of agricultural machinery production in developing countries
- (ii) Visit by group from developing countries to farm machinery plants of industrialized countries
- (iii) Benefits from industrial scholarships in agricultural machinery factories

(g) Assistance from other UN and international agencies

- (i) Product identification
- (ii) Market analysis
- (iii) Training
- (iv) Education
- (v) Industrial aspects
- (vi) Finance

(h) Prototype agricultural machinery plants for developing countries and assistance required

Background papers:

- Problems of manufacturing and marketing agricultural machinery in developing countries - Mr. H. Nuechtern
- Marketing problems in the developing countries - Mr. W.G. Kleckner
- Repair and maintenance problems of operating agricultural machinery in developing countries - Mr. B. Gardner
- Fuels and lubricants in agriculture - Mr. J.D. Savage
- Service and maintenance problems of agricultural machinery in the developing countries - FIAT

SIXTH MEETING - 2.00 p.m. - 5.30 p.m.

Appointment of 3 members drafting subcommittee - VI session

Item-11: Guide towards UNIDO activities

(a) Philosophy: Philosphy of UNIDO in the field of agricultural machinery industries

(b) Second Development Decade:
- need for specific studies in the field of agricultural machinery industries. Areas of lack of information in developing countries are:
  (i) General pattern of agriculture
  (ii) Identification of level of mechanization
  (iii) Existing pattern of farm mechanization
  (iv) Analysis of projected demand
  (v) Inventory of productive capacities in engineering and farm implements industry
  (vi) Information on research, development and testing
  (vii) Government policies with respect to agricultural machinery industry
  (viii) Nature and areas of UNIDO's assistance desired

(c) Supporting activities:
- Fact finding surveys in different regions in industries manufacturing agricultural machinery
- Pre-investment survey teams on specific items for manufacture
- Regional meetings on agricultural machinery manufacture
- Expert group meeting on limited selected farm equipment manufacture
- Association with other relevant input manufacturers, promotion and usage organization (example fertilizer, pesticide, hybrid seeds etc.)

(d) Guide towards instituting field activities
  (i) Regional advisers on agricultural machinery
  (ii) Field experts
  (iii) Questionnaire to all developing countries - assistance desired and priority order
  (iv) Field trips by UNIDO staff members
  (v) Other activities

(e) Other activities
- Directory of manufacturers - regional and world-wide
- Directory of agricultural engineering experts
- Directory of farm machinery research, design and development and testing centres, world-wide

Item-12: Conclusions

- Conclusions on all specific topics discussed

Thursday, 21 August 1969

SEVENTH MEETING - 9.00 a.m. - 12.30 p.m.

Appointment of 3 members drafting subcommittee - VII session

Item-13: Recommendations

EIGHTH MEETING - 2.00 p.m. - 5.30 p.m.

Item-14: Review of the report and recommendations

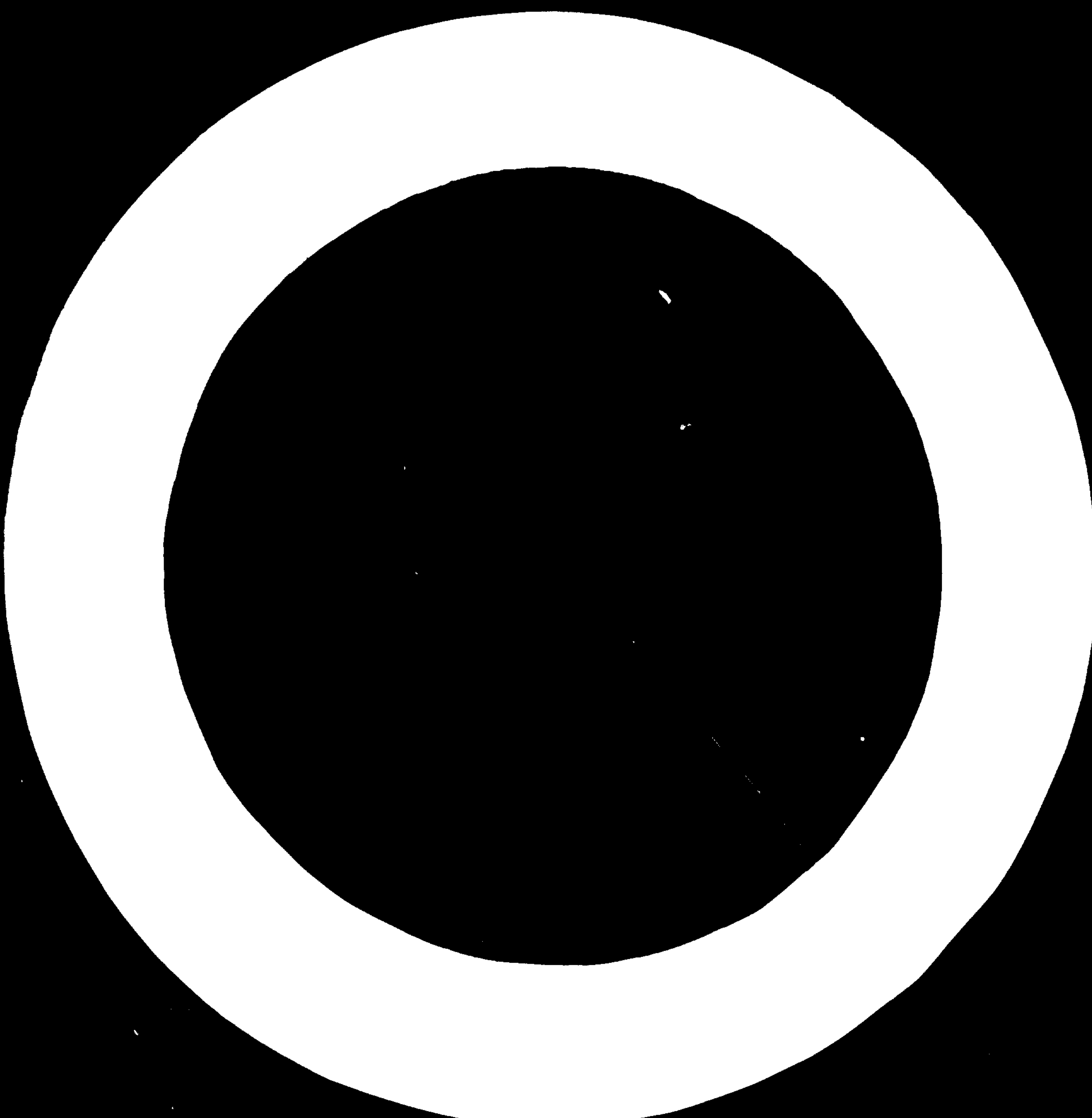
Friday, 22 August 1969

NINTH MEETING - 9.00 a.m. - 12.30 p.m.

Item-15: Approval of the report

TENTH MEETING (CLOSING SESSION) - 2.00 p.m. - 4.00 p.m.

Final approval of the report
Chairman's address
Remarks by the participants
Vote of thanks



Annex 4

LIST OF DOCUMENTS PRESENTED TO THE MEETING

ID/WG.40/1	PROVISIONAL AGENDA (Annex A: Annotated Provisional Agenda) (Annex B: Plan of Meeting)
ID/WG.40/2	LIST OF PARTICIPANTS
ID/WG.40/3 and Summary	TRACTORS AND THEIR USE IN AGRICULTURE IN THE DEVELOPING AREAS OF THE WORLD Prof. G.W. Giles (Consultant, Agricultural Engineer, 2600 Wade Avenue, Raleigh, North Carolina, 27607, U.S.A.)
ID/WG.40/4 and Summary	DEVELOPMENT OF THE SUPPLYING AUXILIARY INDUSTRIES FOR AGRICULTURAL MACHINERY PRODUCTION IN A DEVELOPING COUNTRY - INDIA Mr. K.S. Prabhakar (Chief, Engineering Industries, Planning Commission, Yojana Bhavan, Parliament Street, New Delhi-1, India)
ID/WG.40/5 and Summary	THE DEVELOPMENT AND MANUFACTURE OF MECHANIZED AGRICULTURAL MACHINERY IN DEVELOPING COUNTRIES Dr. Tien-Song Peng (Specialist on Farm Machinery Plant Industry Division, Joint Commission on Rural Reconstruction, Taipeh, Rep. of China)
ID/WG.40/6 and Summary	ANALYSIS OF CRITERIA FOR FARM MECHANIZATION AND FOR THE MANUFACTURE OF AGRICULTURAL MACHINES AND IMPLEMENTS IN THE DEVELOPING COUNTRIES Dipl. Ing. D. Hutla (Head - Research Department, Research Institute of Agricultural Machinery, Praha-4, Chodov, CSSR)
ID/WG.40/7 and Summary	FUELS AND LUBRICANTS IN AGRICULTURE Mr. J.D. Savage and Mr. P.B. Bostock (Technical Service Branch - Products, Marketing Department, B.P. Trading Ltd., Britannic House, Moore Lane, London E.C.2, England, U.K.)
ID/WG.40/8 and Summary	AGRICULTURAL MACHINERY INDUSTRY IN DEVELOPING COUNTRIES - MANUFACTURING POSSIBILITIES OF PLANT PROTECTION EQUIPMENT Compiled by Mr. Frigyes Horchler (Budapest Agricultural Machine Works, Budapest, Hungary)

ID/WG.40/9 and Summary	REPAIR AND MAINTENANCE PROBLEMS OF OPERATING AGRICULTURAL MACHINERY IN DEVELOPING COUNTRIES Mr. B. Gardner (Specialist, Crop Husbandry and Mechanization: Farmers Weekly, 161, Fleet Street, London E.C.4., U.K.)
ID/WG.40/10 and Summary	DESIGN FEATURES OF AGRICULTURAL MACHINERY FOR DEVELOPING COUNTRIES Prof. J.R. O'Callaghan (Head, Department of Agricultural Engineering, The University of Newcastle upon Tyne, NE-1, 7 RU, U.K.)
ID/WG.40/11 and Summary	REPORT OF THE UNITED NATIONS ECAFE/AIDC-UNIDO FACT FINDING TEAM ON INDUSTRIES MANUFACTURING AGRICULTURAL MACHINERY Economic Commission for Asia and the Far East (Sala Santitham, Bangkok, Thailand)
ID/WG.40/12 and Summary	PROBLEMS OF MANUFACTURING AND MARKETING AGRICULTURAL MACHINERY IN DEVELOPING COUNTRIES Mr. H. Nüchtern (Steyr-Daimler-Puch A.G., Postfach, 4400 Steyr, Austria)
ID/WG.40/13 and Summary	SOME ASPECTS FOR DESIGNING MACHINES FOR GRAIN HARVESTING Mr. M. A. Pustygin (Chairman, Grain Harvesting Department, All Union Scientific Research Institute of Agricultural Engineering, Vishom, Moscow U-411, USSR)
ID/WG.40/14 and Summary	SERVICE AND MAINTENANCE PROBLEMS OF AGRICULTURAL MACHINERY IN DEVELOPING COUNTRIES FIAT S.p.A., Sede Centrale (Casella postale 211, Ferr. 10100 Torino, Italy)
ID/WG.40/15 and Summary	OUTLINE RELATING TO PRESENT STATE AND PROBLEMS IN FARM MACHINERY PRODUCTION AND APPLICATION IN DEVELOPING COUNTRIES Mr. Milan Vuco (Cavtat, Trinskih 5, Yugoslavia)
ID/WG.40/16 and Summary	MARKETING PROBLEMS IN THE DEVELOPING COUNTRIES Mr. W.G. Kleckner (Staff Assistance to Manager, Latin American Area, International Harvester Company, Overseas Division, 401 N. Michigan Ave., Chicago, Illinois 60611, USA)

ID/WG.40/17 and Summary	DETERMINATION OF PARAMETERS FOR TRACTOR/MACHINE ASSEMBLIES - CRITERIA FOR THE PREPARATION OF TRACTORS AND AGRICULTURAL MACHINERY DESIGN Mr. N.M. Orlov (Chief of Department, All Union Scientific Research Institute of Agricultural Engineering, Vishom, Moscow U-411, USSR)
ID/WG.40/18	POSSIBLE AREAS OF AGRICULTURAL MACHINERY AND IMPLEMENTS MANUFACTURE IN AFRICA Compiled by UNIDO (Based on selected Reports by Economic Commission for Africa on Engineering Industries in Africa)
ID/WG.40/19	A REVIEW OF FAO's ROLE IN MECHANIZATION FOR AGRICULTURAL DEVELOPMENT Prepared by the Agricultural Engineering Service of the FAO (Rome)
ID/WG.40/20	LIST OF DOCUMENTS ISSUED
-	ADVANCE DRAFT REPORT* Prepared by UNIDO Secretariat
-	PROBABLE AREAS FOR ATTENTION* Prepared by UNIDO Secretariat
ID/WG.40/21	ACTIVITIES OF THE ECE's COMMITTEE IN AGRICULTURAL PROBLEMS IN THE FIELD OF AGRICULTURAL MACHINERY
ID/WG.40 BP-1	STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN KENYA (COUNTRY STUDY REPORT) Mr. J. Maina Wanjigi (Industrial Commercial Development Corporation, Nairobi, Kenya)
ID/WG.40 BP-2	STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN INDIA (COUNTRY STUDY REPORT) Mr. K.S. Prabhakar (Planning Commission, New Delhi, India)
ID/WG.40 BP-3	STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN IRAN (COUNTRY STUDY REPORT) Mr. Farrokh Reza Moasser (Arak Machine Building Plant, Teheran, Iran)

* Restricted. For the participants only.

ID/WG.40 BP-4	STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN TURKEY (COUNTRY STUDY REPORT) Mr. C. Kirac (K.O.C. Holding A.S., Istanbul, Turkey)
ID/WG.40 BP-5	STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN COLOMBIA (COUNTRY STUDY REPORT) Mr. Mario Catano Cordona (Instituto de Fomento Industrial, Bogota, Colombia)
ID/WG.40 BP-6	STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN GHANA (COUNTRY STUDY REPORT) Mr. M.K. Dame (Crop Production Division, Accra, Ghana)
ID/WG.40 BP-7	STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN CHILE (COUNTRY STUDY REPORT) Mr. A. Ossandon-Lautaro (Programme Chief, Corporación de Fomento de la Producción, Santiago, Chile)

Annex 5

SUMMARIES OF BACKGROUND PAPERS PRESENTED AT THE MEETING

ID/WG.40/3 TRACTORS AND THEIR USE IN AGRICULTURE IN THE DEVELOPING AREAS OF THE WORLD by G.W. Giles, USA

There is a growing awareness and concern among developing nations of mechanical power and equipment and its importance, among other things, in the matter of increasing the yield and the production, improving the quality and lowering the cost of food grains. Additional power will contribute to increased yields, production and qualities; 0.5 h.p. per hectare is asserted as a reasonable minimal goal.

There is a positive relationship of horse-power input per unit area to yields of agricultural products per unit of area.

The tractor and associated equipment are dependent on each other. It would be a mistake for developing countries and agencies to think solely in terms of tractors. Low hours of tractor use is partially the result of too little or non-available tractor powered equipment.

The development of unconventional tractor designs for the developing nations is not justified at this time. Rather, resources should be directed to supplying the types and sizes, with modern accessories, that have been proven elsewhere. The row-crop type is preferred. Progressive farmers want and deserve the latest. A range of tractor sizes and types are needed to satisfy the varying agricultural situations in a particular country.

The top priority should go to the larger tractors, 30 h.p. and higher. Economic benefits are on the side of over-powering specific farm machine operations when carried out by operators whose skills are less developed.

The results of a cost/benefit analysis is an important criteria in the farmer's selection of power and associated equipment.

Provide comprehensive service that is farmer orientated and managed by modern practices and techniques. These services include credit to both the farmer and the service agency and competitive demonstrations that are carried through to the final yield stage. Direct subsidies on tractors and equipment may be a hindrance to progress.

Maximum progress in advancing mechanization can be made through individuals and concerns in real competition and with a profit motive. Government agencies's role is in providing credit, conducting demonstrations and teaching the <u>what</u>, <u>why</u> and <u>how</u> of tractor and equipment operation.

ID/WG.40/4 DEVELOPMENT OF THE SUPPLYING AUXILIARY INDUSTRIES FOR AGRICULTURAL MACHINERY PRODUCTION IN A DEVELOPING COUNTRY - INDIA
by K.S. Prabhakar, India

The paper covers the following important industries:

(1) Agricultural implements
(2) Diesel engines
(3) Gasolene engines
(4) Pumps and motors
(5) Ancillary industries

A production of 15,500 tractors was achieved during the year ending March 1969, in India. The demand for tractors has risen very steeply in the recent months and action is under way to enlarge manufacturing capacities in the country.

The total population of wheeled tractors in use in India is approximately 86,000, of which 40,000 have been imported. The average indigenous content, by value, achieved by the industry is about 75 per cent.

An attempt is also being made to popularise the power tillers for use in rice growing and hilly areas where these are most suitable. One unit is already in production and another unit is likely to go into production shortly.

A sizable demand for this equipment is also expected in the years to come. A diesel power tiller of 8 - 10 h.p. seems to be ideal for use in the rice growing areas in the plains and a lighter power tiller with a gasolene engine of 3 - 4 h.p. may serve the needs of the hilly areas.

A wide variety of conventional tractor drawn agricultural implements are already being made in India and an attempt is being made to introduce the more sophisticated equipment such as combine harvesters, reaper binders etc., which are much needed in the harvesting operations.

The diesel engine industry, in so far as it relates to the needs of agriculture in India, has been well developed and is in a position to export substantially to those countries needing them. It has been found that, in agriculture, diesel engines from 3 - 10 h.p. are the most suitable, particularly in India. The production of diesel engines in the year ending 31 March 1969, was approximately 250,000, 50 per cent of which was produced in the small-scale sector.

The production of gasolene engines has also been established in the country but this is more for meeting the internal demand. It has not been possible so far to enter the export market. Engines of horse-power ranging from 1 - 12 h.p. are being made and most of the production has been confined to engines required for knapsack sprayers.

The pumps and motors industry is also very well developed and all that is needed in agricultural operations is available from indigenous production. In addition, India can offer substantial quantities of these for export to the other developing countries in the region.

The ancillary industries which feed the tractor, power tiller and diesel engine industries are also well established and these have contributed largely to the indigenous contents achieved by the tractor industry. The ancillary industries are common to both the automotive and agricultural tractor industries. In addition, large capacities have been established for the manufacture of castings of all types and of forgings too.

The aim has been to achieve self-sufficiency in the production of automotive and agricultural machinery and equipment and it is expected that during the next four years substantial progress would be made in this sector.

ID/WG.40/5 THE DEVELOPMENT AND MANUFACTURE OF MECHANIZED AGRICULTURAL MACHINERY IN DEVELOPING COUNTRIES by Tien-Song Peng, Republic of China

The farm mechanization programme in Taiwan for increasing the productivity of land and saving farm labour is progressing steadily, in order to offset the labour shortage which is being increasingly felt by farmers close to industrial towns. The implementation of the programme, however, is faced with many problems, such as small or family-sized farms and fragmentation of land, low purchasing power of individual farmers, high cost of farm machinery, slow turnover in farm machinery business and low technical level of manufacture.

The following is a brief review of the development and manufacture of rice farming equipment in Taiwan:

1. Water pumps were first introduced into Taiwan about 50 years ago. At present, more than a dozen small local manufacturers are producing this machine, and at present about 50,000 units of the machine including deep well pumps are owned by local farmers.

2. Before 1953, a government-operated plant turned out a small number of hand sprayers. Today, about 200,000 units of hand sprayers, 25,000 units of hand dusters and some 14,000 units of power-driven sprayers and dusters are owned by individual farmers.

3. According to an estimate in 1953, Taiwan needed 100,000 more head of draft animals for carrying out intensive cultivation. To solve this problem, seven units of garden tractors and two units of power tillers were

introduced for trial in 1954-55. In 1959, there were 22 small plants producing power tillers. But within a few years all the local manufacturers, except three, either went bankrupt or changed into making other products due to cut-throat competition and inferior products. In 1961, two local factories, in co-operation with Japanese agricultural machinery companies, began producing power tillers of standard quality with some parts imported. So far, a total of 21,153 units of power tillers were used before the end of 1968, of which 78.61 per cent were home made.

4. In 1966, the bin-type of artificial grain drier was first made available to local rice farmers for adoption. About 650 units of home-made grain driers and 300 units of imported ones were made available to local farmers in the two following years.

5. The hand-pushing type rice transplanter tested by the local agricultural improvement stations gave very good performance. Beginning in 1969, some 50 units of the machine have been constructed for demonstration and training purposes.

6. Up to the present, there is a lack of an adaptable power-driven rice harvesting machine, a weeding machine, fertilizer applicator and grain cleaning machine, which would mechanize rice farming as a whole.

7. Measures adopted so far for farm machinery extension are: (1) to achieve technical co-operation among the farm machinery manufacturers; (2) to improve the farm machinery marketing system; (3) to standardize farm machine parts and attachments; (4) to strengthen research and experimental work; (5) to conduct training of farmers and technicians; (6) to provide farm machinery purchase loans; (7) to initiate rural repair service; (8) to set up fuel stations in all the agricultural areas; and (9) to carry out power machine tests.

8. Significant results attained in mechanizing rice farming in Taiwan are: (1) more income to rice farmers; (2) higher living standards of farmers; (3) more educated youth attracted to rural areas; (4) growth of rural industry

stimulated; (5) commercial production promoted; and (6) improvements in the existing cropping and irrigation system.

In conclusion, the following points should be given careful attention in the introduction of mechanized rice farming: (1) farm machines must be tested thoroughly before adoption and be adaptable to the local conditions; (2) machine operators should possess mechanical know-how; (3) farm machinery service centres are to be provided in major townships; (4) power and machinery are most needed for cultivation of the unused land; (5) poorly adopted machines tend to increase production costs; and (6) farm mechanization is handicapped by the low purchasing power of the farm population, poor handling and maintenance of machines, and the small and irregular size of individual farms.

ID/WG.40/6 ANALYSIS OF CRITERIA FOR FARM MECHANIZATION AND FOR THE MANUFACTURE OF AGRICULTURAL MACHINES AND IMPLEMENTS IN THE DEVELOPING COUNTRIES by D. Hutla, CSSR

The utilization of ancillary material sources and local industry for the manufacture of agricultural machines and implements in the developing countries is closely linked with the specific conditions of the agricultural mechanization in tropical regions. These conditions differ from those in the developed countries notably by adverse climatic conditions, by the general economic level and by the social structure.

The climatic conditions place higher demands on the machines (greater effects of corrosion) and, furthermore, necessitate a completely different use of machines and implements from those currently used in the developed countries. Consequently, the supply of machines and implements for the developing countries must be evaluated from a new angle. Up to now the main attention has been directed to direct industrial help from the developed countries, i.e. the import of finished machines. These machines may not always be suitable for the climatic conditions of the developing countries.

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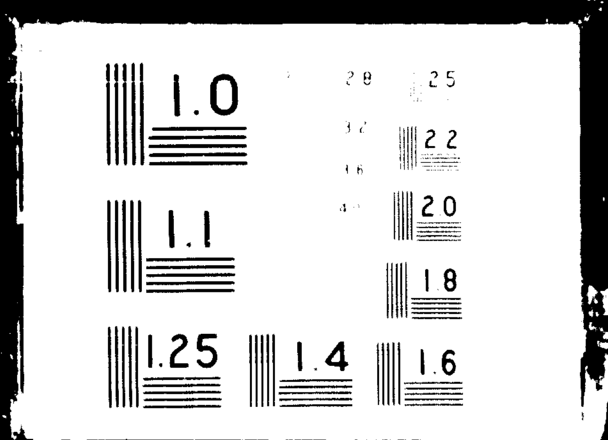


Furthermore, they have always been too expensive for a developing economy with a low purchasing power and unskilled labour. The imported machines are utilized in certain areas only and their life is much shorter than it would be in normal conditions. A new approach to the problem of availability of machines and implements for the developing countries may be in: (a) a development of traditional and standardized manual and animal-drawn implements of simple design, manufactured from local sources, (b) utilization of local sources of materials and local industry for the manufacture of simple parts of some more ingenious modern machines, adapted to local agro-technical conditions; the manufacture of these machines and of design sections or parts of a more complicated design would have to be effected by co-operation with developed countries.

Ancillary industries and sources for the manufacture of agricultural machines can be defined more accurately in actual conditions only. A Czechoslovak project for establishing the manufacture of a representative line of machines and implements in India, comprising a more complicated power machine, several p.t.o. driven machines and some implements of simple design, indicates that their manufacture promotes a demand for steel, grey cast iron castings and simple finished parts, notably connecting parts.

With regard to the low purchasing power of the agricultural population and to other different conditions of the developing countries, it seems reasonable to count for the present and for the near future on the manufacture and utilization of the simplest traditional implements manufactured by the farmers themselves or by the village craftsmen. The projects of modernization of some simple multi-purpose implements in some developing countries (for example in Pakistan and in India) indicate that a certain standardization would enable a concentrated manufacture of steel parts of these machines (shares etc.) in ancillary industries, while some parts of the implements (wooden handles etc.) should be manufactured in agriculture directly, if this were the least costly, due to cheap labour in agriculture. Future manufacture will aim towards a higher technological level, more efficient utilization of ancillary industries and, finally, towards a manufacturing structure similar to the pattern in the developed countries. The utilization of the ancillary industry will gradually take on the characteristics of a co-operation of equal industrial branches in a more or less independent economy. This trend will help to improve the system of raising technical know-how in agriculture and the servicing, with one of its main tasks, i.e. the supply of spare parts. The system of mobile servicing workshops, which seems to be the most suitable at present, will be gradually replaced by a service network similar to that in the developed countries.

ID/WG.40/7 FUELS AND LUBRICANTS IN AGRICULTURE by J.D. Savage and P.B. Bostock, U.K.

The paper deals with two principal topics:

(a) The rationalization of lubricants;

(b) The correct handling and storage of tractor fuel.

The use of different oils in different parts of modern tractors and mechanical farm equipment in general has complicated the servicing and maintenance procedures and has led to poor storage conditions due to the problem of housing several cans and drums of oil for a small range of equipment. The confusion that arises from a multiplicity of grades can lead to serious damage from the use of the wrong oil. In Europe this disadvantage has been overcome by the use of multi-purpose oils suitable for use in engines, transmissions and hydraulics of tractors and in most other farm machinery. The paper shows the extent to which oils of the "universal" type can be used in agricultural equipment and points out the particular applications in which specialized oils must be used.

During the past few years we have had the opportunity to study the effect of proper fuel storage facilities on the operation of a mixed and dispersed fleet of tractors in Scotland. The primitive conditions that existed initially had led to frequent breakdowns, considerable loss of working time and expensive repairs. By providing simple, but technically sound storage and handling facilities, time lost due to dirty fuel has been completely eliminated. The lessons learned from this exercise are directly applicable to any agricultural area, but apply particularly in developing countries where the value of adequate fuel storage and handling facilities is frequently underestimated.

ID/WG.40/8 AGRICULTURAL MACHINERY INDUSTRY IN DEVELOPING COUNTRIES - MANUFACTURING POSSIBILITIES OF PLANT PROTECTION EQUIPMENTS by Frigyes Horchler, Hungary

Plant protection is important because:

According to researchers, all the damage caused by insects, fungi and weeds in world agriculture amounts to an annual value of some US $ 80 billion, i.e. 40-50 per cent of the total agricultural production

The greatest damage occurs in those developing countries where the warm and moist climate usually favours insect, fungi and weed development

There are several methods of plant protection, weed, insect and fungi controls, the most important of which can be mechanized. More than 90 per cent of the equipment used for plant protection purposes can properly be called chemical control. The effectiveness of chemical control has been determined by several statistical methods with the results of quadruple compensation, that is, on an average the monetary unit spent for chemical plant protection is reimbursed by an additional yield in a value of 4 monetary units.

Classification of the plant protection machines are dealt with in the present paper according to the plant protection methods, e.g. spraying equipment, dusting machines, seed dressing machines.

The most important question for the developing countries is: "What is to be produced?". In this part of the study, technical details and descriptions of the principal machine types for plant protection can be found. All types of machinery well known in developed countries are dealt with: from hand-operated equipment to high-capacity, automatically controlled machines.

In order to deal more accurately with the problem of "manufacturing", the principal constructional elements and parts of the enumerated plant protection equipment, as well as their manufacturing possibilities and problems, are dealt with in the chapter "How to Manufacture".

Depending upon the technological level and technical standard of the countries, the production of such machines could be introduced in three different stages:

(a) Assembling the equipment in existing workshops, importing know-how and all machine parts from developed countries;

(b) Assembling the machines in workshops already established or planned, importing know-how from developed countries, as well as the main and most complicated elements, while manufacturing the simplest ones by local industry;

(c) Assembling and manufacturing the machines, importing know-how and technical assistance but manufacturing each part and unit by the local industry of the particular country.

ID/WG.40/9 REPAIR AND MAINTENANCE PROBLEMS OF OPERATING AGRICULTURAL MACHINERY IN DEVELOPING COUNTRIES by Brian Gardner, U.K.

Good service and maintenance of agricultural machinery in the developing countries is made difficult by rigorous operating conditions, poor communications and distance from sources of spare parts supply and the generally low standard of technical and general education. Servicing and repair work is complicated by the shortage and high cost of spares and by inadequate machinery dealer services and availability of trained mechanics.

The problems of servicing and maintenance of machinery in specific countries is demonstrated by three case studies of machinery operation in Uganda, the Republic of China and Ghana.

Study of a small group of tractor owners in a remote region of Uganda showed that they were experiencing extreme difficulty in getting their machines serviced. Spares were costing them 20 per cent more than the price ruling in the main urban centre of the country - Kampala. Main causes of the difficulties were the lack of a good dealer interested in servicing the machinery - the three dealers in the area dealt in farm machinery only as a sideline - and the unwillingness of the farmers to pay for service and spares. Attempts to encourage co-operative servicing and to improve standard of machinery operation had failed.

A different problem was highlighted by the situation in China (Taiwan). Small peasant farmers were being introduced to petrol engine driven walking tractors, replacing animal power with a considerable measure of success. The standard of operation and lack of service faciliti , however, was hampering maximum working efficiency. Several methods of improving operator skills were tried. Most successful was to select the most talented young men and give them concentrated operator and basic mechanics courses. They then passed on their knowledge through operators groups which met regularly in each local community. Existing blacksmiths and motor cycle repair shops were utilized as machine repair centres.

In Ghana, the problem of utilizing many different makes and types of tractors has been tackled by setting up government machine stations, with centralized control and spares servicing, to run and maintain machines on a hire and co-operative basis. The scheme has been moderately successful but problems typical of most countries where this type of system has been tried arose. It was found difficult to operate a tractor hire service on many small peasant holdings and the over-centralization often made efficient operations in remote areas difficult. Experts in Ghana believe that a much more decentralized system with a higher degree of in-the-field supervision is needed.

Examination of the activities of an East African agricultural machinery distributor and dealer show the difficulties of operating in developing countries.

Covering the whole of Kenya and part of Tanzania, his work is hampered by bad roads, poor communications and often bad weather. Servicing is expensive, with much time wasted by the lack of knowledge of machinery on the part of the operators.

According to the experience of one manufacturer, it is necessary for lealers to carry a much greater percentage of their total stock in the form of spare parts because of the slower turnover. Compared to the European dealer, who is likely to turn over his spares at least two and a half times a year, the man in developing countries can only expect a turnover of, at best, once a year; many experienee a turnover much slower than this. The result is greater interest costs, since a dealer is likely to be carrying up to 25 per cent of his stock in the form of spares.

One of the important inadequacies at the moment is the lack of knowledge of machinery by many extension workers. Education is the main long-term cure for many of the problems of maintaining machinery in developing countries. Shortage of middle grade, practically trained men is particulary acute. There is a lack of facilities to train such men in the developing countries at the moment. More must be trained in developed countries with more co-operation from manufacturers and educationalists in the developed countries. Main need in the developing countries is for very basic operator and farm mechanic training.

Main conclusions of the report are that there must be much closer study of the individual problems of the farmers in particular countries before machinery is introduced. This will inevitably involve much greater co-operation between governments and manufacturers. In many situations the development and home manufacture of existing equipment is better than the introduction of sophisticated, Euro-American equipment.

ID/WG.40/10 DESIGN FEATURES OF AGRICULTURAL MACHINERY FOR DEVELOPING COUNTRIES by J.R. O'Callaghan, U.K.

Agricultural holdings are classified in three categories: subsistence, small progressive and large. The machinery requirements for the three groups are discussed, with reference to possible sources of supply of machines.

A systems approach to the specification of machinery is outlined, with special reference to the performance of cultivating machinery in relation to other factors in crop production. The systems approach to design may be used to make an economic comparison of different solutions. Either least cost or maximum profit is proposed as a method of selection of promising solutions and as a design criterion.

Cultivation machinery

The findings of research on cultivating machinery are summarized and the applications of these results in design and operation of machinery are discussed under the following headings:

(i) Tined cultivators - the principle of action and its explanation in terms of the theories of soil mechanics. Prediction of the forces on the tine from measurements of soil properties;

(ii) Disc ploughs - the forces on discs used for shallow ploughing are defined. The effects of furrow width, depth and speed on these forces are reported;

(iii) Mouldboard plough - the forces exerted by a mouldboard plough on the soil are described, together with the effect of speed and shape of mouldboard on the resultant force;

(iv) The mechanics of root growth - description of laboratory studies of the mechanism of root penetration in soil and other granular media which were subjected to known values of confining stress. As the confining stress was increased, root elongation was reduced and finally arrested.

Traction

Wheel traction is often a limiting factor in the performance of agricultural tractors. A simple theory of traction is described and used to predict maximum thrust and maximum drawbar horsepower in terms of the soil properties.

Water supply

Design of simple water systems as an aid to community development.

Crop storage

The process of drying agricultural products and storage in low cost structures.

Land clearing

Description of a tractor mounted tree plucker designed at the University of Newcastle upon Tyne, for bush clearing in Uganda.

Design of frames

Frameworks used for trailer bodies and many agricultural machines are stressed in a torsional mode. A method of predicting torsional stiffness is presented.

ID/WG.40/11 REPORT OF THE UNITED NATIONS ECAFE/AIDC-UNIDO FACT FINDING TEAM ON INDUSTRIES MANUFACTURING AGRICULTURAL MACHINERY by the Economic Commission for Asia and the Far East, Thailand

This report embodies the findings of a team that visited twelve developing ECAFE countries from 3 November 1968 to 18 January 1969 to gather information, consult authorities concerned and ascertain the depth of their interest in erecting/expanding manufacturing facilities for agricultural machinery. The countries visited were: China (Taiwan), the Republic Korea, the Philippines, Indonesia, Singapore, Malaysia, Ceylon, Thailand, Iran, Pakistan (East and West), India, Nepal. Japan was also visited for observation.

The cultivation of Asian farms, which are mostly small and fragmented, is being performed manually by traditional primitive methods with the help of work animals, except in the case of certain plantations. Low crop productivities, the abundance of farm labour, the scarcity of investible incomes beyond the needs of subsistence living to enable the purchase of farm machinery and the lack of appreciation of their merits have been the main reasons for the fact that farm machinery has not been widely used in the ECAFE countries. However, the tide is changing with the advent of the "green" revolution that has brought tremendous increases in outputs of wheat, paddy and corn.

The recent adoption of high yielding wheat and rice seed varieties has resulted in considerable increases in production exceeding the existing capacities for storing, drying, milling and transporting.

Improved prototypes of rice hulling and threshing equipment developed in the Philippines and wheat threshers in Pakistan have possibilities for introduction in the other countries of the region.

The total consumption of four-wheel tractors, estimated to be 120,000 for 1975, is expected to exceed by around 40 per cent the combined productive outputs at that time of manufacturing plants in India and assembly plants in Ceylon, Iran, Pakistan, the Philippines and Thailand.

Power tillers are now assembled/manufactured with increasing local contents in all the countries visited except Nepal. It is expected that the increasing manufacturing capacities will be able to sustain the rapidly increasing demand for power tillers which is now considerably popular in use, particularly in rice farms, due to their accepted performance and price.

Manufacturing plants for small engines used for driving water pumps, threshers, power tillers etc., within 1 - 30 h.p. range, are found in China (Taiwan), India, Indonesia, Pakistan, the Philippines and the Republic of Korea. These countries, and others with present manufacturing plans, such as Ceylon, Iran, and Thailand, are expected to meet their individual national requirements for the general types of engines within the near future.

Water pumps, plant protection equipment, simple paddy and wheat threshers, tractor attachments, such as disc ploughs and tine tillers, are expected to be produced in larger quantities, since their production does not entail high investments and technology. However, product quality has to be improved considerably and ancillary industries established to support their manufacture.

To promote farm mechanization, consideration should be given to the development of an inexpensive small riding paddy tractor suited for the wet land cultivation of paddy farms, the organization of an Asian development agency for farm mechanization and to periodic trade display and demonstration of farm equipment and tools. The governments should also provide incentives for the manufacture of farm machinery including simple hand tools and provide support to farmers and co-operative bodies for their acquisition under reasonable financial terms.

The team recommended the organization of survey missions to investigate the feasibility of manufacturing small engines for agricultural use and rice processing machinery in the ECAFE countries.

ID/WG.40/12 PROBLEMS OF MANUFACTURING AND MARKETING AGRICULTURAL MACHINERY IN DEVELOPING COUNTRIES
by H. Nüchtern, Austria

The main steps in building up a market are defined according to the production. They are split up into the stage before production, the pre-investigent phase, research into market and product, the analysis of sales and production, and service.

Problem analysis is seen as a basic instrument of marketing policy. Distributions are made between primary (general and specific figures), secondary (data of substitute), tertiary (figures belonging to the field of application) and quarternary figures (data of economy).

Collecting experience, setting up a service network and setting up a factory are the three main stages in the sequence of the production. There are three ways of manufacturing industrial products:

Assembly of CKD parts guarantees a quick start of production with a small investment of capital and an easy change of model.

Manufacturing products in small-scale industries would give a further impetus to the established industry. The problem is that it is not easy to control the quantity, quality and the punctual delivery of the product.

Manufacturing products in large-scale industries is adequate for complicated products such as tractors for markets with a high demand for punctual delivery of a quantitatively and qualitatively satisfactory product.

A special problem of manufacturing in developing countries is the assistance of technical and commercial advisers. The possibility of sending advisers for the duration of the long-term programme and while new products are introduced should be agreed on.

The service analysis and service plan shows the importance of sufficient sales to run successful service facilities, with expenses covered by the service returns. In developing countries in particular, the availability of credits is a prerequisite for adequate sales figures. Contacts with the government and credit business are important for the dealer.

A full line programme will be helpful for the success in business of the dealer, but it is not necessary for the company to produce all implements itself. Forms of "mixed collaborations" of private companies and government seem to be the most reasonable. Participation by the government guarantees the constant interest of the official authorities in the company, which is of value for the further development of the company.

The statements made are based solely on the private opinion of the author. They should not be taken as the official policy of a company or any other institution.

ID/WG.40/13 SOME ASPECTS FOR DESIGNING MACHINES FOR GRAIN HARVESTING by M.A. Pustygin, USSR

Over the period 1931 - 1941, a complete transition took place in the USSR from the harvesting of grain crops with sickles and scythes, or the simplest types of machinery such as horsedrawn reapers, threshing machines and hand winnowers, to the utilization of high-output combine harvesters with which over 98 per cent of grain crops are now harvested.

Taking advantage of the experience of the above country, the developing countries should base their plans on the utilization of the most highly perfected high-output combine harvesters.

Laboratory tests carried out in the USSR in recent years on threshing and separating machinery, together with comparative tests of Soviet produced combine harvesters and those produced by foreign firms (the Clayson "Armada", the Massey-Ferguson MF-500, the John Deere 105, the Allis Chalmers Gleaner "C", the Claas "Matador Giant" and the Bolinder-Munktel S-950 etc.), have opened up the way to further considerable improvements in combine harvesters from the point of view of improvement of output and reduction of grain damage.

By making minor modifications to the layout of combine harvesters, without increasing their dimensions or weight, it has proved possible to increase their output by 30 - 40 per cent.

The combine harvester layout with two drums with a reversible beater between them has made it possible to increase output by 50 per cent and greatly reduce grain damage, particularly in rice harvesting.

The throughput capacity (the maximum feed of cut crop in kilogrammes per second, with a grain/straw weight ratio of 1 : 1.5 and permissible threshing losses) of grain combine harvesters varies over a very wide range, depending on the properties and state of the crop being harvested.

According to test data, in the USSR the throughput capacity of one and the same combine harvester may vary from 2.5 - 3 kg/second of cut crop or 3.6 - 4.3 tons/hour of grain (with bearded sorts of wheat and barley, with undersized grain etc.) to 6 - 7 kg/second of cut crop or 8.5 - 10 tons/hour of grain (with non-bearded wheat with large regular grains). With more favourable grain/straw ratios (1 : 1, 1 : 0.8), the grain threshing output per hour of uninterrupted working increases to 12 - 13 tons.

On the basis of studies of the processes governing grain separation, formulae are put forward which enable the relative throughput capacity Q of various combine harvesters to be determined on the basis of the width and length of the separating surfaces, with due account taken of special features of the layout:

$$Q = \eta B \log(\theta \log L)$$

where B and L are the breadth and length (from the beginning of the deck to the end of the straw shaker) of the separator in metres, and η and θ are constants for given sizes and layouts. For most modern combines (SK-4, Class, John Deere etc.):

$$\eta = 4.8 \qquad \theta = 6.8$$

For improved combines, other values of η and θ have been obtained.

In the USSR, the German Democratic Republic and other countries, industrial-type methods of grain production are being worked out: there are plans for the construction of industrial complexes for the cleaning, drying and processing of grain, group utilization of high-output combine harvesters, and the use of high-capacity trucks for receiving the grain from a group of combine harvesters in motion and delivering it to the processing point. These measures will enable great reductions to be made in the amount of time and money expended on the production of each centner of grain.

In all countries where straw is collected and used after combining, there is a tendency to free the combine harvesters themselves from the cumbersome machinery needed for the collection of the straw and instead to leave the straw behind in windrows and collect it later with other machines which are also suitable for picking up hay.

In order for the developing countries to make use of the above advanced methods of grain harvesting and to gain the greatest benefit from them, studies must be carried out to determine the most appropriate form of machinery for use in the specific conditions of the countries in question.

ID/WG.40/14 SERVICE AND MAINTENANCE PROBLEMS OF AGRICULTURAL MACHINERY IN DEVELOPING COUNTRIES - FIAT S.p.A., Sede Centrale, Italy

The problems to be considered are: Service and maintenance of agricultural machinery in developing countries. These problems have a common technological basis, whatever the industrialization stage of the country might be.

On the other hand, some substantial differences are to be found in the field of organizational solutions. In this field the choice can be either on a purely economic basis or on both a political and economic one.

Local conditions, as well as the objectives aimed at by the planners, can lead to a very wide range of solutions, at the extremities of which we can find:

More highly industrialized countries, where service is provided by a chain of privately owned workshops, resulting in lower costs;

Less highly industrialized countries, where agriculture is one of the causes for mechanization and, at least at an early stage, a centralized organization will be considered a logical, if more costly solution.

In less highly industrialized countries, the planning of a specialized organization for service could help to create a sort of pre-industrialization stage by promoting:

(a) The training of diversified personnel (mechanical, clerical, drivers etc.);

(b) The setting up of a basic structure which will be subject to more sophisticated developments;

(c) The popularization of agricultural techniques in the country concerned;

(d) The creation of agricultural contractors;

(e) The building up of experience based on collateral problems (modification to implements, electric power production, irrigation etc.).

In a country in its first stages of agricultural mechanization, the planning of a mechanizational scheme implies a comprehensive set up, since, apart from the actual cultivation of the land, the reclamation of the land itself (earth moving machinery) and subsequently the transportation of agricultural products to the commercial outlets (transport vehicles) must be considered.

Fiat has based its report on the above assumptions.

The main obstacles to an economic operation of mechanization scheme can be indicated as follows:

(a) Insufficient planning of the agricultural problems;

(b) Organizational deficiences in the operational and servicing organization for machinery;

(c) Lack of continuity of mechanization programmes.

As a consequence, our report suggests two main lines in the framework of an increased co-operation between industrialized countries and developing countries, including substantial contributions from international corporations:

International action in order that the responsible executives of the developing countries attain the necessary specialization in respect of economic development programmes and especially of agricultural schemes;

Improved co-ordination between multilateral and bilateral aid programmes and the co-operation offered by international corporations.

In conclusion, the aim should be to favour as much as possible negotiations with international corporations based upon sound economic schemes, the objectives of which should already be clearly determined by the government concerned in conjunction with the international agencies, so that a proper and efficient agricultural mechanization and service will be the logical consequence.

ID/WG.40/15 OUTLINE RELATING TO PRESENT STATE AND PROBLEMS IN FARM MACHINERY PRODUCTION AND APPLICATION IN DEVELOPING COUNTRIES by Milan Vuco, Yugoslavia

The relationship between agriculture and industry in developing countries represents one of the most important, as yet unsolved problems. Indeed, in its effect, the practical approach to it through the production and the application of farm machinery, evinces a far-reaching action.

1. A new approach to the problem

In our opinion, the problem lies mainly in the manner of approach - briefly how to link the natural wealth of some developing countries with the technical wealth of developed ones. Our "Outlines" are in the nature of an attempt to break fresh ground in solving this complex co-operating problem by embracing relevant factors in the field of farm machinery in developing countries as a whole.

2. Virtuous partnership and mutual interest

A fair co-operation between the partners interested can only be carried out through mutual facilities and corresponding obligations. In this case the governments should provide the following: plan and propagate the under-taking; use UN assistance; organize experimental farms, testing and re-search centres; get farmers to take up dry farming of wheat, corn, cotton or rice in monoculture; provide seed and fertilizers; provide land and finance the building of the factory; enter into a licence contract providing privileged facilities with a world known partner. The foreign partner should provide the following: standard models of machines and equipment appropriate to local conditions; prepare technical documentation for optimal technological process; supply corresponding equipment and instruments; secure continual raw material and semi-product supply; perform organizational and know-how assistance; organize stationary and mobile services, finance the above mentioned investments and assistance through sharing. The specialized

UN Agencies UNIDO, FAO and ILO should assist in planning, feasibility studies, product and project design, organization, education and training.

3. Farm machinery classification and selection

According to functional and technological characteristics, farm machinery has been classified in six groups. The first two groups, comprising tillage and seeding machines, the simplest and the most needed in agricultural mechanization, have been selected to begin with. Their principal function consists of soil preparation and seeding, and their technology on forging and pressing. Other machines, designed for irrigation, wet soil preparation, harvesting and threshing, have been left aside for the moment. Besides conventional ease and cost operation, the main characteristic of the selected machinery consists of standard mounted and drawn implements, well adapted to climatic and operational requirements, in order to facilitate their production mastering, manipulation and maintenance. Emphasis should be given to larger tractor types, 35 h.p. and over, especially the row-crop ones. Manual and animal drawn implements should be eliminated.

4. Minimum economic requirements

Feasibility studies have been performed, both from the agricultural and the industrial point of view. In this order, typical farms of 10 to 20 ha growing monoculture yields of wheat, corn, cotton and rice, and tilled by means of standard implements, have been analysed. The study showed that all costs, including investments, operational and maintenance costs, should be covered in normal, indigenous exploitation.

On the other side, medium-scale specialized factories manufacturing the selected tillage and seeding machines at about 100 tons per year capacity have also given satisfactory results. Total fixed assets, annual output and employees gross data, as well as selected coefficients have been dovetailed in normal European frame.

5. Two fundamental ways

Applying progressive methods and means of production organized by the mentioned world known enterprises one may expect to get economic results much faster than by evolutionary methods and narrow techniques. For this reason the so-called progressive approach to the economic improvement of developing countries has drawn our attention throughout our survey.

6. Elaboration of a pilot project

As our outlines carry original conceptions not customarily applied in the complex improvement problems of developing countries, the best way to examine them in practice would be to organize a pilot project elaborated by UN experts and assisted by representatives of the interested countries and leading manufacturers.

Such a project might help the long-awaited joint interest between developing and developed countries.

ID/WG.40/16 MARKETING PROBLEMS IN THE DEVELOPING COUNTRIES by W.G. Kleckner, USA

If one is to view the problem of marketing equipment strictly by exporting goods to the developing countries, the basic problems could be listed in ten very elementary procedures:

(1) Redesign and modification of existing products available to prime markets of developed countries, accommodate national safety laws etc.;

(2) Market analysis of developing countries:
   (a) type of equipment needed,
   (b) how will it be utilized and how productively can equipment be applied,
   (c) what quantities can be sold on a country or regional basis,
   (d) who will actually purchase equipment,
   (e) who will actually operate equipment;

(3) Establish economic method of distribution using direct sales, commission companies handling several manufacturers' lines of

equipment, a distributor organization, through a formal export company, or sales subsidiary companies;

(4) Language in itself presents a whole set of problems in:
(a) instruction and details for equipment,
(b) printing all operating manuals and service instructions in other languages,
(c) sales and advertising information in other languages;

(5) If an export organization is decided upon, it requires a complete organization study in itself for most companies;

(6) People are a most important factor: acquiring them and training them. Where are such people interested in export markets to be found and how are they to be trained?

(7) Communications problems are magnified on a world wide basis;

(8) Credit and financing, currency problems and trade balances are whole areas which need study to improve trade between nations;

(9) Maintaining replacement parts and services for equipment on long-range basis;

(10) Maintaining flexibility in all these areas to accommodate the changes in the markets, national politics, economics and currency problems.

Naturally these interact and are related to one another. The list can be made longer or shorter, but it includes the basic factors.

A feature of development that must receive ultimate attention in carrying out marketing transactions is the human aspect of development. It is only through the co-operation of people that any of our goals will be reached. This requires the combined talents and joint efforts of all concerned.

ID/WG.40/17 DETERMINATION OF PARAMETERS FOR TRACTOR/MACHINE ASSEMBLIES - CRITERIA FOR THE PREPARATION OF TRACTORS AND AGRICULTURAL MACHINERY DESIGN by N.M. Orlov, USSR

A method is set our for determining and justifying the optimum parameters for machine/tractor units, making it possible to identify the economically optimum weight and power of tractors, the working width of agricultural machines and the speed of advance of units in order to ensure maximum efficiency in carrying out a given volume of work.

The criterion for determining and justifying the optimum parameters of assemblies is the achievement of minimum expenditure, expressed as the money cost per unit area worked. At the same time, additional indices such as labour costs, fuel consumption and metal content should be determined, so that a more qualitative approach can be made to the selection of machine/tractor units and the determination of the appropriateness of using them in the national economy.

The collection of data on natural and agricultural conditions and on specific features of the cultivation of agricultural crops, together with the determination of the relation between expenditure and the parameters of machine/tractor units are fundamental tasks in determining the economically optimum parameters of machine/tractor units.

The variants of machine/tractor units for which expenditure is calculated and from which the optimum is selected should, if possible, take into account differences in working conditions as well as in design and economic factors.

The method may be used in the assessment and selection of alternative lines of development of agricultural technology.

As labour costs, fuel consumption and metal content are also determined when estimating the expenditures, analysis can, if necessary, be carried out on the basis of any of these factors and the unit parameters which ensure maximum efficiency of the unit for given values of these factors can be determined.

The method set forth may be used in other branches of the national economy.

ID/WG.40/19 A REVIEW OF FAO's ROLE IN MECHANIZATION FOR AGRICULTURAL DEVELOPMENT prepared by the Agricultural Engineering Service of the FAO, Rome

1. Agricultural engineering series of agricultural development papers

All these have been produced in the three working languages of FAO - English, French and Spanish. Some of the earlier ones may be out of print.

No. 44	(1954)	Consideration and procedures for the successful introduction of farm mechanization
- 60	(1956)	Water lifting devices for irrigation
- 65	(1960)	Irrigation by sprinkling
- 66	(1960)	Agricultural machinery workshops: design, equipment and management
- 67 Revised	(1960) (1969)	Farm implements for arid and tropical regions
- 71	(1960)	Soil erosion by wind and measures for its control on agricultural land
- 78	(1964)	Methods and machines for tile and other tube drainage
- 81	(1965)	Soil erosion by water - some measures for its control in agricultural land
- 84	(1966)	Equipment for rice production
- 85	(1967)	Multifarm use of agricultural machinery
- 90	(1969)	Handling and storage of foodgrains in tropical and subtropical areas

2. Agricultural engineering series of informal working bulletins

Most of these have been produced in at least two of the three working languages of FAO. Some of the earlier ones may be out of print.

No. 1	(1957)	Factors to be considered when selecting tractor and power units
- 2	(1958)	Equipment for rice production under wet paddy conditions
- 3	(1958)	Engine fuels and lubricants

No. 7 Revised	(1958) (1963)	Water control, tillage and seeding practices and machines for crop production under irrigation
- 8 Revised	(1959) (1969)	Tillage and seeding practices and machines for crop production in semi-arid areas
- 9	(1960)	Methods and machinery for the establishment and management of pastures
- 10	(1960)	Methods and machinery for the harvesting and handling of forage crops
- 11	(1960)	Methods and machinery for harvesting, threshing, cleaning and grading of forage seeds
- 12	(1960)	Planning and organization of projects for the improvement of hand and animal operated implements
- 13	(1961)	Methods and machinery for cutting and cleaning irrigation and drainage channels
- 14	(1961)	Safety measures for the use of agricultural machinery
- 15	(1961)	Methods and equipment for rice testing
- 16	(1961)	Possibilities for the utilization of solar energy in underdeveloped rural areas
- 17	(1961)	Windmills for water lifting and the generation of electricity on the farm
- 18	(1962)	Improved methods and equipment for tillage of medium and heavy soils in temperate regions
- 19	(1962)	Interpretation of tractor test reports by the user
- 21	(1962)	Portable equipment for sampling and temperature measurement of bulk grain
- 22	(1962)	The potentialities for rural electrification in Asia and the Far East
- 23	(1963)	Rice drying principles and techniques
- 24	(1963)	Some essential considerations on the storage of food grains (cereals, legumes and oilseeds) in tropical Africa
- 25	(1964)	Rearing and capsizing of tractors
- 26	(1965)	The use of aircraft in the mechanization of agricultural production
- 28	(1966)	Equipment and methods for tied ridge cultivation

3. Agricultural engineering series of informal working papers

(1956)	Mechanization, project planning and management
(1956)	The selection and operation of land development and agricultural machinery
(1956)	Machinery training and advisory services
(1956)	Machinery maintenance
(1956)	Farm implements
(1959)	List of manufacturers of hand and animal operated farm implements

4. Miscellaneous

(1950)	Progress and economic problems in farm mechanization
(1951)	Survey on the farm machinery situation in Europe
(1957)	Illustrated glossary of rice processing machines
(1965)	Agricultural engineering training and education in Africa
(1968)	International directory of agricultural engineering institutions
(1956)	Report on the Regional Technical Meeting and Training Centre of Farm Mechanization and Workshop Problems - Ceylon (19 September - 14 October 1955)
(1957)	Report on the Near East Regional Training Centre on Farm Mechanization Land Development Workshop Problems - Egypt (17 September - 13 October 1956)
(1959)	Report on the South American Regional Training Centre on Problems Relating to the Use and Maintenance of Agricultural Machinery and for Land Development - Chile (24 February - 22 March 1958)
(1963)	Report on the Farm Machinery Training Centre at Fahs - Tunisia (5 June - 26 September 1963)

ID/WG.40/21

ACTIVITIES OF THE ECE's COMMITTEE ON AGRICULTURAL PROBLEMS IN THE FIELD OF AGRICULTURAL MACHINERY

The Committee on Agricultural Problems of the Economic Commission for Europe is entrusted with the main responsibility for studying technical aspects of application of agricultural machinery. Within this Committee operates a Working Party on Mechanization of Agriculture. This Working Party prepares reports on the manifold aspects of mechanization in agriculture and, therefore, it sees mechanization from the user's point of view and not primarily from the point of view of production of agricultural machines. The main stress is given to general questions such as automation in agriculture or economic aspects of mechanization. The Working Party's activities have led to the publication of forty-two studies and a number of reports. These studies can be found in the series coded AGRI/MECH and the full list is annexed to the present note.

In fulfilling the tasks entrusted to it, the Working Party has organized numerous study tours. During these tours the participants have the possibility of visiting agricultural institutes, test stations etc. The next study tour will take place from 14 to 24 September 1969 and is organized by the USSR.

For more details see the last report of the Working Party (AGRI/314 and also AGRI/298).

Another activity of the ECE in the field of agricultural machinery is taking place within the Group of Experts of Farm Rationalization. This Group of Experts studies the adoption of modern techniques for decision-making, planning and control in farm management and the introduction of mathematical methods in that field etc. The Group has also undertaken the preparation of a "Multilingual glossary of terms related to farm rationalization". For more details see the last report of the Group of Experts (AGRI/295).

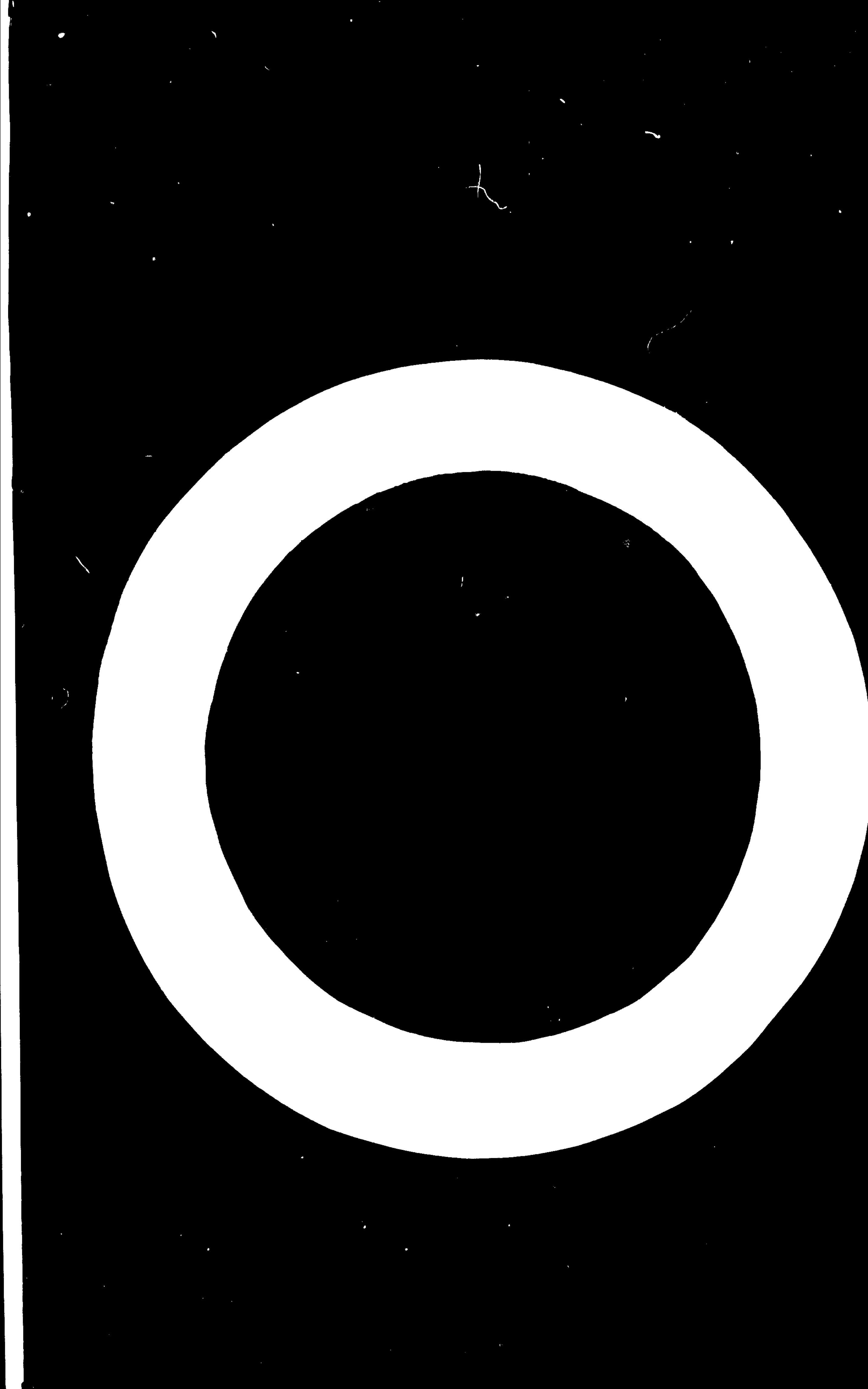
In conclusion, it can be said that while the activities of the ECE's Committee on Agricultural Problems are not directly related to the manufacture of agricultural machinery, which is of primary interest to UNIDO's Expert Group Meeting on Agricultural Machinery Industry in Developing Countries, its activities are adjacent to it.

Working Party on Mechanization of Agriculture

1956	AGRI/MECH/1	E.F.R.	Methods of green fodder conservation.
1956	" Crr. 1	E. only	
1956	AGRI/MECH/2	E.F.R.	Harvesting and conservation of maize stalks for forage.
1956	AGRI/MECH/3	"	The yard and parlour system in milk production in the U.K.
1956	AGRI/MECH/4	"	Rice harvesting.
1957	AGRI/MECH/5	"	Mechanization of dairy farms.
1957	AGRI/MECH/6	"	Harvesting and storage of the more common cereals.
1957	" Corr. 1	E.F.	Corrigendum.
1957	AGRI/MECH/7	E.F.R.	Harvesting transport and storage of green fodder in mountainous regions.
1958	AGRI/MECH/8	"	Harvesting and conservation of green fodder in dry regions. (Stepanov)
1958	AGRI/MECH/9	"	Effects of farm mechanization on horse numbers in European countries.
1958	AGRI/MECH/10	"	Harvesting and storage of grain maize.
1958	AGRI/MECH/11	"	Miling methods and milking machines.
1959	AGRI/MECH/12	"	Mechanization of the cultivation and harvesting of sugar beet.
1959	AGRI/MECH/13	"	The cleaning and sorting of grain.
1959	AGRI/MECH/14 (and Add. 1)	"	The general problem of transport on the farm.
1960	AGRI/MECH/15	"	Potato harvesting (West).
1960	AGRI/MECH/16	"	Mechanization of the application of chemical fertilizers in the form of liquid.

1961	AGRI/MECH/17	E.F.R.	Modern methods of cultivating and harvesting of main vegetables in field production.
1961	AGRI/MECH/18	"	Mechanical equipment for field drainage and ditching. (Culpin)
1961	AGRI/MECH/19	"	Modern methods of cultivation and harvesting of the main vegetables under glass. (Shipway)
1962	AGRI/MECH/20	"	Tractor needs for large-scale farming. (Ukrainian SSR delegation)
1963	AGRI/MECH/21	"	Irrigation by canals and sprinklers. (Carlo Santini-Italy)
1963	AGRI/MECH/22	"	Mechanization of land clearance.
1963	AGRI/MECH/23	"	Tandem tractors.
1963	AGRI/MECH/24	"	Seed drills (Rauscher) + Corr. 1 (F. only)
1963	AGRI/MECH/25	"	Automation in agriculture.
1964	AGRI/MECH/26	"	Mechanization of poultry keeping.
1964	AGRI/MECH/27	"	Equipment and methods used to control soil erosion.
1965	AGRI/MECH/28	"	Self-propelled chassis.
1965	AGRI/MECH/29	"	Mechanization of the cultivation of peas.
1966	AGRI/MECH/30	"	Making high dry silage from grass and leguminous crops.
1967	AGRI/MECH/31	"	Mechanization of fruit harvesting.
1968	AGRI/MECH/32	"	Basic concepts in connection with the economics of mech. of agriculture.
1968	AGRI/MECH/33	"	Methods of weed and pest control.
1968	AGRI/MECH/34	"	Methods and equipment for the application of fertilizers and lime.
1968	AGRI/MECH/35	"	Methods and equipment for drying of green feed (see AGRI/WP.2/83/Rev.1)
1968	AGRI/MECH/36	"	Mechanization of loading, unloading and transport operations in agriculture (see AGRI/WP.2/100)
1968	AGRI/MECH/37	"	Mechanization of maize harvesting for grain (see AGRI/WP.2/94)

1969	AGRI/MECH/38	E.F.R.	Air-tight storage of high-moisture grain (see AGRI/WP.2/99)
1969	AGRI/MECH/39	"	PTO driven machines for rotary cultivation of the soil.
1969	AGRI/MECH/40	"	Frost damage and its prevention (see AGRI/WP.2/110)
1969	AGRI/MECH/41	"	The consumption of mechanical energy in crop production (see AGRI/WP.2/ Working Paper No.49)
1969	AGRI/MECH/42	"	Economic aspects of the mechanization of dairy farms (see AGRI/WP.2/108)



Annex 6

COUNTRY STUDY REPORTS PRESENTED AT THE MEETING

	Country	Author
1	Algeria	M. Maghraoui
2	Chile	A. Ossandon-Lautaro
3	Colombia	M.C. Cardona
4	Ghana	M.K. Dame
5	India	K.S. Prabhakar
6	Iran	Farrokh R. Moasser
7	Kenya	M.J. Wanjigi
8	Pakistan (West)	N. Dimick
9	Sudan	A.R. Ali Galy
10	Syrian Arab Republic	L. Koudsi
11	Thailand	M.R. Debriddhi Devakul
12	Turkey	C. Kiraç
13	United Arab Republic	M.A. El Naggar
14	Venezuela	R.D. Cortes

1. STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN ALGERIA

by M. Maghraoui
Director General
Office National du Matériel Agricole
République Algérienne Démocratique et Populaire

Algeria

Area: 2,376,000 km^2
Population: 12,000,000 inhabitants

Algeria is divided into two distinct parts: the northern part consisting of plains and mountains, and the southern consisting of vast expanses of desert (the Sahara). Ninety per cent (90%) of the population is concentrated in the northern part, which constitutes less than 12 per cent of the total territory of Algeria.

A large variety of soils is found: the "Telle" (well watered clays and marls), the "Ten" (heavy clays), the "Hamri" (light and reddish soils), the "Djebel" (stony soils which are difficult to cultivate), the "Rmel" (sandy soils), the "Chott" (chloride-rich soils), and surface layers of limestone and gypsum.

Algeria's principal economic activity is agriculture. The agricultural potential can be increased, but is limited by the climate and the irregularity of rainfall during the year.

Algerian agriculture is structurally non-homogeneous. It includes both a modern and a traditional sector.

The modern sector corresponds in structure to the former colonial agricultural holdings, which were nationalized shortly after independence and organized into self-managing entities.

The present private sector is also an outgrowth of the colonial period. It arose during that period, when the local inhabitants were driven back into the hillsides and mountains, and on to land least suited for cultivation.

A. The self-managing sector

This sector consists of 2,000 agricultural holdings which occupy less than 16 per cent of the agricultural area of Algeria but which cultivate 33 per cent of the more productive agricultural land.

The production structure is still very similar to that which prevailed during the colonial period. Thus, the self-managing sector engages little in the raising of foodstuffs or livestock, but works a large proportion of the lands devoted to the cultivation of export products (90 per cent of the vineyards, 48 per cent of garden vegetables and 46 per cent of industrial crops).

The cultivation of fertile land and the use of modern methods of production (mechanization, irrigation, fertilizers) enables this sector to obtain yields greatly superior to those of the traditional sector.

Thus, although it cultivates only 27 per cent of the sown surface, it produces 35 per cent of the cereal crops. It plays an essential role in the country's agriculture by providing almost 60 per cent of the gross agricultural revenue and employing approximately 20 per cent of the labour engaged in this form of activity.

At present there is an urgent need to reorganize agricultural production which is almost totally geared toward export. This export-oriented agriculture is very vulnerable. The most economically vulnerable factor in this agriculture is the export of wines which, until 1965, represented more than 60 per cent of the value of Algerian agricultural exports. The traditional and profitable markets for this product have since considerably diminished in number and importance.

Supplying this sector with an ever increasing number of qualified workers, extending the area of irrigation, and increasing the use of Algerian made industrial products (tractors-fertilizers) will facilitate this reorganization and provide a new impetus to the sector.

B. The private sector

Generally speaking, the private sector corresponds to the traditional. It should be pointed out, however, that there are private holdings large enough to employ modern means of production.

This sector occupies 67 per cent of the tilled area and supplies 40 per cent of the revenue accruing from agriculture. It employs over one million persons, of whom 587,000 generally work on poor soil with primitive means. The plots are overworked, and as a result erosion occurs. They are, furthermore, generally small and are often fragmented: thus 423 smallholders have plots of less than 10 hectares, 147,000 farmers have holdings of 10 to 15 hectares, while 17,000 large proprietors have holdings of more than 50 hectares. Altogether, these holdings cover 4,660,000 hectares, exclusive of common pastures.

Agricultural activity in the private sector is first of all aimed at satisfying local needs. This sector produces foodstuffs of which the fellah consumes the greater part and sells only a very little to the outside. The smallness of the plots and the lack of financial means for buying agricultural machinery and fertilizers make it very difficult to increase crop yield and properly feed the family.

This agriculture takes the form of animal husbandry combined with the cultivation of cereals, dried vegetables and fruit trees in the Tell, and of migratory herding in the steppe. Cultivation and animal husbandry are generally extensive.

By taking appropriate measures to increase the available surplus in this sector it will very probably be possible to increase family earnings and integrate this agriculture based on the production of foodstuff into the national economic activity.

Land distribution

	Self-managing sector (ha)	Private sector (ha)	Public sector (ha)	Total	
				ha	%
Land used in agriculture	2,302,280	40,147,110	-	42,449,390	17.9
Wooded areas	107,280	301,040	2,016,000	2,424,320	1.2
Alfalfa grasslands	-	-	3,036,660	3,036,660	1.0
Non-arable land not used for agriculture	-	-	189,645,830	189,645,830	79.9
Total areas for Algeria as a whole	2,409,560	40,448,150	194,698,490	237,556,200	100.0

The public sector includes communal and State property, urban regions etc.

Farm mechanization in Algeria

The holdings within the self-managing sector are quite well mechanized. These holdings are equipped with machinery ranging from implements used in the cultivation of soil to those used for harvesting, sub-soil ploughs, stubble ploughs, ploughs, harrows, tractors, sprayers, reaper-binders, combine harvesters, stationary threshers, pick-up balers.

The National Bureau of Agricultural Equipment (ONAMA) is responsible for the acquisition, maintenance, and repair of this equipment. For this purpose it maintains workshops scattered throughout Algeria.

Training is offered to improve the qualifications of the users of this equipment on the farms. The trainees are usually farm workers.

There is great variation in the range of crops raised on these farms. Some farms cultivate several varieties of crops, while others raise only one or two crops.

The policy towards agricultural machinery industry

The purpose of the National Corporation for Mechanical Engineering (Société Nationale des Constructions Mécaniques), established in 1967, is the construction of mechanical equipment, and agricultural equipment in particular. This agency will begin production in 1972.

There are other State agencies, less important, which manufacture agricultural equipment, such as harrows, trailers etc. One of these is the Société Ben Badis.

DEGREES OF MECHANIZATION

Source: Etudes Statistiques (MARA), Série verte Nos. 5, 6, 7. (Statistical Studies-MARA, Green Series Nos. 5, 6, 7).

(a) Number of agricultural machinery units

Socialist sector

Four-wheeled tractors	16,168
Caterpillar tractors	7,745
Combine harvesters	2,800
Stationary threshers	760
Reaper-binders	575
Mouldboard and disc ploughs	30,346
Vineyard ploughs	4,122
Ridgers	1,290
Clearing attachments for vineyard ploughs	1,900
Weeders	4,032
Disc harrows	7,803
Cultivators	1,929
Stubble ploughs	2,313
Harrows	9,952
Land rollers	2,235
Fertilizer distributors	2,337
Seed drills	3,662
Dusters	4,940
Sprayers	9,226
Mowing attachments	2,752
Swath turners	1,900
Pick-up balers	1,398
Trailers	9,705
Breaker ploughs	402
Sub-soil ploughs	680

Private sector

Four-wheeled tractors	22,662
Caterpillar tractors	1,145
Combine harvesters and threshers	2,160
Ploughs (greater than 25 cm)	
mechanically driven	39,357
animal drawn	20,935
Ploughs (smaller than 25 cm)	
mechanically driven	32,100
animal drawn	327,690
Sub-soil ploughs	2,905
Breaker ploughs	3,690
Disk harrows	9,920
Mowing attachments	10,050
Rakes	4,050
Dusters, knapsack	1,250
Dusters, animal drawn	3,015
Dusters, mechanically driven	1,315
Sprayers, knapsack	1,260
Sprayers, animal drawn	6,725
Sprayers, mechanically driven	1,585
Seed drills	704
Fertilizer distributors	1,650
Reaper-binders	7,960
Two-wheeled tractors	340
Trailers	15,150

Self-managing sector

Four-wheeled tractors	1,100
Caterpillar tractors	560
Combine harvesters	350
Stationary threshers	60
Reaper-binders	80
Ploughing equipment	2,100
Ground breaking equipment	85
Surface-working equipment	1,600
Dressing equipment	35
Harvesting equipment	75
Transportation equipment	200

(b) Type of machinery and equipment used

In the private sector the four-wheeled tractor plays an important part. Of the total number of tractors less than 5 per cent are caterpillar tractors. At the same time 40 per cent of all tractors in the socialist sector are caterpillar tractors, of which 20 per cent are vineyard tractors.

Ninety-five per cent of the combine harvesters are of the bagging platform type. There are very few hillside type combine harvesters. The most common cutting width is 4.20 m.

For ploughing, the private sector seems to use the mouldboard plough, whereas the socialist sector prefers the disc plough (60 per cent of the ploughs).

Disk harrows are in great demand and are often preferred to ploughs for cultivating to a depth of 15 to 20 cm.

Gravity fertilizer distributors are often preferred to centrifugal fertilizer distributors.

Dibbling machines are more commonly used.

Jet sprayers are used for covering large areas, and portable sprayers for orchards and vineyards.

The use of knapsack sprayers is of some interest. The importance of the use of aircraft in spraying pesticides should be noted.

(c) Model popularity and current requirements (see paragraph b)

At present tractors in greatest demand are the 45 h.p. and 65 h.p. tractors. The most desirable cutting widths in self-propelled combine harvesters are 3.60 m and 4.20 m.

In other machinery the preference is for:

- Tandem disk harrows
- Dibbling machines
- Gravity fertilizer distributors
- Sprayers with 6 m booms
- Ploughs with 3 and 4 shares
- Ploughs with 5 and 6 discs
- Disc harrows 16/32 and 20/40
- Two-wheeled trailers
- Vineyard ploughs with 4 and 6 ploughshares

Current requirements are:

Socialist sector

Four-wheeled tractors	2,200
Caterpillar tractors	600
Combine harvesters	500
Stationary threshers	100
Reaper-binders	200
Mouldboard ploughs	700
Disc ploughs	900
Disc harrows	1,200
Fertilizer distributors	300
Sprayers	600
Knapsack dusters	1,200
Seed drills	600
Trailers	200

Private sector

Four-wheeled tractors	2,000
Caterpillar tractors	100
Combine harvesters	500
Mouldboard ploughs	1,000
Disc ploughs	230
Disc harrows	400
Trailers	100
Seed drills	30

(d) Future requirements

During the next 10 years the theoretical annual requirements will be:

Ploughing equipment	4,500	units
Surface working equipment	6,500	"
Sowing equipment	2,500	"
Fertilizer equipment	4,000	"
Dressing equipment	7,500	"
Trailers	1,500	"
Combine harvesters	600	"
Pick-up bailers	500	"
Reaper-binders	400	"
Stationary threshers	350	"
Hay making equipment	300	"
Four-wheeled tractors	4,000	"
Caterpillar tractors	2,000	"

MANUFACTURE INDUSTRIES AND RELATED ENTERPRISES

(a) Industry for the manufacture of agricultural machinery
(source – Ministry of Industry)

There are three principal manufacturers of agricultural equipment.

- The S.A.C.R.A., whose annual production is:

Mouldboard ploughs	100
Disc ploughs	450
Disc harrows	550
Chisels	100
Cultivators	30
Swing ploughs	600
Harrows, animal drawn	300

Production varies with demand.

- The Ben Badis firm, whose average annual production is:

Clearing and ground breaking equipment	20
Mouldboard ploughs	100
Cultivators	100
Field rollers	80
Trailers	75

- The C.A.P.M.A. firm. This firm manufactures crop-dressing equipment, output varying greatly in accordance with demand. Two hundred and fifty (250) to five hundred (500) units per year.

A tractor and engine factory is currently under construction, which will build 6,000 tractors: 4,000 four-wheeled tractors and 2,000 caterpillar tractors.

It will also build 10,000 engines of various capacities. Plans are also being made for the construction of agricultural machinery plants.

Finally, there are also two tractor assembly plants.

One four-wheeled tractor plant assembles 1,200 tractors a year, and one caterpillar tractor plant assembles an average of 400 tractors a year.

The Bourderons (Annaba) firm builds or assembles animal drawn equipment, mouldboard and disc ploughs, stubble ploughs, disc harrows; production capacity is about 4,500 tons.

The Dahmoun (Rouiba) firm produces the same equipment as the Ben Badis firm, but it operates on a semi-handicraft basis and its production is very low.

The Lepori (Oran) firm builds agricultural trailers and storage tanks.

(b) Other related engineering enterprises

There are two plants for assembling service vehicles and touring cars.

Plants for the assembly of hydraulic pumps:

- The Gasquet, Pepin et Coq firm builds and assembles pumps and compressors.
- The Diesolec firm assembles injection pumps.
- The Cimor firm builds vertical pumps at the rate of 300 units a year.
- The CAPMA firm builds vertical, piston, gear, pressure and other pumps.
- The Blachère Company builds centrifugal and compression pumps.
- SIMIA builds vertical pumps.
- The Pompes Algériennes builds vertical and horizontal pumps (Guinard licence). Production is at the rate of 5,000 horizontal pumps and 150 vertical pumps a year.
- The Société Industrielle Electromécanique builds two types of water pumps.

(c) Other related and supporting industries

Manufacture of tubes and pipes by the Société National de Siderurguse (S.N.S.). Manufacture of boiler valves, other valves, couplings, sprinklers etc., by the S.M. Métal firm.

Plans are being made for the construction of a universal forge with an annual production capacity of 700 tons of agricultural implements and 250 tons of mechanical hand tools.

TRENDS IN POLICY CONCERNING THE AGRICULTURAL MACHINERY INDUSTRY

(a) Incentives provided by public authorities

The existing incentives are very limited; however, the entry into force of an investment code has resulted in a significant participation of private national capital in industrial development through the establishment of small industrial enterprises in all industries; nevertheless participation in the engineering and related industries remains small.

Financial incentives have taken the form of equipment loans to small and medium-size farming enterprises. These financial loans, together with those allocated to the self-managing sector, make it possible to make large-scale purchases of agricultural equipment and therefore encourage the flow of industrial goods manufactured in Algeria.

The Government has approved the establishment of a national office of agricultural equipment which will operate the State's larger repair shops. This office will purchase agricultural equipment on behalf of the self-managing agricultural sector.

(b) Research, design, development and testing institutes

In 1966 it was decided to establish a research and testing centre for agricultural machinery, but, owing to the lack of money and staff the centre never materialized.

Nevertheless, with the establishment of the National Office of Agricultural Equipment, one of whose functions is the conduct of research on agricultural machinery, the centre will doubtless be organized by 1970.

2. STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN CHILE

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1. GENERAL PATTERN OF AGRICULTURE

A. Capacity for land use in Chile

		Area (thousands of hectares)
(a)	Arable land without serious limitations	6,196.0
(b)	Arable land subject to limitations	5,728.0
(c)	Land which is not arable but offers perennial pastures associated with annual pastures and mountains with zerophytic vegetation, allowing permanent grazing of sheep etc.	4,365.0
(d)	Land which is not arable but provides annual pastures associated with mountains and zerophytic vegetation, suitable for seasonal grazing	16,737.0
(e)	Land which is not arable but supports trees and vegetation partly usable for timber	20,443.0
(f)	Non-agricultural land	20,707.0
	Total area of the country	74,176.0

Cereals which are grown on 18 per cent of the arable area include wheat, barley, oats, rice, maize and rye. Pulses include vetch, beans, chick-peas and lentils. Tubers and roots include potatoes and beets. Industrial crops include sunflowers ("maravilla"), raps, flax, hemp and tobacco. Pasture land accounts for 60 per cent of the arable area.

B. Distribution of farm land by size of farm

With regard to agricultural land ownership, land distribution and the size of holdings in Chile, the dominant characteristic has been the existence of a large number of small agricultural holdings accounting for only a small share of total arable and irrigated agricultural land area. On the other hand, a large part of this area is distributed among a relatively small number of owners, this irregular distribution being one of the reasons which led the Government to introduce a programme of land reform.

C. Population and current agricultural practices

Population

The growing rate of urbanization has been one of the most marked characteristics of the demographic picture in Chile; the rural population has decreased substantially and it is expected that three quarters of the population will live in urban areas in 1975.

Agricultural practices

It may be said in general that, in the case of small farms of low profitability, animal-drawn machinery is used, all of it made in the country. The preferred animals are the horse in the central area and the ox in the southern area.

Studies are being carried out in order to find efficient equipment for working this type of holding; currently being tested are animal-drawn implement-carrying bars, various kinds of small cereal harvesters and other machines

The other agricultural holdings are worked with tractors and tractor-drawn equipment; it may be said that, in general, the equipment and systems used are technologically up to date.

2. PATTERN OF FARM MECHANIZATION

A. Stock of agricultural machinery

Machinery	Units
Tractors up to 35 h.p.	8,507
Tractors of 36 h.p. and over	13,800

Machinery (cont.)	Units
Mechanically-drawn ploughs	17,370
Animal-drawn ploughs	267,835
Disc harrows	21,017
Seed drills	9,225
Self-propelled harvesters	3,773
Stationary harvesters	4,926
Reapers	12,543
Rakes	9,118
Binders	5,344

B. Pattern of mechanization and machinery used

The Chilean Development Corporation (Corporación de Fomento de la Producción) has carried out a study relating the cultivated area of the country to the number of machines in existence. In general terms, the results were as follows:

Area per machine (average)

201.2 ha cultivated per tractor
495.8 ha of cereals or similar crop per self-propelled harvester
129.8 ha of sown pastures per reaper
555.1 ha of sown pastures per mobile binder

In the most highly mechanized areas the number of hectares cultivated per tractor is 123.3.

C. Production of agricultural machinery

The following types of agricultural machinery are being manufactured in the country in quantities capable of supplying the needs of the market:

Animal-drawn ploughs
Animal-drawn harrows (disc, spring-toothed etc.)
Planet type cultivators
Animal-drawn hay rakes
Animal-drawn reapers (assembly)
Spraying equipment for herbicides and pesticides, operated by power take-off or motor, with a tank capacity of 15,000 litres
Shoulder pack sprayers without motor
Sprayers with a capacity of 2,000 litres

Hammer mills
Attachments for self-propelled maize harvesters
Rotary cutters
Grader blades
Sub-soilers
Field cultivators
Water pumps
Manure spreaders
Fruit-sorting machines
Automatic feeding machines for poultry
Incubators for chicks
Wine-harvesting equipment
Potato planters with fertilizer-spreading attachment
Discs for ploughs and harrows
Broadcast system fertilizer spreaders
Maize shellers
Graders of up to 2.5 cubic yards capacity
Disc ploughs with three-point coupling
Disc harrows, tractor-drawn

Every year the country has to import agricultural machinery to supply the needs of farmers, and these imports can be estimated as follows:

Machinery	Units
Tractors	2,400
Ploughs (tractor-drawn)	1,300
Harrows (tractor-dran)	1,200
Seed drills	240
Self-propelled harvesters	240
Maize harvesting attachments	75
Choppers	180
Reapers	360
Hay rakes	180
Balers	240
Fertilizer spreaders	250

The country obtains supplies of agricultural machinery from the markets that offer the best prices; accordingly, the greatest imports of tractors come from the European market; the same applies to self-propelled machines.

Price is one of the principal factors considered in our country with regard to the authorization of imports of agricultural machinery; accordingly, the importation of equipment incorporating advanced technology that would signify an increase in price is not always permitted when it is possible to replace it by means of simple equipment.

The present trend is towards a continuous increase in the power of tractors; most tractors imported have engines of more than 60 h.p.

There is no doubt that the land reform being undertaken by the country will lead to an increase in the demand for agricultural equipment.

The demand for agricultural machinery during the coming quinquennia has not yet been determined; work on this subject is in hand.

3. MANUFACTURING INDUSTRIES AND AUXILIARY INSTALLATIONS

A. Industries manufacturing agricultural machinery

The Chilean Development Corporation (CORFO) carried out a study in order to ascertain production possibilities and to obtain information from industrialists already manufacturing agricultural machinery, both regarding their expansion or diversification plans and the difficulties they were encountering in this type of production.

The study made by the Development Corporation showed that the country had technical capacity and installations that could be made use of in the manufacture of agricultural machinery; however, there was not sufficient expansion in this type of industry, for the following reasons, among others:

The lack of a system of loans to enable the farmer to buy national products, so that manufacturers could not compete with imported equipment, which was generally marketed on a medium-term basis (3 to 4 years) with loans granted by the foreign supplier through the Corporation;

Lack of knowledge of the market by the manufacturer, with the result that production and sales targets were planned for small areas in the immediate vicinity of the factory;

The lack of a suitable system for the distribution of machinery throughout the country;

The lack of guidance to ensure that industrialists would manufacture certain equipment and models in accordance with the requirements of the country's agriculture;

The lack of technical assistance, with particular reference to the design of equipment suitable for national agriculture;

The inability of some factories, despite idle installed capacity, to produce economically and efficiently as their equipment was not suited to the manufacturing processes or was obsolete;

The inability of national manufacturers to produce for stock owing to the lack of financing.

At the moment there are twenty five factories manufacturing agricultural machinery distributed throughout the country. Half of these are taking part in the Corporation's programme for the manufacture of agricultural machinery, which is described in section 4.

The equipment being manufactured is indicated in section 2 C.

B. Related engineering industries

Before referring to related engineering industries, it should be remembered that Chile is a producer of raw materials, including iron and steel.

The country has many factories that can manufacture parts of machines; there are foundries for iron, steel and non-ferrous metals that produce articles of good quality. Most of these are concentrated around the capital, but there are some in various provinces.

Our country is developing an automobile industry, so that subsidiary industries are well advanced.

4. POLICY FOR THE AGRICULTURAL MACHINERY INDUSTRY

A. Government incentives

With the aim of stimulating the manufacture of agricultural machinery, the Development Corporation formulated a programme aimed at giving this type of industry suitable incentives; its objectives are as follows:

(a) To supply our agriculture with machinery that the country is capable either of producing completely or of assembling;

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[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] agricultural machinery [illegible]

[illegible]

[illegible] specific projects [illegible] greatest agro economic [illegible]

(b) The most important projects being carried out within the programme are those for the manufacture of:

- Ploughs and harrows (under licence from Ransomes);
- Binders, reapers, choppers, side discharge rakes, hay balers and rotary cutters
- Attachments for self propelled maize harvesters;
- Seed drills for cereals, equipment for small holdings, meadow regenerators
- Cultivators
- The assembly of self-propelled harvesters for cereals.

At the moment the Corporation has already received projects for the manufacture of the above-mentioned equipment and it is making a selection and assessment of the various applicants.

The establishment of the "National Register of Manufacturers of Machinery" in the Development Corporation has been an important incentive to industrialists in the country manufacturing agricultural machinery.

The reason for this lies in the fact that some 80 per cent of imported machinery is marketed with the aid of credit granted by the foreign supplier. The establishment of the "register" allowed industrialists access to a very advantageous line of credit for the marketing of their products and thus enabled them to compete with imported machinery.

On the other hand, the National Committee for the Mechanization of Agriculture, a body that inter alia regulates imports of agricultural machinery, does not permit imports when there is some equipment manufactured in the country which in point of quality, efficiency and price is competitive with the foreign product.

Lastly, the Chilean Development Corporation is participating directly in the development of this type of industry by means of a capital contribution, as is the case with "Ransomes Chilena", a factory for ploughs and harrows.

B. Research, design, development and experimental centre

The Development Corporation is in the process of setting up a National Agricultural Mechanization Centre.

The Centre is situated in the town of Los Andes, 70 km from the capital.

An agreement has been made with the United Kingdom National Institute of Agricultural Engineering (NIAE) to obtain the technical assistance required. For this purpose the Institute has twice sent an expert to Chile and will shortly be sending an expert for a period of two years.

Studies of mechanization of various types of cultivation have been carried out and testing of both domestically manufactured and imported equipment is continuing.

It is a matter of national policy that any agricultural machinery to be imported, of a make or model not previously brought into the country, should be tested at the Centre, chiefly from the point of view of ensuring that it is suited to Chilean farming conditions.

With regard to domestically manufactured machinery, the prototype must be tested at the Centre so that any modifications that seem necessary may be made before marketing is authorized.

Chile does not have the technical personnel to design equipment. Most of the machinery manufactured is copied from imported models.

The Development Corporation has encouraged industrialists to seek licences on royalty terms, with a view to the technological improvement of the equipment manufactured or which it is proposed to manufacture. Discs for ploughs and harrows, for example, are made under licence from W.A. Tyzack and Co. Ltd., of Sheffield, England; sprayers are to be made under licence from John Bean (F.M.C.) of the United States; hammer mills have been made under licence from Wetmore (United States) etc.

In this way, it is hoped partly to make up for the lack of technical assistance and at the same time to keep up to date with technical progress.

C. Future needs

The principal constraint on the development programme is the limited Chilean market, the effect of which is that the quantities to be manufactured are uneconomic if wholly manufactured within the country. Integration and complementation with other countries is therefore being encouraged, instead of complete manufacture; this applies to advanced machinery such as self propelled harvesters, binders etc.

Technical assistance, especially for the existing industry, is given importance within the current programme and an effort must be made to raise the level of qualifications of Chilean personnel.

3. STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN COLOMBIA

by M. C. Cardona
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1. GENERAL STATUS OF AGRICULTURE

A. Geographical position and characteristics of terrain

Colombia has an area of 1,138,914 km^2 and 17.5 million inhabitants.

Studies carried out by various bodies in 1964 and covering an area of 690,000 km^2, including the whole populated area of the country, showed that:

(a) 9607 km^2, or 1.4 per cent of the area studied, are suitable for intensive agriculture and stockraising, with slopes of 0-3 per cent, free from erosion, floods and salts harmful to plants;

(b) 41,157 km^2, or 6.0 per cent of the area studied, consist of soils potentially suitable for agriculture and stock raising with slopes of 0-3 per cent subject to occasional flooding but not liable to erosion, and which need to be rendered fit for cultivation;

(c) 72,235 km^2, or 10.5 per cent of the area studied, consist of soils potentially suitable for agriculture and stock raising with slopes of 0-1 per cent, not liable to erosion, with periodic flooding and salts harmful to plants, which must therefore be rendered fit for cultivation;

(d) 156,670 km^2, or 22.7 per cent of the area studied, consist of soils liable to moderate erosion, with slopes of 3-25 per cent and needing to be rendered fit for cultivation;

(e) 160,765 km^2, or 23.8 per cent of the area studied, consist of soils liable to erosion, with slopes of 25-50 per cent;

(f) 205,362 km^2, or 29.8 per cent of the area studied, with slopes of over 50 per cent, are liable to erosion and suitable for afforestation;

(g) 15,462 km^2, or 2.2 per cent of the area studied, with slopes of over 60 per cent, are liable to erosion and suitable only for afforestation;

(h) Some 28,000 km^2, or 4.1 per cent of the area studied, consist of unproductive soils at heights of over 4,000 m.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

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[illegible]

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[illegible]

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[illegible]

[illegible]

[illegible]

[illegible]

The main implements required for such a quantity would be:

3,000 ploughs,
1,400 harrows,
1,200 seed drills,
1,500 cultivators.

3. THE AGRICULTURAL MACHINERY AND TOOLMAKING INDUSTRY IN COLOMBIA

A. The agricultural machinery industry

The metal manufacturing industry is expanding and already produces various types of industrial equipment, but there are still a number of obstacles to the manufacture of heavy machinery which it will not be easy to remove in the near future, notably insufficient markets to allow for adequate economies of scale. Thus there is still no manufacture of tractors in Colombia, though the possibility of setting up assembly plants has already been considered. There is also some interest in the manufacture of low-powered tractors (up to 12 h.p.), which could be produced at economic prices, but such machines would not provide a complete solution to the problem.

Most of the types of implements and tools required for soil preparation and tillage are being produced in sufficient quantities to cover domestic demand. Harvesting and product processing equipment is manufactured in smaller quantities and much of it has to be imported.

There are no up-to-date statistics of production, so that we are unable to give figures. All we can do is to list the equipment, implements and tools now being manufactured, namely:

mills
threshers
maize huskers
grain dryers
fibre separators for sisal
rice-processing machines
trailers
ploughs
cultivators
seed drills
harrows
manure spreaders
mattocks
picks
crow-bars
spades
sickles
machetes
pickaxes
axes

B. Basic and auxiliary industries

The Colombian iron and steel industry is able to meet the bulk of the demand for steels for the manufacture of agricultural implements and tools, except for a number of special steels which it is necessary to import.

With regard to parts and spares for machines and implements, the metal manufacturing industries have installed capacity for the manufacture of nearly all implement parts and a certain number of tractor parts and spares.

4. POLICY FOR THE AGRICULTURAL MACHINERY INDUSTRY

A. Incentives provided by the Government

The industries producing implements, tools and some types of processing equipment satisfy the conditions for receiving tax concessions, including 100 per cent exemption from income tax up to this year.

Customs protection for Colombian manufacturers is really extremely small, because Customs duties on nearly all these products are only 2 per cent ad valorem.

Domestic producers are able to obtain credits from various financial institutions, in particular, the Industrial Development Institute, which is the State financial corporation.

B. Agricultural machinery research institutions

There are a number of bodies in Colombia which study, promote, finance, give technical assistance to and plan agricultural production. Some of these have carried out studies of agricultural machinery requirements. The Industrial Development Institute is now making a study of Colombia's production and needs, with the advice of a UNIDO expert.

C. Future needs

Since Colombia is essentially a farming country in which agricultural and stockraising output constitutes about 30 per cent of the Gross Internal

Product, with vast [illegible] into production, the [illegible] of agriculture is a matter [illegible]

The State is [illegible] bodies designed [illegible] yields.

To achieve this aim, [illegible] count on the [illegible] capable of adequately meeting [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Wheel type tractors	
Massey Ferguson TEA 20	155
International Harvester	200
Massey Ferguson 35	162
Massey Ferguson 65	306
Deutz ([illegible] & [illegible])	200
Porsche (Junior & Master)	303
David Brown	224
Zetor	1,500
MTZ Belarus	34
Fordson	12
Other machinery	
Rice combines	80
Rice mills	226

Crawler tractors	
C-100	109
DT. 54	51
TG. 160	10
TG. 90	150
BNT. 60	8
D. 4	2
D. 6	
D. 7 & D. 8	8
Euclid CD. 8	2
Richard Continent	6
Allis Chalmers	1

Furthermore, there are various makes, models and quantities of disc ploughs, disc harrows, disc and mouldboard ridgers, manure spreaders, seed drills. There are well over 200 wheel tractors in the private sector.

II Mechanization pattern and equipment used

The area available for agricultural purposes is about 24,320,000 acres; about 30 per cent of this area is in the northern and upper regions. There are about 1,100,000 persons cultivating 6.8 million acres (including cocoa and other tree crops). Of this cultivated area, 120,000 acres are worked by motorized power, 150,000 acres by animal power and the rest by manual power employing the cutlass and the hoe. Vast areas are therefore available and suitable for mechanization. Tree crops are generally not mechanized. There are four main categories of mechanization:

Government. Where a government organization, institution or semi-government organization goes into production of arable crops, the government sinks in capital for the purchase of various necessary machinery for the purpose. The State Farms, Settlement Division, Brigade and the Volta River Authority are examples. In this case machinery of all types and descriptions are made available - tracklayers, wheel tractors and ancillary equipment for land preparation through to harvesting and sometimes even up to processing, together with supporting transport facilities.

Some co-operative societies have endeavoured to own some tractors and the Kumasi Groundnut Co-operative Association buys bullocks and bullock ploughs for its members; the Emcot plough is usually used, but some other makes are now appearing on the market. Rowcrop tractors are the rule.

Individuals have bought quite a few tractors – rowcrop and walking.

The Government has established a Mechanization Division which offers custom hire service of agricultural machinery for land clearing and primary cultivations as well as harvesting and processing facilities at moderate charges to all sections of the farming community. The machinery is Zetor wheel tractors, TG.160, 90 and BNT.60 crawler tractors and an admixture of cultivation, harvesting and processing machinery.

Massey Ferguson, David Brown, Fordson and International Harvester tractors are very popular; agency problems restrict Zetor tractors only to the Government Custom Hire Service.

C. Production of farm machinery

The level of production of farm machinery is very low. The local blacksmith forges the hoe and some local matchets. He is also able to make shares and some components of the bullock plough and other machinery, such as disc plough cross-shaft and cultivator members for replacement purposes; he is sometimes able to weld the old broken parts and straighten out distorted components. Real assembly line production is practically nil.

One firm – Agricultural Engineers – engages in the manufacture of agricultural hand tools and appliances such as garden forks, rakes, matchets, head pans, watering cans, feeding troughs, battery cages, feeding hoppers, and watering appliances for poultry. This firm is also assembling bullock drawn implements; it manufactures the main frames of bullock ploughs locally and plans to manufacture all parts locally as soon as possible. The same firm is contemplating manufacturing the main frames of disc harrows and tine cultivators from local materials in the very near future.

Two firms are now assembling tractors imported partly knocked down. These are the G.C.M.T. and John Holt Bartholomew (Lonhro) dealers in Massey Ferguson and Fordson tractors respectively. These firms are also contemplating local assembly of bullock-drawn implements imported partly knocked down, with possibilities of complete local manufacture of same according to future demands.

D. Popularity in design and present demand

Ghana now has to import all her machinery needs from overseas countries, either direct or through local representatives. Machinery has been imported into the country that never served any useful purpose. Some have stood th test of time and achieved some measure of local acceptance. In the field of bullock-drawn implements, the Emcot ridger has been accepted for ploughing and cultivation jobs. A more versatile version - say a tool frame to take a plough cultivator and seeding boxes - would be welcome, even if not a pressing need. About 3,000 bullock ploughs are sold annually with room for expansion. The Massey-Ferguson and Ford tractors are in popular demand for farming purposes in the private and co-operative fields. Deutz, Zetor, David Brown and International Harvester tractors are in Government stations but have not much popularity with private organizations who have not been able to handle them to advantage as yet. The International Harvester is very popular in the timber extraction field.

E. Future demand (1975-1980) and trend in design

There is bound to be an increase in demand for agricultural machinery of the right type for application in the growing of sugar-cane, cotton, tobacco, kenaf, rice and maize which are being pursued closely with expansion programmes to feed both humans and provide for the manufacturing industries. It is estimated that about 200 wheel tractors will be required annually in the private sector alone, with possibilities of attaining 400 annually between 1975-1980. The demand will be for the rowcrop type tractor, which must be sturdy enough to do the work and stand a reasonable degree of [illegible] misuse. This tractor should be simple in design with simple [illegible] over-simplification must be avoided.

3. MANUFACTURING INDUSTRIES AND ANCILLARY FACILITIES

A. Farm machinery manufacturing industries

At the moment, no farm machinery industries as such exist [illegible] One firm – Agricultural Engineers, Limited – has just [illegible] towards establishing a farm machinery industry, manufacturing [illegible] hand tools, garden tools and some parts of bullock drawn [illegible] hope eventually to embark on manufacturing certain parts [illegible] implements. Assembling some partly knocked down [illegible] is now carried out and it is hoped to start manufacturing [illegible] of the pumps locally in the very near future

Two companies are assembling Fordson and Massey [illegible] imported partly knocked down. The same firms intend assembling [illegible] drawn implements imported partly knocked down

B. Other allied engineering industries

A steel mill has been established at Tema for the [illegible] steel rods, angle irons, and some flat sheets. This [illegible] a few component parts on request. There is an [illegible] but the ingots are exported. There are metal working [illegible] refinery and electrical industries.

Six vegetable oil mills are situated at [illegible] Asesewa (Eastern Region), Denu (Volta Region) [illegible] Region), Tamale (Northern Region) and [illegible] duce copra oil (refined and unrefined), [illegible] oil and shea butter.

[illegible] POLICY TOWARDS AGRICULTURAL MACHINERY INDUSTRY

A. Incentives by the Government

The policy of the Government of Ghana is to encourage private enterprise within the framework of a welfare state.

The Capital Investment Act, 1963, sets out benefits such as

Guarantee against expropriation;
Transfer of profits;
Remittances abroad;
Capital allowances;
Allowance for scientific research;
Tax concessions on exports; and
Exemption from property tax and rates.

B. Research design and development and testing institutions

The Council for Scientific and Industrial Research exists to conduct research studies into various scientific and industrial problems. However, not much has yet been done in the field of agricultural machinery. The Ministry of Agriculture has, over the years, conducted adaptability tests and has selected and accepted some machinery that meets [illegible] tractors, disc ploughs, disc harrows, mould[illegible] and [illegible] combine harvester and a host of other implements [illegible] is now vigorously being pursued by the Ministry with the [illegible] of the newly formed Steering Committee on Mechanisation.

The Universities at Kumasi and Legon are pursuing research studies and [illegible] some agricultural machinery. They have invented a few [illegible] machinery, so also have some individuals, but due to the lack [illegible] established testing institutions, no scientific data [illegible] is available. Trials by farmers are the basis [illegible]

C. Need for the future

Ghana does not at the moment manufacture her own agricultural [illegible] has perforce to look to outside supplies. It appears that [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
	[illegible]

[illegible]

[illegible]

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[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Non-ferrous castings

Like the ferrous castings [illegible] manufacture of non-ferrous castings [illegible]

While in the case of [illegible] is available [illegible] In the case of [illegible] limited quantities in India [illegible] up the short fall [illegible] would have to be imported [illegible]

Forgings

Considerable capacity has [illegible] die forgings [illegible] wagons etc. [illegible] addition, [illegible] cater to the needs of [illegible] plus capacity [illegible] industries is already [illegible] forging quality [illegible] is anticipated [illegible] the country [illegible] forgings capacity [illegible] the requirements [illegible] the manufacture [illegible] addition, [illegible] facture [illegible] dustries [illegible]

Machine tools

India is now in a position to manufacture a wide variety of machine tools which are required in the production of [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Sources for primary iron and steel products

Large steel plants [illegible] Jamshedpur, Bhilai and Rourkela [illegible] another large steel plant at Bokaro [illegible]. These plants manufacture all the principal iron and steel products including pig iron, ingot steel etc. [illegible] steel products [illegible] sizes and types of [illegible]. Alloy steel production has [illegible] alloy steels including stainless steel [illegible] Bombay and Bhadrawati. These [illegible] in the production of a wide variety of [illegible] automobile and heavy industries.

For the future growth of steel industry, manufacturing facilities have also been provided for setting up new steel plants and also expansion of the existing ones. The raw materials for the steel plants is abundantly available and only [illegible] are required to be imported at present.

POLICY TOWARDS AGRICULTURAL MACHINERY INDUSTRY

As a [illegible] of the adoption of new strategy and intensification of cultivation, the demand for agricultural machinery, particularly the tractor and power tillers has increased [illegible] in the agriculturally progressive areas. The cost of unskilled labour for harvesting crops has gone up [illegible]. The production capacity for tractors has since been raised and shortages are being met by imports from abroad. Improved agricultural implements are also being employed increasingly by the farmers.

The following significant steps have been taken to promote the use of agricultural machinery:

(a) Tractor and power tiller industry has been exempted from the licensing provisions of the Industries (D & R) Act, 1951. This measure would enable intending manufacturers to enter the market. The existing manufacturers are also likely to organize themselves more efficiently as a result of keener competition. These measures are likely to show results by the end of the Fourth Plan.

(b) Tractors and power tillers industry has been included in the list of priority categories and foreign exchange up to the full installed capacity is allowed to these units to import components from abroad.

(c) The Government has also liberalized the allocation of foreign exchange for the import of capital goods required by the existing units.

(d) Five schemes have been approved for the manufacture of crawler tractors in various ranges. These will be useful for levelling and normal agricultural operations in hilly areas and sugar-cane farms.

(e) Tractors and power tillers are being imported to fill the gap between the present demand and supply from the indigenous sources.

(f) The production of different types of tillage implements is being organized.

(g) Credit facilities are being extended to farmers for the purchase of tractors and implements through co-operative institutions, land mortgage banks etc.

Agricultural engineering has a pride of place in the engineering colleges. Some colleges have been set up only for courses in agricultural engineering and agriculture. Research institutions have also been set up to develop new designs for implements, new techniques in farming, and for the development of high yielding types of seeds. Model farms and seed farms, which also help to propagate new ideas and methods, have been set up. Tractor training and testing stations have also been set up to test equipment scientifically and thoroughly prior to acceptance of the prototypes for regular production. This has helped in ensuring that imported equipment chosen for production in India is suitable under Indian conditions.

The Agro Industries Corporations set up in each State are to provide sales and after-sales service facilities for the various types of agricultural machinery in use in the farms and also to impart training in the maintenance and operation of the agricultural machinery.

Efforts will be made to strengthen and expand the above-mentioned facilities and organizations.

6. STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN IRAN

by Farrokh R. Moasser
Arak Machine Building Plant,
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GENERAL PATTERN OF AGRICULTURE

A. Geographical land distribution pattern

Iran has a total area of about 1,650,000 km^2. It lies between 25° to 40° North latitude and 44° to 64° East longitude. Over 50 per cent of total surface is mountainous. Iran is predominantly an arid and semi arid country. The rainfall varies from 6 to 200 centimetres. Agricultural lands of Iran extend from 300 up to 1,500 metres height above sea level. The majority of this land is in the north (Caspian Sea), north-west (Azarbayjan), south (Khuzistan) and the central plains.

Reflecting the rugged nature of Iran's terrain and climate, only 12 per cent of the total area is under cultivation, and of this only about one-third is cropped each year, the remainder being left fallow.

Generally, agricultural land occupies 7,100,000 hectares, of which 3.1 million hectares is irrigated and 4 million hectares is for dry farming cultivation.

Food crops (including barley and pulses)	520,000 ha
Paddy	360,000 ha
Cotton	350,000 ha
Vegetables	210,000 ha
Sugar-beet	115,000 ha
Sugar-cane	5,000 ha

It may be mentioned here that 31 million ha land is capable of reclamation and development.

B. Distribution and size of holdings

The land reform in Iran, which was initiated in 1961 by His Imperial Majesty Shahanshah Aryamehr, has completely reorganized the rural life and the structure of the country. According to the latest statistics, the number of owner cultivators is reaching the figure of 607,291 persons. As a result of the second phase of the land reform law, some 1,842,218 farm families are shifted from the crop sharing.

At the same time, according to the land reform law, there will be no limit for the area in the ownership of mechanized farms. Quite a few farms with an area of more than 1,000 ha exist. In the case of land cultivated in dry farming, the average area is approximately 10 ha, while in the irrigated lands, the average is estimated at about 5 ha.

It has been planned to establish farm sharing co-operatives in the Fourth Development Plan. Every farmer will have a share in the co-operative according to his lands. These establishments will be managed by agricultural engineers and technicians.

C. Population and current agricultural practices

The population of peasants (1966) in Iran is about 16,275,000, which is 61 per cent of the total population and at the same time 49 per cent of the total working population. The policy of the Fourth Development Plan is to reduce this percentage to 46 in 1972. Owing to considerable variation of climate in Iran, there are almost all the usual lines of agriculture, livestock, food crops (especially wheat, barley and pulses), paddy, cotton, vegetables, sugar-beet, sugar-cane, fruits etc.

Within the past ten years, modern tractors and other farm machinery were introduced by Iranian farmers, and now old practices of ploughing are being replaced by modern ploughs, discs etc. In other farming methods, such as planting, plant conservation and harvesting, there is comparatively slow progress. In the dry farming system, which is adopted [illegible] for wheat and barley, the practices are limited to ploughing, planting and harvesting, but in irrigation systems some inter-planting practices are applied.

PATTERN OF FARM MECHANISATION

Different kinds of [illegible]

follows [illegible]

[illegible]	Specifications
[illegible]	Power tillers (5 - 7 h.p.) 45 - 65 h.p. tractors, [illegible]
[illegible] ploughs	3 bottom mounted - 5 bottom [illegible] 15 - 20 cm depth
[illegible]	3 bottom mounted 45 [illegible]
[illegible]	Used both for land preparation [illegible] and barley threshing, 28 [illegible] diameter above 50 cm
[illegible]	3 - 5 tons capacity
[illegible]	One row
[illegible]	Simple cylindrical knapsack [illegible] operated
[illegible]	For dry farming as a broad [illegible]
[illegible] and seed [illegible]	For rice and other cereals

Production of farm machinery

[illegible] no manufacturing facility for farm machinery [illegible] needs are met from imports. In some small [illegible] of Iran, a few simple farm implements such as [illegible] farm trailer, and simple sprayers are being [illegible] workshops only do the assembling work.

[illegible]larity in design and present demand

[illegible] major groups of tractors are required:

[illegible] for paddy cultivation with their attached [illegible] north region of Iran.

[illegible] power tractors 45-65. All purpose tractors [illegible] hydraulic system, power take off, pulley and [illegible] high efficiency in arid and semi-arid regions of [illegible]

[illegible] horse-power tractors and crawler type in [illegible] lines.

1. STATUS OF AGRI[illegible] INDUSTRY [illegible]

[illegible]

Industrial and [illegible]

The Republic of Kenya [illegible] and extends 4° each side of the [illegible] of 10.209 million [illegible] the remaining [illegible] including [illegible] 85 per cent of the [illegible] 14.5 per cent of the total [illegible] K.[illegible] million [illegible]

The [illegible] portion [illegible] potential [illegible] Coast and Eastern [illegible] other [illegible] sea shore [illegible] platform [illegible] North [illegible] and Eastern [illegible] with [illegible] North [illegible] Rift Valley and [illegible] tion acres.

In order [illegible] Government [illegible] Tana River [illegible] irrigation [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]		[illegible]
[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

Size of holdings

The total land available for different agricultural purposes is about [illegible],000 acres. Large farms numbering [illegible] account for an area of about [illegible] million acres and the rest of the land is occupied by small farms. [illegible] million acres of land in Western, Central, Rift Valley, Nyanza and Eastern Provinces have been acquired from large farmers and cut up into 11,000 [illegible] holdings and [illegible] families in the new farms [illegible] Million Acre Settlement Programme.

There are about [illegible] small farms (each having an area of less than [illegible] acres) in Nyanza, Western, Coast and Eastern Provinces, their number in Central and Rift Valley Provinces being rather small. The average size of holdings is approximately [illegible] acres though it varies from as small as [illegible] acres in [illegible] District of Central Province to as high as [illegible] acres in [illegible] Province. The farming potential of small farms, which until [illegible] was [illegible] on account of fragmentation into more than one parcel and sometimes even nine parcels, has considerably improved on account of consolidation of land holdings undertaken by the Ministry of Lands and Settlement. This and other schemes such as demonstration cum training provided to farmers in the application of fertilisers, the use of improved seeds, soil conservation schemes etc., have had a telling impact on the productivity of the small farms' sector. From a more or less subsistence production, they have started yielding substantial marketable surplus.

Agricultural practices

Agriculture in Kenya, particularly on large farms, is highly mechanised. The large farms are operated on a highly commercial basis using modern techniques of farm management. They employ a large range of wheel tractors, crawler tractors, harrows, self propelled combines and tractor drawn harvesters, sprayers, grass cutters, balers etc. Every year they spend substantial amounts of money on additions and replacements of machanical equipment, for example during 1967 they spent K £2.109 million for the purpose. During 1964 these farms used 42,826 long tons of (nitrogenous and phosphates) fertilizers for 549,550 acres, and the amounts of fertilizers used continue to increase.

The average size of small farms being only 8.42 acres, the application of mechanized farming is rather slow and problematical. Normally, the small farmers use ox-driven ploughs, hoes, cultivators, hand-operated planters, drills, matchets etc. However, some of the small farms in Western, Nyanza, Central and Rift Valley Provinces own tractors and, apart from ploughing their own land, rent tractors to others. In order to facilitate the progress of mechanization of small farms, the Agricultural Finance Corporation, an autonomous body of the Ministry of Agriculture, Kenya, has been advancing loans to small farm-holders for the purchase of tractors since early 1967. By the end of 1968, the Corporation had advanced K £291,000 as loans for purchase of 210 tractors with auxiliary equipments, such as disc ploughs and harrows etc. These loans have, no doubt, infused new technology in the small-scale agriculture and helped in expanding their productivity.

PATTERN OF FARM MECHANIZATION

Equipments used and their population

Agriculture in Kenya, particularly on large farms, is highly mechanized. According to the Statitistics Division, which conducts an agricultural census on a yearly basis, the number of tractors and combine harvesters on large farms is as given in Table 2.

The number of other agricultural implements and machinery in use is not available. It is, however, believed that on average at least 1.5 ploughs, 1 harrow and 1 trailer is available for each tractor. In other words about 6,600 trailers, 6,600 harrows and 9,900 ploughs (to be mounted on tractors) would be available on large farms. It is also reported that the large farms spend K £2.109 million on replacement and addition to their stock of mechanical equipment each year.

Table 2

Particulars of mechanical equipment	1964	1965	1966	1967
Tractors				
Wheel	4,976	4,886	5,345	5,894
Crawler	807	843	800	723
TOTAL	5,783	5,729	6,145	6,617
Combine harvesters				
Self-propelled	483	502	575	596
Tractor drawn	444	408	455	446
TOTAL	927	910	1,030	1,042

The number of agricultural machinery and implements in use on small farms is also not available. According to reliable sources, however, about 600-700 tractors are available on the small farms.

Thus the total farm machinery population in respect of tractors and harvesters in Kenya is as shown in Table 3.

Table 3

Mechanical equipment	No. in use in 1967
Tractors	
Wheel and crawler	7,200
Combine harvesters	
Self-propelled and tractor drawn	1,140
Trailers	
Harrows	7,200
Ploughs (to be mounted on tractors)	9,900

Manufacturing industries

There are eight factories in Kenya making agricultural machinery and farm implements, viz: ox-driven ploughs, hoes, disc ploughs (to be mounted on tractors), harrows (to be mounted on tractors), grass slashers, coffee spraying machines, trailers for tractors and spares for ploughs and harrows.

Apart from these organized factories, there are a number of large scale farms that make their own trailers. Trailers are also made by one of the organized foundry works, though only on a sporadic basis.

These factories are well equipped with general purpose machines. The estimated capacity and production of these factories for different items are given in Table 4.

Table 4

Annual capacity and production of agricultural implements and machinery in Kenya

Agricultural implements and machinery	Unit of quantity	Annual capacity (single shift) quantity	Annual production (1968) quantity	Annual production (1968) Value (ex-factory)	Ex-factory price per unit of quantity (K£)
1. Ploughs - single ox furrow	Nos.	10,000	12,000	48,000	4.0
2. Hoes	dozens pcs.	100,000	50,000	150,000	3.0 (per dozen pcs.)
3. Ploughs (to be mounted on tractors)					
(a) 3 disc type	Nos.	N.A.	400	55,600	122.50 - 145.0
(b) 4 disc type	Nos.	N.A.	400	66,640	143.75 - 175.0
4. Harrows (to be mounted on tractors)					
(a) 14 disc	Nos.	N.A.	25	3,125	125.0
(b) 18 disc	Nos.	N.A.	25	4,625	185.00

Table 4 (cont.)

Agricultural implements and machinery	Unit of quantity	Annual capacity (single shift) quantity	Annual production (1968) quantity	Annual production (1968) Value (ex-factory)	[illegible]
5. Coffee spray machines (to be mounted on tractors)	Nos.	N.A.	50	17,500	[illegible]
6. Grass slashers	Nos.	N.A.	25	3,750	[illegible]
7. Spares of ploughs, such as rear wheels, stabilizer bars, shafts, disc handles etc.	-	-	-	10,000	
8. Driers for tea, coffee and grains	Nos.	100	41	82,000	[illegible]
9. Low speed general farm trailors					
(a) 3 ton capacity (i) non-tipping	Nos.	N.A.	90	21,[illegible]	[illegible]
(ii) tipping	Nos.	N.A.	155	42,[illegible]	[illegible]
(b) 5 tons capacity (i) non-tipping	Nos.	N.A.	35	10,[illegible]	[illegible]
(ii) tipping	Nos.	N.A.	65	27,[illegible]	[illegible]
(c) 5-7 tons capacity tipping	Nos.	N.A.	20	10,000	[illegible]
(d) 8 tons capacity sugar-cane trailors	Nos.	N.A.	30	17,000	[illegible]
(e) 10 tons capacity	Nos.	N.A.	4	5,600	[illegible]
(f) Tea bodies for chassis	Nos.	N.A.	33	11,[illegible]	[illegible]
(g) Turn-table trailors (3-8 tons capacity)	Nos.	N.A.	40	24,[illegible]	[illegible]

Almost all factories in Kenya are subsidiaries of internationa[illegible] and are well equipped with general-purpose machines. Their [illegible] fore compare favourably both as regards quality and price with [illegible] elsewhere by their principals. Moreover, the Ministry of Agri[illegible] set up an Agricultural Machinery Testing Centre at Nakuru (in Rift Valley Province), which examines the suitability of all agricultural machinery and implements including tractors, disc ploughs, harrows etc., both imported and locally produced. In addition single ox-furrow ploughs and hoes produced in Kenya are also tested and approved for quality by this Centre.

The factories in Kenya, apart from meeting the internal demand of the country, are able to export their products to countries such as Uganda, Tanzania and Zambia. For example, about 6,000 or 50 per cent of single ox-furrow ploughs produced in Kenya are exported to Uganda and Zambia. Similarly about 80 per cent of the hoes produced are consumed in Kenya and the balance of 10,000 dozen are exported to Uganda and Rwanda. In the case of trailers, driers and disc ploughs, about 10 per cent of production is exported to Ethiopia and Uganda.

It should be mentioned that none of these factories produces all the parts required for the finished products. For example, cast iron wheels and bolts and nuts required for single furrow ploughs are being imported. Similarly in the case of tractor ploughs, discs and bearings are being imported. [illegible] for machines are imported. These parts and spares are not being made in the country at present, and have therefore to be imported. However as the country advances industrially and factories for production of these parts and spares are set up, the local content of these finished products will correspondingly increase.

Import policy for agricultural machinery and implements

The importation of single ox-furrow ploughs, hoes and trailers is not allowed. These items have therefore been placed under the category of [illegible] items. Imports of all other items viz. tractors, disc ploughs, [illegible] cultivators, drillers, binders, combines, mowers etc., are allowed into the country duty free.

Imports

The import of agricultural implements in the categories 'others, including disc ploughs, harrows, cultivators, drillers etc.' (corresponding to International Trade Classification 712.1.9), lawn mowers, coffee cleaning, grading and sorting machines, sisal machinery, 'others, including binders, combines, mowers etc.' (corresponding to International Trade Classification 712.2.1, 712.2.2, 712.2.3 and 712.3.9), 'Tractors, other than road tractors for tractor-trailer combinations', 'other wheeled tractors' (corresponding to International Trade Classification 712.5.1 and 712.5.2) for three years, i.e. from [illegible] and principal countries of import are shown in Table 3.

In order to iron out seasonal fluctuations in imports, the average of the imports of agricultural machinery and implements for the three years [illegible] has been taken to represent the current level of imports. To obtain the break up of imports for different individual items in categories 'Others including disc ploughs, harrows, cultivators, drillers etc.' and 'Others including binders, combines, mowers etc.' (corresponding to ITC 712.1.9 and [illegible]) [illegible] with [illegible]. The average level of imports of different individual items are given in Table 4.

Table 4

Imports of agricultural machinery

Description of items	Quantity No.	Value K£
[illegible]	[illegible]	[illegible]
[illegible]		
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]		[illegible]
[illegible]	[illegible]	[illegible]
[illegible]		[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]

Present annual consumption

The total present consumption (1968) of different items of agricultural machinery has been worked out by adding current production and imports (projected for 1968). In cases of items not being imported the sales of locally produced items in the country have been taken to represent the domestic consumption. It may be mentioned that some quantities of driers for tea and coffee during the last three years have been received by the Government of Kenya from foreign governments on long term loans. The average value of imports of driers during the last two years has been estimated at K £ 100,000. This has been taken into consideration, while estimating present consumption. Based on such calculations and assumptions, the current consumption of different items of agricultural machinery are as follows.

Table 7

Consumption of different items of agricultural machinery during 1968

[illegible]	[illegible]	Value [illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

Future demand

The demand for agricultural machinery from large farms comes mainly for replacement purposes. Since there is no possibility of any increase in the number of large farms, their demand would be confined to making up for depreciated stocks of agricultural machinery and implements.

Ever since Independence, the Government of Kenya, through the Ministry of Agriculture, has been consistently striving to mechanise small scale agriculture. For this purpose, since 1967, the Agricultural Finance Corporation has been advancing loans to small scale farmers for the purchase of tractors and auxiliary equipment such as ploughs and harrows. As previously stated, loans amounting to K£ [illegible] for the purchase of [illegible] tractors with auxiliary equipment had been advanced up to the end of 1968. This scheme is still continuing. Other allied measures, such as training farmers in improved agricultural practices at the Farmers' Training Centre, the supply of hybrid and high quality seeds etc., have also been introduced with a view to increasing productivity and making Kenyan produce competitive in the world market. As a result, the demand for tractors, ploughs, harrows, seed drills, cultivators etc. has been increasing at a very high rate. The dealers estimate the demand to increase by about 8 per cent per annum during 1968-75 and 10 per cent from 1975-80. In other words, the demand will go up by [illegible] per cent during 1975 over 1968, and by 61 per cent during 1980 over 1975.

It may also be mentioned that due to competition amongst coffee producing countries, the demand for Kenya coffee is expected to remain more or less stagnant. As a result, the demand for coffee driers and grinding and sorting machines would remain at the present level during the next seven years. The international market for sisal has also been declining due to competition from [illegible]. The demand for sisal machinery is therefore expected to fall at least by 10 per cent p.a. during the next seven years. The place of sisal is progressively being taken by cotton and other crops in Kenya.

Taking all these factors into consideration, the demand for agricultural machinery during 1975 and 1980 is expected to be as follows:

Table 8

Estimated demand of different items of agricultural machinery during 1975 and 1980

Particulars of items	1975 Quantity (Nos)	1975 Value K £	1980 Quantity (Nos)	1980 Value K £
Tractors for tractor-trailer combination	70	467,000	110	752,000
Wheeled tractors	1,370	1,236,000	2,200	1,990,000
Trailers (generally 3-5 tons capacity)	690	261,000	1,110	420,000
Disc ploughs (3-4 furrow)	1,460	223,000	2,350	359,000
Harrows (4' 6"-13')	340	141,000	550	227,000
Cultivators	90	10,500	145	16,900
Seed drills (5' - 13')	450	131,500	720	211,700
Combines (8'-12')	70	326,000	110	525,000
Lawn mowers	2,570	36,000	4,140	58,000
Driers for coffee, tea and grains	120	240,000	140	280,000
Coffee cleaning, grinding and sorting machines	-	17,000	-	17,000
Sisal machinery	-	7,000	-	-
Single furrow ox-ploughs	10,300	41,200	16,600	66,400
Hoes	68,600 doz.	205,800	109,760 doz.	332,000

GOVERNMENT POLICY TOWARDS AGRICULTURAL MACHINERY INDUSTRY

Incentives by the Government

Kenya is primarily an agricultural country and, as such, industries directly connected with agriculture receive great encouragement from the

Government. Broadly speaking, the Government of Kenya promotes all those industries which increase the country's productivity, save foreign exchange and [illegible] modern technology and management. Kenya being short of trained [illegible] the Government through the Ministry of Commerce [illegible] and the Industrial and Commercial Development Corporation [illegible] joint ventures with foreign industrialists so as to take advantage of their modern technology and business management expertise. For this purpose the Government has framed a very attractive policy towards foreign capital embodied in the Foreign Investment Protection Act which affords [illegible] industries the necessary tariff protection, whenever necessary, [illegible] the repatriation of capital and profits as desired. Financial assistance by way of loans or equity participation are also afforded to certain key industries.

Government's policy towards foreign capital

The Kenya Government welcomes foreign investors/industrialists who risk their capital to increase industrial production and employment in the country. Such industries are generously protected under the Foreign Investment Protection Act. Where the investment is accepted since the project is likely to contribute to the development of the country, the foreign investor can get an "Approved Status Certificate" from the Government. This Certificate authorizes the owner to repatriate profits, dividends and capital whenever he wishes, regardless of any exchange restrictions which might otherwise apply. As a general guide, the conditions that have to be satisfied before an application for an Approved Status Certificate is granted can be summarized as follows:

(a) The proposed project will lead either to the earning or saving of foreign exchange, or

(b) The investment will result in gain in technical knowledge, that would be of over-all importance to the economic development of the country.

Financial assistance by way of loans and equity participation

[illegible] (ICDC), which [illegible] extends [illegible] ICDC [illegible]

[illegible]

(a) [illegible] thereby reducing [illegible] goods, which continue to drain the foreign exchange [illegible]

(b) [illegible]

(c) The need to create new job opportunities and thereby relieve the country of the burden of unemployment

(d) The need to acquire African interest and/or control in economic activities of the country which are largely supported by African [illegible]

(e) The need to attract such industries into Kenya, which could be supported largely by local market

(f) The need to take advantage of modern technology and technical expertise of the foreign industrialists

It is under this policy that the Corporation has invested K 11,164,472 or about 68 per cent of its resources in large and medium scale ventures. Thus all potential agricultural implements and machinery industries could be sure of receiving financial accommodation from the ICDC so long as these could prove to be economically viable and technically feasible.

Protection to local industries

The Government of Kenya affords tariff protection to all such industries which can satisfy the entire local demand and whose products are comparable in price and quality with those of imported products. It is under this policy that import of single furrow ploughs, hoes and trailers has been placed under licence. Apart from tariff protection to nascent industries, the Government also considers applications from existing industries for duty draw-backs for imported raw materials.

RESEARCH AND TESTING INSTITUTIONS

Research has a crucial part to play in the development of agriculture. Thus far the Kenya Government have placed increasing emphasis on production-oriented research such as the development of hybrid and synthetic seeds (for maize, wheat, pyrethrum, sugar cane, coffee, tea and cotton) and training of farmers in mechanization at such institutes as Egerton College, the Embu Institute of Agriculture, the Narosura Farm Mechanization Scheme, the Naivasha Dairy Training School and the Animal Health and Industry Training Institute etc. The aim of this research has been to improve the yield and quality of crops. The only research in implements has been the setting up of the Agricultural Machinery Testing Centre and Soil Conservation Station at Nakuru (Rift Valley Province). This Centre, which started early in 1955, provides testing facilities to farmers for examining the suitability of agricultural machinery and implements, such as tractors, ploughs, grass slashers, hoes and ox-driven ploughs, both indigenously produced and imported.

Not much seems to have been done in terms of developing new technology and new equipments or carrying out research into ideally suited mechanization practices, both for small and large farms, so as to reduce production costs. However, the Ministry of Agriculture is alive to this problem and suggestions for setting up a research-cum-extension services unit in order to develop and promote hand, animal draft and power machinery for small and large scale farms are being seriously considered. The proposed research-cum-extension services unit will have two main objectives, viz:

i) To examine the present equipment and implements being used on small and large farms and recommend after field experiments and research the type of implements and machinery most suited to local conditions. It would be necessary to carry out extension services so as to bring home to the farmers the advantages of recommended farm machinery;

ii) To set up a workshop for fabrication of prototypes of recommended farm machinery. Apart from supplying prototypes, it will be essential to provide technical advice to the local manufacturers.

Perhaps a start in this direction could be made from the existing Machinery Testing Unit and Soil Conservation Station at Nakuru. The staff, land and machinery facilities there could be entrusted with programmes of research, investigation and education.

PROPOSAL FOR AGRICULTURAL MACHINERY INDUSTRY

The Industrial and Commercial Development Corporation, an autonomous body of the Ministry of Commerce and Industry, is exploring possibilities of encouraging agricultural machinery industry, particularly the assembly of tractors in Kenya. The Corporation is in touch with German Consortium of Industrialists, which is expected to submit a detailed feasibility study shortly. In case the study confirms the economic viability of this project, the I.C.D.C. intends to participate in equity capital of the project.

It should be mentioned that the present consumption of lawn mowers, harrows and seed drills is too small to justify the encouragement of their local manufacture. By 1975, however, the demand in respect of each of these items will have gone up sufficiently and it would be possible to undertake their manufacture locally, unless production techniques make a dramatic change.

The existing factories making ox-ploughs, hoes and disc ploughs, driers for tea, coffee and grain, and trailers will also be able to expand their operations in response to rising demand for their products.

Ancillary facilities

It has already been mentioned that the existing factories do not manufacture all the parts required for manuiacture of different items of agricultural machinery. For example, the manufacturers of ox-driven ploughs import cast iron wheels and bolts and nuts. The manufacturers of disc ploughs have to depend on imports for discs and bearings. Similarly, wheels for trailers have to be imported. Most of these ancillary facilities have not yet been developed, mainly because the present demand for them is too small to warrant their local manufacture. It may, however, be mentioned that automobile tyres and tubes will shortly be produced in the country and the project for them has already been approved by the Government of Kenya. There is already a factory in Kenya manufacturing bolts and nuts, but so far it has not been producing those sizes of bolts and nuts which are required for ox-driven ploughs. This factory has now made arrangements for the production of desired sizes and the bolts and nuts will now be obtained from the local factory.

The development of ancillary industries is directly related to the status of parent industries. As major parent industries develop and the demand for ancillary parts and spares rises, ancillary industries would automatically develop in the process of general industrialization.

8. STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN PAKISTAN (WEST)

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Soil and climate are very different in East and West Pakistan. Farms of East Pakistan are smaller holdings. There are approximately 7 million farmers with an average holding of about 3.4 acres. Crops in East Pakistan vary greatly, with rice being the main crop. Two crops of rice can be grown and, if adequate water is available, three crops can be produced. Other crops are jute, sugar-cane, wheat, potatoes, barley, tea, tobacco, maize, vegetables, pulses, fruits and oil seeds. Rainfall is very high; however, most of it occurs during the monsoon season. Irrigation is required during winter and drainage during the summer. Only about one third of the land is cultivated during the winter because there is a shortage of water. Animal power is the primary source of power, but about one third of the land is farmed by farmers who do not own a pair of bullocks.

West Pakistan has approximately 5 million farmers with an average farm holding of 10 acres each. However, a little over 40 per cent of the farmable area is in holdings of 25 acres, or larger. The farms of this portion of the cultivable area range in size from 25 acres to several thousand, with an average of approximately 50 acres each. The major portion of the farm area is irrigated.

Wheat is the major winter crop and rice, cotton and sugar-cane the primary summer crops. From 10 to 15 per cent of the area is utilized for the production of fodder for work animals.

There has been a great drive during the past few years to increase agricultural production. Various incentives have been initiated by the Government and the farmers have responded well. High yielding wheat and rice, coupled with additional quantities of fertilizers and pesticides, have lifted West

Pakistan to the point of self-sufficiency. Along with this, however has come new problems of storage, marketing, future incentives, price supports etc.

The farmers have been wanting more tractors. The supply does not anywhere nearly meet the demand. Foreign exchange is the major ... Approximately one year ago, the Government appointed a Farm Mechanization Committee, made up primarily of Government employees and chaired by the ... Secretary of Agriculture, to study the problem of farm mechanization ... West Pakistan and come up with a plan for the future. The report is to be completed this fall.

The tractor importers, both private and Government, have organized an association which they call "The Farm Mechanization Association". This association has promoted the co-operation and discussion of the importers and manufacturers. They have joined hands in putting on seminars, exhibitions and demonstrations. In approximately one month they are sponsoring a ... session which is designed to cover many of the maintenance problems.

In Pakistan the movement toward mechanization has confronted many obstacles. The following are a few of them:

(1) The farmers, tractor operators, extension staff and the people who sell the equipment have very little background mechanical knowledge.

(2) In order to make efficient use of mechanical equipment, a tradition has to be changed, and until the farmer is shown that there is a monetary advantage to him he is reluctant to make changes.

(3) During the early stages of mechanization many obstacles, such as spares, poor adjustment and availability of equipment have been encountered;

(4) Some progressive farmers have done very well. They ... a tractor with the wheat they produced from 25 acres. This encouraged a movement of business people toward investment in agriculture by purchasing land and developing mechanized farms etc.

(5) Locally manufactured equipment is often a good copy of the original. However, it is generally made of mild steel and does not stand the wear and tear of farming operations.

[illegible]

[illegible]

[illegible]

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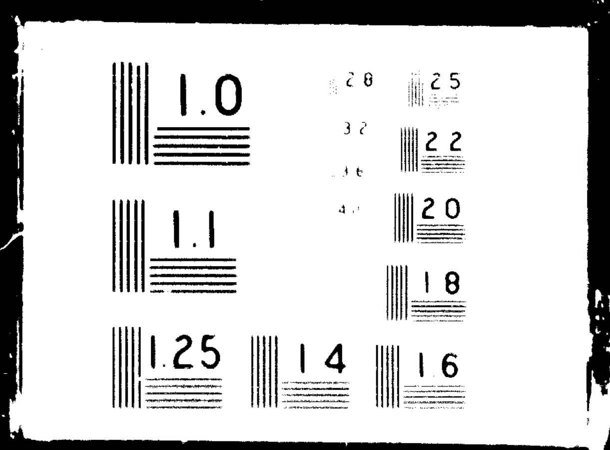

At the present time tractors and agricultural machinery are extensively operated by Government, stations, schemes and the private sector. The bulk of the machinery is in the hands of private owners and contractors, thus there is a great variety of organizations owning and operating machinery.

The accent generally is on extensive operation and high output per machine, and therefore the range of operations carried out is small and confined to land preparation and weed control, with seeding in the rainland areas. In irrigated areas, a simple ridge and split ridging system is practiced. Thus the equipment most commonly seen in irrigated areas is the tractor and tool bar, with the wide level disc tiller and seed box in rainland areas. Also used on a reasonable scale are specially designed deep straight blades for perennial weed control in Gezira Scheme. Wheat (approximately 200,000 acres) is a crop which is almost completely mechanized, and combine harvesters of many different makes and types are thus abundant. Disc ploughs and offset disc harrows are widely used in the new irrigated areas and may become more used when the new schemes of some two million acres are established. Crop protection is carried out by planes, and herbicides, although they proved promising and were tried on large scale experiments, are not in common use. Planters for cotton, ground-nuts, sorghum, are gaining more ground and are becoming popular.

As regards future planning, a good deal of investigation has been carried out in all areas using more advanced equipment and techniques. Mechanized fertilizer spreading, land levelling, cultivation methods, weed control, crop harvesting and processing, planting and cotton picking have all received attention. The operations have been feasible and the economies, increase in yield etc., are part of the data collected and ready for application. In many cases new mechanized methods have been adopted.

There is a need for planned extension and education services and for ways and means of financing the purchases. These are the current limitations to the wider application of farm power.

Manufacturing facilities only exist in the Government workshops and the workshops of big firms These are well equipped and the working force well trained Highly qualified engineers are available and skilled artizans plentiful The flow of trained and educated labour is absorbed here. Here spare parts and small machinery manufacture and items could be initiated, or else the skill could be transferred to form a nucleus for new manufacturing firms or ancillary and supporting enterprises. Otherwise, very few facilities are found elsewhere.

Before embarking on the future need for manufacturing development and demand, we have to review some of the problems facing us in mechanization:

The high cost of machinery and spares,

The high cost of servicing machinery;

The absence of the right type of machinery for special problems·

Scarcity of expertise at all levels,

Comparative absence of extension services;

The relative inexperience of co-operatives and other enterprises when undertaking machinery ownership and operations.

These are only a few of the many problems that will affect the requirements of the design features of agricultural machinery.

Thus, more powerful versatile wheel tractors with robust tool bars and ridging bodies will be needed Crawler tractors will be needed in special areas of large schemes The wide level disc is widely accepted in rainlands, but if heavy crop residue is encountered, disc harrows should be operated. The application of fertilizer by machine as a single or combined operation will increase in irrigated areas where cash return crops are grown. These machines should be simple, unblockable and easy to calibrate. Planting by machine will replace the traditional hand method, though some difficulties will be encountered when sowing cotton during the wet season. Other crops, e.g. wheat, lubia, dura, ground-nuts, can feasibly be planted by machines to give accurate seed rate, correct spacing and controlled depth. In rainlands, seed box attachments of the wide level disc will continue to be used, but there will be a need for planters where other crops are usually grown extensively.

Combine harvesters will be extensively used and the use of levellers will be investigated and considered. Herbicides will be introduced a great deal and other measures for pest and disease control will be implemented on a large scale. Small machines, p.t.o. or engine driven, will be required to cater for those special local problems, e.g. sweeping of cotton, cross ridging, pulling cotton stalks etc.

Cotton picking for short staple varieties will continue to receive attention, but pickers for the long, slow maturing varieties have failed and new designs will have to be initiated. Efficient combining of dura will be linked with production of dwarf varieties in rainlands and harvesters will continue to be used extensively, as opposed to the irrigated area, where the tenants would like to see dura stalks unspoiled by machines. The harvesting of ground-nuts from heavy clays previously gave rise to difficulties, but acceptable and economical solutions are in sight and the future lies with full mechanization. Cutting and binding sesance (oil seed) should be continued by producing non-shattering varieties.

Forage harvesting is as yet little explored, but will become of considerable importance, especially during the drought period.

Processing and storage have proved successful in many instances, but should be expanded further and other crops included.

The order in which agricultural machinery manufacturing industries should develop are:

Tool bar manufacturing with ridging bodies;

Fertilizer spreaders;

Simple planters;

Small machines to meet the needs of coping with those special problems for which no machine is available on the market;

Spare parts manufacture

Tractors, small and medium size.

UNIDO will be needed to assist in:

1. Training

The training for specialized personnel, especially agricultural engineers and extensionists, should be sponsored and initiated on a proper footing, as the agricultural engineer will be asked to work as a designer, consultant, research/development engineer, extensionist, as a manager or engineer of a large distributor of agricultural machinery, as an educationalist or instructor and so forth.

We would like to see the training of supervisors/instructors and even mechanics, in the developing countries (which has never been done before). Training centres for drivers should be assisted. The e are training schools to supply workshops and we would like to see these well equipped and expanded.

One important aspect in tackling the education of the farmer, if these efforts are to be successful, is a planned and effective method.

2. Testing

This is at present non-existent and it will be of tremendous help if testing stations could be aided in the process of construction. We also call for international testing institutions so that the peasant can select his machinery not by paint, shape or reputation. Testing reports given now are too technical for him.

3. Industries for specialized machinery

We would like assistance to establish industries concerned with small specialized machinery to solve specific problems.

4. Advice from experts

Assistance will be required to solve some of the problems we are facing and tackling now, e.g. sweeping cotton fields, by sending experts. For instance, we have already received technical assistance from the United

Kingdom in designing a cotton stalks puller. Experts could assist by advising on unaccomplished projects.

5. Research stations

Aid to establish proper agricultural engineering research stations on a modern basis. These are initiated now, but need more expansion and improvement with regard to equipment and personnel.

10. STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN THE SYRIAN ARAB REPUBLIC

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Agriculture accounts for 43 per cent of the national income in the Syrian Arab Republic.

The application of agricultural machinery is expected to increase the national income and, at the same time, create a new technical industry which will contribute in the development of agricultural industrialization and reduce the imports of agricultural implements.

In addition, the existence of dams in the different regions of Syria, above all, the Euphrates dam, and the application of new technical irrigation systems, along with the best chemical fertilizers, oblige us technically to use the most modern agricultural implements.

Local workshops started producing simple equipment for large consumption, such as water pumps, harvesters, cultivators, and some plough discs and trailers, using simple machinery with the number of labour between 15-20. However we find that the production of these workshops was not enough to meet the demand for agricultural machinery.

The Syrian Government has established a factory to secure the different kinds of agricultural implements necessary for farmers to increase the productivity of their land. It has established a factory for assembling and manufacturing tractors and agricultural implements.

The agricultural implements in the S.A.R.

From the statistical abstract for 1967, issued by the Central Bureau of Statistics, we have taken a table comprising agricultural machines and implements sold in the Syrian Arab Republic between the years 1962 - 1967

	1962	1963	1964	1965	1966	1967	1969
Tractors	1,592	1,786	1,538	1,630	105	45	1,000
Harvesters	1	57	3	1	-	4	
Combined harvester threshers	149	337	99	27	-	8	
Threshers	41	16	44	42	13	33	
Mouldboard ploughs	414	123	108	66	52	575	
Disc harrows	731	966	682	272	51	227	
Harrows	265	251	151	49	60	21	
Seed drills	65	57	49	16	7	5	
Fertilizer distributors	2	4	1	7	-	-	
Irrigation pumps	822	570	700	668	434	481	
Sprayers, dusters	35	11	658	421	706	279	
Motors	2,538	1,943	2,022	1,534	1,124	533	

It is to be observed from the quantity sold in 1967 that this is due to the decrease of foreign imports and, at the same time, the creation of a local industry.

A number of local workshops began producing some of these implements in small quantities, insufficient for the local demand; this is due to the following reasons:

1. Decrease in the means of production;
2. Decrease of workers in the workshops;
3. Merging of other industries with machine industry;
4. Lack of technical experience;
5. Lack of raw material;
6. Small numbers of production workshops;
7. Occupation of most workshops with maintenance.

The workshops manufacturing pumps do not exceed five and produce 500 pumps a year, and the number of workshops manufacturing agricultural equipment varies from six to ten.

Programme of agricultural machinery production in the future

The M.G.M. factories in Aleppo have taken charge of the production of these implements due to its great future capacity and due to the great capacity of its technical foundry.

The programme comprises the following implements:

1. Tractors

The Syrian Arab Republic has recently signed a contract with FFSA of France for the production, under licence, of the 670 tractor of 65 h.p., equipped with Fiat engine.

The assembling of tractors will begin in the year 1970, using parts of French origin, in the M.G.M. Factories in Aleppo, on the Basis of 2,000 tractors per year.

In the year 1973 70 per cent of the produced parts of the tractor will be manufactured in M.G.M. Tractor Factories.

An assembly line has been designed for the assembling of the tractor and its motor on the basis of the production of one motor every 24 minutes, and the production of one tractor per hour; 7 per cent of the tractor spare parts will be added to the programme policy, with the proposed quantity of 140 tractors per year.

2. Engine

The engine which is mounted on the tractors is Fiat 65 h.p. and the proposed quantity in this production programme is 2,000 motors per year; 400 motors will be used as a reserve for spare parts.

3. Rear attachment

Quantity of production: 50 pieces per year.

4. Truck excavator

Lateral scraper; quantity of production: 100 pieces per year.

5. Disc harrows

Type B 187 - 4; quantity of production: 500 discs per year.

6. Cultivator

Quantity of production: 500 cultivators per year.

7. Ground leveller

Type B 391 consisting of three ploughs.
Quantity of production: 500 pieces per year.

8. Roller for ground levelling

Quantity of production: 500 pieces per year.

9. Trailer

Charge capacity of three tons.
Quantity of production: 500 trailers per year.

10. Fertilizer distributor

Type D 010 ST.
Quantity production: 300 pieces per year.

11. Fertilizer dispenser

Quantity of production: 300 pieces per year.

12. Seeder

Quantity of production: 300 pieces per year.

13. Centrifugal pump

Pump with dimension	2"	Qty:	200	pumps per year
"	3"	"	200	"
"	4"	"	200	"
"	5"	"	200	"
"	6"	"	200	"
"	8"	"	100	"

14. Multiple vertical pump

Dimensions between 2" - 5".
Quantity of production: 300 pumps per year.

15. Valves

The importance of valves in the industrial and agricultural sectors has been considered in relation to our production programme and we have chosen the Standard TGL Valves

with dimension	$\frac{1}{2}$"	Qty:	20,000	valves per year
"	$\frac{3}{4}$"	"	10,000	"
"	1"	"	20,000	"
"	$1\frac{1}{2}$"	"	10,000	"
"	2"	"	10,000	"
"	$2\frac{1}{2}$"	"	5,000	"
"	3"	"	5,000	"
"	4"	"	3,000	"
"	5"	"	1,000	"

All the suggested types of machinery mentioned above have been consiuered by our farmers as practical, uncomplicated implements and are, at the same time, capable of equipping the Someca Tractor Type 670, 65 h.p.

Conclusion

The agricultural implements industry in the S.A.R. will undoubtedly make a step forward by establishing the M.G.M. Factory, along with the great Euphrates Dam. This step will impose on us new designs in our industry and, in due course, will enable the farming system to march in the right direction.

General agricultural data in the S.A.R.

The Ministry of Agriculture and Agrarian Reform in the S.A.R. has issued an annual statistical bulletin comprising different agricultural subjects, among which is the geographical land distribution. The following table shows this distribution in different provinces.

Province	Area of cultivated land in hectares	Area of arid land in hectares	Area of pasture	Area of forest
Damascus	543,611	312,077	32,832	26,535
Homs	692,799	1,165,769	2,240,161	122,052
Hama	676,948	42,900	80,613	14,035
Aleppo	1,417,877	14[illegible],416	30,730	23,165
Edleb	509,991	125,791	5,151	14,455
Lattakia	244,354	118,446	9,200	65,000
Derel-Zor	800,359	1,206,856	1,297,170	1,615
Rakka	1,149,912	450,290	599,750	48
Hassaka	1,986,730	47,705	170,080	45,000
Darha	316,006	54,711	8,675	158
Suweida	293,875	233,515	15,780	11,920

Considering 2,535,684 hectares as non-cultivated land and from the same bulletin mentioned above, we obtained the following table comprising the areas and some of the most important agricultural products for the year 1967.

Province	Com		Barley		Lentils		Chick peas		Beans		Cotton	
	Area production		Area production		Area production		Area production		Area production		Area production	
	hectare	ton	hectare	ton	hectare	ton	hectare	ton	hectare	ton	hectare	ton
Damascus	32,214	41,836	[illegible],077	10,316	553	546	807	839	1,284	1,823	4,107	7,085
Homs	104,091	65,670	79,5[illegible]7	64,686	7,475	7,812	4,800	3,840	1,500	1,500	6,402	13,023
Hama	104,630	83,[illegible]80	58,483	67,[illegible]67	8,505	7,761	1,314	828	1,[illegible]7	3,11[illegible]	34,[illegible]26	42,335
Aleppo	178,384	104,873	133,292	[illegible],774	14,096	12,215	860	643	1,764	3,961	46,7[illegible]3	63,382
Edleb	73,160	41,231	60,780	64,001	[illegible],70[illegible]	10,990	6,520	6,820	1,244	1,637	20,5[illegible]	11,589
Lattakia	46,625	[illegible],833	[illegible]	8,683	1,432	1,146	3,539	3,215	2,021	706	5,061	2,098
Derel-Zor	31,678	36,136	12,107	11,787	911	750	-	-	-	-	34,340	46,967
Rakka	115,590	96,237	74,743	86,002	17	28	-	-	60	56	67,100	86,761
Hassaka	361,140	306,086	177,364	147,714	5,000	6,945	120	169	67	74	[illegible]	55,760
Darha	103,559	124,845	17,826	29,082	25,410	33,033	28,990	43	1,745	1,112	86	666
Suweida	4[illegible],690	38,189	13,800	9,591	1,895	2,518	4,680	37	-	-	-	-

To conclude this section, it is necessary to have some idea about the number and distribution of active peasants in different regions.

Region	Number of peasants	Region	Number of peasants
Damascus	86,830	Lattakia	154,272
Homs	77,789	Derel-Zor	77,875
Hama	91,295	Rakka	101,709
Aleppo	247,762	Hassaka	69,248
Edleb	107,132	Darha	25,380
Suweida	22,550	Kouneitra	22,722

11. STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN THAILAND

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GENERAL PATTERN OF AGRICULTURE

Geographical land distribution pattern

Thailand has a land area of 321,250,000 rai (128,500,000 acres) which is roughly classified into farm holdings land, swamp land, forest and other unclassified land which includes urban, river, canal, highways, railroad etc. Farm holdings area in 1965 amounted to 78,715,500 rai (31,486,200 acres) or 23.53 per cent of the total land area, an increase of about 34 per cent since 1950. Approximately 82.73 per cent or four fifths of the total farm holdings land was under cultivation; woodland occupied 8.03 per cent, other uses about 9.24 per cent. Forest area made up 56.23 per cent of the total country land area or 170,960,994 rai (68,384,398 acres). Swamps and unclassified land occupied 0.53 per cent and 19.71 per cent respectively.

The whole country is divided into four geographical regions.

(1) The northern region

The total area of the northern region is about 55,927,500 rai (22,371,000 acres) or 17.41 per cent of the whole country. Much of the region is mountainous evergreen forest and grazing land, and one of the most prosperous national resources to the economy of the country. The region is endowed with teaks and other valuable timber, and produces numerous forest products. Farm holdings land occupies only 8.17 per cent of the whole region, of which 79.12 per cent are under good irrigation, with good soil and climate where crops can be grown all the year round.

(2) The north-eastern region

This is the second largest region, with an area of 106,391,250 rai (42,556,600 acres) or 33.12 per cent of the whole country. Much of the land is unsuitable for cultivation. The lack of water and poor soil fertility are the main problems in this region. However, the Government has been trying to accelerate National Development Projects in order to solve these problems The farm holdings area takes up 24.97 per cent of the whole region, the rest is forest and grazing land, swamp and unclassified land – 38.60, 0.37 and 36.06 per cent respectively.

(3) The central plain

This is the largest region with an area of 115,063,125 rai (46,025,250 acres) or 35.82 per cent of the whole, and is called "The Rice-Bowl of Thailand". Of this region, 29.26 per cent is farm holdings land, 54.24 per cent is forest and grazing land, 0.31 per cent swamp and 16.19 unclassified land.

(4) The southern region

This is the smallest area of all with 43,868,125 rai (17,547,250 acres) or 13.65 per cent of the whole country. The sandy soil and frequency of rain make the land ideal for rubber, coconut and fruit plantations. Farm land takes up 13,916,853 rai (5,566,741.2 acres) of 31.73 per cent of the whole region. Forest and grazing land, swamp land and unclassified land are 52.96, 1.42 and 13.89 per cent respectively.

Seventy per cent of all holdings are less than 12 acres. The population is 33 million, of whom 75 per cent reside in rural areas.

PATTERN OF FARM MECHANIZATION

Farm machinery population

Table 1

Number of holdings using power and agricultural equipment by size (excluding holdings under 2 rai)

Item	All sizes	Size of holdings (rai) 2-5.9	6-9.9	10-29.9	30-44.9	45-59.9	60-139.9	140 and over
Use of power (%)								
All holdings	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Human power only	14.5	33.9	13.3	9.8	8.9	10.0	10.5	20.5
Animal power	70.6	58.6	76.4	74.8	70.8	65.7	58.6	37.0
Mechanical power	3.3	3.2	3.1	3.3	2.9	3.2	3.9	14.6
Animal and mech. power	11.6	4.3	7.3	12.1	17.8	21.1	27.0	27.2
Use of agricultural equipment (%)								
All holdings	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Electric and gasoline motor	7.3	3.7	4.7	7.3	10.5	12.6	16.0	20.3
Tractors	5.7	2.3	3.8	6.1	8.3	10.2	14.9	29.9
Sprayers	4.0	2.6	3.9	4.3	5.9	7.0	8.8	11.3
Threshers	1.9	0.5	1.1	2.5	2.7	3.3	3.4	5.9
Windmill and water wheels	0.6	0.2	0.3	0.5	0.9	1.2	1.5	1.3
No specified equipment	79.9	90.7	86.7	79.3	71.7	65.7	55.4	31.3

Table 2

Tractors imported for distribution in Thailand 1957 - 1966

Year	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	Total
Number imported	234	360	418	855	1,487	1,353	1,922	3,446	3,210	3,700	16,734

Table 3

Tractor implements imported 1965-67

Type of implement	Year and number imported		
	1965	1966	1967
3-4 disc plough (for upland crop)	267	1,085	956
5-9 disc plough (for paddy field)	49	168	140
Rotavator (50-70 inches)	64	125	128
Disc harrow (14-18 discs)	18	138	52
Spring harrow	-	33	69
Lister plough (ridger)	-	14	15
Earth moving equipment (front and rear mounted)	59	101	120
Ditch drilling equipment	5	17	11
Grass cutter	5	67	68
Grain drilling equipment	8	15	18

Mechanization pattern

Twenty-three years ago, farm machines were introduced into Thailand for Experimental Farm Stations. These machines were tractors and harvesters which did not excite much public interest at that time. However, after World War II, farm mechanization became better known to farmers and more tractors were bought for private use as well as for hire, but to date only a limited number of farmers can afford them. In the public sector more threshers and combines were bought for experimental purposes on research stations.

From experience gained both in the private and public sectors, we may conclude that the use of farm machinery and equipment is still limited for the following reasons:

1. Unsuitability to economic conditions of Thai farmers;
2. Land owned by Thai farmers is generally of small holdings, average 25 rai;

3. Unsuitability for use under local conditions;
4. Insufficient knowledge and experience of farmers with regard to application, repair and maintenance;
5. Farm machinery distributors do not provide their customers with adequate after-sales services and aim at too high a profit;
6. Lack of vigorous encouragement from the Government.

Notwithstanding these problems, farmers and the Government are now showing a greater interest in farm mechanization. From 1953 onwards, the Government for the first time established a Rice Department in which an Engineering Division was set up. In the private sector, tractors are increasingly bought for the farmer's own private use, as well as for renting out, as may be seen in Table 2. Besides tractors, other farm machinery is also popular, e.g. water pumps, mechanical grain separators, corn threshers and low horse-power land engines which farmers commonly use as general sources of power.

Production of farm machinery and implements; popularity in design and present demand

Besides the agricultural machinery and implements imported, there are several types of farm machinery and implements which have been locally developed and produced for distribution by small machine shops and factories. These are modified from the imported and home-designed machines to suit the conditions and environment in Thailand. The following are the farm machinery and implements presently produced and popularly used:

- 7-8 disc ploughs, for paddy field soil preparation. The production of this type of implement is 100 per cent manufactured by local factories.
- 3-4 disc ploughs, for upland crop soil preparation. This type of implement is locally produced taking up 50 per cent of the total demand, the rest is imported.
- Earth moving blades, for land levelling. These are locally produced, meeting approximately 80 per cent of the present annual demand. The rest are imported.
- Centrifugal pumps, for irrigation purposes. These are manufactured locally, meeting approximately 90 per cent of the total demand, only 10 per cent is imported.

Locally designed and manufactured machinery and implements are as follows:

- Different sizes of low-lift propeller and centrifugal pumps, driven by low horse-power engine, used for paddy field irrigation. The present annual production is approximately 10,000 units.
- Different sizes of puddling machines, driven by 10-15 h.p. engine, used for paddy seed bed preparation under wet field conditions. The present annual production is about 2,000 units.
- Hand tractors, driven by 4.5 - 6 h.p. engines, used for wet paddy field soil preparation, approximately 3,000 units are produced annually.
- Soil opener - 3 to 4 rows, attached to farm tractors for row marking before grain drilling by hand. About 200 units are produced annually.
- Corn and sorghum sheller - attached to farm tractor, driven by p.t.o. The present annual production is about 500 units.
- Grass cutters - 2 wheels, driven by 4.5 - 6 h.p. used for rubber plantation and orchard weeding. The present annual production is about 2,000 units.
- Hand-pump insecticide sprayer - locally manufactured, used for spraying cotton and corn crops. The annual production is approximately 5,000 units.

Future demand and trend in design

1. 1. Tractors. Compared to 1966 the annual demand is expected to increase 196 per cent in 1975 and 280 per cent in 1980.

2. Power tillers including hand tractors and puddling machines. It is estimated that this type of machinery will be produced 100 per cent locally before 1975. The annual demand is expected to increase 20 per cent.

3. Water pumps - both centrifugal and low-lift propeller. Production is expected to meet the demand in the next few years and is expected to increase to approximately 80,000 units annually.

4. Tractor implements. The annual demand will be increased according to the increased demand for tractors. It is expected that all types of tillage and earth-moving implements will be adequately produced for domestic use before 1980.

5. Cereal grain threshers - corn, sorghum, paddy etc. The annual demand is expected to increase gradually to about 1,000 units. These machines will be produced to meet the demand by the local factories.

6. Centrifugal paddy huskers and compact centrifugal white rice mills. These new huskers have been recently designed, production has just started and it is expected to reach 2,000 units annually.

Table 4

Tractor assembling plants in Thailand

Make	Model	h.p.	Production Year	Production No.	Full production capacity	Future production plan
Ford	5000 deluxe	72		1,200	Can be increased as much as the market demand	
	2000 Dexta	38	1967	24	Can be increased as much as the market demand	
Massey-Ferguson	135	45.5	1967	569	Can be increased to 4000 units per year	To produce at least 800 units for the present and near future demand
	165	60				
	175	67				
Steyr		56	1969	100	Can be increased to 4000 units annually	

MANUFACTURING INDUSTRIES AND ANCILLARY FACILITIES

Farm machinery manufacturing industries

Thailand has now 672 small machine and repair shops, of which approximately 50 per cent are located in Bangkok and Thonbury, the capital and twin city. Some ten years ago these shops changed over to spare parts production for farm machinery and implements. In the early stages the spare parts were produced by imitation and modification of the imported machinery and equipment, especially the tillage implement attached to the tractor.

Table 5

Number of small machine and repair shops and larger plants for producing and assembling farm machinery and implements registered in Thailand from 1957-1965

Year	1957	1958	1959	1960	1961	1962	1963	1964	1965
Number	352	378	396	441	480	533	584	633	672

Table 6

Number of support factories, registered increasingly in Thailand, 1957-1965

Type of industry	Year and number increased to								
	1957	1958	1959	1960	1961	1962	1963	1964	1965
Foundry or metal turning shop	765	917	1,058	1,123	1,230	1,275	1,358	1,463	1,574
Blacksmith's shop	2	2	2	2	2	2	2	2	2
Factory using electricity or gas for welding, galvanizing and plating	224	301	368	412	481	523	580	619	685
Metal smelting plant	1	1	1	1	2	2	2	2	3
Rubber products factory	68	83	105	117	151	166	191	204	221
Paint and linseed oil factory	4	7	10	11	13	17	18	22	24
Plastic products factory	23	73	116	134	148	164	191	218	275
Metal conversion mill	2	3	3	6	6	7	13	8	8
Galvanized metal factory	223	276	324	344	377	401	427	435	451
Mechanized metal conversion factory	84	174	233	245	308	354	423	505	633
Aluminium, lead, zinc, tin or other metals plating factory	2	2	2	2	3	3	4	6	6
Paint spraying factory	37	70	88	93	110	117	120	122	127
Nail, screw, bolt and nut factory	10	10	11	11	15	16	19	21	23

These workshops have carried on their business quite progressively and their products are acceptable to the farmers, as the initial cost of locally produced machinery and implements is usually 30 - 50 per cent cheaper than those imported, and the modification and reinforcement to the original design has been done to meet the needs of the particular local condition and the demand for a special type of work by the individual farmer. In recent years a few small workshops have turned their business exclusively over to farm machinery and implement manufacturing. In addition, the Government has established two modern plants for the production of these farm labour-saving devices. These two new agricultural machinery manufacturing plants will play an important part in the future development programme of farm mechanization in Thailand.

GOVERNMENT POLICY

The Government of Thailand's policy towards the agricultural industry is to promote the organization of this industry in order to cope with the increasing demand for farm machinery and implements from the various farmer groups, associations and co-operatives, numbering over 6,000 groups comprising of more than six million farmers, and excluding another 24 million individual farmers, who are also becoming drawn into this mechanization era.

The Government is also expanding facilities for research, design, development and testing institutions. The present Engineering Division of the Rice Department, Ministry of Agriculture, is now diverting its attention to the research and design of up-land crop farm machinery and implements. The work on the development of the rice farming machinery and implements has been quite successful. A large majority of rice farmers are now using equipment designed by this organization.

Since a greater variety of farm tractors and implements are being imported into Thailand and many new designs of locally produced farm equipment are being developed and manufactured, there is a great need for establishing a modern testing institution with facilities and instruments to carry out such testing work as may be required. This testing institute would greatly aid farmers in the proper selection and types of farm machinery to be used on various types of farming such as up-land crop, low land crop, wet soil and deep mud field conditions usually found in rice farming. As the situation now stands, only the Engineering Division of the Rice Department, Ministry of Agriculture, is doing some testing on farm machinery and implements when requested. However, the facilities for such work are still very small and greater support is needed in setting up a fully equipped testing institute to assist the fast growing agricultural industries in the testing of their products before these reach the farmers.

Training of farmers in the proper use and maintenance of farm machinery is also urgently required. The Rice Department, Ministry of Agriculture, has one such training centre, but its facilities are limited and only small numbers can be accepted. In the last five years only 3,000 young farmers have been trained. With the fast development in the use of mechanized equipment more such training centres should be set up in Thailand.

Equally important, the educational system of universities should be widened in their facilities so that a greater number can be trained in agricultural engineering than at present. Thailand has only a limited number of trained engineers in this field.

12. STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN TURKEY

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GENERAL ASPECTS OF AGRICULTURE

The agricultural sector has the largest share in the national income; the active population and export earnings of the Turkish economy; 30 per cent of the national income is agricultural income. The size of the active population in this sector is 10 million and the ratio of agricultural workers to total active population is 72 per cent. Agricultural products constitute 75 per cent of Turkey's exports.

Modernization in agriculture

Turkish agriculture is being modernized in order to transfer some of the 72 per cent of active population to other sectors of the economy. The number of tractors in Turkey reached 85,000 by the end of 1968, from only 1,100 in 1945. Within the same period, the area cultivated by tractors increased from 87,000 hectares to 6,400,000 hectares.

Chemical fertilizers used per hectare have gone up to 10 kg from 0.14 kg and the area of irrigated land amounts to 2 million hectares by the end of 1968. If this rate of growth continues the ratio of agricultural population to total active population will fall to 65 per cent by 1972.

Distribution of land

The utilization of land in Turkey has gained a stable nature with respect to area. According to 1967 figures, 30 per cent of the total area is being cultivated, 40 per cent is meadows and pastures, 13 per cent is forests, and unproductive soil constitutes the remaining 17 per cent. Fourteen million hectares are sown, 7 million hectares are fallowed and 2.5 million hectares are fruit and vegetable gardens making a total of 23.5 million hectares. Neary 70 per cent of the holdings are under 5 hectares.

Crops	Area (1,00 hectares)
Wheat	6,900
Barley	2,560
Seed crops	725
Cotton	700
Maize	600
Sunflower	270
Tobacco	216
Sugar-beet	180
Potatoes	160
Rice	57
Grapes	800
Olives	654
Vegetables	300
Citrus	37

Mechanization in agriculture

In every region of Turkey that is available for agriculture, there is a trend towards mechanization within the limits of the farmers' payment possibilities. The following table showing the increasing number of tractors used and area cultivated by tractors also confirms this improvement:

	1963	1966	1968
Number of tractors	50,800	65,000	85,000
Area cultivated by tractors (1,000 hectares)	3,800	4,800	6,400
Area cultivated by draught animals	19,700	18,700	17,100

In spite of this improvement, Turkey's agriculture still depends on animal power. The number of draught animals was 2.75 million in 1968. The area cultivated by these draught animals is 17 million hectares. The following table shows the 1968 figures of main Turkish agricultural equipment and machinery:

Wooden ploughs	2,084,000
Wheel-less ploughs	455,000
Wheeled ploughs	1,000,000

Tractor driven drills	12,500
Animal driven drills	35,000
Cotton drills	22,000
Beetroot drills	7,000
Mowers	28,000
Threshing sled	2,330,000
Binders	3,000
Combines	8,000
Sprayers	135,000

Manufacturing of agricultural equipment and machinery

Tractor manufacturing occupies the largest division in this sector. Since the inclusion of tractors in the assembly production in 1960, imports of tractors have been prohibited excluding 56-65 h.p. tractors, two-wheeled tractors and crawler tractors which cannot be locally manufactured. Imported tractors meet only 5 per cent of yearly demand. Savings on foreign exchange from assembling industries have now reached a level of 50 per cent. In 1968, six different firms actually achieved the assembly and production of agricultural tractors. A total production of 15,500 was realized in 1968. The following table shows production of each make:

Make	Units
Massey-Ferguson	6,700
Ford	3,700
Fiat	3,200
Nuffield	1,100
McCormick	450
Hanomag	350
	15,500

Total production is being divided into small segments, because of the great number of firms in this sector. Therefore, until now, firms have tried to avoid large investments. But in 1969, Massey-Ferguson's project for a yearly production of 20,000 units and Fiat's project for a yearly production of 10,000 units have been approved. Thus, by 1972, these two firms will be able to increase their production and realize at least 64 per cent local content.

Another factor which will increase the local content in the near future is the approval of the Perkins diesel project by the Turkish Government.

Progress is also observed in the production of other agricultural equipment and machinery besides tractors. Unfortunately, the capacity of production is not yet sufficient to meet domestic demand of the main items. Since the demand for agricultural equipment and machinery is a seasonal demand, it is met by a continuous domestic production and stocking in periods of low demand. However, this situation prevents the manufacturers and distributors from making large production and sale programmes.

The following table summarizes the realized production of agricultural equipment and machinery in 1968:

	Units
Tractor	15,500
Tractor plough	7,200
Tractor drill	3,200
Tractor trailer	4,200
Combines	110
Animal-drawn drill	13,500

Increasing demands

Turkey's demand for agricultural equipment and machinery in 1975 is predicted to be as follows:

Tractor	40,000
Tractor plough	30,000
Tractor drill	10,000
Tractor trailer	25,000
Combines	1,000

Encouragement of the agricultural machinery industry

The private sector's investments in this field are encouraged by lowering of taxes, in order to attain the above targets of production.

These are:

Tax exemptions for investments up to 80 per cent;

Custom duty exemptions for investment goods up to 100 per cent;

Duty payments by instalments;

Less expensive credits for industrialists.

Farmers' credits

In Turkey, the farmers get credit for tractors and agricultural equipment from the Agricultural Bank. The amount and payment conditions of the loan depend on the kind of machine to be bought, the kind of crop to be produced and the geographic region of the farm. A duration of four years is possible for tractor credits. These loans cost the farmers about 12 per cent each year. However, the interest expenses of loans from the private sector exceed 18 per cent. In 1968, 6 billion[1] Turkish liras, making 25 per cent of total credits, were allocated for agricultural credits.

Conclusion

In order that capital goods and raw materials required by the economic development of Turkey and the consumption goods for the needs of the public may be imported in sufficient quantities, it would be necessary to increase agricultural production and exports.

It is necessary to change the production technique and develop the technology applied in agriculture for the above principle to be realized. Thus, increasing the productivity of agricultural production will both help provide a higher standard of living for agricultural workers and augment the contribution of agriculture to Turkish economy.

However, the primitive condition of agricultural implements in Turkey, as well as the inadequacy of the machinery and equipment required by modern technology, increase the difficulties of carrying out agricultural work properly and on time.

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[1] billion = one thousand million.

On the other hand, due to climate and soil conditions, one third of the arable land is left fallow. Production on a fallow basis does not allow efficient utilization of the land, manpower and capital.

Finally, the fact that agricultural operations in Turkey are divided into too small units causes a decrease in the quantity of the products marketed by the farmers, so that these farmers work as producers with low productivity and negligible income, burdened with high debts and producing only to satisfy their own needs.

Factors such as military service and education, development of communications and transportation facilities and population movements due to industrialization have brought Turkish farmers into contact with the external world. Turkish farmers now desire an easier life, to eat better, to purchase radios and refrigerators, to use electricity, in short, a higher standard of living. It is this desire that has created the environment in which technological development in Turkish agriculture can be realized.

The problem is to give impetus to the planned equipping and education of Turkish farmers, which involves the following:

1. To manufacture locally, or import whenever necessary, all implements to increase and improve agricultural production;
2. To provide the necessary capital and credit to farmers for purchasing the implements in question;
3. To develop a marketing system that will make a fair remuneration to the labour of the producers;
4. To support the growth of the agricultural industry that will most effectively evaluate agricultural production;
5. To revise and reorganize the property ownership regime so that small land units can be united.

13. STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN THE UNITED ARAB REPUBLIC

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Since 1952, the United Arab Republic has been manufacturing tractors, implements and equipment locally, depending upon the local production of materials.

From 1962, a tractor factory at Helwan has been manufacturing wheel type 50 h.p. tractors, with a capacity of 1,500 tractors per year. Most of these tractors are designed for field operation and co-operative societies in rural areas, and also for such operations as road-making.

Farmers are satisfied with the production, which is now on a large scale. Plans are also made for manufacturing wheel type tractors with 35 h.p. engines for performing light field work.

Large quantities of agricultural machinery and equipment are produced in engineering factories to avoid importation of many types, such as:

- Chisel ploughs
- Cultivators
- Subsoilers
- Ditchers
- Small scrapers
- Land levellers
- Farm trailers
- Knapsack sprayers
- Pumps
- Corn shellers
- Winnowing machines
- Seed cleaners
- Threshers

During the next five year plan for agricultural equipment, a crawler type 60 - 75 h.p. tractor will be manufactured in a special factory, with the co-operation of one of the industrialized countries which is advanced in this field. These tractors will replace the foreign types used now for land reclamation and other heavy duty work.

There are also many ancillary and supporting factories, such as foundry and forging factories, rubber factories etc.

All tillage operations will soon be completely mechanized. The percentage of mechanized farm operations is expected to increase, to cover planting grain, corn picking, spraying machines, harvesting operations and fertilizing, especially in the new reclaimed area cultivated as a result of the large water supply from the High Dam (about 2,000,000 acres).

An estimate of farm machinery in the country in 1967 is given below:

Tractors

Wheel tractors	19,026
Crawler tractors	2,948
	21,974

Pumps

Stationary (15 - 40 h.p.)	17,130
Small units (less than 5 - 15 h.p.)	21,573
Driven by tractor	1,093
	39,796

Threshers

Stationary	4,861
Combine harvesters	400
	5,261

Sprayers

Complete unit (self-propelled)	12,168
Knapsack	201,365
Knapsacks with small motor	700
	214,133

Chisel ploughs (mounted and trailed)	22,000
Subsoilers	2,000
Small scrapers	500
Ditchers	500
Ridgers	2,000
Trailers	6,000

Corn shellers		350
Winnowing machines		4,000
Seed cleaners:	Portable	100
	Receiving stations	10

Future demand 1970 - 1975

Tractors:	Wheel type 50 h.p.	3,000
	Crawler type 60 - 75 h.p.	600
Chisel ploughs:	9 tines hydraulic type	2,400
	11 tines trailed type	600
Trailers (3 - 5 tons)		1,000
Subsoilers		500
Disc harrows		1,500
Ridgers		1,500
Mouldboard ploughs		350
Manure spreaders		300
Land levellers		250
Mowers		250
Threshers		500
Planters		500
Seed drills		500
Combine harvesters		60
Seed cleaners		50
Pumps		1,000
Motor sprayers		50
Sprayers (knapsack)		

An increase in the industrial programme is needed for the manufacture and development of agricultural machinery to satisfy all needs. This requires trained personnel, who can be obtained by establishing maintenance, repair and training centres.

The Testing and Research Station for tractors and agricultural machinery, which was established in 1962, plays an important part in improving the manufacture and raising the performance of tractors and agricultural machinery in the country.

The priority of recommended areas of technical assistance should, in my opinion, be as follows:

(1) Product design;

(2) Rationalization, modernization of plant;

(3) Production planning and control;

(4) Quality improvement, testing and cost reduction;

(5) In-plant standardization.

14. STATUS OF AGRICULTURAL MACHINERY INDUSTRY IN VENEZUELA

by Mr. Rafael Daniel Cortes
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Venezuela has an area of approximately 912,000 km^2 and a population of 8 million.

Land tenure

According to the last agricultural census, privately owned land is distributed as follows:

Owner-operated	21,765,022 ha
Rented	319,885 ha
Share cropping (Aparcería)	124,238 ha
Share cropping (Medianería)	29,211 ha
Squatter-occupied	1,346,501 ha

Public land was distributed as follows:

Held on temporary title	300,312 ha
Rented	261,864 ha
Squatter-occupied	2,067,793 ha

This land distribution has now changed owing to the impact of progress in agrarian reform.

From the commencement of this reform in 1961 up to 1968, 3,134,162 ha had been distributed - 1,154,640 ha of private land and 1,970,523 ha of public land - 131,046 families having benefited.

Agricultural production

During 1968, agricultural production reached Bs 3,306,917,590, the arable sector accounting for Bs 1,864,724,712 and animal husbandry for Bs 1,287,427,062; the remainder was distributed between forestry and fisheries.

The area under cultivation in the country in 1968 was 1,808,870 ha, distributed as follows:

Cereals	784,016 ha
Leguminous plants	131,835 ha
Roots and tubers	90,648 ha
Textile fibres and oil-seeds	229,962 ha
Fruit	126,494 ha
Vegetables	12,508 ha
Coffee, cocoa, sugar-cane and tobacco	433,407 ha

There are three harvest periods in these regions: summer, winter and "Norte" (lit. north), the greatest output coming in winter.

Among the main crops in terms of the volume of production that deserve mention are: coffee, cocoa, sesame, rice, maize and bananas and coffee, of which cocoa and rice make the greatest contribution to agricultural exports.

Government policy on the agricultural machinery industry

Loans

(1) There is import control of agricultural machinery under different types of policy: for machinery produced in the country there is a negative import to protect industry, and for agricultural machinery not produced in the country there is a positive policy, though this is subject to Government-controlled import licences.

(2) There are special loans for the purchase of agricultural machinery:

(a) Normal loans from firms representing various foreign factories in Venezuela - medium-term loans with 20 per cent initial payment and the remainder in two years at 20 per cent interest per annum.

(b) Government-backed loans, divided into two types:
Loans to peasants (campesinos), with 10 per cent initial payment, two years to pay and 10 per cent interest per annum.
Loans for commercialized farming (empresarial), with 20 per cent initial payment, two years to pay and interest of 10 per cent per annum.

(c) Direct Government credit through the Agricultural Associations at the cost of the loan in the country of origin, through the Export-Import bank, with interest at 8 per cent and two years to pay.

(3) It is intended to introduce loans for the establishment of firms manufacturing agricultural machinery and equipment, through the Ministry of Development (Venezuelan Development Corporation).

Research, design and development

There is little research on agricultural machinery; only experimentation on conditions and adaptation to certain normal working systems are carried on in the agricultural faculties of the various Venezuelan universities.

Design and development work has only been carried out by newly-established firms with regard to smaller implements that are manufactured in the country (see annexed tables).

Apart from this, there is only the assembly of imported components which arrive in semi-knocked down condition for reasons of volume or weight.

All agricultural aircraft for sowing, dusting and spraying are imported, as is the case with agricultural transport equipment such as jeeps, vans and four-wheel drive lorries; these, however, are not imported complete but are assembled in the country.

Agricultural machinery

1. Prime movers

Since tractors can generate power for a very wide variety of agricultural purposes, this type of machine is becoming more and more popular day by day. So far there are no projects for the installation of tractor works in the country. There are no kinds of restrictions on imports of this type of machine, nor are there any customs duties.

Wheeled tractors with two axles: volume of imports (in units)

	1958	1964	1965	1966	1967	1968
TOTAL	915	2,039	3,038	1,678	1,479	1,764
Less than 18 h.p.	4	0	31	7	7	4
18 - 26 h.p.	27	9	-	2	6	-
27 - 36 h.p.	110	56	171	40	29	15
37 - 55 h.p.	527	1,111	1,930	822	704	227
56 h.p. and above	247	854	906	807	733	1,518

Track-laying tractors: volume of imports (in units)

	1958	1964	1965	1966	1967	1968
Less than 18 h.p.	-	2	-	-	-	-
27 - 36 h.p.	2	5	4	38	-	-
37 - 55 h.p.	52	33	39	40	33	-
56 h.p. and above	212	51	49	136	454	106
TOTAL	266	91	92	214	487	106

2. Initial cultivation machine

There are various types of ploughs: disc ploughs, mouldboard ploughs, sub-soilers, light disc ploughs and rotary ploughs. Here, only disc ploughs and mouldboard ploughs are considered.

There are projects for launching the production of disc ploughs of every type in the country. This does not apply to mouldboard ploughs. A licence is required for their importation.

Ploughs: volume of imports (in units)

	1958	1964	1965	1966	1967	1968
Less than 3 discs	37	90	90	63	39	41
3 discs	96	669	568	200	111	125
4 discs	134	166	103	94	33	80
5 and more discs	45	37	32	84	47	14
Mouldboard ploughs with one axle	75	-	4	-	-	-
Mouldboard ploughs with more than one axle	-	-	1	16	18	20
TOTAL	387	962	798	457	248	280

3. Final cultivation machines

This category includes disc and tined harrows.

There are enterprises in the country manufacturing two-gang harrows with 12 to 32 discs of 18 to 36 inches diameter supplying the national market for harrows, trailers and rotary reapers, excepting three-gang machines. Some harrows weighing 5,000 kg and over, for which demand is slight, are still being imported.

In the case of harrows, the proportion of the domestically produced parts incorporated is quite high, only discs, which represent about 20 per cent by weight, being imported.

In the case of rotary sprayers only universal joints, heads and some gears in the gearbox are imported.

Tined harrows are not produced in the country, as there is a very small market for such implements.

Harrows: volume of imports (in units)

	Disc	Tined	Total
1958	558	7	565
1964	1,678	2	1,680
1965	1,994	68	2,062
1966	1,250	-	1,250
1967	747	2	749
1968	513	2	515

4. Seed drills and planting machines

Seed drills are classified in two categories - those with fertilizer-spreading attachments and those without. There has been no production of these machines in the country so far; nevertheless, production of machines with two and four drills mounted on frameworks or on tool bars is to be developed. There are no prospects of producing machines with ten and more drills for rice and sesame or spacing drills.

Seed drills: volume of imports (in units)

	Without fertilizer-spreading attachment	With fertilizer-spreading attachment	Total
1958	120	30	150
1964	42	224	266
1965	154	293	477
1966	167	284	451
1967	11	445	456
1968	65	287	352

Importation of such machinery is subject to the advance issue of a licence from the Ministry of Development. Customs duty is not charged.

5. Equipment for the control of pests, insects and plant disease

This category includes cultivators, sprinklers and dusting machines.

The following information has been obtained regarding the possibilities for producing this machinery in the country: both disc cultivators and spring tined cultivators to be produced. The production of manual sprinklers (knapsack type) has begun in the country, but other types are not being manufactured. We do not know of any projects to begin production of dusting machines.

Cultivators: volume of imports (in units)

	Disc	Tined	Total
1958	162	157	319
1964	50	220	270
1965	98	306	404
1966	7	207	214
1967	2	175	177
1968	-	103	103

Sprinklers: volume of imports (in units)

	Integrated	Trailer type	Stationary, with motor	Total
1958	508	51	-	559
1964	10,006	70	-	10,076
1965	357	2,193	-	2,550
1966	4,780	126	-	4,906
1967	41	55	-	96
1968	10	-	-	10

Dusting machines: volume of imports (in units)

	Integrated	Trailer type	Knapsack type	Total
1958	220	2	-	222
1964	432	2	-	434
1965	23	72	-	95
1966	485	-	-	485
1967	7	-	-	7
1968	7	-	-	7

6. Harvesting equipment

There are various types of harvesters, depending on the product in question. There is known to be a project in the country for the production of mowing machines for meadows, without binders. There are no short-term prospects of the production of combine harvesters.

The advance issue of an import licence by the Ministry of Development is a requirement for this category.

Harvesters: volume of imports (in units)

	Trailer type	Self-propelled	Total
1958	66	5	71
1964	43	80	123
1965	47	133	180
1966	44	137	181
1967	24	174	198
1968	48	116	164

7. Equipment for the initial processing products

In this category we have included several types of processing machinery; none of them are produced in the country.

Miscellaneous machinery: volume of imports (in units)

	1958	1964	1965	1966	1967	1968
TOTAL	332	221	459	205	163	55
Seed cleaners and graders	-	2	-	2	-	-
Maize shellers	246	102	146	54	43	10
Grassland aerators	84	115	307	147	112	45
Hullers	-	-	-	-	-	-
Threshers	2	-	-	-	-	-
Seed driers	-	2	6	2	8	-

To sum up, there are at the moment two enterprises engaged in the manufacture of agricultural machinery and other projects are being established. These enterprises have been in production for four years, and fixed assets represent 2.2 million bolivars; employment is created for 199 workers. Some 83 per cent of raw materials of national origin are used by this industry.

In April 1966, a government regulation (No. 976) was passed, modifying the customs tariff and introducing the requirement of an advance licence from the Ministry of Development for the following tariff categories: 712.01.01; 712.01.09 and 733.09.02.1.

At the moment the policy applied with regard to the granting of import licences and the incorporation of parts is being revised.

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