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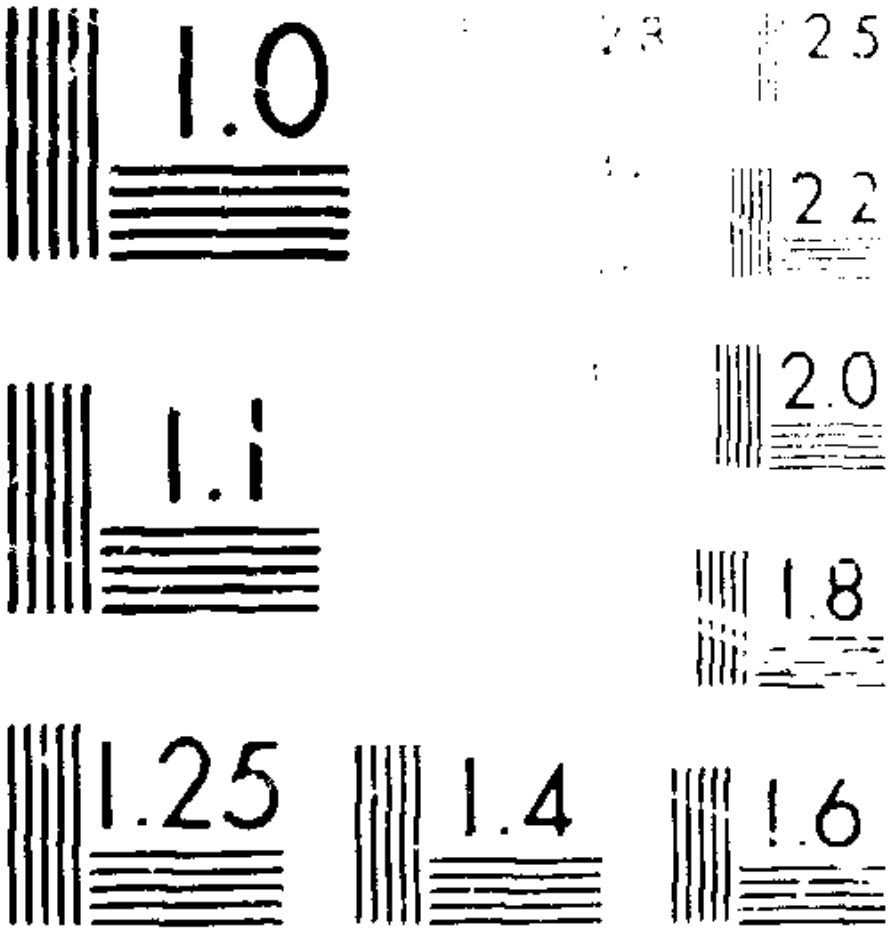
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THE AGRICULTURAL MACHINERY INDUSTRY IN THE 1980s

FACTORS FOR INTERNATIONAL CO-OPERATION

Prepared by

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V.83 59501

Explanatory notes

Reference to dollars ($) are to United States dollars, unless otherwise stated.

The following forms have been used in tables:

Three dots (...) indicate that data are not available or are not separately reported

n.a. indicates that data are not available.

The following abbreviations are used in this document:

CEMA	European Committee of Associations of Manufacturers of Agricultural Machinery
CISE	Centre d'intervention sociale et économique
EEC	European Economic Community
hp	horsepower
LDCs	least developed countries
NICs	newly industrialized countries
TNCs	transnational corporations

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SUMMARY

The agricultural machinery industry has not been spared by the economic crisis. Its outlets have continued to decline over the last five years; this has primarily affected equipment and machinery connected with the heavy mechanization model, e.g. tractors, tractor-drawn machines, self-propelled machines, etc.

The markets of developing countries have not taken the place of markets in the industrialized countries. Competition is extremely keen between the large manufacturers. Growth for some of them is largely offset by stagnation or even recession for others. The medium and short-term prospects remain limited.

Still, the agricultural machinery industry fills only a small part of the needs of world agriculture in terms of mechanical equipment. More than two-thirds of all agriculture is excluded from programmes involving the mechanization of agro-food production due to ecological, social, and economic factors. Intensification provides the possibility of redefining mechanization, but it also brings new actors on to the stage, e.g. the capital goods industry, the electrical and electronics industry, the plant protectives industry, the pharmaceutical and genetics industries. It also calls for a substantial research and development effort.

The large manufacturers of the world have given priority to the reorganization of their industrial equipment. Their strategy is characterized by the concentration, specialization, and rationalization of production. Technical agreements are increasing in number and involve sharing the production range, cross supplying of components and parts, and marketing agreements with small and medium enterprises producing specialized machines. The use of automatons and robots, adaptable workshops, and computer aided design is growing. These efforts have contributed to increasing the scale of production and heightened the oligopolistic nature of this production. The agricultural machinery industry remains a relatively exclusive field of activity. There is not strictly speaking any alternative model of mechanization. The short-term prospects are limited to improving the performance of conventional machines and equipment. For more intensive farming the long-term prospects are related to progress made in scientific fields other than those that brought in the mechanization model.

The world economic situation favours two types of scenarios of development:

- The scenarios of the "probable", which are linked with the strengthening of the influence of the large agro-industrial Powers in the agro-food area. They are accompanied by the reinforcement of the heavy mechanization model for agricultural production and the diversification of equipment both upstream and downstream from this production.
- The scenarios of the "possible", deriving from the desire of certain countries, particularly the newly industrialized countries (NICs), to maintain or develop self-sufficiency in agro-food production. When achieved within the framework of intensive farming, this objective favours, on one hand, the renewal of the dominant mechanization model, and on the other hand, an enlarged field of industrial or State partners concerned with the development prospects for mechanical equipment used in agro-food production. These scenarios are voluntarist and strongly involve the States in the implementation of agricultural, industrial, and social policies having coherent objectives.

The effects of the economic crisis are altering the conditions under which co-operation programmes are begun and carried out. Geopolitical data are redefining the input channels in the agricultural machinery industry. They contribute to the jamming of industrial delocalization, favour commercial negotiations, and involve new fields and new partners in negotiations which previously had been reserved exclusively to the main actors of the agricultural machinery industry.

As far as the poorest countries are concerned, the possibilities of "co-development" within the logic of the quest for a new international economic order may usefully be considered. This would favour specialized small-scale and medium-scale industry and would involve negotiations between States. In this way the function of mechanization in agricultural, rural and industrial development, and not simply the products of the agricultural machinery industry, would be given priority.

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INTRODUCTION

The imbalances in the supply and demand of metal-mechanical capital goods used in agricultural production have grown sharper over the last five years.[1/] These imbalances have resulted in the simultaneous appearance of deficits and surpluses: industrial product surpluses underlined by the slump in sales of tractors and tractor-drawn machines; deficits indicated by estimates in regard to simple or complex machines and mechanical equipment derived from forecasts of food needs; agricultural surpluses revealed by the fall in prices of the most important agricultural raw materials and the fierce competition among the large suppliers; agricultural deficits which FAO forecasts continue to underline.[2/]

The agricultural machinery industry has never been affected so directly by variations in the prices of agricultural products exchanged on world markets and their direct consequences on the purchasing power of farmers and on State policies. The future of heavy mechanization is closely linked to the development of international exchanges of merchandise. The diversification of the mechanization models is based on the wish of some States to maintain an agriculture employing a large population and to defend food self-sufficiency. The introduction of new mechanization models goes hand in hand with a desire to take up the challenge of a further growth in agricultural production and productivity in conformity with the interests of the farmers of developing countries.

The agricultural and industrial options relating to the abandonment or the establishment, maintenance or consolidation of an agricultural machinery industry are to be seen in an international context marked by heightened power relationships among major actors, whether industrial or political. The importance of geopolitical factors in industrial orientations and the prospects of co-operation will be emphasized in this report.

1/ This term is used to designate four types of goods: hand tools; simple machines and equipment; tractors and tractor-drawn machines; self-propelled machines and complex equipment. UNIDO, "World study on the agricultural machinery industry", 1979.

2/ "Agriculture: Toward 2000", Rome, 1979.

I. THE AGRICULTURAL MACHINERY INDUSTRY IN CRISIS

For nearly ten years the agricultural machinery industry has been going through what all observers agree is a crisis of unprecedented proportions and duration. Although this crisis is general, the forms it takes differ according to economic regions, the amount of development, the systems of agricultural production and the large categories of machines and equipment associated with them.

1. The last five years have been marked by a sharpening of the difficulties in the agricultural machinery industry which first appeared at the beginning of the 1970s in the industrialized countries. The activity of the large world producers of tractors and harvesters has stagnated or declined.

Sales on the markets of developed countries have fallen sharply (see table 1). In the United States of America, sales of tractors and combine harvesters (expressed in the number of units) declined by one-half between 1978 and 1982 (see figure I).

Figure I. Sales of tractors and combine harvesters in the United States

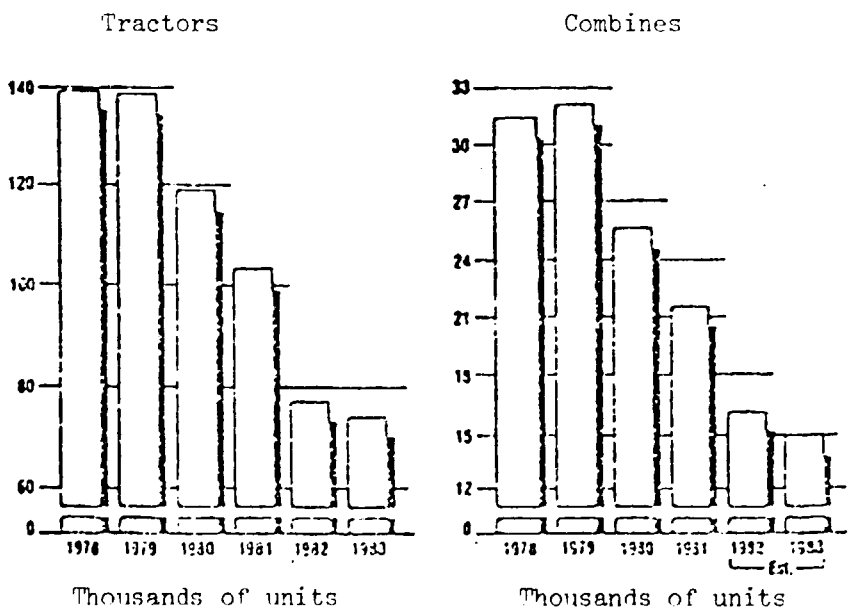


Table 1. Sales of tractors and combine harvesters [a/]
(Number of machines)

		1978	1979	1980	1981	1982
Germany, Federal Republic of	T [b/]	61 347	55 603	45 477	41 098	41 100(e)
	CH [c/]	5 705	5 515	4 418	3 829	-
France	T	64 083	64 470	58 784	53 849	56 817
	CH	5 464	4 959	4 392	4 773	4 207
United Kingdom	T	34 193	29 991	22 372	21 510	26 000(e)
	CH	2 779	2 825	2 383	2 113	-
Italy	T	74 425	74 870	75 760	61 996	55 000(e)
	CH	2 049	2 280	2 149	1 564	-
The "Seven" of Europe [d/]	T	252 789	246 859	219 281	190 540	-
	CH	n.a.	18 020	13 770	13 891	-
Spain	T	37 404	34 532	32 154	22 849	-
	CH	1 615	1 311	1 666	1 013	-
Canada	T	28 575	28 625			-
	CH	4 526	5 070	4 170	4 450	-

Source: European Committee of Associations of Manufacturers of Agricultural Machinery (CEMA), Paris, France.

a/ Registration or apparent consumption.

b/ T = tractors.

c/ CH = combine harvesters.

d/ EEC with the exclusion of Luxembourg and Ireland.

During the same period in France registrations of tractors fell by 11.3 per cent (with a slight recovery in 1982), and those of combine harvesters by 23 per cent. In Western Europe total tractor sales fell from 370,000 units in 1979 to 264,000 units in 1981, rising in 1982 to 268,000 units. World-wide, in market economy countries, sales declined by more than 26 per cent between 1976 and 1982.

The consequences - particularly the financial consequences - of this reduction in sales are all the greater since the turnover in sales of tractors and combine harvesters represents, according to producers, between 55 and 70 per cent of their "agricultural machinery" turnover.

The repercussions are partly attenuated by an upward movement in the range of products: overall the sales of four-wheel-drive tractors continue to climb, and the same is true of the horsepower of two-wheel-drive and caterpillar tractors, and the cutting width of combines.

The forecast for 1983 is hardly bright. In fact, experts are predicting a new decline in the sales of tractors and combine harvesters in Canada and the United States. For the European Economic Community the most optimistic estimates indicate at best a very slight progression, at worst stagnation. But the worsening of Community relations and the persistence of the economic crisis could result in a new fall in registrations, all the more so as the occasional signs of a slight recovery noted at the end of 1982 may be regarded simply as the making up of the lag in equipment purchases during the preceding fiscal periods.

2. The situation of the markets for other categories of equipment is hardly better, at least with respect to the most conventional tractor-drawn equipment: pick-up balers, tractor-drawn mouldboard ploughs, rotating and alternating reapers, disc harrows, cultivators, windrowers, etc. (see table 2).

3. Exports and manufacture under licence in developing countries have not furnished the relief the large producers had hoped.

After the boom years of 1970-1975, sales and local production flattened out and have gone on to decline in the last few years, often drastically (see table 3). According to professional estimates, the sales of tractors in the third world (excluding countries with centrally planned economies) have fallen from more than 400,000 units in 1976 to less than 310,000 units in 1981.

Although the needs of most of the countries concerned are far from being satisfied, the prospects for outlets appear very limited if there is no recovery. Over the last five years only some oil-producing countries and India (a producer of machinery), which have pursued a constant policy of food self-sufficiency, appear to have eluded the slump. The slight recovery in 1982 can essentially be attributed to them. In Argentina, which is an extreme case, registrations of tractors fell from a record 21,932 units in 1977 to 3,054 in 1981, and those of combine harvesters from 1,977 units to 102 units during the same period.

Table 2. Sales of agricultural machines
(Number of machines)

	Pick-up balers a/					Reapers				Tractor-drawn mouldboard ploughs			
	1978	1979	1980	1981	1982	1978	1979	1980	1981	1978	1979	1980	1981
United States b/	43 982	52 310	49 511	39 149	...	46 153 c/	56 089 c/	46 757 c/	38 746 d/	15 272	19 328	17 576	12 732
Canada	7 913	7 560	7 160	7 240	...	4 800 c/	4 685 d/	4 295 d/	4 375 d/	n.a.	9 745	8 195	8 415
France	20 580	17 351	12 765	14 041	12 658	36 000	24 766	21 809	26 144	36 000	27 732	31 700	24 889
Germany, Fed. Rep. of	9 727	8 625	6 589	5 387	...	32 587	37 945	30 340	27 981	19 334	17 304	14 686	12 952
Italy	8 735	8 700	9 095	9 445	...	11 913	12 747	14 977	15 308	...	...	...	...
United Kingdom	6 412	4 471	3 692	3 480	...	9 750	8 700	7 341	...	5 900	6 489	4 741	4 450
Spain	3 988	2 356	3 536	3 047	...	7 000	6 350	5 486	10 600	17 763	17 980	17 247	12 360

Source: CEMA.

a/ All types.

b/ Including exports and including chisel ploughs.

c/ Including windrowers and self-propelled equipment.

d/ Reapers-windrowers only.

Table 3. Production of tractors
(Number of machines)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Algeria	389	799	1 562	2 110	2 839	3 724	4 883	4 206	4 379 a/	4 500 a/
Argentina	21 460	24 505	18 397	24 098	25 631	5 997	10 901	3 618	1 408 b/	-
Brazil	41 513	49 075	59 061	65 279	53 691	49 474	56 418	69 993 c/	47 022 a/	-
Mexico	5 830	7 539	10 082	11 574	10 489	13 005	15 595	17 893	-	-
India	23 537	29 097	32 445	36 675	34 675	52 368	60 094	67 528	84 320	-
Turkey	32 818	25 653	26 106	36 889	31 658	31 943	32 097	-	-	-

Sources: Until 1980: United Nations, Yearbook of Industrial Statistics, 1980 edition, volume II, p. 573.

a/ Maghreb Development.

b/ Data provided by UNILO on the basis of an expert's report.

c/ Predicast.

The share of developing countries in the total imports (in value) of market economy countries has declined regularly for all categories of equipment since the mid-1970s. For soil preparation equipment it went from 23.1 per cent to 17.3 per cent between 1975 and 1980, and for harvesting equipment from 16.5 per cent to 11.4 per cent.

4. The slump has not only affected developed and developing countries with liberal economies. It has also hit countries with centrally planned economies. The markets of Eastern Europe now appear practically saturated. Unable to dispose of a significant portion of their production in the developing countries of their traditional zone of influence (countries of South-East Asia, Africa and the Middle East, associated with the Council for Mutual Economic Assistance), the principal producers (Czechoslovakia, Poland, Romania and the USSR) must seek export outlets, notably in Europe (see table 4).

Table 4. Tractor and agricultural machinery exports
(Millions of dollars)

	1970	1973	1975	1977	1979
USSR	238.1	257.6	571.3	599.48	1 712.1
Czechoslovakia	50.9	115.8	166.8	286.4	367.1

Source: United Nations, Yearbook of International Trade Statistics, 1980 edition and earlier editions.

5. International competition has increased sharply. This is shown by the intensification of exchanges between developed market economy countries. This intensification began to appear clearly in 1978 and has become accentuated over the last two years (see tables 5 and 6).

National production no longer seems to have the benefit of really effective protectionism. In the United States imports increased on the average by more than 17 per cent a year between 1977 and 1980, compared to 7.8 per cent between 1974 and 1977. In Canada they climbed nearly 20 per cent a year between 1978 and 1980, compared to less than 1 per cent between 1975 and 1978. In France the average was 18.5 per cent between 1977 and 1980, and less than 6 per cent between 1974 and 1977.

Table 5. Value of exports of principal exporters of tractors and agricultural machinery (Millions of dollars)

	1970	1975	1977	1978	1979	1980
United States	626.4	2 094.4	1 893.6	2 173.5	2 657.4	3 128.6
Canada	153.8	525.7	502.9	492.0	684.5	724.4
Japan a/	71.8	534.5	474.8	715.5	771.8	781.0
Belgium	93.4	305.6	424.4	397.0	482.6	432.7
Denmark	45.2	132.7	151.9	165.6	201.6	228.7
France	142.4	450.7	487.5	550.9	592.7	620.0
Germany, Fed. Rep. of	289.0	1 066.9	1 287.3	1 407.3	1 691.2	1 839.2
United Kingdom	385.3	904.5	1 074.0	1 001.4	1 219.6	1 410.0
Italy	163.0	483.5	587.0	715.5	911.6	1 078.0

Source: United Nations, Yearbook of International Trade Statistics, 1980 edition and earlier editions, volume II.

a/ Tractors only.

Table 6. Value of imports of principal importers of tractors and agricultural machinery (Millions of dollars)

	1970	1975	1977	1978	1979	1980
United States	263.9	872.0	929.9	1 084.1	1 539.7	1 490.9
Canada	217.3	993.7	1 014.7	1 015.7	1 442.2	1 453.6
Belgium	41.0	112.4	176.2	220.3	273.5	233.6
Denmark	42.8	113.4	163.6	179.9	250.5	138.9
France	197.4	561.7	615.8	811.4	939.0	1 024.5
Germany, Fed. Rep. of	91.6	245.2	314.0	410.7	472.1	490.6
United Kingdom	-	221.7	314.7	376.9	512.4	478.9

Source: United Nations, Yearbook of International Trade Statistics, 1980 edition and earlier editions, volume II.

6. The shrinking of markets is reflected in production. Production decreases, often in large proportions, for the majority of countries producing tractors and combine harvesters. One major exception is India, whose production increased by a factor of 2.4 between 1977 and 1981. The geographic distribution of tractor and combine harvester production has not been fundamentally modified. It has remained heavily concentrated in industrialized countries. The slight advance of the developing countries was assured by China and India, while the share of Latin America and Turkey declined considerably.

Most of the large transnational corporations (TNCs) have had and are still having financial difficulties. These difficulties have been made worse by the fact that their other activities - notably, the production of public works and land transport equipment - have also been floundering.

7. The difficulties assailing the world agricultural machinery industry manifest themselves differently according to the country.

- In the industrialized countries existing equipment has been simply replaced without, as in years of rapid agricultural growth, an expansion of the market for conventional equipment. In many cases the sales of high-performance equipment adversely affect sales of lower-quality or less sophisticated equipment. It is this phenomenon that is confirmed by the stagnation of the number of machines in use and the increase in the average hp of tractors and cutting width of harvesting machinery. In the Federal Republic of Germany, for example, the number of tractors in service in agriculture, forestry, and fishing remained relatively stable from 1971 (1.39 million units) to 1981 (1.47 million units) while the average hp doubled, reaching 40 hp. In France the 5,670 combine harvesters sold in 1976 represented approximately 20,000 m of cutting width; in 1981, 4,773 machines represented about 19,000 m of cutting width.[3/] The average hp of tractors sold on the United States market went from 85 hp in 1972 to 98.6 hp in 1976, then to 102.4 in 1980. In France the average hp also rose from 60 hp in 1975 to 69 hp in 1979, and to 72 hp in 1982, and sales of four-wheel-drive tractors increased both in absolute and relative value (see table 7). The success of machines of recent design goes along with the decline of older equipment. This is true for example, of round-balers compared to conventional pick-up balers, of liquid fertilizer spreaders compared to solid fertilizer spreaders, etc.

3/ R. Carillon: CEMAGREFF information bulletin, No. 297, October 1982.

Table 7. Registration of wheel-type tractors in France

	New tractor registration	Percentage of tractors with more than 65 hp	Percentage of tractors with four-wheel-drive	Used tractor registration
1975	77 770	31.8	14.3	...
1976	74 559	39.4	16.8	...
1977	62 205	47.8	19.1	...
1978	64 084	49.7	23.9	...
1979	62 382	51.0	26.0	109 678
1980	58 784	48.7	35.8	111 408
1981	53 848	53.6	42.0	111 441
1982	56 817	56.6	52.0	...

Source: CEMAGREF, Argus.

The vitality of the used machinery market, and particularly that of tractors, is one of the characteristics of the slump in the agricultural machinery industry of developed countries. The stagnation or decline of average farm income along with chronic under-use of equipment explains this vitality.

- In the developing countries - particularly those hardest hit by the world economic crisis, which deprives them of means of financing - the crisis shows that the mechanization model devised by the industrialized countries is increasingly unadapted to the real needs and purchasing power of developing countries. In order partially to cope with the second aspect, an increasingly large share of the market is supplied with used tractors and machines imported from countries of the European Economic Community, where a vast collection, repair, and distribution network has been organized. This is especially the case regarding North Africa, Black Africa, and the Middle East.

8. The crisis in the agricultural machinery industry has not, however, adversely affected the capital goods or metal-mechanical equipment used in agricultural production. While sales of conventional mobile equipment designed for large-scale mechanized crop farming (cereals, oil seeds, cotton, industrial plants) are stagnating or declining, those of equipment designed for the more complex systems of agricultural production (specialized mobile equipment) or the more intensive systems (fixed equipment for pre- or post-harvest treatment and processing) continue to rise.

This is true, for example, of grape harvesting machines, dairy production equipment, animal feed preparation equipment (grinders, etc.), storage facilities (grain silos, etc.), transport and handling equipment, and so on. This diversified machinery and equipment is designed for farms in industrialized countries. The market for home and garden equipment - garden tractors, lawn mowers, power cultivators and harrows, chain saws, etc. - also continues to be good but only marginally helps the agricultural machinery industry as it is traditionally defined.

In developing countries the production and sales of hand tools and animal-drawn and simple machines continue to grow (see table 8). This is the case, for example, for portable sprayers, power cultivators, hoes and harrows, irrigation and transport equipment, and equipment for storage and pre-processing of agricultural products. The use of this equipment is compatible with the presence of a large labour force. It accompanies the growing intensification of agricultural production, and it is increasing, particularly, in those agricultural production lines with solvent outlets (agriculture near urban centres), specialized agriculture, and the agriculture of the newly industrialized countries (NICs). The production of this equipment is poorly inventoried and not well known; it is produced by small-scale and medium-scale industries often located in the NICs (Brazil, India, Mexico, Republic of Korea, Spain, etc.).

9. The manufacture of hand tools and simple machines in developing countries is not yet expanding as it should. The pursuit of large-scale production has gone against diversity of demand. The development of new multi-purpose simple machines, some with motor attachments, still remains insufficient, which has led the countries involved not to give priority to these goods, but to go directly to the heavy mechanization model, with all its drawbacks.

Still, it is apparent and generally admitted that the needs for such equipment are great and that the industrial capacity to produce the necessary equipment exists. However, as these needs are poorly formulated, and consequently poorly analysed, and production capacity poorly inventoried, there is a clear imbalance between supply and demand. This maladjustment remains the principal cause of the stagnation or failure of these production lines in developing countries.

Table 8. Developing Africa's imports of agricultural machinery, 1973-1979
(Thousands of dollars)

Year	Group	Hand tools a/	Tractors b/	Other c/	Total
1973	All developing Africa	14 366	142 092	77 595	234 053
	of which:				
	Sub-Saharan countries	11 189	93 389	36 171	140 749
	LDCs	3 472	25 609	14 168	43 249
1974	All developing Africa	20 016	227 215	102 724	349 955
	of which:				
	Sub-Saharan countries	16 310	129 389	50 506	196 205
	LDCs	5 193	36 533	19 183	60 909
1975	All developing Africa	28 934	366 026	166 723	561 683
	of which:				
	Sub-Saharan countries	25 644	224 632	83 983	334 259
	LDCs	10 113	50 354	32 026	92 493
1976	All developing Africa	28 859	349 012	134 477	512 348
	of which:				
	Sub-Saharan countries	25 482	235 268	73 785	334 535
	LDCs	9 018	41 480	26 301	76 799
1977	All developing Africa	34 682	441 983	167 338	644 003
	of which:				
	Sub-Saharan countries	28 912	296 793	107 169	432 874
	LDCs	10 079	50 113	30 040	90 232
1978	All developing Africa	42 274	525 126	213 613	781 013
	of which:				
	Sub-Saharan countries	37 095	270 975	135 635	443 705
	LDCs	14 831	46 084	41 328	102 243
1979	All developing Africa	32 004	293 481	193 623	519 108
	of which:				
	Sub-Saharan countries	25 504	171 195	101 450	298 149
	LDCs	8 166	60 115	44 282	112 563

Source: United Nations Statistical Office, New York.

a/ SITC 695.1.

b/ SITC 712.5.

c/ SITC 712 less 712.5.

It is true that the use of hand tools or simple machines, usually animal-drawn, is the only possible alternative for more than 2 billion agricultural workers, i.e. more than two thirds of the world agricultural population. This equipment remains a possible outlet for a metal-mechanical industry organized in small and medium-sized, often versatile, enterprises.

It can be said that this portion of humanity is excluded from the conventional models of mechanization as determined by the agricultural machinery industry, but it can also be said that the production of the agricultural machinery industry in the strict sense of the word meets only a small part of the equipment needs of most third world farmers. This may be due to a lack of solvency, to agricultural production structures poorly adapted to the norms imposed by the use of heavy machinery, or more generally, to the inadequacy of mechanical solutions in overcoming the limitations of production.

II. MONOLITHISM AND DIVERSIFICATION OF MECHANIZATION

The current situation reveals the limitations involved in the diffusion of a mechanization model dominated by tractorization. In spite of the potential outlets which exist in developing countries, the agricultural machinery industry remains specialized in the tractor/tractor-drawn machine unit. It has failed to grasp the new market conditions and is not receptive to other industrial sectors.

The economic difficulties related to the worsening of the world crisis have apparently not caused the agricultural machinery industry to question its fundamental orientations. On the whole it remains geared to strategies of commercial expansion (periodical renewal of models; competition and winning markets) aimed at generalizing the model of heavy mechanization developed in the industrialized countries. The industry continues to ignore the diversity of agricultural demand for metal-mechanical capital goods from the most intensive and least solvent agriculture. See table 9.

Four specific types of demand should be distinguished (see table 10):

- Extensive farming in industrialized countries (Australia, Canada, United States, etc.);
- Intensive farming in developed countries (Western Europe);
- Extensive farming in newly industrialized countries or developing countries (Brazil, Sudan, etc.);
- Intensive farming in developing countries (South-East Asia, Egypt, etc.).

These specific characteristics have repercussions on the range of metal-mechanical capital goods used in agricultural production and on the nature of the agricultural machinery industry.

A. Extensive mechanized farming

10. The mechanization of extensive farming or heavy mechanization affects all agricultural productions - primarily vegetal - which can be industrialized and have international commercial markets. Mechanization has shaped the processes of agricultural production in such a way as to break them down and simplify them to allow the use of specialized machines behind a

Table 9. Diversity of agriculture

Geo-economic region	Nature and yield of most productive cereal		Population (in 10^9)	Agricultural area in use (AAU) (in 10^6 ha)	Per capita AAU (m^2)	Per capita daily availability of food (kcal)	Per capita commercial consumption of energy in 1979 (tEP)	1979 per capita gross domestic product in dollars
	Nature	100 kg/ha						
North America	Corn	68.3	0.244	501	20 530	3 300	7.8	10 000
Western Europe	Wheat Corn	35.4 49.7	0.370	168	4 540	3 250	2.9	8 000
Eastern Europe	Wheat	17.4	0.375	668	17 815	3 400	3.9	4 000
Developed Oceania	Rice	63.5	0.017	503	295 880	3 200	...	7 000
Other developed countries (Japan, South Africa, etc.)	Rice Wheat	62.4 13.2	0.148	102	6 890	2 600	2.35	4 000
Developing Africa	Corn	9.1	0.366	836	22 840	2 200	0.16	600
Central and South America	Corn Wheat	15.8 14.4	0.359	675	18 800	2 520	0.64	1 500
Near East	Rice	42.4	0.211	348	16 490	2 210	0.46	3 000
Developing Asia	Rice	20.7	1.215	299	2 460	2 220	0.23	250
China and Democratic People's Republic of Korea	Rice	34.6	1.024	462	4 510	2 350	0.49	300
Other developing countries	Rice	55.7(5)	0.005	2	4 000	...	...	1 000
All countries	Wheat Corn Rice	17.8 32.7 26.2	4.335	4 564	10 530	2 750	1.38	2 000

Sources: Statistical data: FAO, World Bank, Comité professionnel du pétrole (according to R. Carillon - CNEEMA).

Table 10. Models of mechanization

	Percentage of population in farming (%)	Arable area per farmer (ha)	Number of tractors per 100 farmers	Number of arable hectares per tractor
1. Extensive mechanized farming				
United States	2.3	37.8	85.7	43.5
Canada	6	31.1	46.8	66.5
Australia	6	49.2	38.4	128.1
Argentina	14	6.7	5.5	122.4
USSR	20	4.3	4.8	89.3
2. Intensive mechanized farming				
Denmark	8	6.5	46.4	13.9
United Kingdom	2.7	4.6	27.9	16.5
Netherlands	6	1.0	20.6	4.8
Israel	8	1.1	8.5	12.7
Japan	13	0.29	8.0	3.6
3. Extensive, little mechanized farming				
Brazil	40	0.68	0.67	100.9
Algeria	50	0.72	0.56	128.0
Mexico	35	0.89	0.47	190.4
Saudi Arabia	60	0.21	0.02	945.5
4. Intensive little mechanized farming				
Sri Lanka	55	0.13	0.27	47.5
China	60	0.17	0.12	1 148.2
Viet Nam	70	0.15	0.08	200.0
India	65	0.39	0.07	530.7
Bangladesh	80	0.13	0.006	2 174.4
Rwanda	90	0.17	0.002	8 658.5

traction vehicle. The use of this model requires large areas of land and crop simplification. It goes hand in hand with a small labour force, whose working conditions are progressively assimilated to those of industrial labour. It appears to be operational wherever there is sufficient arable land, large amounts of capital, and a small labour force. All other things being equal, it implies high salaries and relatively low land prices justifying the rapid substitution of capital for labour. The use of the heavy mechanization model has a cumulative effect on the capitalization of land: the heavier and more powerful one's tractor is, the more land is required to pay it off; and the more land one has, the more one needs of this type of equipment.

The heavy mechanization model has shown itself to be particularly fragile, notably in times of slow economic growth: the prices of mechanical equipment increase faster than the prices of the agricultural products that it helps to put on the market. The investment induced by the use of the heavy mechanization model (land investment) increases faster than the productivity of the land. See table 11. Moreover, heavy mechanization appears increasingly unadapted to a complex production process of which it has lost control (technical maladjustment).

Table 11. A model of heavy mechanization: the United States trends for some symptomatic indicators

	Agricultural population (millions)	Average price of farm land (dollars per acre)	Average farm size (acres)	Percentage of farmland devoted to export crop production
1950	23.0	65	210	14.5
1960	15.6	117	295	19.8
1970	9.7	196	375	24.6
1975	...	340	395	30.3
1980	7.5 a/	720	405	33.0

a/ 1979.

Table 11 (continued)

	Average horsepower of tractors sold	Average cost of 100 hp tractor (bushels of wheat)
1972	85.0	...
1973	90.1	3 333
1975	98.7	3 583
1979	102.8	6 314
1980	102.4	6 148

Source: United States Department of Agriculture.

Heavy mechanization has shaped agricultural production techniques. It has shown itself to be technically efficient in increasing agricultural production within a relatively short period of time. This explains its particularly rapid diffusion in all developing countries with adequate purchasing power - oil-producing countries and newly industrialized countries - which have given priority to their agriculture or are trying to develop agro-export programmes quickly (Argentina, Brazil, Sudan, Thailand).

B. Intensive mechanized farming

11. The mechanization of intensive farming in industrialized countries is much less advanced. Technical and social limitations require a more pin-pointed and more complex form of mechanization. Mechanization penetrates progressively into the agricultural production process by way of specialized machines and mechanical equipment. It is associated with, rather than substituted for, the agricultural labour which controls it. Moreover, it is linked to and shaped by the intermediate inputs of chemical and genetic origin that it uses. It is more diversified and affects all operations of the agro-food production process, from the equipment of buildings or land to animal or plant production and post-harvest processing. See table 12.

This diversity has its counterpart in the mechanical equipment industry which designs and produces these specialized machines. The small-scale production and specificity of the equipment contrast with the mass production of the heavy mechanization model and account for the large number of small and medium enterprises, many of which verge on being cottage industries. While some of them are dependent on the dynamics of the heavy mechanization model,

Table 12. Diversification of production of machinery and agricultural equipment in France

The importance of soil cultivation and fixed equipment compared to that of traction and harvesting equipment (% of value)

	Agricultural production equipment/ tractors a/	Harvesting equipment/ tractors b/	Post-harvest equipment/ harvesting equipment c/
1960	28	47	35
1970	55	69	72
1975	46.3	55.1	73
1980	43.0	40.6	88.2

Source. National Institute of Statistics and Economic Studies (INSEE), France.

a/ Soil cultivation equipment - seeders, planters, fertilizers - crop production equipment.

b/ Harvest equipment (grain, straw, fodder, other productions).

c/ Equipment used in processing, animal husbandry, wine- and cider-making, dairy farming, and farm storage.

Portions of various kinds of equipment in annual investment (% of value)

	Tractors	Cultivating equipment a/	Harvest equipment	Post-harvest equipment b/
1960	0.45	0.13	0.21	0.07
1970	0.32	0.18	0.22	0.16
1975	0.36	0.17	0.20	0.18
1980	0.39	0.17	0.16	0.17

Source: INSEE.

a/ Soil cultivation equipment - seeders, planters, fertilizers - crop production equipment.

b/ Equipment used in post-harvest processing, animal husbandry, wine- and cider-making, and dairy farming.

their products are, on one hand, more easily adapted to the requirements of more diversified farming, and on the other hand, more attuned to the needs of developing countries. In the strict sense, they cannot always be defined as being part of the agricultural machinery industry, but they meet needs just as important as production itself, such as on-site preserving or processing of agricultural products, recovery and use of agricultural and food by-products, transport and handling, rural equipment, and the manufacture of inputs for agricultural production.

The size of the industrial firms which market them is well suited to that of the small and medium-sized unspecialized farms and the variety of their needs. Is it due to these factors that the specialized machine and equipment industries have stood up better to the effects of the economic crisis, or is it due to the fact that agriculture on the whole remains predominantly a small-scale production process strongly linked to the existence of decentralized rural communities?

Whatever the case, it is clear that mechanization occurring in a localized way and affecting the whole agro-food production process, rather than operating by way of a coherent production process and affecting only agricultural production in the strict sense, as is the case for heavy mechanization, cannot be ignored when one considers the mechanization of agriculture. With the diversification of agricultural production, the agricultural machinery industry is obliged to widen its field of activity considerably. But the predominance of the mechanization model and its technological boundaries have limited or blocked such a widening up to now. In most cases adapting the traditional technical routes will not be sufficient. The principal obstacles will probably only be removed by innovations from technologies from sectors other than agricultural machinery: electronic control and monitoring systems for the "management" of livestock, gathering robots for market-garden crops, video locating and laser cutting in tree farming.

C. Intensive farming with little mechanization

12. Intensive farming with little mechanization reveals the real limits of the heavy mechanization model. Technically speaking this model is poorly suited to the requirements of the form of agriculture in question, and

can no longer be seen as the key to higher agricultural productivity. Intensification, which is a direct consequence of the growing scarcity of land suited to agricultural production, but is paradoxically considered one of the obstacles to heavy mechanization in developing countries, has for several years now been emerging as an important option for industrialized countries. The land area used in agricultural production is growing increasingly smaller, and increases in productivity depend on the growing use of intermediate inputs of chemical or biological origin. Mechanization now appears to be nothing more than one component of the technical model, and it is much more subject to the constraints of the biological process than before. In industrialized countries at least, machines and mechanical equipment are integrated into complex production schemes, if not replaced by electric, electronic, or chemical systems. In Asia, notably in the Republic of Korea and on the island of Taiwan, intensification appears to be based on a large agricultural work-force for a small surface area, often less than one hectare per household (see table 13). It is obvious that the small average size of farms considerably restricts mechanization outlets, even for simple machines and equipment such as mechanical sprayers, transplanting machines and rice threshers. However, this type of farming provides great prospects for the sales of portable or mobile equipment (portable sprayers, transport equipment, power cultivators).

Forced intensification (developing or industrialized countries with limited land availability) or deliberate intensification of agricultural production leads simultaneously to a relative decline and a redefinition of mechanization. Thus, it does not really affect the agricultural machinery industry as such, nor the manufacture of specialized capital goods for agricultural production. It affects the industries situated both upstream and downstream from agricultural production, e.g. the agro-food capital goods industry, the electrical and electronics industries, the fine chemicals industry - plant protection, pharmaceuticals, genetics. The range of new mechanical products depends on a research and development policy independent of the agricultural machinery industry. The use of these products affects industrialized as much as developing countries. It is closely linked with the implementation of agricultural programmes involving irrigation, the extension of animal and plant production away from the land (in buildings),

Table 13. An example of intensive farming with little mechanization: Republic of Korea

	Area under cultivation (thousands of hectares)			Total agricultural population (thousands)	Percentage of total population in agriculture	Annual consumption of fertilizer/ha (kg)	Number of machines/1 000 ha			
	Irrigated	Dry	Total				Cultivators	Pumps	Grinders	Reapers
1965	-	-	-	15 812	55.1	104.5	...	...	...	...
1976	1 098	1 150	2 248	13 153	36.7	200.8	54.3	38.1	73.0	64.4
1981	1 216	987	2 203	11 702	30.2	215.0	158.9	59.0	122.6	77.2

Source: Republic of Korea, Ministry of Agriculture and Fisheries.

policies for the use of animal and plant by-products, increasing energy and protein self-sufficiency for agricultural production, techniques for developing non-food uses and the exploitation of plant, tree, and fish biomass.

This range of products corresponds to considerable needs at the world level, needs likely to increase in view of the growing gap between land available and food needs for many countries.

D. Extensive farming with little mechanization

13. The metal-mechanical equipment of extensive farming with little mechanization is based on the use of hand tools and simple machines better adapted, it would seem, to the technical and financial limitations of most third world farmers. The progressive industrialization of these manufactures may be good from the industrial point of view, but it is not always so for farmers. The extreme diversification of traditional tools corresponds to the diversity of soil and agricultural production techniques; this diversity is rarely taken into consideration by the hand tools industry in its mass production.

The range of simple machines in traditional agriculture too often imitates that of motorized agriculture. The range of these machines remains too narrow and is too much determined by the requirements of "modern farming". Some equipment associated with the use of other industrial products (fertilizers, plant protectives) is over-stressed, while the dissemination of equipment simultaneously satisfying the needs of farmers and of rural dwellers (preservation, pre-processing of harvests, handling and transport machines and equipment, pumps, small, versatile mechanized cultivation) continues to be inadequate. Thus, national industries specialized in the production of these machines are all too often unable to sell their products. There is often an imbalance between the industrial capacity of these workshops or factories and real demand, farmers preferring then to turn to local iron-smiths or imported equipment considered to be of higher quality. For this category of machines and simple equipment, mistakes in the evaluation of local needs more often explain industrial difficulties than do the effects of the world economic crisis.

14. The combination of these four mechanization models is found to be common when one analyses the realities of agriculture at the geographical and

political level. Agricultural growth in industrialized countries depends on the simultaneous use of the following:

- Heavy tractors and harvest machinery for the production of cereals and industrial plants (oilseeds, sugar, textile plants) for the domestic or external market;
- Specialized fixed equipment or machinery for mixed crop farming and animal husbandry systems;
- Mechanical equipment used in production away from the land (table 14).

The growth of agriculture in developing countries is too often reduced, on the one hand, to the use of large-scale farming equipment for crop production of substantial dimensions (the output being consumed domestically, or, more often, exported), and on the other hand, to the use of hand tools in food production. The ranges of these two large categories of equipment are very different, compromising the effects of any potential combined approach by industry. The tractor industry and the hand tools industry have no common points, and there is no practical way of moving from one to the other. The mechanical capital goods industry of developing countries is usually excluded from the manufacture of large-scale farming equipment and too often limited to supplying products whose manufacture does not allow it to master new techniques. It is in fact rare for developing countries to master the four major stages in the specific production process of the engineering industries, i.e. forging/smelting, welding, machine finishing of complex mechanical units (engine-blocks, transmissions, etc.), and their assembly. The exceptions are those countries which have a locally integrated engineering industry and produce agricultural tractors, trucks, public works and handling machinery, and so on. Consequently, as national agricultural needs increase in regard to more specialized and more intensive farming, it is not surprising that the metal-mechanical industries of the least developed countries (LDCs) should progressively become dominated by foreign manufacturers, even though the industrial and technological infrastructure often appears sufficient for the mastery of the manufacture of these products.

For developing countries it is apparent that the transition from one mechanization model to the other depends on their ability to implement a voluntarist agricultural and industrial policy. The possibility of creating

Table 14. Diversity of demand for metal-mechanical capital goods

	Typical agricultural production	Form of production	Metal-mechanical capital goods used	Type of agricultural machinery industry	Typical country
1. Extensive mechanized farming	Cereals Industrial plants	Large farms Labour-saving	Tractors, tractor-drawn and self-propelled equipment	Transnational corporations (TNCs)	United States Canada
2. Intensive mechanized farming	Polyculture Livestock	Small or medium capital-intensive farms	Tractors, tractor-drawn equipment, fixed farm equipment	TNCs Small and medium industrial enterprises	Denmark Netherlands
3. Extensive little mechanized farming	Industrial plants Extensive livestock farming	Large labour-using farms	Tractors and self-propelled equipment	TNCs	Brazil Sudan
4. Intensive little mechanized farming	Rice Related food crops	Small and very small labour-using farms	Hand tools Simple machines Light mechanized cultivation	Small and medium enterprises (artisanal and industrial)	Egypt Republic of Korea

or strengthening an agricultural machinery industry or diversified equipment industry, in the medium and long term, depends on the implementation of this policy. It should be emphasized, however, that the extent to which the developing countries, and more particularly the LDCs, are free to choose and promote an agricultural production model is strongly linked to the world geopolitical context and the degree of these countries' integration in international economic relations.

III. STRATEGY OF FIRMS AND LIKELY FUTURE OF THE AGRICULTURAL MACHINERY INDUSTRY

15. The abrupt fall of the price of raw materials on international agricultural markets and the equally abrupt rise of production costs have provoked a price squeeze in recent years and contributed to a drop in the incomes of farmers in industrialized countries (see table 15). With growing indebtedness added to everything else, demand responds less now to drops in the price of equipment designed to stimulate the market. These factors, along with those mentioned previously, aggravate the short and medium-term difficulties of the agricultural machinery industry.

These depressive factors are considered by some to be cyclical; many people, however, take the view that they go hand in hand with a profound change in agricultural production techniques. The main characteristic of this change appears to be the gradual decline of the dominant role of mechanization in agricultural production techniques. Thus, the decline in the number of hours of use per tractor or harvest machine, particularly for combine harvesters, is not simply due to increases in their performance - speed and drawing power for tractors and speed and cutting width for harvesters - but is increasingly linked with a different utilization of these machines in all stages of agricultural production. This means light ploughing and equipment "trains" in soil preparation, increased use of liquid, gaseous, and microgranulated products in fertilization, direct planting of seeds, micro-spraying in crop treatment, green silage for the harvest. These agricultural techniques have been made possible by the growing use of industrial products designed to "save" mechanical labour. These "savings" are obtained by reducing the number of passes, lightening tractor-drawn equipment, developing self-propelled equipment, and using new fixed and mobile equipment. Thus in more intensive and more modern farming, mechanical labour is not just decreasing in intensity, but also progressively changing its forms.

Tractors and tractor-drawn machines are no longer the only alternative for increasing agricultural production. Competition between mechanical methods and chemical methods is increasing. Intensification and the desire to make better use of available land (absolute or relative scarcity of land resulting from its relative price) are modifying the range of equipment.

Table 15. The price squeeze

Price indexes in constant francs a/

	Agricultural prices	Intermediate consumption
1970	100	100
1971	98.8	101.4
1972	106.1	100
1973	109.1	104.9
1974	102.5	117.5
1975	98.3	113.0
1976	100.7	109.4
1977	98.9	110.0
1978	93.0	105.6
1979	89.7	104.9
1980	85.5	109.0
1981	85.2	110.6

a/ These indexes were obtained using the annual indices of agricultural accounts. They were deflated using the gross domestic product price index.

16. These immediate difficulties, but especially the unfavourable prospects for an agricultural machinery industry specialized in the range of heavy implements derived from the extensive model, are threatening the large multinational companies. These companies still clearly dominate the world market, providing nearly 75 per cent of the production of tractors and 95 per cent of harvesters, but they are poorly equipped to deal with the challenge of mechanical diversification.

As the market progressively dwindles, even in the industrialized countries which provide the bulk of outlets, competition increases even for the most common products. The number of companies capable of producing tractors remains too large, taking into account the paying capacity of world agriculture. There is strong pressure on prices, paradoxically favouring the purchasing countries. This pressure leads to competition in price-cutting, fostered by the distribution circuits which are directly threatened by the decline of farmers' purchasing power.

17. The most organized companies at the world level are trying to control the world market by stepping up technical, economic, and commercial agreements. Operations of this type have been increasing for the last 10 years and may no doubt be explained by the fact that the big multinational companies prefer to remain in a field where they have sound experience rather than embark on a diversification which they may consider risky in the context of the world economic crisis. This preference is also based on an optimistic perception of world demand for tractors and harvesters, firstly because the agricultural machinery in industrialized countries will inevitably have to be renewed, allowing a technical recovery, and secondly because the growth in world food demand cannot be properly covered without the revival of heavy mechanization programmes.

Their conviction is so strong that some of the big multinationals have preferred to cancel all or part of their diversified activities - gas turbines (transfer to Caterpillar in 1980) and public works equipment (transfer of American units to Dresser Industries in 1982, and of Yumbo to French management) in the case of International Harvester, which is also planning to sell its stock in Sedron Trucks (United Kingdom), Daf (Netherlands), and Enasa (Spain), which produce trucks in Europe, big diesel motors in the case of Massey-Ferguson and civil engineering equipment in the case of the Fiat group (reassigned to Allis Chalmers) - in order to allow them to keep their agricultural machinery activities in spite of everything. Meanwhile, many medium range manufacturers are preparing to broaden their production to include horsepowers above 100, and Volvo, which up to now has not been involved in the agricultural machinery industry, is officially planning to enter it in order to diversify outlets for its production. See tables 16, 17 and 18.

18. This specialization of industrial machines goes along with the multiplication of technical, economic, and commercial agreements which began 10 years ago and is growing:

- The sharing of the range by large manufacturers under one commercial label. International Harvester sells its whole range of tractors under its trade mark in this way, but the 18, 21 and 24 hp tractors are produced in Japan by Mitsubishi. Ford, Massey-Ferguson, and John Deere subcontract the manufacture of less powerful tractors to Ishikawajima, Kubota, and Yanmar respectively. Fiat has turned over the manufacture of special tractors to Carraro.

Table 16. Principal producers' shares of world market in tractors for 1980

	Number of machines	Percentage
Massey-Ferguson	120 000	15.0
John Deere	95 000	11.5
International Harvester	88 000	10.7
Ford	80 000	9.7
Fiat	55 000	6.7
Same	30 000	3.6
David Brown/Case	28 000	3.4
Deutz	25 000	3.0
Volvo Valmet	18 000	2.2
Renault	13 000	1.6
Fendt	12 000	1.4
Other	256 000	31.0
Total	820 000	100.0

Source: Centre d'intervention sociale et économique (CISE).

Table 17: Turnover of principal manufacturers of agricultural machinery in 1980 (in millions of dollars)

	Country of mother-firm	Turnover for agricultural branch in 1981
John Deere	United States	4 665
International Harvester	United States	2 979
Massey-Ferguson	Canada	1 587
Ford	United States	n.a.
Fiat	Italy	1 173
New Holland Sperry-Rand	United States	1 087
Kubota	Japan	951
Allis-Chalmer	United States	700
K.H.D.	FRG	505
Renault-DMA	France	314
Claas	FRG	309

Source: Company reports.

Table 18. Distribution of turnover of principal manufacturers by sector of activity in 1979

MASSEY-FERGUSON		FORD		JOHN DEERE	
Agricultural equipment	93.4%	Automobile	91.7%	Agricultural equipment	79.8%
Industrial equipment	6.6%	Agricultural equipment	4.8%	Industrial equipment	20.2%
		Other a/	3.5%		
INT. HARVESTER		**TENNECO**		**SPERRY CORPORATION**	
Trucks	47.3%	Petroleum extraction	27.0%	Data processing	49.0%
Agricultural equipment	36.6%	Natural gas	26.0%	Agricultural equipment	20.9%
Industrial equipment and civil engineering	11.9%	Chemical products	12.0%	Control and guidance systems	15.9%
Gas turbines	4.2%	Agricultural equipment (Case D. Brown)	18.0%	Hydraulic equipment	10.3%
		Naval construction	7.0%	Other	3.9%
		Packing	5.0%		
		Other	5.0%		
KUBOTA		**RENAULT**		**FIAT b/**	
Agricultural equipment	39.3%	Automobile	70.4%	Automobiles	45.0%
Pipes and tubes	28.9%	Transportation and other	11.0%	Industrial vehicles	20.6%
Factory engineering	20.9%	Spare parts vehicles	10.0%	Civil engineering	7.8%
Household equipment	10.9%	Small utility vehicles	4.0%	Agricultural tractors	6.0%
		Agricultural equipment	3.4%	Components	5.2%
		General mechanical	1.2%	Steel	4.3%
				Public transport	4.0%
				Machine tools - energy	2.1%
				Railway - tourism	1.5%
				Other	3.5%

Source: Companies' annual reports.

a/ Includes trucks, aerospace and communications.

b/ For 1980 - In Tracteurs et machines agricoles, No. 792, March 1982, p. 151.

- The intensification of cross-supplying of components and parts among the large manufacturers. International Harvester and Massey-Ferguson signed an agreement in 1983 which could lead to the production of cabs and foundry components by the former and the manufacture of transmissions and traditional combine harvesters by the latter. Renault is negotiating the delivery of live axles produced in its adaptable workshop at Le Mans to International Harvester in exchange for the finishing of cast components for automobiles. John Deere has said that it is prepared to supply 35 to 150 hp diesel motors to manufacturers implanted in France (Renault, International Harvester, and Massey-Ferguson). Fiat is associated with Tecumseh Products (United States) for the production of small two- and four-stroke motors.

- Multiplication of marketing agreements with small and medium enterprises for tractor-drawn machines. The large manufacturers do not produce these machines, but they would like to appear to be the only firms capable of providing the most complete machine kits. By way of these specialized machines they hope to penetrate markets which they have not penetrated before. Their partners in these marketing agreements are easy enough to convince as they themselves are often in difficulty and do not have the financial means required to set up effective export structures. For most of these small and medium enterprises of the machinery industry, the tractor manufacturers are increasingly necessary for broadening their industrial or commercial implantation in foreign countries, and more particularly in NICs or developing countries.

19. In addition to strengthening technical and commercial organization, in order to defend positions threatened by new producers (NICs, countries of Eastern Europe, small and medium enterprises, components manufacturers), the large manufacturers are thoroughly reorganizing their industrial infrastructures. The concentration of machines, the closing of factories, and the consolidation of units throughout the world indicate that the large firms are falling back on their strongest bases. International Harvester is concentrating its units of production in the United States, France, and the Federal Republic of Germany and giving up its factories in Latin America, Asia, and Australia. Massey-Ferguson has also begun to reorganize its structure and is planning to shut down its Detroit unit (United States). The activity of this unit would have to be transferred to Canada (four-wheel-drive tractors)

or to Europe. For Massey-Ferguson, Europe will become the principal centre of tractor production. John Deere has concentrated all of its European research and production for fodder equipment at Arc les Gray (France). Ford has specialized its factory at Aaveris (Belgium) in the assembly of top line tractors and the production of rear axles, while its factory at Basildon (United Kingdom) has taken over the assembly of bottom line tractors and the production of motors and hydraulic lifts.

20. This geographical concentration is accompanied by a change in production techniques and the growth of a subcontracting network. It also facilitates the introduction of automatons and robots into the industrial production process. All of the manufacturers' efforts are intended to increase the scale of production and productivity. These economic constraints spur technological and organizational innovation at all levels of the production process, e.g. design (computer aided design), production in the strict sense (robots, adaptable workshops, computer aided production), administration and management (office computers). This movement has already begun, but should speed up quickly to keep pace with developments in other sub-branches of the mechanical industry (construction of public works equipment, trucks and handling machinery, etc.) which are technically and commercially very close to the agricultural machinery industry.

21. It is clear that the aim of all the efforts of the transnational corporations to reduce production costs, or at least to slow their increase, and to improve the quality and reliability of equipment is to protect the privileged position of these corporations.

The tractor, combine harvester, and conventional tractor-drawn machine manufacturers have already completely mastered the common technological channels, and it is not in their best interest to encourage the emergence of alternative technology to their own equipment by helping to promote "disruptive" innovations. It is in their interest to proceed with progressive technological improvements in their products, adapting them to the economic, social, and agronomical constraints which determine farmers' demand for equipment. These improvements may render even their most recently designed machines obsolete, but they will give new impetus to the firms' activities. And they will also delay the emergence of truly competitive innovations.

The technological evolution of equipment designed for large specialized farming should occur on the fringe of the agricultural machinery industry, but it should be adapted to the logic of the dominant model it is designed to sustain: improved performance (speed, capacity, etc.), greater comfort, reduced utilization and maintenance costs, improved control of tractor-drawn and specialized machines. In this way the introduction of electrical and electronic components in conventional material and equipment tends to better adapt the heavy mechanical tools to the variability of agricultural production conditions, to simplify the construction of equipment (microcircuits reduce the number of mechanical components), to improve the reliability of equipment and reduce maintenance costs, but especially to allow the designer to get ahead of the competition. Thus, the race for complex equipment is not over, even if powerful tractors and high-capacity machines are now finding fewer buyers. The transnational corporations are not ready to give up their positions and are trying, through electronics for example, to protect their positions as specialists. Cornering the market on the basis of mass produced equipment which changes very little technically is and should remain their principal objective. There should nevertheless be undeniable progress in the fields of comfort, tractor-machine coupling, information control (speed, plough depth, amount of fertilizer or plant protective spread, energy consumption, etc.).

22. Thus, most of the small and medium enterprises have fallen back on the markets of industrialized countries, whether their sales depend on the diffusion of the heavy mechanization model or the use of equipment and fixed capital goods in more intensive farming. The markets of industrialized countries remain more attractive because they are better known than those of developing countries, there is less risk involved, and the needs are better understood. To explain and justify the limits to their internationalization (production or simple marketing) the small and medium enterprises advance their weakness in approach, understanding, and control of the so-called "large export" markets and the relative insolvency of developing countries. That the transferred technology, developed according to the extensive agricultural model, is chronically unadapted to agriculture in these countries is rarely considered to be an obstacle. The most dynamic small and medium enterprises in developing countries remain those that market the simplest equipment, such as hand tools and portable sprayers. But these firms are still not prepared to transfer their technology or set up locally integrated production units.

In any case, despite the slump, demand in industrialized countries remains steadier for these firms than the demand for tractors and harvesters. Mechanization has so far had little effect on specialized productions and animal husbandry. Many Western countries are seeking to intensify agriculture, questions are being raised about certain agricultural techniques, some countries are seeking more autonomy in energy and food, the wage-earning agricultural labourers which had until now obviated handling and surveillance equipment are becoming scarcer, and attempts are being made to improve working conditions - all these are factors in favour of the integrated production of agricultural machines and tools growing and diversifying. The variety of needs and the search for gaps should widen the range of specialized machines and equipment.

23. The technological prospects differ according to the category of machines and material and also according to the agricultural model for which they are designed.

Among the most widespread mechanization models at the moment, three categories may be distinguished:

- The most widely-used equipment, for which the pre-eminence of conventional technical channels should continue. As is the case for large-scale farming machines, the aim of innovations should be the perfecting of equipment. These improvements could be obtained not by the addition of sub-systems, but by the substitution of newly designed mechanical equipment for old techniques. For example, the round-baler is tending to replace the conventional pick-up baler.

- The newest equipment designed for agricultural productions which have only recently been affected by the mechanization model (green silage, viticulture, etc.). Most of the machines and equipment available may be considered first generation equipment, and significant innovations can be expected with the systematic application of electronic control devices. The principal obstacle to the large-scale diffusion of efficient electronic modules in agricultural as well as industrial fields is still the unavailability of reasonably priced pick-ups adapted to specific uses.

- Finally, miscellaneous equipment (handling, transport, storage, processing) which, like the most widely-used equipment, should only undergo minor improvements designed essentially to lower the relative price.

With respect to more intensive farming, the unsuitability of machinist logic should prove to be an important factor in inciting major technological innovation, inspired and perhaps generated by advances made in scientific fields outside those which produced the mechanization model, i.e. chemistry, genetics, electronics, optics, metrology, automatics, and biomechanics. Mechanical, hydraulic, and thermal systems will certainly not disappear, but they will come to serve the sub-systems derived from the above-mentioned disciplines.

24. Unlike tractor and harvester manufacturers, the small and medium enterprises producing specialized material and machinery have no immediate need of a world market to pursue their activity. In fact, the risks involved in such an internationalization of their outlets could well seem to them to outweigh the possible advantages. A simple rise in the average income of farmers in industrialized countries would be sufficient for a recovery to begin, in which case their short- and medium-term objectives would be achieved since the markets of industrialized countries are far from being saturated with this equipment.

25. On the other hand, the opening of the world market would help the manufacturers of agro-food equipment. The needs of developing countries are enormous because they accumulate the needs of agriculture, food processing, and rural development; among these needs are fixed capital goods designed for pre- or post-harvest treatment and processing, specialized transport equipment, and equipment designed to make new use of the agricultural biomass.

The technical organization of world agro-food production impedes the diffusion of this new equipment, but the prospects of diffusion appear better in developing countries, where this equipment could contribute to the success of food self-sufficiency policies as well as those of integrated rural development.

IV. FOUR DEVELOPMENT SCENARIOS FOR THE AGRICULTURAL MACHINERY INDUSTRY IN NEWLY EMERGING COUNTRIES

26. The prospects for the agricultural machinery industry cannot be separated from the geopolitical, industrial, and financial context which dominates international exchanges.

Particularly in newly emerging countries, these prospects must be related to three developments concerning agricultural production:

(a) The general decline in the growth rate of world agricultural production over the last 30 years (table 19);

(b) The growing role of industrialized countries in international exchanges of agricultural raw materials;

(c) The decline of arable surface area per agricultural worker over the last 20 years - except for Latin America - reflecting a forced intensification of agricultural production (figure II).

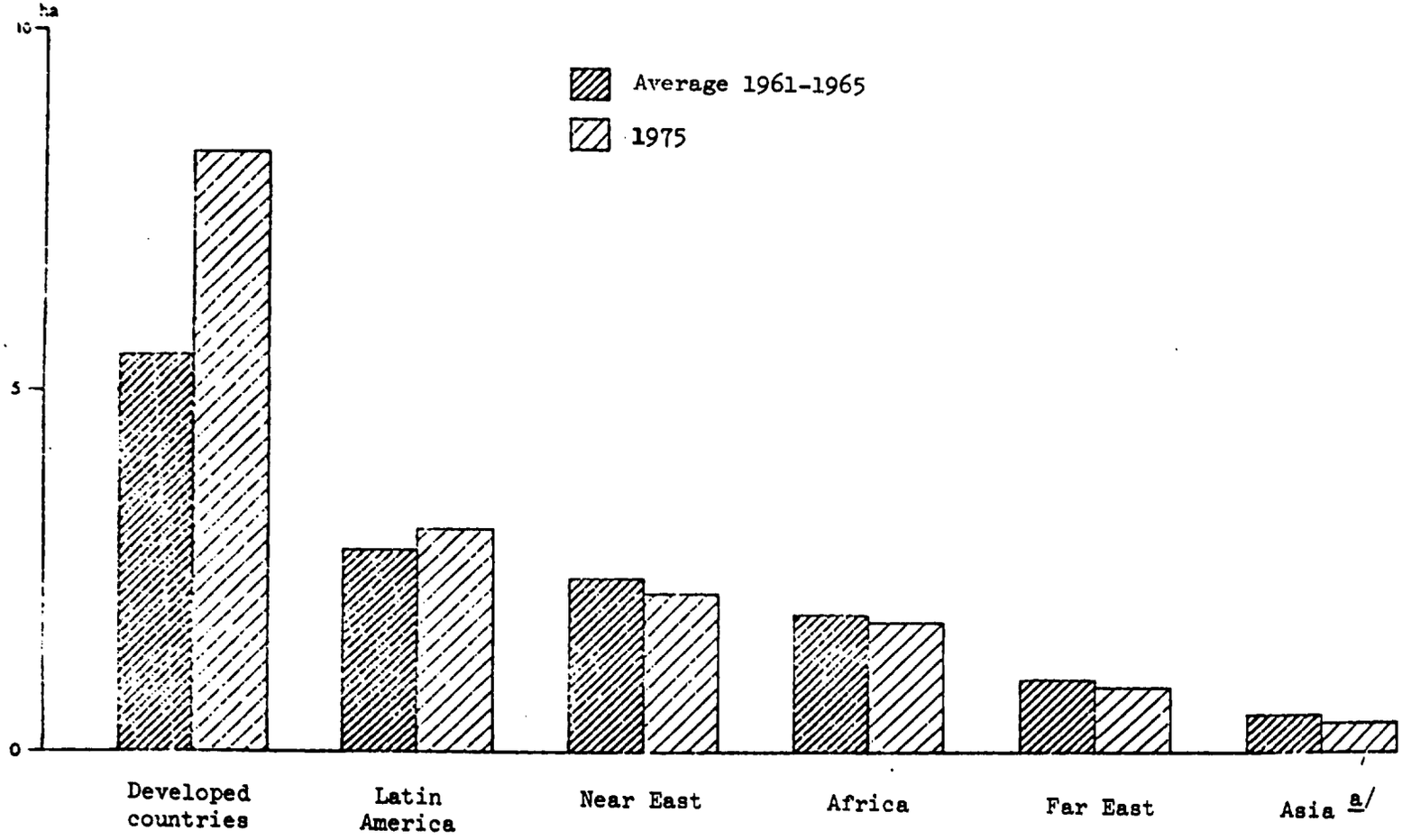
These past developments weigh heavily on the options currently open to States, which sometimes favour the opening of international exchanges of raw materials in order to establish their growth, and sometimes the implementation of agro-food self-sufficiency policies, which are a better demonstration of technical, industrial, and political autonomy. These choices have had a direct effect on related developments in agriculture, food, and industry. They constitute one of the essential variables in possible forecasts that can be made for the agricultural machinery industry. And they are the basis for four development scenarios which can be grouped according to whether priority is given to the heavy development described previously or to voluntarist policies which attempt to modify heavy development.

The four scenarios are based on a whole series of largely well-established developments. The first two are justified by the domination of international exchanges and the international division of labour by the big Powers of agro-industrial production (United States, European Economic Community, Canada, Australia, Japan). The third takes into account the agro-food self-sufficiency policies of some newly industrialized countries (countries of South-East Asia, Southern Europe) and the growing difficulties encountered by mechanization in more intensive farming (Western Europe, Japan). The fourth scenario involves the least developed countries or regions (African countries, poorer regions of South America).

Table 19. Slowing of the growth of world agricultural production
(Percentages)

	Total output			Per capita output		
	1951-1960	1960-1970	1970-1980	1951-1960	1960-1970	1970-1980
World	3.3	2.6	2.1	1.3	0.6	0.3
Developed countries	2.5	1.9	1.8	1.3	0.8	1.0
United States/Canada	1.0	1.8	2.0	1.0	0.3	1.1
Western Europe	2.7	2.3	1.9	1.8	1.5	1.4
Japan	3.9	0.9	0.1	2.8	0.8	-1.0
Oceania	3.9	3.2	1.4	1.0	1.3	0.0
South Africa	3.4	3.4	2.5	0.8	0.7	0.1
Eastern Europe/USSR	4.4	2.9	2.1	2.9	1.8	1.3
Eastern Europe	3.0	2.1	2.3	2.0	1.4	1.6
USSR	5.2	3.4	1.7	3.4	2.0	0.9
Developing countries	3.2	2.8	2.8	1.0	0.4	0.1
Latin America	3.5	3.0	3.4	0.8	0.8	0.8
Africa	2.5	2.7	1.1	0.3	0.1	-1.8
Western Asia	3.4	2.9	3.8	0.6	0.0	1.1
Southern Asia	3.0	2.7	2.0	1.2	0.0	-0.2
Eastern Asia/Pacific	3.6	3.6	3.8	1.3	1.1	-1.8
China	...	3.0	3.3	...	1.1	1.8

Source: United States Department of Agriculture, 1981.



Source: Food and Agriculture Organization, "Agriculture: Toward 2000".

a/ Countries with centrally planned economies.

Figure II. Arable land per agricultural worker

The four scenarios can be realized simultaneously in different parts of the world, or in one large country implementing differentiated agricultural policies on a regional basis. It is clear that the growth of the agricultural machinery industry is determined by the dominant model of mechanization. The first scenario predicts the progressive adaptation of this model by its principal promoters, the manufacturers. The other scenarios anticipate the transformation of this model through the combined action of industries outside the agricultural machinery industry and States deliberately opting for the development of national agriculture and industry.

A. Development scenario 1: The strengthening of the dominant role of the world's large agricultural producers

27. This scenario is based on the power relationships which currently dominate world exchanges and govern the international division of labour. Its realization may be speeded up if the economic recovery continues in the large industrial countries. In this scenario the options of developing countries for agricultural and food self-sufficiency are strongly compromised. The scheme is based on the assumption that the trends which have appeared over the last decade will continue or become more marked. A growing portion of world food production in basic agro-food products (cereals, oilseeds, industrial plants, animal products) is provided by courtries which have both mastered the heavy mechanization model and control international trade in agricultural raw materials.

The geopolitical power acquired by this strengthening of the agricultural position explains why States with agro-exporting policies facilitate the financing of the investment necessary to expand land area sown with wheat and increase yield. These measures favour the renewal of mechanical equipment purchases and those of other agricultural inputs in the countries concerned, i.e. those that constitute the current "fall-back base" of the transnational corporations of the agricultural machinery industry. The strategy implemented by these corporations over the last two or three years (restructuring, rationalization, automation) confirm this development.

The heavy mechanization model is not only given new impetus, it is improved and becomes even heavier. It eliminates all other mechanization alternatives for the large industrial vegetal productions and spreads to developing countries integrated into international exchanges, e.g. Brazil (oilseeds), Sudan (cereals), Cuba (sugar), Thailand (manioc).

Transport, handling, and processing of agricultural raw materials into end or intermediate products may lead to some diversification of mechanical equipment upstream and downstream from agriculture. Thus, the massive importation of cereals, oilseeds, and manioc leads to the use of grinding, mixing, and pre-processing equipment in the importing country, as well as the introduction of poultry, pig, and dairy farming.

The mechanical equipment needed for production in developing countries involves equipment necessary for the processing of basic products (including animal production) rather than equipment used in the production of raw materials as such.

Diversification of the mechanization model remains limited because it occurs at a centralized level and because its primary objective is to satisfy the food needs of a low-income urban population. Processing and handling involve large-scale processing of a homogeneous raw material.

The mechanization model may become diversified downstream, but it none the less descends from the heavy mechanization model used upstream in agricultural production. Treatment and processing equipment is designed and produced by the same industrial Powers that diffuse the heavy mechanization model. Thus, the agricultural machinery model in the broad sense remains located in industrial countries, although for the production of the more widely-used equipment, it is growing stronger in some newly industrialized countries able to supply this equipment at lower prices. Most developing countries are confined to assembly and finishing operations. If technological progress in the automation of production processes speeds up, they may lose even these operations (see above).

The likelihood that this scenario will be realized rests on the converging interests of agro-exporting industrialized countries and the multinationals producing agricultural machinery. Indeed, this scenario does not fundamentally bring into question international economic relations (flow of exchange and financing), nor does it imply fundamental technological changes in the principal equipment. The changes in production techniques are perfectly compatible with those already introduced in other sectors of activity close to agricultural machinery - land transport equipment, public works, and handling. These changes may even become a further factor encouraging the realization of this scenario, inasmuch as the investments they require must be paid off by an increased production of standardized machines and equipment.

B. Development scenario 2: Promotion or strengthening of agricultural and food self-sufficiency on an extensive basis

28. This voluntarist option does not run counter to the strengthening of the dominant role of the world's great agricultural Powers. Nor does it necessarily mean a development or integration policy for all agriculture. It may favour national agricultural production, but it only concerns a part of farming - that part able to supply the greatest increases in agricultural production in the shortest period of time. State intervention is absolutely necessary for the realization of this scenario, and it is concentrated in particular areas. All possible means are mobilized in order to reach the objective. They include efforts in regard to infrastructure, financing, training, and advising. Increasing the volume of agricultural production takes priority over maintaining or developing jobs in agriculture and over control of growth in the agricultural machinery industry. Like the previous option, this one favours the diffusion of the current dominant model. Once the financial capacity is mobilized, this option will boost the demand for tractors, combine harvesters, and tractor-drawn machines in many developing countries. This is the case in Thailand (manioc exports), Brazil (alcohol plan), India and Pakistan (cereal production), and Algeria (self-management areas), and more generally in all countries trying to establish an efficient agricultural infrastructure within a very short period of time: colonization or new frontier policies in Latin America, "small lot" or irrigated zones in Africa, large domain policies in countries with centrally planned economies. The mechanization model remains the reference model, whether in making use of national resources or in responding to the food challenge.

This option may not "exclude" a more diversified mechanization satisfying the needs of more traditional farming, but priority is more often given to setting up an industrial infrastructure designed to fill only the needs of modern agriculture.

The risks that lie with this option are well known today. The domestic market may too often remain unstable or insufficient to allow satisfactory operation, with optimal price and yield conditions, of industrial units designed for other industrial and commercial settings.

The transposition of the heavy mechanization model can only be successful in certain favourable agricultural and political environments (see above). It is much more difficult on the industrial level. Products themselves may not

evolve a great deal, but the industrial manufacturing techniques become very complex. The minimum production scale necessary for amortization increases. The base materials change. After-sales services must be able to "follow" the technical transformations in progress.

These accumulated difficulties, well illustrated by the case of many industrial units set up hastily to equip "modern" agricultures, throw light on the differences which exist between the autonomous and often spectacular growth of these State-supported agricultures and the fragility or even dependence of the agricultural machinery industry which equips them.

If a voluntarist policy including the agricultural machinery industry in an overall industrial strategy is not adopted, the setting up of extensive farming programmes will go hand in hand with increased purchases of patents and licences for the production of components or finished products, depending on the supposed size of the market and the degree of industrial development attained. This situation does not bring into question the domination of large agricultural machinery manufacturers examined in the previous scenario. Their position can however be modified by the following:

(a) The continuation of the slump for heavy machinery products leading the large manufacturers to relax their grip. In order to penetrate or hold their own on strategic markets, and get ahead of the competition, they may have to accept industrial delocalization or transfer licences to developing countries on more favourable terms;

(b) The diversification of the mechanization model downstream from agricultural production in the strict sense. When applied to pre-processing, handling, transport, and distribution of the major agricultural raw materials produced in the country concerned, this diversification increases mechanical equipment. At the same time it increases the outlets of industry, on the basis not only of products from the heavy mechanization model, but of a much wider range of equipment as well. It opens industrial co-operation to partners other than the large specialized firms of the tractor industry.

C. Development scenario 3: Priority for agro-food self-sufficiency on the basis of an intensive model

29. In many developing countries the favoured option for the heavy mechanization model runs into various obstacles, e.g. structural (size of farms), ecological (difficult terrain), financial (solvency of farmers), and political (farmers'

importance in political representation). These obstacles do not however eliminate support for food self-sufficiency policies. Here, the intensification of agricultural production is an obvious solution. The mechanization of agriculture is operated on the basis of a wide range of highly diversified mechanical capital goods designed for small, decentralized farms with little specialization, an abundant labour force, and limited financial capacity. Neither the supply from industrialized countries nor the range of products marketed by the transnational corporations is sufficient to satisfy these needs.

If the political options selected are maintained, the agro-food needs of these States may well stimulate the development of a new industrial policy. The likelihood of this is even greater since these States usually have a large agricultural population. This policy would organize cottage industries into village collectivities, integrate certain specialized industrial units for the production of metal-mechanical intermediate products, and incorporate the know-how and capacity of industry from both the newly industrialized countries and the industrialized countries. These objectives set by some developing countries coincide with certain difficulties, both technical (yield ceiling) and economic (excessive costs of agricultural infrastructures) which have recently been encountered in the more intensive farming systems of industrialized countries (Western Europe, Japan). The combination of the two may favour the revival of the intensified mechanical model or even the creation of a new model.

Thus, the probabilities for the realization of this third scenario are based on the existence of large domestic markets and the mobilization of a mechanical capacity other than that of the agricultural machinery industry in the strict sense. This scenario has already been realized to a large extent in some newly industrialized countries of South-East Asia. The Republic of Korea has mechanization programmes. The Philippines has an irrigation programme. And India has begun the rural development of agricultural communities. The State controls the success of these operations with direct commitments in the following areas:

(a) In agriculture, it supports small but technically efficient farming;

(b) In international relations, it protects the domestic market with customs legislation favouring its agricultural producers and agro-supplying industries;

(c) In industrial policy, it intervenes directly in invitations to tender and authorizations for the implantation of industries of very varied dimensions; it thus helps to narrow the gap between agricultural demand (by way of co-operatives and public organizations) and industrial supply (from the big multinational corporations to the local small and medium enterprises).

The diffusion of this model - and, consequently, the overall scope of this scenario, which depends on both a tradition of intensive agriculture and a minimal industrial base - is limited to a small number of newly industrialized countries. However, it clearly broadens the field reserved for the agricultural machinery industry in scenarios 1 and 2. Although more limited geographically, it is really much broader considering the number of actors in both industrialized countries and newly industrialized countries affected by the renewal and enlarging of a mechanization model better suited to the needs of intensive farming. The greatest prospects of industrial co-operation lie with these actors.

D. Development scenario 4: Promotion of a self-centred agricultural and industrial development

This last scenario involves developing countries with primarily "traditional farming" wishing to use the agricultural machinery industry to increase agricultural productivity and at the same time to create a metal-mechanical industrial infrastructure. This scenario may appear very attractive, but it remains limited in terms of actual realization. The difficulties accumulate, because learning new techniques in the production of consumer goods (agricultural and food products) and that of the required means of production is extremely difficult in areas poor in human, technical, and financial means. This renders the "turnkey" solutions of scenarios 1 and 2 completely inoperative.

In most cases, this scenario requires the development of new technical models. These models should be less related than previous ones to the mechanical capital goods systems proposed by the agricultural machinery industry. However, they should be able to modify these systems.

These phenomena limit the plausibility of this scenario to a certain number of countries where the State has committed itself to a policy of economic growth based on controlled and innovative agricultural growth. Finding political and

industrial partners in industrialized countries is necessary, firstly, to keep the options adopted from "slipping" (the importation of agricultural products and means of production unsuited to the technical model adopted must not be substituted for national production), and secondly in order to mobilize technical and industrial skills. What is needed is not to go backwards in the name of self-centred development but to develop new agricultural and industrial techniques which are compatible with the objectives of economic growth and autonomy.

The actors of the agricultural machinery industry seen in scenarios 1 and 2 are excluded from these options. They involve rather those actors who are participating more directly in promoting a new model of intensive agricultural production in industrialized countries and in the newly industrialized countries of scenario 3. They favour the development of appropriate technologies designed with the participation of local officials responsible for agricultural and industrial policies, national technicians and agronomists, and the farmers concerned, all of whom are aware of the options involved. The partners are most often small and medium enterprises of industrialized countries or others difficult to identify because they exercise their activity in fields other than those covered by the agricultural machinery industry as it is usually defined.

The States have an essential role to play. They must draw up and implement agricultural and industrial policy, evaluate domestic demand for machines and equipment, decide on technology (machines and equipment), negotiate with foreign industrial partners, publicly finance and supervise the construction and management of production units, and finally, popularize agronomic methods compatible with the new technology.

Although limited in its geographical and political applications, this fourth scenario has the advantage of opening new doors to industrial partners that otherwise would remain blocked in their regions of origin by the priorities given to heavy mechanization. The realization of this scenario renews the contents of the co-operation programmes and international exchanges. It increases technological choices and alternatives to the dominant agricultural and food model. It allows greater mastery of agricultural and industrial technology involved in this choice of mechanization.

V. FACTORS FOR INCREASING INTERNATIONAL INDUSTRIAL CO-OPERATION

The four development scenarios presented offer developing countries unequal possibilities of access to and development of the agricultural machinery industry. The countries referred to in scenarios 1 and 2 can take advantage of the commercial difficulties of the TNCs to negotiate the transfer of maintenance techniques (scenario 1) and manufacturing techniques (scenario 2). The multiplication of industrial partners and the direct involvement of Governments appear to be the most favourable factors to the renewal of the mechanization model (scenario 3) and the implementation of co-development programmes (scenario 4). The opening up and success of industrial co-operation programmes are based on certain prerequisite conditions necessary for the dialogue to begin.

31. An evaluation of both partners' interests must first be made. For all developing countries this concerns the needs in mechanical equipment for agricultural production and the advantages of progressive mastery and control of all or a part of manufacturing. Whatever the size of the firm (multinational corporation or small or medium enterprise) and whatever its principal sector of activity, these firms must open new outlets by extending existing markets or penetrating new ones.

Knowledge of and respect for these mutual interests are necessary for negotiations to begin.

32. Next, the consistency of these choices for the creation, extension, and diversification of the agricultural machinery industry and the following options must be respected:

- The options of agricultural policy. For example, it is obvious that a policy to reorganize land structure favouring large State-run areas encourages the diffusion of the heavy mechanization model. This model progressively becomes the technical reference. Conversely, an agrarian reform based on the redistribution of land can favour the intensive model and involve simple mechanical equipment or diversified material and tools. In any case, such a redistribution is in contradiction with the promotion of national production of tractors and conventional tractor-drawn machines.

- The options of social policies, particularly with respect to employment. Theoretically, an intensification of agricultural production favours rural employment, while the mechanical equipment of the extensive model tends to reduce employment in agriculture. The creation of jobs in the agricultural machinery industry, however, in no way compensates for the loss of jobs in agriculture.

- The options of technological policy. Adopting the heavy mechanization model, i.e. the technical model developed in the industrialized countries, can create needs for industrial products and for the services necessary to the operation of this model. These products and services are in general imported and involve the risk of strengthening technological dependence.

- The options of industrial policy. The mastery of certain links in the industrial process is vital. For the conventional equipment of the heavy mechanization model, this involves mechanics (machining and assembly of motors, live axles, transmission units, and gear boxes), metal working and metal construction (machining and welding of chassis, structures, and precision hollow-ware), and finishing (surface treatment, respect for operating and safety norms and tolerances). For diversified machines and equipment, this option involves the mastery of mechanics and metal fabrication using welding processes. For simplified and less powerful components and systems (power cultivators, pumps) it involves the injection of plastic materials (sprayers).

Mastering the production technology is an essential factor. It is the only possible way that autonomous growth of diversified manufactures inside or outside the agricultural machinery industry can occur.

The implantation of a tractor production unit can raise two problems, depending on the degree of integration desired. One problem may be the disparity between the mastery necessary for the technology and in organizing the production process and the actual level that can be obtained. Disregard for this rule, elementary as it may seem, is one of the primary causes of difficulties and has resulted in the failure of some previous experiments in the engineering industry: chronic under-use of production capacity, falling productivity. The other problem is that of the real efficiency of implantations in the process of acquiring and mastering technology. Assembly units as well as those producing accessories and simple equipment (plastic parts, seats, batteries, etc.) do not appear to be much help in attaining ambitious objectives.

33. It is also necessary to stress the following points:

- The broadening of the field of partners in negotiations. The industrial partners able to help the development of these mechanization models are often situated outside the agricultural machinery industry. This fact must be taken into consideration. In the line of conventional equipment (tractors and tractor-drawn machines), increasing competition between the dominant multinational firms and the new specialized manufacturers would be a good way of increasing respect for the host country's interests and the consistency of its development policy. Moreover, the industrial partners are not always the only ones able to finance the projects negotiated. Thus, it is necessary to open the negotiations to national, regional, or international institutions or countries able to contribute financial aid to such operations.

- The direct participation of the State in negotiations. This is a way for the State to ensure the consistency of the options of agricultural and industrial policies and social and economic development. The sharing of economic and financial risks is probably the appropriate way to bring the small and medium enterprises to penetrate markets that they may consider difficult of access and weak in purchasing power. Such a guarantee for firms with stiff competition on international markets may be one way for them to put some regularity into their industrial activities in an unstable business world. For States, it may represent a possibility to obtain better prices for the products and the services connected with their use (distribution network, spare parts, maintenance guarantees).

The role of the State is equally decisive in the financial aspect of negotiations. On one hand, they can play on their position in the geopolitical balance to obtain external means of finance within the framework of bilateral or multilateral relations. They can also mobilize domestic saving capacities and participate directly in the financing of new investments. In this way they maintain absolute control.

34. The technical context (interconnection of production channels), economic context (increased competition and new industrial partners) and political context (new power relationships in the world, South-South exchanges) favour the renewal of co-operation programmes involving the following:

- Packages of related products. Here co-operation involves not just one product of agricultural machinery, but a whole group of mechanical, chemical, or genetic products deriving from use of the mechanization model.

- The functions of mechanization in agro-food production, and not just the isolated products involved. In this case, co-operation emphasizes the multi-purpose nature of projects within development programmes, whether rural, technological, or industrial.

- The sharing of economic and financial risks involved in starting research and development programmes able to respond to the specific needs of intensive farming in the LDCs and to renew the related agricultural techniques and equipment.

35. Some configurations for industrial co-operation

Four types of situation can be imagined, deriving from the realization of the four scenarios of development discussed earlier. The essential data in this regard are assembled in table 20.

Configuration 1

Configuration 1 involves developing countries whose large, though recent export activity (Sudan, Thailand, Indonesia), degree of industrial development, and domestic market have not yet justified the implementation of industrial programmes. Commercial negotiations on common products for which international competition is stiff allow these countries to obtain the best price and financing conditions from the TNCs of the agricultural machinery and capital goods industry. The power relationship is even more favourable to buyers since invitations to tender involve large quantities at standard quality. For the large manufacturers a large and renewed order is a real shot in the arm under current market conditions. Knowing this, buyers must condition their orders on obtaining maintenance programmes for the equipment bought (formal commitments for supply and prices of spare parts, establishment of distribution networks, training of personnel for maintenance and repair). Commercial negotiations enlarged to include after-sale service may be a means of access to the learning of mechanical techniques. Later, it can also facilitate the establishment of an industrial infrastructure specialized in the assembly of the machines and equipment of the heavy mechanization model.

Table 20. Partners and fields of co-operation

	Configuration 1	Configuration 2A	Configuration 2B	Configuration 3	Configuration 4
PARTNERS					
Developing countries, agricultural exporters	X				
Developing countries, self-sufficiency, extensive model		X			
Developing countries, self-sufficiency, intensive model					X
NICs - exporters			X		
NICs, self-sufficiency, extensive model			X		
NICs, self-sufficiency, intensive model				X	
Agricultural machinery, TNCs	X	X	X		
Agricultural machinery, small and medium-sized firms				X	X
Heavy capital goods	X	X	X		
Diversified capital goods			X	X	X
FIELDS OF NEGOTIATION					
Technological					
Classical heavy mechanization products	X	X	X		
Light mechanization products				X	X
Specialized equipment		X	X	X	X
New material and equipment					X
Commercial					
Prices	X				
Models	X				
Spare parts	X				
After-sale	X				
Licences			X	X	X
Industrial					
Assembly		X			
Manufacture of mechanical elements			X	X	X
Manufacture of components			X	X	X
Maintenance	X	X	X		X
Training	X	X	X		X
Financial					
National	X	X	X	X	
Bilateral	X	X			X
Multilateral	X	X		X	X
Manufacturer		X	X		

Configurations 2A and 2B

Configuration 2A involves developing countries trying to achieve food self-sufficiency on the basis of the extensive model but without an agricultural machinery industry. These are generally oil-producing countries (Nigeria, Venezuela). As such, they either have financial resources of their own or credit facilities with international organizations, with their principal trading partners, and with the transnational corporations. They may have both. With these financial possibilities they can negotiate the implantation of tractor or combine-harvester assembly units with the TNCs. This allows them to begin the acquisition of technology and know-how, to establish a training system for qualified personnel, and to set up a maintenance and repair network for mechanical systems. They also have no trouble acquiring production units for specialized equipment - irrigation equipment, equipment for farming away from the land, etc.

Configuration 2B concerns newly industrialized countries which already have an agricultural machinery industry and are also trying to achieve agricultural and food self-sufficiency on an extensive basis. These countries (Brazil, Mexico) are also agro-exporters. In the future they will be able to extend their agricultural machinery industry's field of activity to the whole range of conventional machines and equipment, to heavy equipment and diversified equipment, by acquiring licences and perhaps by promoting a national research and development effort. The financing necessary for such an extension could be provided, either partially or wholly, by the national or foreign manufacturers concerned. The prospects of public financial aid in the form of tax relief, investment credit, etc., could prove to be an effective incentive. Additional international financing appears more difficult.

Configuration 3

Configuration 3 concerns above all the newly industrialized countries or developing countries which have chosen to maintain a large agricultural population on small farms and a high degree of productivity simultaneously (see development scenario 3). In order to accomplish this, the light mechanization model must be extended to the whole of agricultural production without appreciably reducing employment, and at the same time the use of mechanical equipment in the processing and distribution of agro-food products must be increased.

This diversification of the mechanization model must be taken advantage of by national industry. It involves the strengthening of industrial and technical relations between national manufacturers (large firms and small and medium enterprises) and foreign manufacturers which are not part of the agricultural machinery industry in the strict sense. The State controls these agreements in order to avoid departure from the agricultural and industrial objectives it has established.

In the presence of needs which are both immediate and solvent, particularly motivated partners for the enlargement and renewal of the mechanization model may be found in NICs (South-South exchanges) and industrial countries (North-South exchanges). This is particularly true if the development of this new equipment later helps to meet the needs of all intensive farming for which the heavy mechanization model has failed to provide technical solutions.

Configuration 4

Configuration 4 essentially concerns developing countries with intensive farming wishing to defend or strengthen food self-sufficiency. The per capita income in these countries is often below the minimum threshold of subsistence, and they have no significant industrial base in the fields of metallurgy or mechanics. Their agricultural needs in farming equipment involve a wide range of industrial products, from hand tools to simple machines and mechanical equipment, but they also include the new technology associated with crop intensification. The objectives and constraints of the LDCs concerned require renewal of the content, forms, and partners of co-operation programmes.

(a) The content. The idea of the function of mechanization in self-centred agricultural and industrial development must take precedence over the idea of the products of the agricultural machinery industry. The identification of national needs in mechanical and specialized equipment can be extended to the following areas:

- To sectors of activity technically more closely related to agricultural and rural mechanization, e.g. on site transport (airports and harbours), public works, construction, rural and hydraulic engineering, handling, etc.

- To priority programmes in the field of agricultural production which maintain employment in rural areas and respond to priority food needs, e.g. irrigation programmes, programmes for developing animal production (production, transport, and processing of milk, production of animal feed, recovery of fodder and food by-products, etc., programmes to reduce harvest loss and harvest preservation programmes.

(b) The forms and partners. The implementation of industrial co-development programmes involves the following:

- The renewal of associated industrial partners. The specialized small and medium enterprises able to respond to the diversity of demand for metal-mechanical equipment must be systematically indexed. This can be done using information banks on previous similar experiments, for example;

- Direct involvement of States in evaluating domestic demand and assuming part of the economic and financial risks connected with the implementation of research and development programmes. The Governments of industrialized countries are also urged not only to participate in the bilateral or multilateral aid necessary for financing, but also to identify and organize the specialized small and medium enterprises;

- The strengthening of relations between agriculture and industry so that the diffusion of mechanization is accompanied by the production of agricultural or industrial inputs (seeds, chemical products) necessary to agricultural production;

- Increasing the financial, procedural, and fiscal regulations that might reduce the inherent risks of industrial operations with new form, content, and partners.

This configuration does not imply a break in political, economic, and financial relations between industrialized and developing countries, but it presupposes the establishment of a new international economic order.