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This paper is prepared with the sole objective of stimulating discussion by the Panel and therefore the highlighted possible issues and opinions are to be considered as preliminary.

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C O N T E N T S

SUMMARY

World trade in agricultural machinery and the closely allied subgroups represents one fifth of the total trade described under the broad classification 'machinery non-electric'. Trade has quadrupled in value during the period 1967-75 growing from (US) $ 4581 millions in 1967 to (US) $ 19210 millions in 1975. Imports of agricultural machinery and pumps into developing countries accounted for 26 and 34 per cent of the total world trade in these two sectors. Statistical returns since 1974 have indicated a marked increase in the share of world trade accounted for by imports of agricultural machinery and the allied subgroups into the developing countries. In addition to the trade which originated in the principal exporting countries and which is reported in international statistics, there are imports of agricultural hand tools, animal draught equipment, simple machinery and specialised power machinery not reported, as well as internal trade from manufacture of agricultural machinery to meet local needs.

The dynamism of world trade in agricultural machinery created by the demands in the developing countries is not unexpected, when viewed against the importance of agriculture in developing countries, and the good rates of growth in agriculture, which have been maintained by those countries since about 1960, under the stimulus of population increase.

Projections to 2000 require the rate of growth to be increased, a feat which has been shown to be possible through intensification of crop production by increasing the energy inputs to crops. If inputs of mechanical energy were to be raised to a modest level of intensification (0.5 hp/ha) it would mean doubling existing power inputs in Asia and Latin America and increasing them fivefold in Africa.

Every developing country needs to participate in an expanding way in meeting its own demand for agricultural machinery. The growing requirement for foreign exchange to pay for imports of agricultural machinery makes local manufacture a necessity. More important, however, for the strategic growth of industry in predominantly agricultural countries, is the coupling of industrial and agricultural development.

The agricultural machinery, which a country needs, is that which is compatible with its crop and food processing systems. Broadly speaking there are four categories of farm machinery which fit recognisable patterns of farm mechanization and require different levels of manufacturing skill:-

i) <u>simple implements and machinery</u> - hand tools and animal drawn equipment for which there is a strong demand in many developing countries either in a traditional form or, more likely, in new and improved versions. Such simple implements may be manufactured in units that are appropriate to a country's manufacturing capability, either by upgrading the artisan level or establishing small production units with simple forge and machine facilities.

ii) crop intensifying machinery - to raise yields using more fertilizers requires pumps for water control, better ploughs and harrows to give quicker cultivation, weeders, sprayers, trailers for transport and appropriate irrigation equipment. Such machinery is also of the kind that could be manufactured in small to medium production units with machining, forging and welding facilities provided well-proven designs were available and there was a supply of suitable castings, bearing and steels.

iii) powered machinery - as yields are increased through cropping intensification and especially where multiple cropping is practised, a stage is reached at which it is not possible to meet the timeliness requirements of cultivation, planting and harvesting without using powered machinery such as tractors, power-tillers, threshers and dryers as well as more complex pumping equipment. Manufacture of such equipment requires an adequate infrastructure in the metallurgical and capital goods industries such as foundry, forging, heat treatment, precision machining and quality control facilities. A very critical look needs to be taken at what constitutes an appropriate tractor for a developing country taking into account both functional requirements and manufacturing capability.

iv) specialized machinery - the advanced stages of farm mechanization use machines with a high potential for saving labour e.g. self-propelled harvesting machinery and food processing equipment. Such machines are built in countries with a skilled metallurgical industry, high capital production facilities and a good capability in R and D. Machinery for land development is, probably, also in this category.

Why do a majority of developing countries find it difficult to meet their requirements for agricultural machinery in categories (i) (ii) and (iii) in manufacturing units that are appropriate to the countries?

Some of the difficulties lie in:-

- the failure of Governments to define a clear policy for farm mechanization and to convert it into a package of industrial inputs,
- the difficult engineering task of adapting even a simple implement or machine to combine satisfactory performance with ease of manufacture, reliability and low cost,
- countries not having satisfactory institutional arrangements for financing small manufacturers, for allocating them materials and for protecting them from imports,
- lack of training facilities,
- lack of integrated mechanism for investment promotion and licensing where appropriate,
- insufficiency of the development of local supporting infrastructure such as forging, casting, heat treatment, machine shop etc.,
- insufficiency of the development of ancillary industry and interlinage with engineering/metallurgical industries,
- lack of repair and maintenance facilities,
- lack of investment capital and rural financing
- that manufacture of agricultural machinery is not for a static market but has to develop in step with agricultural production systems.

Part of the answer lies in promotion of:-

a) Co-operation among developing countries

b) Collaboration between small/medium enterprises from developed countries with industries of developing countries and

c) Judicious investment promotion from industrialized countries with due consideration to choice of appropriate technology.

POSSIBLE ISSUES FOR CONSULTATION

1. Strategic

Agricultural machinery is a prototype issue in relation to the Lima Declaration in that it occupies a complementary position between industry and agriculture; manufacturing units can be on a small or medium scale, at a level to suit every country and with a market which is growing rapidly and mainly in the developing countries.

The present pattern and balance of trade in agricultural machinery and allied sub-groups is blatantly against the interests of the developing countries and is likely to get worse. The industrialized countries should understand the need for the developing countries to expand the manufacture of agricultural machinery and join with them, to mutual advantage, in manufacture of selected items and in shifting part of the growth in world trade in agricultural machinery to the developing countries.

Could the following targets be adopted and what forms of international co-operation would be necessary to implement them? :

(a) developing countries as a group should manufacture their own requirements for all agricultural machinery in categories (i,ii)

(b) developing countries should take an increasing part in the manufacture of powered machinery in category (iii), specially adapted to their needs, and expand its share of world trade in this category.

(c) specialized equipment in category (iv) has strong labour saving implications and is likely to be of greater concern for the industrialised countries and continue to be supplied mainly by them but with some supplies coming from developing countries.

2. Institutional

Definition of a clear national policy for farm mechanization and its conversion into a package of industrial inputs is the major first step in quantifying a country's requirements for agricultural machinery, (para. 10-12).

Should Governments of developing countries be urged to formulate a policy for manufacture of agricultural machinery and to direct inputs?

3. Design for manufacture

Who should adapt and design agricultural machinery, and how, especially when it is to be manufactured in categories (i,ii), is crucial? Most machinery is not expected to cope with the full change in environment between one country and another (e.g. terrain is modified by roads to suit motor cars and lorries and by rails to suit locomotives) to the extent that agricultural machinery must adapt to local conditions of soil, climate, crops and farm practice. While national and international research institutes in agricultural engineering have been prolific in ideas and inventions, they have failed to carry development to the stage at which a working prototype to meet a local need can be handed over with confidence to a small manufacturer, a situation which stifles practical progress especially in categories (i) and (ii).

Should research institutes be directed through national and international co-operation to solve this problem?

4. Technology

The technological activities of the agricultural machinery industry contained within categories (i-iv) cover a bread spectrum of the engineering industry. It is easier to identify interests at the multinational end of the spectrum than it is in the more diffuse area of small/medium

production units of categories (i,ii) and parts of (iii), where most of the activity in developing countries is likely to be. Therefore, a special effort is required to promote co-operation at the small/medium level of manufacturing, involving enterprises from both developed and developing countries.

Some issues are

(a) transfer of technology - how, in categories (i,ii) and selected parts of category (iii) can the flow of technolgoy between developing countries, which naturally have the greatest experience in this area, be improved, both to accelerate manufacturing progress and encourage the development of appropriate technology?

Adaptation of the technology of industrialised countries for manufacture in category (iii) needs to take account of the developing countries' need for ease of manufacture and robustness against the preference of the developed countries for saving of labour and sophisticated technical performance.

(b) infra-structure - while lack of an infra-structure in capital goods and machinery manufacture is not a barrier to establishment of small/medium production units in categories (i,ii); what are the pre-requisites for entering manufacture in category (iii) taking into account the possibilities of redesign in adaptation of technology? (para. 62)

(c) manufacture of tractors - at what stage in the overall industrial development of a country is the manufacture of tractors and power-tillers a feasible undertaking and what could be the phases of such an operation? What is an appropriate tractor and tractor ranges and is the configuration of tractors evolved in developed countries right for developing countries?

(d) technical co-operation - special efforts should be made to promote collaboration between manufacturers of comparable areas of technical expertise and size. Already there are, in some developing countries, existing manufacturing plants for agricultural machinery which are not realizing their potential: could a programme of such technical co-operation help them?

5. Finance and Investment Promotion

Finance is required to provide the capital for the manufacturing units, and for the rural credit to the farmers so that they can purchase the machines. While there appears to be general agreement about the necessity for external financing of manufacturing units in category (iii), there is an opinion that the small/medium units in categories (i,ii) could be financed by local entrepreneurs.

(a) What form of co-operation involving external partners could be mutually advantageous in establishing manufacturing units in category (iii)?

(b) How could investment promotion of specific agricultural machinery projects in developing countries be made more effective?

(c) What special provision is necessary for financing small/medium/ relatively large manufacturing units in categories (i,ii)(para.55).

BACKGROUND

1. The Second General Conference of the United Nations Industrial Development Organization (UNIDO), held at Lima, Peru, in March 1975, recommended that UNIDO should include among its activities a system of continuing consultations between developed and developing countries and among developing countries themselves with the object of raising the developing countries' share in world industrial output through increased international co-operation.

2. The General Assembly, at its seventh special session in September 1975, decided that a system of consultations called for by the Lima Declaration and Plan of Action should be established at global, regional, interregional and sectoral levels. In this context, UNIDO should at the request of the countries concerned, provide a forum for the negotiation of agreements in the field of industry between developed and developing countries and among developing countries.

3. In April 1976, the Industrial Development Board decided that consultations on industrial sectors should be organised on an experimental basis, with account taken of the priority sectors indicated in the Lima Declaration, the varying capacity of developing countries to benefit from such consultations, and the views expressed by the States members of the Board.

4. Subsequently, in September 1976, the Industrial Development Board decided that

> "the consultations should be convened among member countries, the participants from interested countries to include representatives of any or all of the following: government, industry, labour, consumer groups etc. - as deemed appropriate. Invitations to participate in the consultation meeting will be extended by UNIDO to Governments, or as otherwise agreed between UNIDO and Governments; other participating Governments will be informed by UNIDO of such arrangements". 1/

5. The predominant position of agriculture in developing countries was taken into account in the Lima Declaration 2/

> "that in view of the basic complementarity between industry and agriculture, every attempt should be made to promote agro-based or agro-related industries which besides arresting rural exodus and stimulating food production activities, provide an incentive for the establishment of further natural resource-based industries".

> "Encouragement and support of small, medium-scale and rural industry and industries which fulfil the basic needs of the population and which contribute to the integration of different sectors of the economy and to this end due attention should also be given to the industrial co-operatives as means of mobilising the local human, natural and financial resources for the achievement of national objectives of economic growth and social development".

1/ "Report of the Industrial Development Board on the work of its resumed tenth session" (ID/B/171/Add.1), para. 24(d).

and in the case of the least developed, land-locked and island developing countries

> "the creation of integrated production units such as agricultural machinery plants, appropriate engineering industries, and repair and maintenance services".

CONSULTATION IN THE PLANNING PROCESS

6. The economies of most developing countries are characterised by the predominance of agriculture and the low state of development of the metal working industries. In this situation the agricultural machinery industry is in a special position in the choice of technologies which are appropriate to the conditions in the developing countries.

7. The importance of the agricultural sector in the economies of the developing countries can be gauged from the fact that in the base year 1962, it accounted for nearly one-third of total GDP, provided two-fifths of total exports and supported directly over two-thirds of the total population. In its Provisional Indicative World Plan for Agricultural Development (IWP) FAO shows that the challenge facing agriculture in Zone C countries in 1985 is enormous - demand for food will increase by nearly 150 percent while the number of people directly dependent on agriculture will have increased by nearly 50 percent. Most of the countries will

depend heavily on agricultural exports for their foreign exchange earnings. The main emphasis of IWP is to meet the demands for food by intensification of agricultural production largely by widespread adoption of the new "high-yielding" strains of crops. Intensification can take place in two ways - by increasing the magnitude of the package of energy inputs to a high yielding crop and by taking more than one crop from the same area in a year. It is also an objective of the plan to improve the nutritive value of the diet partly by raising the protein contribution from cereals and partly by expanding the supply of pulses, vegetable oils, fruits and vegetables.

8. Translated into the time-scale of the Second Development Decade, IWP meant a 4 per cent average annual growth rate of agricultural production in the developing countries from 1972 to 1980. In a review of the plan (FAO, the State of Food and Agriculture 1974) it was clear that despite years of poor harvest, considerable progress had been made : in each of the developing regions, production kept pace with the unprecedented growth of population. However, the 4 per cent rate of growth was not reached and increases in agricultural production beyond population growth are needed in most countries if the total expansion in demand (coming from rising incomes as well as population growth) is to be met, if

nutritional levels are to be improved, and if the agricultural sector is to play its potential role in economic and social development.

IWP remains the cornerstone of world food policy. Under the pull of the population growth which is projected up to 2000, most countries will have to continue to intensify their agricultural development.

9. The intensification of agricultural production through the introduction of high-yielding varieties, fertilizers, and, in some cases, multiple-cropping, increases the demand for energy in cultivating the soil, pumping water, and in harvesting, processing and transporting crops. The mechanization of some operations is necessary in order to meet planting schedules, combat competition from weeds and disease, ensure water supplies and reduce losses in storage.

10. The agricultural machinery industry covers a wide spectrum of technology, with production units ranging from one-man workshops to multinational corporations. In every country it is possible to match a production unit to a local demand for machinery, and at a level of technology which is appropriate both to the manufacturer and the farmer. In many cases the manufacturer is only competent to handle part of the chain of industrial activities between

design and commercialization. The recognition of this limitation at the level of national planning, and the formulation of suitable measures to assist an agricultural machinery industry within a national plan for development appear to be realistic steps towards accelerating industrialization while promoting progress in the agricultural sector of the economy.

11. The agro-industries (farm machinery, fertilizers, food processing) have linkages with both the agricultural and industrial sectors of a country's economy; the two sectors are usually the interests of two different ministries as shown in Figure 1. It is essential that policies should be clarified by consultations at Government level in order to provide the institutional arrangements for development without conflicts of interest.

12. It is assumed that the pattern of demand for agricultural machinery in a country will be determined by the dynamics of a rapidly growing agricultural production sector. One of the tasks of the Ministry of Agriculture is the formulation of a feasible agro-ecological production system together with a specification of the inputs required by the system, leading to an allocation of resources to purchase the inputs.

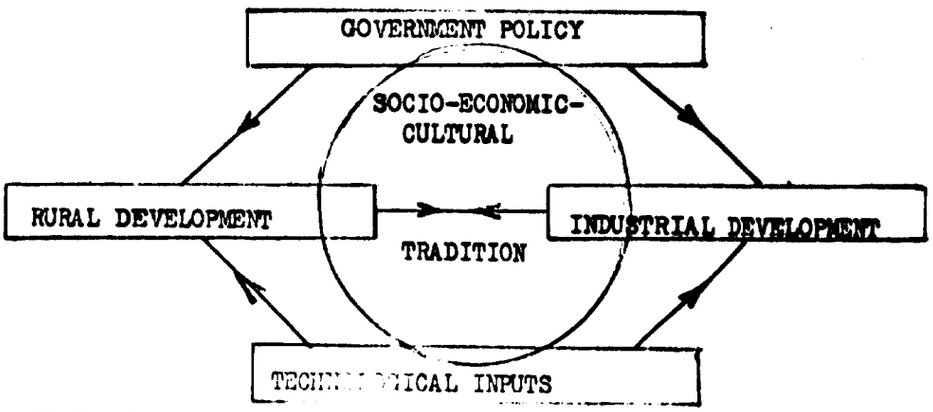

FIG. 1 PATHWAYS OF CONSULTATION FOR AGRICULTURAL MACHINERY

13. Lack of consultation within countries has delayed the emergence of coherent official policies about levels of mechanization and policies for manufacture and associated industrial inputs. A view has to be taken on the effects of farm mechanization on production and employment. There are a number of areas in which it is agreed that mechanization increases employment e.g. pumping water for irrigation, cultivation in semi-arid areas with a short and erratic rainy season, where the size of the cultivated area depends on how much land can be cultivated quickly, harvesting and cultivation in areas where multiple cropping is possible and where the chances of sowing a new crop depend on harvesting the mature one quickly. Most land clearance is only possible with tractor-drawn equipment. Usually mechanization should not be allowed to become labour displacing. A mechanization policy implies a market for agricultural machinery, with corresponding investments in the industrial sector, guarantees for imports of some supplies and provision of rural credit for the farmers to purchase the machines.

14. Given a framework of Government policy, consultations between the farming and engineering industries are a necessary part of the planning process. The parameters of the farming industry depend on climate, soil, farm size, crops and the technical competence of farmers, while those of the engineering industry depend on manufacturing resources, supporting metal-working facilities, skill and market opportunities. It is essential to marry the functional needs of the machines the farmers will buy to the production capabilities of the manufacturers, while at the same time helping to create an awareness of the requirements, which are likely to emerge from dynamic agricultural production systems.

15. Consultations within countries should create a framework in which targets for requirements of agricultural machinery can be identified in as much detail as possible and a strategy formulated for meeting these requirements.

16. Consultations on a wider front are necessary in order to decide how international co-operation in both trade and manufacture of agricultural machinery and the closely allied sub-groups may be organized so that everybody can participate in an advantageous way in the dynamically expanding market that exists now, and shows good signs of growth. It is imperative to decide what are the levels of technolgy that are appropriate to different countries at various stages of their development. The industrialized countries are too ready to assume that the markets of the developing countries are an extension of their own, and that it is just a matter of investment and time until there is a standardized global technology. There are enough examples of attempts to transplant unsuitable packages of machines and techniques from developed to developing countries to raise the question about the ultimate requirements in agricultural machinery for temperate and tropical countries.

PRODUCTION CHANGES IN AGRICULTURE

17. One of the most persistent world problems of the past thirty years has been that of raising agricultural production in order to keep pace with the food demands of a rapidly growing population, with the desire to raise nutritional standards and with the need to increase the agricultural export earnings of developing countries. Based on actual production in different countries in the early 1960's and on their varying objectives for agricultural production FAO prepared in IWP a realistic set of targets for the developing regions for the periods 1961-63 to 1975 and 1985.

18. The IWP places great emphasis on intensification of agricultural production by widespread adoption of high yield strains of cultivated crops especially cereals. Adoption of the new varieties in most cases requires modifications of cultivation techniques and a considerable break with past tradition; in particular they require an assured supply of water and purchased inputs. As the value of the purchased inputs to the agricultural production process is increased it signals the transition from subsistence to market agriculture. A properly balanced package of inputs for raising the yield of cereals would comprise:

quality seeds of high responsive varieties;

correctly balanced application of fertilizers;

an assured and controllable supply of irrigation water;

satisfactory and timely seed bed preparation;

crop protection, where necessary;

efficient harvesting;

facilities for drying and storage which prevent unnecessary wastage.

19. Each input has a machinery counterpart. Experience in several countries over the last decade has been a growing demand for better cultivation and weeding equipment, for low-lift pumps, sprayers, power-tillers tractors and trailers. Although no new machines are required, it takes considerable time to find a "suitable mix" which exactly balances the agricultural produotion system at a particular time in its evolution. IWP identified in a global way the current inputs and investment requirements shown in Table 1. While the highest growth rates are in fertilizers and crop protection, there is also a high growth in mechanization.

TABLE 1. Identified current inputs and investment requirements in Zone C study countries 1/

	Value		Change	Growth rates
	1962 4/	1968	1962 4/ to 1985	1962 4/ to 1985
	Mill. $ at 1962 4/ prices		per cent	per cent per year.
A. IDENTIFIED CURRENT INPUTS				
Seed	1673.1	2473.6	+ 48	1.7
Feed	3028.8	6993.8	+ 131	3.7
Fertilizers	671.4	8362.4	+ 1146	11.6
Crop protection 2/	180.0	2076.9	+ 1054	11.2
Mechanization	797.1	2610.2	+ 227	5.3
Irrigation	1494.7	2433.7	+ 63	2.1
Total crops and livestock	7845.1	24950.6	+ 218	5.2
Fishery	358.9	983.7	+ 174	4.5
Forestry	183.9	413.0	+ 125	3.6
Total identified inputs	8387.9	26347.3	+ 214	5.1
Total output (gross value)	54900.1	121640.4	+ 122	3.5
Ratio input/output	15.3	21.7		

B. IDENTIFIED INVESTMENT REQUIREMENTS	Cumulative 1962 to 1985 Mill. $ at 1962 4/ prices	Distribution per cent
Land improvement and development	47 100	42
Equipment, machines, etc. 3/	39 064	35
Livestock inventory and buildings	18 229	16
Fisheries: vessels, etc.	4 329	4
Forestry and logging	3 743	3
Total identified investments	112 465	100

1/ As taken from regional studies
2/ Excluding Central America
3/ Excluding Africa, South of Sahara
4/ 1961-1963 average

20. Stock-taking studies[1/] in the mid 1970's on the progress of IWP showed that the rate of growth of agricultural production which had been proposed had been reached in twenty one of the sixty four countries covered. The wheat production objectives have been exceeded in both Africa South of Sahara and the Far East. For rice the objectives have not been met in the Far East, the main producing area. The objectives for the starchy foods were exceeded in each of the regions where they play an important role in the diet but for pulses production lagged behind the objectives in every region. Among export crops, objeotives were exceeded for bananas, rubber, soybeans, sugar and total fruit but there were shortfalls for oocoa, coffee, tea, groundnuts and total oilseeds.

21. Overall while production kept pace with population growth and the basic soundness of the strategy proposed in IWP has been demonstrated, there was not enough growth in production to cushion the effects of poor harvests, to raise nutritional standards nor to raise agricultural exports. In assessing the take-up of inputs, it was was found that the consumption of fertilizers grew at an annual rate of 13.8 per cent, slightly below the objective of 14.6 per cent; while the use of herbicides increased rapidly that of insectioides and fungicides had risen more slowly; the development of irrigation

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1/ FAO The State of Food and Agriculture 1974.

was below expectations. Taking tractor numbers as a rough overall indicator of the level of mechanization, the IWP targets had been considerably exceeded in every region except Latin America, as shown in Table 2. In northwest Africa tractor numbers are already greater than the total proposed for 1985. Commenting on the increase in the report [1]

> "In most countries machinery still appears to be introduced without a properly phased programme covering training and servicing facilities and possible labour displacement. Training facilities for machinery operators, field and workshop mechanics and extension workers are extremely limited in relation to the number of machines in use and inadequate provision for spare parts is almost universal. Machinery for the rapid handling, drying, storage and processing of grain crops is insufficient in many areas of multiple cropping".

Table 2

	Actual rate of growth 1965-70	IWP objectives	
		1965-75	1975-85
	Percent per year		
Africa, South of Sahara	6.2	4.8	4.8
Far East			
2-Wheel tractors	28.0	19.1	20.0
4-Wheel tractors	15.6	12.5	13.2
Near East	18.8	7.3	5.1
Northwest Africa	6.0	3.1	2.9
Latin America	3.8	4.3	3.6
Total	9.5	8.4	9.3

1/ Monthly Bulletin of Agricultural Economics and Statistics Vol. 22 No. 4 April 1973.

22. In parallel with the intensification of the agricultural production system there is an improvement in rural living conditions often helped by electrification which creates a demand for pumped water supply systems, storage containers, etc.

23. Population in the developing countries is expected to expand up to the end of the century and whatever the rate of migration from the countryside to the cities, rural populations will also continue to expand. Probably 200 million persons will be added to the rural labour force between 1970 and 1985 and a further 250 million between then and the year 2000. An impression of the growth in demand for the major food groups both on a world and developing country basis is shown in Tables 3 and 4. The compound growth rates are formidable in that 1.5 per cent for the developed countries represents an increase of 26 per cent over a 15 year period and 3.6 per cent for developing countries would mean a 70 per cent increase in food volume over the same period.

24. On the assumption that the exponential growth rates in food production can be maintained from the mid sixties indications are that in developed market economies production can meet demand but in the developing market economies the trend

TABLE 3 — WORLD DEMAND BY MAJOR COMMODITY GROUP [1]

	Consumption	Projected demand			Total increase		Compound growth rate	
	1969-71	1980	1985	1990	1970-85	1970-90	1970-85	1970-90
	Million metric tons				*Percent*		*Percent per annum*	
Cereals [2]	1 207	1 538	1 725	1 910	42.9	58.3	2.4	2.3
Wheat [3]	332	404	447	490	43.8	47.6	2.0	2.0
Rice, paddy [3]	310	400	447	493	44.3	59.1	2.5	2.3
Coarse grains [3]	565	734	831	927	46.9	64.0	2.6	2.5
Starchy roots	279	321	342	361	22.3	29.2	1.4	1.3
Sugar, centrifugal (raw basis)	70	92	107	126	54.1	80.9	2.9	3.0
Sugar, noncentrifugal	12	15	17	19	42.1	54.0	2.4	2.2
Pulses, nuts and oilseeds	52	69	79	91	51.2	73.5	2.8	2.8
Vegetables	223	290	330	374	48.0	67.7	2.6	2.6
Fruits	158	214	250	290	58.2	83.5	3.1	3.1
Meat [3]	107	144	168	197	57.3	84.7	3.1	3.1
Beef and veal	39	51	60	70	54.7	80.1	3.0	3.0
Mutton and lamb	7	10	12	14	69.1	104.5	3.6	3.6
Pigmeat	36	46	53	61	48.3	71.4	2.7	2.7
Poultry meat	16	24	29	36	83.5	125.4	4.1	4.1
Eggs	19	25	29	34	50.8	75.1	2.8	2.8
Fish	41	57	68	81	64.6	96.3	3.4	3.4
Whole milk, including butter [4]	389	476	532	597	36.9	53.3	2.1	2.2
(Skim milk)	(40)	(50)	(58)	(66)	(44.4)	(65.5)	(2.5)	(2.6)
Cheese	9	12	14	16	51.7	74.4	2.8	2.8
Fats and oils [5]	33	43	49	57	47.9	70.8	2.6	2.7
Butter (fat content)	5	6	7	8	33.9	49.3	2.0	2.0
Vegetable oils	22	30	35	41	55.1	81.9	3.0	3.0

SOURCES: For 1969-71, OECD Food Consumption Statistics, and FAO Statistics Division, Supply Utilization Accounts; for 1980, 1985 and 1990, FAO estimates.

[1] All demand data are rounded. — [2] Including feed and nonfood demand in primary commodity equivalent. — [3] Including offals. — [4] Including milk products in liquid milk equivalent. — [5] Including animal fats.

TABLE 4 — TOTAL DEMAND OF DEVELOPING MARKET ECONOMIES BY MAJOR COMMODITY GROUPS [1]

	Consumption	Projected demand			Total increase		Compound growth rate	
	1969-71	1980	1985	1990	1970-85	1970-90	1970-85	1970-90
	Million metric tons				*Percent*		*Percent per annum*	
Cereals [2]	385.70	534.3	628.5	737.6	63.0	91.2	3.3	3.3
Wheat [3]	87.0	119.3	140.2	164.0	61.1	88.5	3.2	3.2
Rice, paddy [3]	171.2	235.3	274.8	318.6	60.5	86.1	3.2	3.2
Coarse grains [3]	127.5	179.7	213.5	255.0	67.5	100.0	3.5	3.5
Starchy roots	107.9	136.5	153.4	171.6	42.2	59.0	2.4	2.3
Sugar, centrifugal (raw basis)	23.9	36.9	46.7	59.3	95.2	148.1	4.6	4.6
Sugar, noncentrifugal	10.8	13.5	15.3	17.4	42.1	62.0	2.4	2.4
Pulses, nuts and oilseeds	32.4	44.7	52.8	62.3	63.0	92.2	3.3	3.3
Vegetables	69.7	99.4	119.3	142.4	71.1	104.3	3.6	3.6
Fruits	73.4	107.5	130.4	157.3	77.5	114.2	3.9	3.9
Meat [3]	21.1	32.2	40.6	51.7	92.1	144.4	4.4	4.6
Beef and veal	9.6	14.0	17.3	21.5	80.1	123.8	4.0	4.1
Mutton and lamb	2.6	4.2	5.5	7.1	110.9	174.4	5.1	5.2
Pigmeat	3.5	5.3	6.6	8.3	88.0	135.5	4.3	4.4
Poultry meat	2.3	4.1	5.6	7.9	143.6	241.1	6.1	6.3
Eggs	2.8	4.5	5.9	7.7	112.4	179.7	5.2	5.3
Fish	12.3	19.0	24.3	31.4	98.7	155.9	4.7	4.8
Whole milk, including butter [4]	93.7	137.6	168.4	205.8	79.6	119.6	4.0	4.0
(Skim milk)	(13.6)	(20.2)	(25.1)	(31.1)	(84.9)	(129.4)	(4.2)	(4.2)
Cheese	2.6	3.7	4.5	5.5	75.0	112.6	3.8	3.8
Fats and oils [5]	9.9	14.8	18.5	23.0	84.9	129.4	4.2	4.2
Butter (fat content)	1.1	1.7	2.1	2.5	81.4	122.6	4.1	4.1
Vegetable oils	7.7	11.7	14.5	18.1	87.6	133.6	4.3	4.3

SOURCES: For 1969-71, OECD Food Consumption Statistics, and FAO Statistics Division, Supply Utilization Accounts; for 1980, 1985 and 1990, FAO estimates.

[1] All demand data rounded. — [2] Including feed and nonfood demand in primary commodity equivalent. — [3] Including offals. — [4] Including milk products in liquid milk equivalent. — [5] Including animal fats.

annual growth is only 2.6 per cent. An accelerated rate of expansion must be maintained in the developing countries to atleast 2000 by intensification of the IWP package. The initial impact of the package has been mainly on the larger farmers but in the future, the smaller farmers must be drawn into the development, possibly as part of a more ambitious integrated policy for rural development involving not only expanding agricultural production, storage and marketing but development of decentralized rural towns, public works programmes and industrial development.

WORLD TRADE IN TRACTORS AND AGRICULTURAL MACHINERY 1/

25. Total World Trade in the ECE Bulletin of Statistics covers the exports of 38 countries which between them represent approximately 99 per cent of the world trade in engineering products. The total trade in engineering products in 1975 was 240,226 million U.S. dollars which was subdivided as follows:-

Total machinery non-electric	101,810	millions U.S.$
Total electrical machinery	46,398	millions U.S.$
Total transport equipment	88,776	millions U.S.$

26. The group agricultural machinery and the closely allied subgroups, which either overlap with agricultural machinery in manufacture or which are used in large quantities as inputs to the agricultural sector, accounted for almost one-fifth of the total trade described under machinery "non-electric". Total trade in agricultural machinery and closely allied subgroups was distributed as follows:-

	SITC	1975	
Agricultural Machinery	(712)	8808.9	millions U.S.$
Pumps and centrifuges	(719.2)	6688.7	millions U.S.$
Internal combustion engines for agricultural usage	(711.5) 2/	1439.7	millions U.S.$
Land development machinery	(718.4) 3/	2272.8	millions U.S.$
	Total	19210.1	

Of the 8808.9 million dollars' trade in agricultural machinery nearly half was in tractors (4371.7 million dollars) and nearly two-fifths (3352.3 million dollars) was concerned with machines for cultivating the soil.

1/ Source of data: ECE bulletin of Statistics on World Trade in Engineering Products 1975. E/E/R.77.11., E.4 New York, 1977.

2/ Only 20 per cent of sub-group "other internal combustion engines" is assumed as allocated to agricultural sector.

3/ Only 30 per cent of sub-group "Construction, mining machinery" is assumed as allocated to agricultural sector.

27. The three principal exporters of both agricultural machinery and tractors are United States, Federal Republic of Germany and United Kingdom. The principal exporters of equipment for cultivating the soil are Federal Republic of Germany, United States and Canada. Detailed information for the main exporting countries are given in Table 5.

28. The values of exports by region of destination are shown in Table 6. Total imports into the four regions accounted for 26 and 34 per cent of total trade in agricultural machinery and in pumps and centrifuges respectively; an increase of approximately five percentage points from the average share in the previous decade. In all four regions imports of tractors account for between 60 and 78 per cent of the trade in agricultural machinery. Imports of tractors into the four regions remained at about 32 per cent of the world trade in tractors between 1967 and 1974 but in 1975 the share jumped to 36 per cent. The volume of trade in agricultural machinery for cultivating the soil was low which is a reflection partly of the restricted range of equipment which is imported and partly of the efforts being made to manufacture machinery locally.

Table 6 Exports of agricultural machinery, tractors and pumps and centrifuges by regions of destination (millions US $) together with percentage of total world trade 1975

	Agricultural machinery	%	Agricultural machinery for cultivating soil	%	Pumps and centrifuges	%	Tractors	%
Africa (ex. Rep.of S. Africa)	533.6	6.1	140.8	4.2	414.8	6.2	357.9	8.2
Asia Middle East	523.3	5.9	73.4	2.2	595.3	8.9	374.8	8.6
Asia and Far East (ex. Japan)	340.3	3.9	64.2	1.9	647.3	9.7	256.8	5.9
Latin America	937.9	10.6	279.6	8.3	619.5	9.3	599.8	13.7

Table 5

TOTAL EXPORTS OF ENGINEERING PRODUCTS, BY MAIN EXPORTERS AND BY COMMODITY GROUPS

Value in millions of US dollars, f.o.b.

1973

ORIGINS \ PRODUCTS	Agricultural machinery	Agricultural machinery for cultivating soil	Dairy farm equipment	Tractors	Pumps and centrifuges
SITC rev. code	712	712.1,2	712.3	712.5	719.2
ARGENTINA	21.8	7.9	0.5	13.4	11.5
AUSTRALIA	36.8	32.1	1.5	2.0	13.4
AUSTRIA	41.3	13.4	0.8	21.2	49.5
BELGIUM-LUXEMBOURG	161.0	92.4	6.0	56.6	100.4
BRAZIL	9.2	3.5	0.0	5.5	7.4
BULGARIA	134.0	-	-	-	-
CANADA	276.8	208.6	3.1	40.7	27.1
CZECHOSLOVAKIA	115.8	-	-	-	-
DENMARK	87.3	62.6	17.0	0.5	106.8
FINLAND	14.3	9.0	1.3	3.8	8.9
FRANCE	239.7	127.0	5.1	90.2	330.2
GERMAN DEMOCRATIC REPUBLIC	331.2	165.8	32.0	20.6	35.0
GERMANY, FEDERAL REPUBLIC OF	632.5	341.0	27.6	241.5	975.9
GREECE	0.2	0.0	0.0	0.2	0.6
HUNGARY	91.2	19.3	-	-	10.3
IRELAND	4.0	2.5	0.6	0.8	6.8
ISRAEL	1.0	1.0	0.0	0.0	1.8
ITALY	278.8	62.4	2.1	206.2	256.6
JAPAN	184.2	17.2	0.5	166.0	208.9
NETHERLANDS	96.6	70.8	6.4	2.6	131.2
NORWAY	27.2	26.2	0.4	0.6	29.1
POLAND	78.4	38.3	-	40.1	29.4
PORTUGAL	1.7	1.2	0.1	0.3	1.7
ROMANIA	130.6	32.3	1.5	78.8	2.1
SINGAPORE	0.6	0.3	0.0	0.3	7.2
SPAIN	23.1	10.2	0.0	9.5	21.0
SWEDEN	136.9	-	-	-	189.1
SWITZERLAND	11.0	6.1	0.4	1.1	157.2
USSR	257.6	60.1	0.2	142.2	25.4
UNITED KINGDOM	543.2	111.8	15.9	400.8	333.9
UNITED STATES	987.1	265.2	14.8	841.2	832.6
YUGOSLAVIA	11.6	5.2	-	4.7	8.3
Total	4967.0	1813.6	137.8	2191.2	3919.4

1974

DESTINATIONS \ PRODUCTS	Agricultural machinery	Agricultural machinery for cultivating soil	Dairy farm equipment	Tractors	Pumps and centrifuges
SITC rev. code	712	712.1,2	712.3	712.5	719.2
AUSTRALIA	56.5	43.2	1.8	3.0	19.0
AUSTRIA	55.0	17.3	0.8	30.9	66.2
BELGIUM-LUXEMBOURG	244.0	152.5	6.4	76.6	115.1
BRAZIL	22.7	9.2	0.0	12.8	10.2
BULGARIA	141.5	-	-	-	-
CANADA	386.5	284.0	2.8	65.8	39.5
CZECHOSLOVAKIA	148.9	-	-	-	-
DENMARK	123.0	91.2	20.5	1.6	138.9
FINLAND	20.6	12.3	1.8	6.4	17.4
FRANCE	308.5	178.2	6.9	100.4	399.1
GERMAN DEMOCRATIC REPUBLIC	356.7	211.0	28.2	15.1	36.0
GERMANY, FEDERAL REPUBLIC OF	928.4	470.5	29.9	388.9	1265.2
GREECE	0.4	0.2	-	0.2	2.4
HONG KONG	-	-	-	-	1.5
HUNGARY	90.4	15.7	2.2	-	10.9
IRELAND	5.6	2.6	0.5	2.2	10.4
ISRAEL	1.8	1.7	0.0	0.0	2.8
ITALY	356.6	91.8	1.8	249.5	342.1
JAPAN	391.7	33.7	0.6	356.6	311.3
KOREA, REPUBLIC OF	0.8	0.7	-	0.1	1.5
NETHERLANDS	127.6	94.8	7.6	3.5	167.8
NEW ZEALAND	5.9	2.1	3.1	0.0	2.1
NORWAY	37.9	36.8	0.3	0.5	40.7
POLAND	84.3	34.5	-	49.8	31.8
PORTUGAL	1.8	1.4	0.0	0.3	1.4
SINGAPORE	1.1	0.4	0.0	0.6	20.4
SPAIN	46.7	16.7	0.1	25.1	35.5
SWEDEN	163.3	-	-	-	242.1
SWITZERLAND	15.1	8.6	0.6	1.0	192.3
USSR	360.4	109.8	0.2	164.6	31.7
UNITED KINGDOM	423.3	145.0	26.6	435.9	436.7
UNITED STATES	1398.4	421.3	18.9	854.6	1168.2
YUGOSLAVIA	14.2	7.3	-	6.1	12.7
Total	[illegible]	[illegible]	161.8	[illegible]	5165.8

1975

EXPORTERS \ PRODUCTS	Agricultural machinery	Agricultural machinery for cultivating soil	Dairy farm equipment	Tractors	
SITC rev. code	712	712.1,2	712.3	712.5	
ARGENTINA	41.2	12.5	1.3	27.1	
AUSTRALIA	67.3	54.5	0.7	4.9	
AUSTRIA	60.2	19.8	0.5	35.6	
BELGIUM-LUXEMBURG	305.6	188.7	5.4	103.5	[illegible]
BRAZIL	33.2	12.4	0.0	19.9	[illegible]
BULGARIA	164.6	-	-	-	-
CANADA	525.7	373.4	1.9	117.3	[illegible]
CZECHOSLOVAKIA	166.8	23.6	0.3	95.7	[illegible]
DENMARK	132.7	93.5	23.8	4.4	[illegible]
FINLAND	28.7	16.7	1.6	10.1	[illegible]
FRANCE	450.7	234.2	11.5	182.7	[illegible]
GERMAN DEMOCRATIC REPUBLIC	404.2	305.6	25.5	9.9	[illegible]
GERMANY, FEDERAL REPUBLIC OF	1066.9	478.1	34.7	504.6	[illegible]
GREECE	0.4	0.1	0.0	0.4	[illegible]
HONG KONG	0.0	-	-	-	[illegible]
HUNGARY	119.4	17.5	2.7	-	[illegible]
INDIA	3.8	2.4	0.1	0.7	[illegible]
IRELAND	8.0	3.3	0.7	3.7	[illegible]
ISRAEL	2.0	1.9	0.0	-	[illegible]
ITALY	483.5	112.7	2.2	351.4	[illegible]
JAPAN	534.5	35.7	0.4	497.2	[illegible]
KOREA, REPUBLIC OF	0.8	0.7	0.0	0.0	[illegible]
NETHERLANDS	146.7	109.6	5.5	8.4	[illegible]
NEW ZEALAND	6.2	2.9	2.3	0.1	[illegible]
NORWAY	43.9	39.3	0.8	0.5	[illegible]
POLAND	121.7	59.1	-	62.6	[illegible]
PORTUGAL	1.9	0.6	0.0	1.3	[illegible]
SINGAPORE	4.2	0.5	0.0	3.6	[illegible]
SPAIN	82.3	19.9	0.1	59.4	[illegible]
SWEDEN	203.8	-	-	-	[illegible]
SWITZERLAND	15.2	8.2	0.5	2.8	[illegible]
USSR	571.3	390.3	2.3	178.7	[illegible]
UNITED KINGDOM	904.5	188.0	26.7	687.9	[illegible]
UNITED STATES	2594.4	562.8	21.4	1388.1	[illegible]
YUGOSLAVIA	15.2	3.7	-	11.1	[illegible]
Total	8838.9	3352.3	173.0	4371.7	[illegible]

29. The value of world trade in agricultural machinery and the allied subgroups during the years 1967, 1969, 1974 and 1975 are compared in Table 7. A more detailed comparison of trade in agricultural machinery and tractors in the four main regions during the period 1973-75 is shown in Table 8. which gives imports into each country. These statistics do not take into account imports of hand tools and animal drawn equipment which for many developing countries seem to be of greater value than is sometimes realised. An example of the range and value of hand tools which may be imported are those for Thailand during the period 1966-70 shown in Table 9 which had an annual value of US $ 9 millions.

Table 7. World trade in agricultural machinery and allied subgroups 1967-75 (millions U.S. $)

	SITC	1967	1969	1974	1975
Agricultural machinery	(712)	**2257.7**	**2659.6**	**6521.6**	8808.9
Pumps and centrifuges	(719.2)	**1537.4**	**1926.3**	**5195.8**	6688.7
Other internal combustion engines	(711.5)	367.2	470.9	1235.1	1439.7
Construction, mining machinery	(718.4)	418.7	586.9	1626.9	2272.8
	Total	4581.0	5643.7	14579.4	19210.1

Table 3. Exports of Agricultural Machinery by Countries of Destination (million US $) 1973-75

PRODUCTS / DESTINATIONS	1973 SITC (Rev. 1) code	Agricultural machinery	Agricultural machinery for cultivating soil	Dairy farm equipment	Tractors	Pumps and centrifuges
		711	711.1.2	711.3	711.5	711.7
AFRICA - TOTAL		313.4	79.4	3.1	211.2	283.9
ALGERIA		51.1	20.8	0.2	26.4	39.8
ANGOLA		10.2	2.4	0.1	7.6	4.9
BURUNDI RWANDA		0.4	0.0	0.0	0.3	0.3
CONGO		10.1	0.9	0.0	8.9	7.2
EAST AFRICA		14.8	3.7	0.5	10.1	8.2
LIBYA		3.3	0.4	0.4	1.7	10.8
LIBERIA		2.9	0.8	0.0	1.4	1.6
GHANA		7.7	2.3	0.8	4.8	2.4
GUINEA		0.9	0.7	-	0.1	0.6
LIBERIA		2.2	0.1	-	2.1	2.8
LIBYAN ARAB REP.		21.4	4.1	0.6	15.4	33.3
MADAGASCAR		1.6	0.1	-	1.2	1.3
MALAWI		0.5	0.2	0.0	0.2	0.2
MOROCCO		11.4	2.8	0.1	7.8	9.9
MOZAMBIQUE		10.1	1.3	0.0	8.5	3.7
NIGERIA		18.0	1.7	0.0	13.7	18.1
SOUTH AFRICA		98.8	24.6	1.1	65.8	87.9
SOUTHERN RHODESIA		0.0	0.0	-	-	0.1
SUDAN		4.6	1.3	0.0	3.0	4.2
TOGO		0.2	0.1	-	0.1	0.6
TUNISIA		13.6	3.5	0.0	6.6	10.1
ZAIRE		3.5	0.4	0.1	2.5	8.1
ZAMBIA		6.4	1.1	0.0	4.7	7.8
OTHER AFRICA		18.6	3.7	0.0	14.8	18.0
OTHER AMERICA - TOTAL		347.6	88.1	6.2	245.8	329.8
ARGENTINA		9.6	2.7	0.4	5.9	26.2
BOLIVIA		10.0	1.2	0.3	7.9	2.1
BRAZIL		83.1	17.1	1.1	65.7	78.2
CHILE		11.1	4.8	0.5	5.5	10.2
COLOMBIA		14.7	3.0	0.1	10.2	13.2
COSTA RICA		4.0	1.0	0.1	2.7	2.8
CUBA		53.7	17.0	0.2	19.9	13.8
DOMINICAN REP.		5.7	1.0	0.1	4.0	4.3
ECUADOR		9.5	0.7	0.2	8.2	6.7
EL SALVADOR		3.1	0.9	0.3	2.1	2.4
GUATEMALA		5.2	1.4	0.1	3.6	2.5
HAITI		0.4	0.1	0.0	0.3	0.6
HONDURAS		3.3	0.3	0.1	2.5	2.3
MEXICO		41.5	13.1	1.8	44.3	55.9
NICARAGUA		4.3	1.0	0.0	3.1	2.5
PANAMA INCL. CZ.		12.5	2.9	0.1	5.0	4.9
PARAGUAY		7.6	2.4	0.0	4.3	0.7
PERU		12.1	1.6	0.2	9.3	19.3
SURINAM		1.6	0.5	0.0	1.0	1.3
URUGUAY		3.6	0.9	0.1	2.5	1.0
VENEZUELA		26.0	3.4	0.5	21.3	49.2
WEST INDIES		8.3	1.4	0.1	3.7	16.0
OTHER		8.7	1.6	0.0	7.8	19.2
ASIA, MIDDLE EAST - TOTAL		128.0	28.4	1.3	86.6	183.3
BAHRAIN		0.1	0.0	0.0	0.0	4.8
IRAN		67.7	8.9	0.3	51.4	33.4
IRAQ		11.3	2.7	0.2	1.3	12.8
ISRAEL		17.8	4.3	0.6	9.1	24.1
JORDAN		2.3	0.3	0.0	1.1	2.0
KUWAIT		1.4	0.1	0.1	1.1	6.7
LEBANON		5.0	0.4	0.1	0.5	9.8
SAUDI ARABIA		12.1	0.6	0.1	11.0	45.4
SYRIAN ARAB R.		3.0	2.3	0.1	5.2	6.1
OTHER MIDDLE EAST		2.9	0.4	0.0	2.2	20.2

PRODUCTS / DESTINATIONS	1974 SITC (Rev. 1) code	Agricultural machinery	Agricultural machinery for cultivating soil	Dairy farm equipment	Tractors	Pumps and centrifuges
		712	712.1.2	712.3	712.5	719.2
AFRICA - TOTAL		479.7	128.1	7.1	314.9	362.7
ALGERIA		72.0	24.9	0.8	41.4	55.8
ANGOLA		14.9	2.3	0.0	13.1	8.3
BURUNDI RWANDA		0.3	0.0	-	0.2	0.4
CONGO		14.3	1.1	0.0	12.8	10.4
EAST AFRICA		14.4	3.6	0.8	11.5	9.6
LIBYA		5.8	0.3	0.3	4.3	17.4
LIBERIA		4.7	2.0	0.0	2.3	2.5
GHANA		7.4	2.7	0.0	4.7	4.5
GUINEA		0.7	0.1	-	0.5	0.8
LIBERIA		2.9	0.2	0.0	2.6	3.5
LIBYAN ARAB REP.		67.3	14.4	0.5	26.9	50.1
MADAGASCAR		2.4	1.1	0.0	1.0	1.6
MALAWI		0.6	0.2	0.0	0.4	0.3
MOROCCO		20.4	4.4	0.4	13.0	12.4
MOZAMBIQUE		10.5	1.5	0.0	7.4	3.3
NIGERIA		20.0	2.7	1.6	15.1	24.5
SOUTH AFRICA		146.3	49.1	2.7	103.7	97.5
SOUTHERN RHODESIA		0.0	0.0	0.0	0.0	0.3
SUDAN		11.0	3.7	0.3	6.6	4.5
TOGO		0.8	0.1	-	0.7	1.1
TUNISIA		16.9	4.9	0.0	10.6	12.6
ZAIRE		4.8	0.6	0.0	3.8	9.6
ZAMBIA		8.2	2.0	0.0	5.3	10.1
OTHER AFRICA		28.7	6.8	0.1	21.7	21.8
OTHER AMERICA - TOTAL		563.2	166.0	6.8	365.1	637.7
ARGENTINA		14.4	2.9	0.3	9.8	28.6
BOLIVIA		9.9	2.1	0.1	6.8	4.2
BRAZIL		162.0	56.9	1.6	98.6	110.8
CHILE		9.9	3.8	0.3	4.7	13.4
COLOMBIA		24.4	6.1	0.3	16.2	16.1
COSTA RICA		10.9	1.8	0.2	8.3	4.5
CUBA		64.6	14.0	0.1	29.2	19.6
DOMINICAN REP.		8.7	1.2	0.0	6.5	7.2
ECUADOR		28.1	4.0	0.7	20.7	13.8
EL SALVADOR		4.9	1.2	0.1	3.2	5.0
GUATEMALA		9.7	2.1	0.1	7.1	1.6
HAITI		1.3	0.1	0.0	1.1	0.8
HONDURAS		6.0	0.8	0.1	4.7	2.4
MEXICO		90.3	29.6	1.4	55.5	69.9
NICARAGUA		9.6	2.6	0.1	6.7	5.8
PANAMA INCL. CZ.		14.7	4.7	0.2	8.8	5.7
PARAGUAY		9.9	3.6	0.0	4.9	0.8
PERU		19.8	1.8	0.1	6.5	18.8
SURINAM		1.8	0.7	0.0	1.0	2.6
URUGUAY		4.7	2.9	0.0	1.9	1.5
VENEZUELA		55.8	12.4	0.8	38.8	71.8
WEST INDIES		10.2	2.2	0.2	6.4	16.4
OTHER		19.5	2.9	0.1	6.9	17.4
ASIA, MIDDLE EAST - TOTAL		149.1	28.9	6.6	57.1	316.2
BAHRAIN		0.2	0.5	0.0	0.1	5.8
IRAN		46.4	10.5	1.2	29.0	88.3
IRAQ		30.9	5.4	1.7	6.5	28.9
ISRAEL		29.4	5.6	0.7	17.0	38.5
JORDAN		5.6	2.5	0.0	2.9	3.8
KUWAIT		1.9	0.1	0.1	1.7	14.9
LEBANON		3.5	0.6	0.2	3.8	15.1
SAUDI ARABIA		27.8	2.1	0.3	27.9	85.8
SYRIAN ARAB R.		11.9	1.1	0.1	10.3	8.9
OTHER MIDDLE EAST		7.3	0.6	0.2	5.5	35.2

PRODUCTS / DESTINATIONS	1975 SITC (Rev. 1) code	Agricultural machinery	Agricultural machinery for cultivating soil	Dairy farm equipment	Tractors	Pumps and centrifuges
		712	712.1.2	712.3	712.5	719.2
AFRICA - TOTAL		814.8	204.2	9.5	561.8	530.9
ALGERIA		91.6	42.7	3.0	34.8	97.3
ANGOLA		4.5	0.8	0.0	3.5	4.3
BURUNDI RWANDA		0.6	0.1	0.0	0.5	0.3
CONGO		27.3	3.9	0.3	22.2	17.6
EAST AFRICA		29.5	7.0	0.7	19.5	11.6
LIBYA		33.0	3.0	0.1	27.5	61.3
LIBERIA		3.7	0.7	0.0	2.8	2.0
GHANA		7.2	1.9	0.0	5.1	5.6
GUINEA		4.1	2.2	-	1.8	1.9
LIBERIA		7.0	2.3	-	4.6	5.6
LIBYAN ARAB REP.		83.0	24.3	1.1	49.2	71.1
MADAGASCAR		3.8	1.6	0.0	2.1	2.5
MALAWI		1.7	0.3	0.0	1.4	0.7
MOROCCO		29.3	6.3	0.1	21.5	24.2
MOZAMBIQUE		5.6	0.7	0.0	4.7	1.8
NIGERIA		41.6	7.8	0.3	70.5	32.7
SOUTH AFRICA		281.2	63.6	3.2	203.9	113.2
SOUTHERN RHODESIA		-	-	-	-	0.2
SUDAN		32.7	13.3	0.2	14.6	7.9
TOGO		0.8	0.1	-	0.5	1.4
TUNISIA		25.5	6.5	0.0	17.7	15.7
ZAIRE		7.7	1.6	0.0	5.9	5.3
ZAMBIA		12.7	3.5	0.5	8.2	15.4
OTHER AFRICA		44.9	11.0	0.2	32.5	25.2
OTHER AMERICA - TOTAL		937.9	279.6	10.6	599.8	815.5
ARGENTINA		18.2	5.5	0.3	10.6	33.5
BOLIVIA		18.6	3.1	0.5	14.6	9.1
BRAZIL		157.6	56.9	1.6	97.2	128.9
CHILE		40.5	8.5	1.6	29.6	25.7
COLOMBIA		24.8	9.6	0.2	17.3	18.1
COSTA RICA		19.1	7.6	0.3	10.8	6.1
CUBA		117.2	56.8	1.6	35.3	42.2
DOMINICAN REP.		18.9	2.6	0.2	14.7	19.0
ECUADOR		44.6	11.9	0.7	30.5	16.3
EL SALVADOR		7.0	1.6	0.2	3.3	6.1
GUATEMALA		13.9	3.9	0.1	9.5	4.7
HAITI		2.1	0.1	0.0	2.0	1.0
HONDURAS		8.6	1.9	0.1	6.1	4.1
MEXICO		174.5	56.7	1.3	113.3	114.5
NICARAGUA		7.8	3.3	0.1	4.1	6.1
PANAMA INCL. CZ.		13.8	3.3	0.1	9.6	7.1
PARAGUAY		12.0	3.8	0.0	7.1	1.6
PERU		29.2	3.5	0.1	23.6	31.7
SURINAM		3.1	1.1	0.0	1.8	2.0
URUGUAY		12.9	3.5	0.3	7.2	2.4
VENEZUELA		156.2	25.0	1.2	122.1	105.3
WEST INDIES		15.6	3.3	0.1	9.9	24.8
OTHER		22.6	6.1	0.1	17.2	17.1
ASIA, MIDDLE EAST - TOTAL		925.3	73.6	7.0	376.8	385.3
BAHRAIN		2.1	0.1	0.0	0.7	14.8
IRAN		181.3	22.9	3.1	116.7	175.4
IRAQ		127.0	29.7	1.4	76.6	120.6
ISRAEL		31.7	8.1	0.5	20.1	38.1
JORDAN		8.2	0.7	0.1	5.0	4.6
KUWAIT		4.3	0.2	0.2	3.7	21.4
LEBANON		17.2	1.0	0.1	15.0	17.5
SAUDI ARABIA		88.3	5.5	0.2	76.7	106.7
SYRIAN ARAB R.		36.1	3.6	0.7	27.7	15.6
OTHER MIDDLE EAST		20.4	1.9	0.8	16.7	73.6

1973

PRODUCTS / DESTINATIONS	SITC rev. code	712	712.1,2	712.3	712.5	719
ASIA, FAR EAST - TOTAL		422.3	87.3	4.2	304.4	555.4
AFGHANISTAN		1.3	0.4	-	0.4	0.3
BANGLADESH		1.0	0.4	0.1	0.3	2.4
BURMA		5.7	1.1	0.0	4.4	1.3
CHINA		19.6	4.4	0.0	14.4	26.7
DEMOCRATIC KAMPUCHEA		0.2	0.0	-	0.2	12.4
HONG KONG		4.0	0.2	0.1	4.3	41.0
INDIA		21.1	1.4	0.3	19.1	48.2
INDONESIA		14.1	1.0	0.1	13.0	61.4
JAPAN		82.0	25.1	2.1	47.4	0.4
KOREA, DEM PP REP.		1.0	1.1	0.0	0.0	1.4
KOREA, REP.		10.4	1.3	1.5	7.7	25.1
LAO PP DEM REP.		0.1	0.0	-	0.1	0.3
MALAYSIA		27.4	4.4	0.3	17.3	18.4
MONGOLIA		20.5	16.0	0.1	3.1	1.0
PAKISTAN		55.5	2.0	0.1	50.4	4.4
PHILIPPINES		51.2	7.7	0.4	41.0	25.4
SINGAPORE		16.4	1.7	0.1	13.7	75.7
SOCIALIST REP OF VIET NAM		10.4	4.2	0.0	11.0	1.7
SRI LANKA		4.5	1.0	0.3	2.4	22.5
THAILAND		45.0	4.0	0.4	40.2	0.0
OTHER ASIA, FAR EAST		20.0	0.7	0.1	9.0	3.3
						51.5

1974

PRODUCTS / DESTINATIONS	SITC rev. code	712	712.1,2	712.3	712.2	719.2
ASIA, FAR EAST - TOTAL		493.5	70.5	3.3	314.6	394.6
AFGHANISTAN		0.8	0.1	0.0	0.3	0.2
BANGLADESH		2.4	0.1	0.9	1.0	3.7
BURMA		3.0	0.2	-	0.7	1.5
CAMBODIA		0.7	0.0	-	0.7	3.4
CHINA		29.8	0.5	0.0	29.0	63.2
HONG KONG		7.1	0.5	0.2	1.5	17.7
INDIA		19.8	0.4	3.0	11.6	41.7
INDONESIA		27.7	2.3	3.5	20.7	43.7
JAPAN		89.2	50.1	1.3	46.0	96.8
KOREA, DEM PP REP.		4.5	1.0	0.0	2.2	17.5
KOREA, REP.		8.0	1.1	0.2	6.5	50.0
LAOS		1.0	0.1	-	0.9	0.2
MALAYSIA		49.8	4.8	0.3	39.1	28.7
MONGOLIA		10.4	4.2	-	2.9	1.0
PAKISTAN		18.1	0.8	0.1	10.5	7.7
PHILIPPINES		35.9	6.6	0.2	27.4	29.3
SINGAPORE		48.1	1.8	0.2	80.9	41.3
SRI LANKA		1.8	0.7	0.0	1.1	1.3
THAILAND		93.4	2.8	0.1	25.9	34.7
VIET-NAM, DEM. REP.		0.7	1.5	-	4.3	1.4
VIET NAM REP.		7.9	2.4	0.1	5.1	3.0
OTHER ASIA, FAR EAST		27.7	7.7	0.5	14.2	34.0

1975

PRODUCTS / DESTINATIONS	SITC rev. code	712	712.1,2	712.3	712.2	712.2
ASIA, FAR EAST - TOTAL		422.3	89.3	4.2	304.4	143.9
AFGHANISTAN		1.3	0.4	-	0.4	0.9
BANGLADESH		1.0	0.4	0.1	0.3	7.9
BURMA		5.7	1.1	0.0	4.0	1.0
CHINA		19.6	4.4	0.3	14.4	126.1
DEMOCRATIC KAMPUCHEA		0.2	0.0	-	0.2	0.2
HONG KONG		4.0	0.2	0.1	4.3	18.9
INDIA		21.1	1.4	0.3	19.1	49.4
INDONESIA		14.2	1.0	0.3	13.0	82.4
JAPAN		82.0	20.1	2.2	47.6	96.0
KOREA, DEM PP REP.		3.0	1.1	0.0	0.0	17.0
KOREA, REP.		10.9	1.3	1.0	7.7	71.0
LAO PP DEM REP.		0.1	0.0	-	0.1	0.5
MALAYSIA		22.6	1.0	0.3	17.3	28.0
MONGOLIA		20.3	16.0	0.1	3.1	1.1
PAKISTAN		53.3	2.0	0.1	50.2	21.9
PHILIPPINES		51.2	7.7	0.4	41.4	43.9
SINGAPORE		13.4	1.7	0.1	13.7	44.0
SOCIALIST REP OF VIET NAM		14.0	4.2	0.0	11.0	4.3
SRI LANKA		4.5	1.0	0.3	2.4	2.7
THAILAND		49.0	4.0	0.4	40.2	30.1
OTHER ASIA, FAR EAST		20.0	0.7	0.2	9.0	82.0

Table 9

HAND TOOL IMPORTS 1966 - 1970

	1966 CIF Value	1967 CIF Value	1968 CIF Value	1969 CIF Value	1970 CIF Value
Spades, shovels	1,119,438	1,466,071	1,265,699	1,381,244	1,952,725
Changkols, hoes	23,061,335	26,917,575	8,962,418	9,536,982	4,383,439
Picks, forks and rakes	662,336	1,115,461	406,201	527,779	457,005
Axes, bill hooks	2,756,616	2,730,631	3,118,602	2,494,973	2,345,255
Saws, non-mechanical	4,580,624	6,950,344	9,153,557	11,244,211	11,608,133
Hand saw blades	8,378,729	10,893,079	12,584,725	11,134,397	10,405,791
Toothless saw blades	1,764,499	2,565,599	2,458,656	2,986,955	1,805,880
Machine saw blades	9,514,220	11,361,567	10,921,146	14,105,920	11,628,205
Pliers, pincers	3,307,412	5,011,471	4,889,672	10,338,068	6,241,500
Tinmen's snips, bolt croppers	1,250,578	1,379,785	2,057,998	1,753,398	1,809,871
Spanners, wrenches	15,394,632	20,942,122	18,977,116	20,209,349	18,055,551
Files, rasps	11,587,390	19,513,275	15,148,412	17,008,520	19,638,953
Vices, clamps	2,499,759	4,606,115	5,341,264	3,871,066	2,918,414
Hammers	3,554,692	4,825,056	5,521,025	7,301,562	6,822,849
Tools for masons, plasterers	670,815	1,298,135	1,156,170	1,387,596	
Tools for carpenters	5,576,227	6,192,193	5,300,612	5,398,599	4,907,423
Drilling, threading, tapping tools	5,645,182	4,694,860	3,628,154	6,232,282	4,086,827
Interchangeable tools for hand tools	30,814,313	38,973,534	47,172,577	43,645,698	3,372,605
Knives and cutting blades for machines	4,230,421	5,083,552	5,832,172	6,075,667	9,914,920
Screwdrivers	-	-	-	-	3,656,213
Hand tools (not elsewhere specified)	14,953,496	13,842,083	17,929,031	17,687,654	17,207,492
TOTAL (Baht)	151,323,654	190,362,508	181,825,201	194,121,900	143,195,019
(US$ millions)	7.56	9.52	9.09	9.70	7.02

30. The latest figures available for exports of tractors from the major exporting countries (U.S.A., U.K., Japan, FRG, France, Italy and Belgium) which traditionally account for about 80 per cent of the tractors imported by the developing countries are shown in Table 10.[1]. They give further emphasis to the marked growth in mechanization which is taking place in the developing countries. Tractor imports to these regions increased by over 40 per cent between 1974 and 1976 despite price increase and the world-wide recession which occured during this period. Four wheel tractors imports by the developing regions increased from 57,800 units in 1974 to 94,800 units in 1976, an increase of over 64 per cent in the two year period. The largest increase in imports was in the Near East (183 per cent) but there was also a substantial increase in the Far East (81 per cent). Africa was the only region which showed a decrease.

In addition to larger numbers of imports by the developing countries, the size of four-wheel tractors also appears to be increasing. Exports to the developing countries from USA of tractors with engines less than 35 h.p. decreased 14 per cent between 1974 and 1976 while exports of tractors in the 35-100 h.p. range increased by 134 per cent. Both the FRG and France reported similar experience of decreasing exports to developing countries of wheeled tractors with less than 35 h.p. and increasing exports of tractors with more than 35 h.p.

1/ FAO Agricultural Engineering Services

Table 10 - Exports of Tractors by seven industrialized countries 1/

Exports to:	Hand tractors Number 1974	Hand tractors Number 1976	Hand tractors % Change	Wheel tractors Number 1974	Wheel tractors Number 1976	Wheel tractors % Change	Crawler Tractors Number 1974	Crawler Tractors Number 1976	Crawler Tractors % Change	Total Tractors Number 1974	Total Tractors Number 1976
Developing	9,529	10,788	13.2	57,792	94,860	64.2	15,165	11,129	-26.7	82,447	116,768
Latin America	1,663	1,337	-19.6	16,586	19,089	15.1	5,668	4,716	-16.8	23,917	25,141
Near East	4,410	5,233	18.7	14,213	40,234	183.1	1,556	2,363	51.9	20,179	47,830
Far East	3,184	4,085	28.3	14,833	26,793	80.6	5,736	2,902	-49.4	23,753	33,785
Africa	272	133	-51.1	12,146	9,740	-28.1	2,205	1,139	-48.3	14,623	10,012
Developed	153,456	197,982	29.0	231,942	253,575	9.3	13,279	9,229	-30.5	393,677	460,786
Not Specified	1,089	9,731	-	7,029	11,565	-	404	1,933	-	8,522	23,229
Total	164,074	218,501	33.2	296,754	360,000	21.3	28,848	22,282	-22.8	489,676	600,783

1/ United States, U.K., France, Federal Republic of Germany, Italy, Belgium and Japan.

32. The total imports into the developing regions of hand operated tractors, including single axle tractors, garden tractors, power tillers and motor cultivators, also increased between 1974 and 1976 but at a much slower rate than the larger tractors; hand tractors are taking a decreasing share of an already small market relative to four-wheel tractors. The number of exports of hand tractors from the seven developed countries to the developing regions indicated an overall increase of only 13 per cent. Observers in the field are discouraging in their reports about the suitability of power tillers for dryland conditions; they lack robustness, are tiring to handle and are not as satisfactory for transport as four wheeled tractors.

33. The share of world trade in non-electric machinery occupied by agricultural machinery points to the importance of the market in engineering goods for tractors, farm machinery, pumps and allied equipment; these figures do not ofcourse take into account the contribution of similar magnitude by firms who are satisfied to supply a domestic market. The growth of the trade in agricultural machinery over the years and the consistent way in which it has maintained its share of the total is an indication of the stable way in which the market is growing. Four-wheeled tractors have a major position in agricultural machinery exports. The numbers are growing very rapidly although the total park of tractors in the developing countries is still small so that percentage growth is more an indication of dynamic agricultural development rather than a big increase in actual numbers. The increasing sales of larger tractors and the slackening demand for power tillers in the developing regions should be noted.

ESTIMATES OF DEMAND FOR AGRICULTURAL MACHINERY

34. Agricultural production systems are in the hands of a large number of managers whose first concern is to maintain the stability of their system of production in the long run. The problem of intensification is one of finding more responsive strains and the best combination of inputs to give new and more economically rewarding production systems, which must also have long-term stability. Without entering into the technical details of agro-ecological systems, it is clear that considerable experimentation is required to find the correct level of inputs which have to be tuned to different micro-climates and soils; machinery ie just one of a large number of inputs. General experience has been that progress is evolutionary and that reasonable forecasts can be made by extrapolating present trends.

35. A further simplifying assumption is that of two distinct market situations - static and dynamic. In a static agricultural production situation , whatever its level of sophistication, the market is largely a replacement one. When the market is supplied with a traditional line of equipment, annual sales tend towards a mean, probably with seasonal variations and possibly with slight changes from one year to another which reflect variations in farm income, access to credit or even weather. Such a relatively stable demand is found for hand tools in subsistence type agriculture and for tractors,,combine harvesters and similar equipment

in the industrialized countries. Clearly within the statio situation there are industrial opportunities in manufacturing a range of equipment to meet an existing demand; how the market is shared between different suppliers depends on factors of price, performance, service etc. There are also exacting technical problems of improving design, raising product reliability and streamlining produotion methods.

36. The agricultural production situation envisaged for the developing countries is strongly dynamic, if they are to attain the levels of output which have been postulated in IWP both for the period up to 1985 and later to 2000. The demand for tractors and farm maohinery, in the light both of experience and the statistical returns on production and trade, is also dynamic. A complicating factor is that the pattern of mechanization is also in transition, so that it is not just growth within a fixed production system but growth within a changing production framework. However, taking account of the evolutionary nature of changes in agro-ecological production systems it may be assumed that the rate of change of level of equipment will be relatively slow. Countries can learn from one another's experience but it is not usually a straightforward transplantation of ideas or machines from one location to another; it is a question of adaptation. But to select what is appropriate and how to replace what is unsuitable is a difficult intellectual and practical exercise and one in whioh great perseverance in international co-operation is needed.

37. It is possible to sub-divide the complete range of agricultural machinery into four broad categories, each category requiring a different level of production facilities and skill in its manufacture and catering for a market that fits into a recognisable pattern of farm machinery mechanization:-

First category - simple implements and machinery, mainly hand tools and animal drawn equipment of a traditional kind that can be manufactured with simple forge and machine facilities.

Second category- crop intensifying machinery, improved versions of machinery in the first category with the addition of low-head pumps, harrows, weeders and trailers, which are needed as farmers begin to raise crop yields by using fertilizers. Such machinery can be made in small to medium production units with simple machining, forge and welding facilities.

Third category - powered machinery, further intensification of cropping and especially the practice of multiple cropping raises the need for powered machinery (tractors, power-tillers, threshers, dryers, deep-well pumps) in order to reduce the time spent on such critical operations as cultivation, planting and harvesting. Manufacture of such equipment belongs in medium size production units with good foundry, precision machining, heat treatment and quality control facilities.

Fourth category - specialized machinery, saving of labour is the characteristic feature of the advanced stages of farm mechanization which is achieved by specialized harvesting and other machines that make big demands on R and D.

38. In his thesis on Systems Development in Agricultural Mechanization 1/, Curfs sees the transition from subsistence agriculture to cash cropping taking place in West Africa with the aid of tractor hiring units, which may be government owned in the first instance but should be handed over to private individuals as soon as possible, on the grounds that in this way the hiring system is more responsive to the needs of those using the system. The further development of the system is shown in Figure 2.

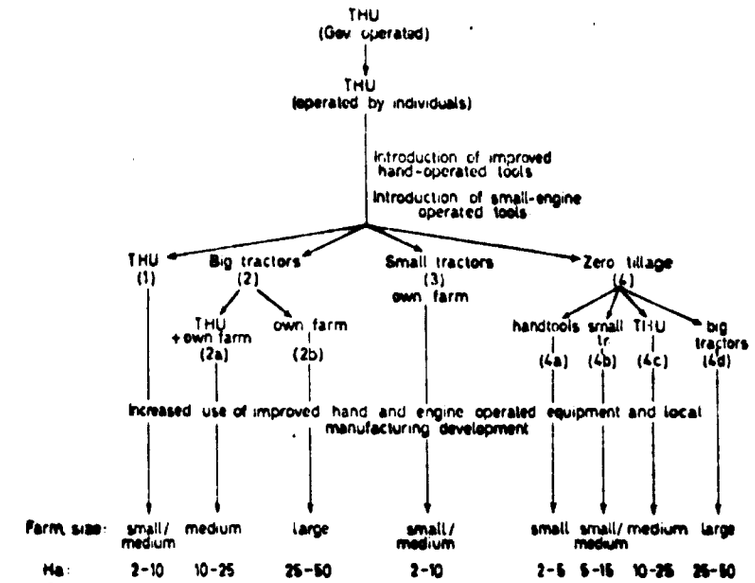

FIG. 2 Introduction of mechanization and mechanization alternatives in tropical West African agriculture.

1/ H.P.F. Curfs "Systems Development in Agricultural Mechanization with special reference to soil tillage and weed control" Mededelingen Landbouwhogeschool, Wageningen 1976.

39. The pattern of development in the Far East has been of this kind. In the first stage intensification has been through the use of annual inputs - higher yielding strains of seed, fertilizer, water, weed control - followed by use of contractors to reduce bottlenecks at critical periods, leading finally to individual ownership of tractors and power tillers.

40. Asia and Africa are very much tied to human and animal power for a long time to come as indicated in Table 9 prepared by Giles [1] who also makes the point that within a country such as India, different areas are at very different stages of development at the same time.

Table 11. Distribution of Agricultural Power

Region	Total h.p. per ha	Percentage of available power per ha		
		Human	Animal	Mechanical
Asia (exc. China)	0.22	26	51	23
Africa	0.10	35	7	58
Latin America	0.25	9	20	71
India as a whole	0.23	26	62	12
India - Ludhiana	0.82	4	22	74
India - W. Godavari	0.40	20	60	20

1/ G.W. Giles "The Reorientation of Agricultural Mechanization for the Developing Countries" Effects of Farm Mechanization on Production and Employment FAO 1975

A farm equipment classification table has been drawn up for India in the Final Report of an International Co-ordinated Research Project (1970-76) 2/ and is reproduced below, Table 12.

Table 12: Farm equipment classifications.

Power source	Equipment	
	T = traditional	N = new
H = human	sickle hookshovel 'Kurpi' (hoe) threshing frame (bamboo) water lifting device	hand hoe knapsack sprayer seed drill threshing frame (angle iron) rotary paddle thresher water lifting device power sprayer
A = animal	Yoke (wooden pole) 'wooden' plough with straight rigid beam spike tooth harrow for uprooting wooden levelling frame (ladder) one-axle trailer with rigid rimmed wooden wheels (150 cm diameter) water lifting devices (Persian wheel)	iron mouldboard plough with straight rigid beams harrows (disc and tine) soil levelers sowing equipment one-axle trailer and two-axle wagon with pneumatic tyres
S = stationary fuel power equipment		pump sets: 2.2-3.7 kW (3-5 hp) threshers: 2.2-11.0 kW (3-15 hp)
TT = two-wheel tractor		upto 5.2 kW (7 hp) 5.2-8.8 kW (7-12 hp) Rotavator normally standard equipment, further water pump, ridger, m.b. plough, 1-ton-trailer
FT = Four-wheel tractor		11.0-18.4 kW (15-25 hp) 18.4-25.7 kW (25-35 hp) 25.7 kW and more (35 hp) Three point linkage/hydraulic lift standard for almost all categories, popular: 9-11 tine tiller, 3-5 ton trailer, disc plough

2/ Mechanization of Rice Production: India-Nigeria-Senegal FAO 1976

It shows that within the traditional sectors of subsistence farming based on human and animal power there is plenty of opportunity for new development. More ergonomically sensible and better quality versions of traditional implements, as well as new manually operated equipment such as hand hoes, knapsack sprayers, threshing frames, are needed in the intensification of cropping. There is an urgent need to provide manufacturing prototypes suitable for construction in local workshops but prototypes whose performance is shown to be acceptable in the agriculture of the district. There are too many designs on offer that are incompletely thought out for the function they must fulfill and poorly engineered for the task. Just as new strains of cereals needed to be screened for different environments so do different machines in order to check that they are appropriate to the overall production system, are an improvement in function on existing solutions and are economic to manufacture.

41. Quoting from Co-ordinated Research Project Report:

"Many of the improved hand tools and some of the bullock drawn equipment can be made at the present production centres for traditional equipment serving areas of 5-10 km square. The loss in quality at this production level, if any, is adequately made up for by the lower overhead and distribution costs."

42. Even in the hand-tool and animal-drawn equipment stages of mechanization, intensification creates a demand for new equipment. The use of fertilizers stimulates growth of weeds, so that weeding becomes much more important than in the traditional system, creating a requirement for hand hoes and rotary weeders. Farmers also seek better control of weeds in further developments:-

(i) more thorough initial cultivations for longer term control of weeds, creating a need for better ploughs,

(ii) drilling of the crop in rows to make intercultivation easier, creating a requirement for drills,

(iii) chemical control by herbicides which needs sprayers.

The supply and control of water is an essential input to intensify crop production. In many cases pump sets are needed to develop very low lifts and are of a simple kind that could be manufactured locally. In its study of the Philippines ILO estimated that 1.5 man years of gainful employment would be generated for each hectare brought under irrigation. Diesel engine pump sets which probably are part of the third level of mechanization have made an enormous contribution to irrigation and drainage in Asia. It is estimated that there are more than half a million sets in India and the possibility of installing many more.

Harvesting is almost entirely by hand in early stages of mechanization but there is a demand for simple threshing frames.

Intensification inevitably leads to a need for more transport raising the demand for carts and trailers.

43. As intensification of cropping proceeds so does the demand for an input of mechanical energy which is used to prepare seed beds, to plant, weed and harvest crops and to dry, store and transport the final produce. Using average figures, Giles has shown that it is possible to get yields up to about 2.5 tonnes/ha with modest power inputs reaching about 0.5 h.p./ha; to increase the yields further requires a higher rate of power input; Japan has gone furthest along this trend with about 4 h.p./ha, U.S.A has 1.5, U.K. has 2.5.

44. The total energy demand of a cropping system is not spread uniformly over the whole year but is concentrated is short periods during sowing and harvesting. A number of operations in crop production are critically time dependant - planting within a strictly limited period to catch either rains or a certain temperature condition, harvesting to reduce losses by shelling or cracking, or in order to sow a second crop. Traditional systems have evolved within such constraints so that the work load is limited at critical periods e.g. the modal hand cultivated area in Western Nigeria is 1 ha and for transplanted rice is 0.5 ha. Transition from the second to the third level of mechanization is signalled when crop yields approach 2.5 tonnes/ha because at this point the labour supply is overstreched at critical periods during the year.

45. The transition from the second to the third level of mechanization means fairly widespread adoption of motorized power. But there is a serious mismatch on small holdings between an engine size that will give an acceptable rate of working and average figures for power input (which, incidentally, is the principal explanation for the very high power inputs in Japan, quoted in 43 above, and which are possible in a country where rice prices are 6 times higher than the world average.) The rating of the unit package which a farmer might expect to own is related directly to the power requirements of the machinery which he will use with the power package. Almost always cultivation implements have the highest power demand which may be calculated from the draught requirements and working speed of the common implements:-

mouldboard plough	10 newtons/cm^2 of furrow slice
rotary tiller	55 newtons/cm of working width
cultivator	250 newtons/tine
row planter	200 newtons/row

46. The minimum speed of travel which is acceptable in order to get the task finished within the timeliness contraint of crop production is 3 km/hour, which leads to the following engine ratings using the formula

$$\text{Engine power (kw)} = \frac{\text{Pull (newtons)} \times \text{Speed (m/s)}}{e} \times 10^{-3}$$

where e is the overall efficiency of power utilization between the engine and the implement and taken to be 0.5 :-

single furrow plough, 20 cm wide x 20 cm deep	= 6.7 kw
rotary tiller working 60 cm wide	= 5.5 kw
spring time cultivator 1 m wide	= 3.0 kw
three-row planter	= 1.0 kw

47. Those calculations indicate that for cultivations with a single furrow mouldboard or a rotary cultivator 60 cm wide, an acceptable rate of working needs an installed engine capacity of 7 kw (10 h.p.) which should be sufficient to mechanize 20 ha , using the critical figure of 0.5 h.p./ha proposed by Giles. Herein lies one of the major dilemmas of appropriate mechanization. Many of the family farms which could benefit most from multiple cropping are not of the right size to own a tractor or power tiller. The most sensible approach at this stage of mechanization is the hiring of tractors and equipment to remove bottlenecks in the production cycle at cultivation and harvest.

48. The relative merits of four wheel tractors and two wheel power tillers are becoming clearer. At first sight the purchase price of tillers is much less than that of tractors but the work rate of tillers is also much below that of four-wheel tractors. The Co-ordinated Research Project on Mechanization of Rice Production found that in a 1½ month season in Senegal, a 12 h.p power tiller could prepare 20-25 ha land at a cost of 24 $/ha whereas a 75 h.p. tractor could prepare 150 ha in the same

time at approximately the same cost per ha. In Nigeria it was found that two-wheel tractors, which are designed for well developed paddy fields and cultivation under wet-land conditions, are not strong enough for the rougher upland conditions. A serious limitation in the utilization of two wheel tractors is the very tiring effect which they have on the operator - it may only be possible for an operator of a 2 wheel tractor to work half as long as the driver of a 4 wheel tractor. The importance of transport by tractor and trailer in developing countries must be underlined and for this important duty, power-tillers are not really acceptable.

49. The pattern of intensification of agricultural production in a country appears to follow a fairly regular pattern through increase in annual inputs of seeds, fertilizers, simple equipment to a take-off point in machinery requirements where there is a strong demand for tractors and associated equipment mainly for cultivation and seeding and particularly transport. Numerous surveys have shown that in the developing countries at least 60 per cent of the working life of a tractor is spend on transport. In parallel with an increase in the tractor park of a country is a demand for agricultural trailers and simple loaders.

50. One fairly reliable statistical indicator which leads the demand for farm machinery in a dynamic agricultural situation is a country's consumption of nitrogeneous fertilizer.

50a Total fertilizer consumption might be used as an indicator of a country's market potential for agricultural machinery and of its capacity to sustain a manufacturer at national level, who could be expected to take a responsibility for R and D. Local manufacturers, especially in the first two categories, owe their competiveness to the fact that they do not have to carry the costs of a national marketing network, nor worry about the problems of agents carrying stocks of spare parts, and of repair and maintenance. Such problems are dealt with locally between the manufacturer and the customer. Also because of their size and scale of operations, small/medium manufacturers cannot afford to take part in R and D so that some other institution has to provide a progression of well-engineered, adequately tested prototypes that can be copied. So far this service has not been well met by research institutes which are more concerned with research than development. Unless institutional arrangements can be made to do development of agricultural machinery for the small sector, it will remain technologically stagnant.

50b Another solution to the R and D problem is a manufacturing unit big enough to do it for itself, as well as overcome the other hurdles that accompany operations on a national scale. As a discussion figure, is it possible to state that only when consumption of nitrogeneous fertilizer exceeds a certain tonnage (say 100,000 tonnes) per annum, then there is a reasonable chance for manufacturing agricultural machinery on a national scale?

51. The same sort of question is also relevant in regard to starting local manufacture of tractors. Despite the rate of increase in imports, the absolute numbers in most countries are way below the point where (Rate of replacement + Rate of growth) approaches a certain number (say 10,000) units of annual production which appears to be the minimum to support such a capital intensive industry in the industrialized countries. At the same time a query may also be raised as to whether the presently sophisticated form of tractor which has evolved in the developed countries does not contain in its design the necessity for manufacture in quantity. The main characteristic of the design is the absence of a separate chassis because the housings for the engine, gearbox and rear transmission are linked to provide load-carrying strength. As well as reconsidering the functional requirements of a tractor to meet the needs of the developing countries, it should also be worthwhile examining whether adoption of chassis construction would simplify and reduce the total annual production run to make manufacture more appropriate in a developing country. The experience of selected developing countries which have already initiated local production may be useful in finding an answer to the above questions.

52. Should investment in manufacture of conventional tractors in developing countries with a national park of less than a certain optimum figure of tractors be seriously questioned on the following grounds:-

(i) that the opportunity cost of such an investment of scarce foreign exchange compares unfavourably with the possibilities for investment in lower-cost small scale manufacturing projects.

(ii) the local content is invariably small, so that tractor assembly is likely to make long term demands on foreign exchange for buying knockod-down units, payment of foreign managers and technicians, servicing of interest, royalties and amortization. The rate of increase of local content is usually slower than expected.

(iii) Committment of the local market, even in a joint venture, to a single foreign manufacturer with a limited range of models means cutting the farmers off from the benefits of competition between major world manufacturers and especially from the technical developments that take place continually. It is especially discouraging when at the same time as their source of supply is limited, the farmers find that they have to pay above world prices for their tractors, a situation that can only result in higher agricultural prices which limits export opportunities abroad and raises food prices at home.

Therefore the experience of developing countries and opinions of international manufacturers on the above concept would be very useful.

FACILITIES FOR MANUFACTURING AGRICULTURAL MACHINERY

53. The agricultural machinery production facilities of an area should be a response to the market pull of local efforts towards the intensification of agricultural production. Manufacturers should participate in the demand for machinery inputs because of growth in the farming sectors while at the same time generating a complementary growth in the industrial sector. If a policy for manufacture of agricultural machinery has to be summed up in a sentence then it is

"Identify well proven designs which are compatible with a local cropping system, test the prototypes for function under local conditions and adapt them to local manufacture".

On historical grounds and in the experience of many countries, there are four levels in the development of appropriate agricultural machinery in a country and at least three levels have counterparts in local manufacture in developing countries. Reaching a higher stage does not mark the end of either demand for replacements or development in the earlier stages.

First Category - Simple implements and machinery

54. In this category there is a traditional range of handtools (axe, hoe, sickle) and animal draught equipment (wooden yokes, ploughs and single axle carts). Usually there are new requirements such as weeding hoes and steel ploughs associated with the initial stages of intensification.
Every society possesses skilled craftsmen, who, for generations, have produced implements to meet a local need. A range of implements produced by blacksmiths includes small implements and tools for farmers, carpenters and joiners, for the processing of fibres as well as the manufacture of kitchen utensils and rural household equipment.

It is important that a country should retain and enhance its artisan level by encouraging family workshops which are a source of traditional skill. They should be encouraged to use simple powered machines such as small presses and guillotines, saws and grinders, oxy-acetylene and electric welding sets. Improved designs and instruction in welding and heat treatment also help.

55. A problem in the industrialization of a country is to provide as advantageous institutional arrangements for such entrepeneurs as for those involved in larger scale undertakings e.g. access to credit at subsidized rates, training facilities, adequate supplies of medium carbon steel, protected market opportunities. Although small rural enterprises may seem primitive in their level of technology and operating efficiency, they are usually highly competitive in overall economic performance. Their small scale nature is no disadvantage since the investment of fixed and working capital is minimal. The working methods are labour intensive but labour is at a low opportunity cost and charged as such.

56. The facilities required for such a workshop include forging, welding, sheet-metal working, simple production machinery including wood-working as well as simple jigs, fixtures and dyes. The products to be manufactured with the approximate price and requirements of raw materials are shown in Table 13. The capital cost of the equipment excluding buildings may vary between US $20,000-40,000 which is not a small investment seen against the availability of capital in developing countries and the fact that one workshop should not be expected to serve an area greater than 10 km radius. Such workshops in turn would provide a market for relatively simple capital goods, castings and forgings. They also provide a training ground in mechanical skills which are widely diffused through the countryside and complement the social structure. The ability of such production

units to recycle material and consume small amounts of energy gives them additional vigour.

Table 13. Products of a hand-tool workshop

Product and approx. price ($)	Volume of production/day	Raw materials
Chopper (1.20)	100	Most of these items require medium and high carbon steel for cutting edges and mild steel for the body, wood for handles and cast iron on a limited scale.
Sickle (1)	100	
Hand hoe (2)	100	
Fodder cutter (50)	2	
Mouldboard plough (20)	2	
Bladed harrow (20)	1	

Second category - Crop intensifying machinery

57. Crop intensification is launched when the farmers apply fertilizers and use higher yielding varieties, which in turn need better cultivation, water control and weeding, creating a demand for more effective ploughs and harrows, low-head pumps, weeders, sprayers and trailers for transport. Most of the equipment in this category can be brought within the capability of the more progressive manufacturing units described for the first category through upgrading of the basic manufacturing facilities by

provision of a small press, forging hammer, furnace

machines for sawing, turning, drilling, milling

supplies of suitable steels and bearings

access to castings of reasonable quality.

At this stage of development it is very important that designs in the form of working prototypes should be available whose performance is acceptable from a functional point of view and which have been designed for manufacture with the facilities to hand.

58. Successful examples of rural factories in this category are common in the Far East. They employ 30-50 people, using simple manufacturing methods with a modest investment in capital equipment. Using small machine presses, turning and drilling machines, a tube bending machine and oxy-acetylene and electric welding, one such firm had an annual production of

400 tractor-drawn ploughs and harrows,

3000 animal drawn ploughs

1000 seeders

400 maize millers,

an annual turnover of about a quarter million dollars. The animal-drawn plough is made of tubular steel, formed and welded. Construction is simple and durable, with wearing components such as the blade tip and the blade assembly being easily replaced.

Third category - Powered machinery

59. A point is reached fairly early in the intensification of cropping systems, and especially when multiple cropping is attempted, at which the timing of certain operations, such as planting and harvesting, becomes critical. At this stage powered inputs are necessary in order to raise work rates to meet critical deadlines. Demand is for machines, tractors, disc harrows, power-tillers, threshers, dryers, deep-well pumps, sprayers.

60. The manufacture of powered machinery is at an entirely different level of technology from that in categories (i,ii). From a design point of view, machinery in categories (i,ii) is "static" and is undemanding of bearing surfaces, fits and tolerances. Neither does it have difficult repair problems. Powered machines, on the other hand, work at high speed so that "dynamic" effects are important and must be taken into account in design and manufacture. They also require back-up in the form of specialized repair facilities.

61. Manufacture of powered machinery requires foundry, forging, machining and heat treatment facilities as well as skill in metal-working techniques and metallurgy. The capital investment is of at least another magnitude from that in category (ii) with a consequent need to match throughput to investment. As there is a minimum quantum of facilities necessary to start manufacture, there is a corresponding minimum production run for the operation to be economic.

62. However, the minimum throughput that is possible in a developing country is not automatically the same as in an industrialized country; a point which is at the heart of adaptation of technology from developed to developing countries. In the developed countries, production technolgy places great emphasis on saving labour and exploiting the materials of construction by pushing them closer to their technological limits. These objectives are not necessarily those of the developing countries which are more concerned with entering the technology of category (iii), simplicity of design and ease of repair. A key question in adaptation is the amount of redesign of the machine which is possible in order to reduce the investment for its manufacture.

63. A proposal for manufacture of 5 h.p. diesel engines in a developing country was able to make the project give an economic rate of return on an annual production of 10,000 units with a labour force of 300 by

buying locally cast unmachined iron cylinder blocks,
sub-contracting the forging of connecting rods and crankshafts
importing bearings, pistons, valves and injection equipment
using universal machine tools.

Engines of the same size in the industrial countries are air-cooled and use precision castings manufactured with highly specialized production techniques requiring a large investment and high production runs.

64. Those closely associated with agriculture in developing countries show a strong preference for four-wheel tractors against power-tillers. The four-wheel tractor has a better working rate during cultivations so that output off-sets capital investment to give the same operating cost as a power-tiller. The four-wheel tractor is very much more suitable for transport than a power-tiller and transport is an important duty. In its present configuration a tractor requires a high investment in production facilites which raises the threshold of an economic production run. It is still worth considering the configuration of a tractor for developing countries with the objective of producing a design for economic manufacture of less than 10,000 per annum which appears to be the minimum that is viable in the industrialized countries, and even then, considerable use is made of bought in components, which are mass produced for other applications.

Fourth Category - specialized machinery

65. Highly specialized equipment is associated with the final stages of a mechanization programme. It includes such equipment as combine harvesters for cereals, forage or root crops, machines for land development and equipment for agro-processing on an industrial scale. Characteristics of such equipment are the relatively high amount of R and D associated with it, the sophisticated nature of some of the manufacturing processess used in its fabrication, the need for good quality control and, in some cases, genuine economics of scale in its manufacture.

The development of the market in such equipment has reached the stage where there is only a small number of developed countries engaged in the manufacture of such machinery and developing countries should be cautious

TRANSFER OF TECHNOLOGY

66. Elemcnts of technology are being bought and sold in world markets in the following forms : machinery, equipment and intermediate goods, patents, industrial designs, know-how, engineering design and technical, managerial and marketing expertise. Transfer may be through wholly owned subsidaries or acquired directly by domestically owned enterprises. Between these two extremes are a variety of joint ventures with various degrees of collaboration.

67. The core of concern of recipients of technology about the present arrangement are the large number of limitations imposed by foreign enterprises on the use of technology, and the high direct and indirect costs of technology transfer. It can be argued that the developing countries have a case for special treatment to overcome the technical, managerial and information constraints which result from the nature of their underdevelopment. Technology cannot be said to have been fully and effectively transferred unless the recipient acquires an independent ability to use and develop it on his own, according to local needs and conditions.

68. Some of the practices that are a cause for concern are:- 1/

a) restriction in the field of use in which the recipient may use the technology

b) imposition of production quotas, which may prevent the recipient from producing enough to be able to export or territorial restrictions on exports

c) tied purchase clauses that limit the sources of supply of raw materials, spare parts and intermediate products

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1/ UNCTAD "An International Code of Conduct on Transfer of Technology". TD/B/C6/AC/2/Suppl 1/Rev.1 1975.

d) excessive quality control standards which impede the possibilities of adapting technology to local demand and local resources.

e) overpricing of imports as a means of boosting royalty payments in connexion with technology transfer.

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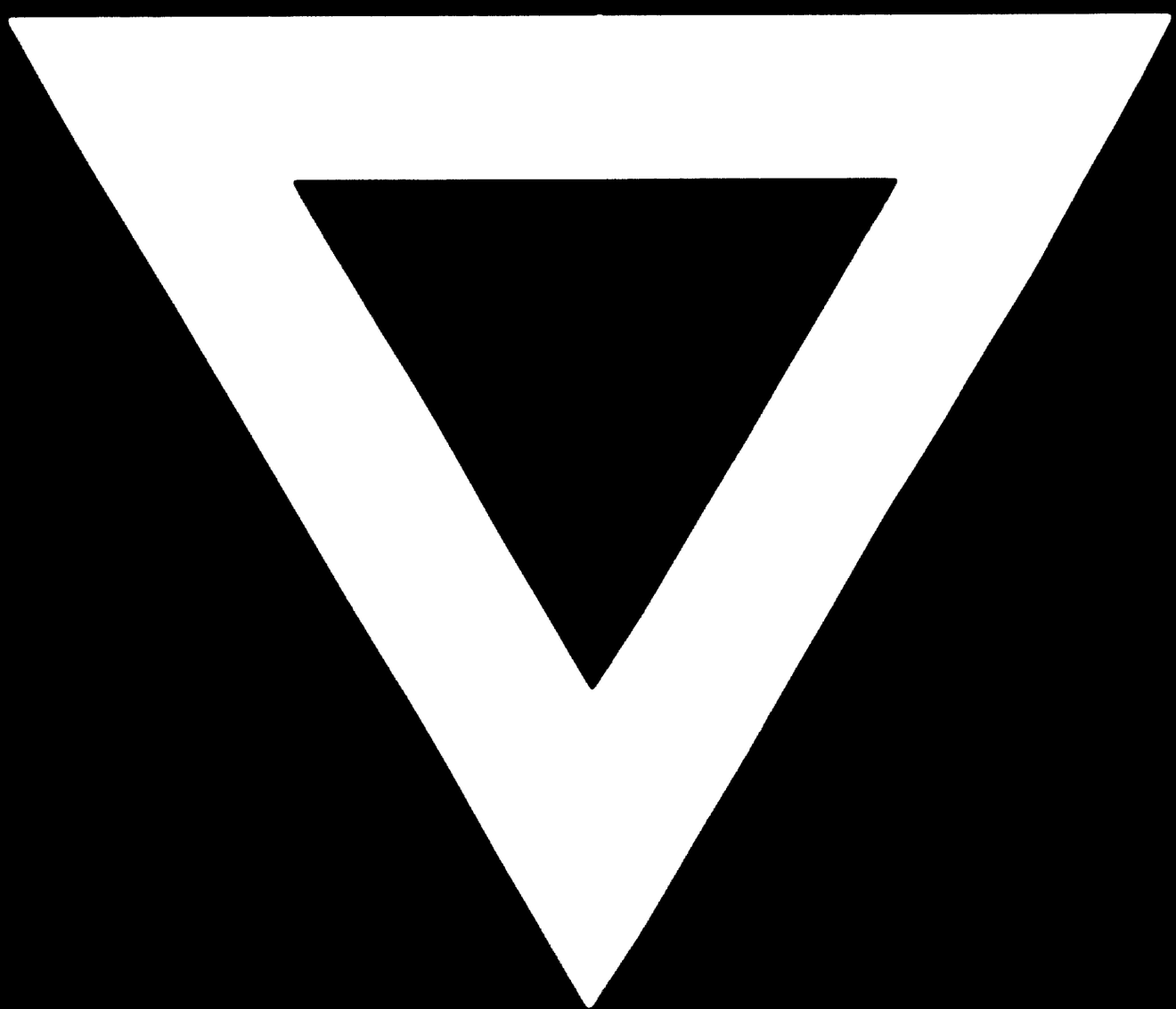

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