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INTRODUCTION

The Approach and Necessary Mechanism

The major problem most of the developing countries are encountering, is a continued recurrent imbalance between agricultural food production and evergrowing population both in the rural and urban areas. In developing countries the trend in industrialization is taking shape more in the urban or rural-urban border than in the rural areas. This trend is creating enormous socio-economic problems particularly high rate of underemployment and unemployment in the rural areas and greater migration of agricultural labour force from rural to urban areas.

The developing countries economy is broadly based on more rural agriculture and limited level of industrialisation both in engineering and allied metalworking industries sector. The tools and equipment available for farming are often inadequate and poor in quality. It is estimated that about 60% of agricultural producers in the developing countries are traditional users of hand tools and simple animal drawn equipment. In vast areas. irrigation is carried out mainly from seasonal rainfall. The cultivation techniques are often based on past conventional methods. To a great extent the manufacture of agricultural tools and equipment is often made at village blacksmith level without sufficient technological and engineering facilities. It is also an accepted fact that most of the developing countries will continue to depend on import of machinery, material and parts from foreign developed countries which are often inconsistant with their actual requirement.

Considering the present situation in the developing world, FAO comments the long term trend in food production in the developing countries remains disappointingly inadequate and recent world trade in agricultural products have been unfavourable for developing countries. The possible solution to this problem will be to intensify food production particularly the crop production in developing countries. Therefore, this paper highlights

the requirement for the intensification of crop production through the introduction of animal or mechanical power in place of manual agricultural farming operations. Such application of non-manual power assisted farming is called mechanization. This paper is thus concerned not so much with the mechanization of agriculture or even more so as compared to tractorization, but with improvement of tools and introduction of such means which will enlarge the activity of the farmer or farm labour to eliminate drudgery, improve the overall efficiency of the work in order to intensify the crop production. Also intensification of crop production requires wide range of inputs particularly suitable tools, equipment and machinery for basic agricultural crop production. Although great effort is made by many developing countries to produce modern farming equipment, power assisted mechanizable forms of agriculture is limited in many developing countries due to socio-economic, geographical, environmental and agrarian constraints, prevailing in many parts of the developing world.

Industrialisation in rural areas of developing countries demands two important aspects of development, introduction, promotion and use of appropriate mechanization of crop production and creation of rural industries based on non-farm activities particularly manufacture of agricultural equipment and allied engineering products at appropriate level of technology in widely dispersed rural areas. In order to promote such activities in rural areas, a comprehensive review of the style of agricultural mechanization and agricultural machinery industry more suited to special needs is of paramount importance both at National and Farm level.

This requires substantial injection of investment in rural areas. The capital requirement for such investment must be generated within the rural areas. The capital formation in the rural areas can be developed through the intensification of agricultural food particularly crop production in the majority of the developing countries. This will allow the developing countries to be self sufficient in cereal requirement and will open up export market opportunities.

The intensification of crop production can only be achieved through the introduction of relevant farm mechanizations based on technology level according to various farm sizes. As farm mechanization is an independent variable to production function and greatly related to the farm sizes, there is a great limitation introducing farm mechanization in relatively small hectare of land. (Refer Section III)

In Section I the paper has examined the outlook of mechanization both in developed and in developing countries and suggests a National Mechanization Policy based on manual farming, mixed-mechanization and advanced mechanization system in order to intensify crop production. A comprehensive mechanization policy requires appropriate choice of agricultural machinery and equipment at a particular level of technology sophistication. There exists great demand for appropriate agricultural machinery and equipment in the developing countries. In order to cater for such a demand, it is essential to set up a National Agricultural Mechanization Policy in each developing particularly in the least developed countries. Such a policy should promote and cultivate the actual need for farm mechanization. Simultaneously the policy should encourage off-farm engineering activities particularly for the manufacture of agricultural machinery and tools in the rural areas. This will create greater employment opportunities and capital formations in the rural areas. Moreover, it is important to examine the overall farm distribution and holdings in each country before the introduction of specific level of mechanization as it is greatly related to the farm sizes. (Refer to Section I and III)

In order to intensify rural industrial development in developing and least developed countries, it is necessary to introduce systematic survey to explore the existing level of technology and the problems in the manufacturing industries. Having diagnosed the existing level of operations and problems in terms of availability of machinery, equipment, design, raw materials, trained manpower and marketing aspects of the industries, an appropriate level of technology (refer Section II) need to be introduced which will have to be "tailor made" to suit the local conditions. This requires the industries in the rural areas to be established at various technology levels i.e. Industries at Artisan and Village Level -I, Industries at Small Scale Level -II, and Industries at Medium or Large Scale Level -III. The improvement in the manufacturing technique should be an important aspect of inducement of modern technology in rural areas. The traditional technologies will have to be modified or reoriented to suit the real need of appropriate technology. It is important to take adequate care in the Artisan microindustry level which requires substantial Governmental institutional assistance both finance and marketing for effective running of establishments. Moreover, the existing industries operating at Technology Level I (Family Type of Worker/ Ownership) and Technology Level II (Small Scale Industries) referred in Section II can be promoted for rural industrial development. These two sectors

create employment at an accelerated rate and produces diverse tools, parts, components and products even for larger industries in agricultural sector.

Section III of this paper has identified the selection of mechanization parameters for various input resources and establishes mechanization levels for various farming operations. It has also explored the identification of line mechanization existing in agricultural operations in the developing countries with relative degree of appropriate technology based on human, animal and power operated equipment. The paper reiterates that mechanization alone cannot intensify the food production, it is necessary to promote and cultivate improved farm management, improved credit facilities and efficient marketing operation for tangible agricultural development in the rural areas of the developing nations.

The important aspect of rural industrial development is the creation of large employment opportunities in rural areas. The mechanization of agriculture alone cannot solve this chronic unemployment problem. The level of mechanization only identifies the requirement of appropriate agricultural machinery and equipment best suited under local conditions for effective farming operations in order to intensify crop production. Therefore, the machinery and equipment required for mechanization acts as a prerequisite for the selection of appropriate products to be manufactured in agricultural machinery industry. In order to create rural employment the paper suggests possible development of rural off-farm activities particularly the promotion of manufacturing agricultural machinery and equipment which will create intensive rural industrialisation. The foundation of rural industrialisation require establishment of rural agricultural machinery industries at various appropriate technology level of sophistication, e.g. Artisan level manufacturing simple hand tools and

manually operated implements, Small Scale Industry Level manufacturing animal drawn equipment and selected power operated machinery, and Medium-Large Scale Industry Level manufacturing power operated sophisticated agricultural machinery and equipment. Such manufacturing industries require selected product grouping (as specified in Section IV) of agricultural machinery and equipment used at different technology level of farming operation.

The paper outlines in Section IV that such promotion and development of agricultural machinery industry needs to be reflected through the evaluation of techno-economic profiles based on selected grouping of agricultural tools, implements and machinery. The three techno-economic manufacturing profiles attached as annex to this paper on selected product grouping, identify the need for establishment of appropriate level of manufacturing technology best suited in rural areas. These manufacturing profiles call for an appropriate choice of machinery and equipment at three distinct levels of industrial sophistication, i.e. at Artisan level manufacturing simple hand tools and implements, Rural Small Scale Level manufacturing animal drawn implements, and Rural Medium/Large Scale Level manufacturing power operated agricultural machinery. The proper selection of these industries based on the criteria outlined in this paper (refer Section IV) are the vital fibres in the industrial network of rural industrialization. The selected techno-economic manufacturing profiles illustrate the size of investment, type of machinery and equipment and manpower required at different levels of skill for each level of industry.

These profiles also suggest a greater requirement of sub-contracting arrangement, improved industrial co-operation, installation of supporting ancillary industries and facilities for common engineering services, e.g. foundry, forging, heat treatment, etc. for the rural

agricultural machinery and implements manufacturing industries operating at various technology levels as indicated in Section VII. The overall expansion for rural industrialisation requires considerable magnitude of investment, finance, technical know-how, training, product designs and institutional and technological back up facilities at all levels of industrial operations. The details are outlined in Sections VI, VIII .

Section V highlights the role of these industries (Artisan, Small Scale and Medium/Large Scale Levels) in the rural industrial development and a systematic approach to local manufacture of agricultural machinery and equipment within the framework of possible technological and institutional linkage among the rural industries.

The effective interlinked development in rural areas can only be achieved through the improvisation of a National Technology Plan as outlined in Section VIII. Such a plan needs specific Government policy and planning. The paper comments that such a plan must dictate:

- accelerated adaptation and absorption of imported technology;
- development of domestic technology through research and development;
- assistance to industries particularly in the rural areas in transfer of both imported and domestic technolgoies.

The process of such transfer and development of technologies needs manufacturing, administrative, financial and marketing infrastructure within the rural areas. In order to translate the National Technology Plan into reality, the paper suggests the setting up of an Agricultural Machinery Board, under the relevant Ministry, in any country which will be responsible for the formulation of the National Technology Plan. The creation of an Agricultural Machinery Industries Development Corporation will add a new dimension for the effective implementation of such a plan. These are being discussed in Section VII and VIII.

The promotion of interlinkage through such National Technology Plan requires a cohesive infrastructural development which should include:

- institutional interlinkage;
- manufacturing and technological interlinkage;
- administrative interlinkage;
- taxes and legislative interlinkage;
- financial interlinkage.

The paper then recommends the creation of an administrative mechanism for interlinked development of agricultural machinery industry in the rural areas by creation of:

- Agricultural Machinery Board;
- Agricultural Machinery Industries Development Corporation;
- Agricultural Machinery and Allied Industries Development Centre;
- Research and Development Centres;
- Ancillary Industries;
- Establishment of Engineering Common Service Facilities;
- Entrepreneurship Promotion Scheme;
- Rural Banks and Marketing Centres.

The National Technology Plan alone cannot solve the problems for rural industrialisation, there is a definite requirement for a guide-line policy for integrated development programmes for agricultural machinery as outlined in Section IX. Such programmes must envisage:

- Integrated programmes for the development of design and prototype manufacture of agricultural machinery best suited for local conditions.
- Integrated programmes for the manufacture of agricultural machinery within the available manufacturing resources of the country;
- Integrated programmes for the development of maintenanoe of agricultural machinery and equipment.

Such integrated development programmes must be organised at:

- National Level
- Regional Level
- Inter-Regional Level between developing countries.

Therefore, an approach to interlinked development of Agricultural Machinery Industries will create a new epoch of substantial capital formation in the rural areas. The continuance of this interlinked development will create a self generating industrial development in the rural areas of the developing countries.

RECOMMENDATION

The discussion in the following nine sections on this paper lead to the following issues for consideration.

While the substitution of mechanical power in farming operation is independent variable to the production function, it is obvious that mechanization at an appropriate level will lead to intensification of food particularly crop production. The appropriateness of mechanization will depend on a number of factors, one main factor being the size of farms.Special consideration will have to be given to the distribution of physical size of the farms particularly the farms up to 2 hectare of land where application of mecahnization is very critical in relation to investment and performance of power machinery and equipment. However, it is suggested to examine carefully the overall farm distribution and holdings in each developing country before the introduction of specific level of mechanization as level of mechanization is greatly attributed to the farm sizes.

The outlook of mechanization shows a great demand for appropriate agricultural machinery and equipment in developing countries. There is also evidence that some of this demand is being catered to by the exports from advanced developed countries without much consideration for the actual need of appropriate agricultural machinery and equipment for developing countries. In many cases, the equipment is not entirely appropriate for the local conditions. Because of this, there is an urgent need for a National Mechanization Policy, particularly in the least developed countries. Such a policy should ascertain the existing stock of farm sizes, operating conditions at farm level, existing inventory of agricultural machinery and equipment, and existing agricultural machinery manufacturing technologies available in the developing countries. In line with this, the policy must define and spell out the measures for the promotion of farm mechanization and off-farm engineering activities.

The prime objective of the National Mechanization Policy should be to intensify agricultural crop production through mechaniza-

08270

Distr.
LIMITED
ID/WG.282/4
20 Sept. 1978
ENGLISH

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

INTERNATIONAL FORUM ON APPROPRIATE INDUSTRIAL TECHNOLOGY

New Delhi/Anand, India 20—30 November 1978

WORKING GROUP No.7

APPROPRIATE TECHNOLOGY FOR THE PRODUCTION OF AGRICULTURAL MACHINERY AND IMPLEMENTS

INTERLINKAGE IN AGRICULTURAL MACHINERY INDUSTRY FOR RURAL INDUSTRIALIZATION IN DEVELOPING COUNTRIES

Background Paper

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tion of farming operations and develop off-farm engineering activities particularly the manufacture of agricultural machinery and equipment in rural areas. Through these and other measures, the policy must actively promote and foster agricultural development in order to generate rural employment and rural capital formation.

It is essential to create a specific Government policy for the promotion and introduction of mechanization levels through adequate supply of inputs, credit, subsidy and marketing aspects to the farmers particularly in the backward areas. (Refer Section III) In addition to this, the introduction of co-operative supply of inputs and marketing facilities for agricultural farm products will add a new dimension for the agricultural development. This can best be achieved by creation of an infrastructure facility as described in Section III, which will provide necessary guidelines for the establishment of effective mechanization levels in the farming operations followed by back-up marketing facilities.

Governmental policy for the stabilization and enlargement of agricultural employment in the rural areas is an essential requirement for the developing nations. (Refer Section III) Such Government policy should be directed through the integrated rural industrial and agricultural development plan which will include expansion of direct agricultural activities in rural areas, promotion of agricultural off-farm activities e.g. creation of Small Scale and Family Type enterprises for the manufacture of machinery and equipment, creation of dams, river valley projects, irrigation projects, road construction, factory and house construction, etc. which will open up new avenues of large scale employment in rural areas and retard the rural migration to urban areas.

Moreover, Government policy for the promotion of credit and marketing facilities for agricultural operations will create additional large employment and capital formation in the rural areas. This capital formation will induce more off-farm activities at farm level and thereby create greater employment opportunities in rural areas.

The paper suggests that agricultural machinery manufacturing industries be considered as part of mechanical and metal working capital goods industries sector. In order to accelerate agricultural development it is suggested to include agricultural development into overall development plan of the country and integrate the regional, sectoral, macro and micro-economic planning for agricultural development within the framework of Governmental policy. It is necessary to create suitable institution for the development in planning techno-economic projects at national and farm level. (Refer Section III)

In order to intensify rural industrial development in developing and least developed countries, it is highly recommended to undertake a systematic survey to explore the existing level of technology and the problems of the manufacturing industries. Having diagnosed the existing level of operations and problems in terms of availability of machinery, equipment, design, raw materials, trained manpower and marketing aspects of the industries, an appropriate level or levels of technology (refer Section II) need to be introduced which will be "tailor Made" to suit the local conditions. This requires the industries in the rural areas to be established at various technology levels i.e. Industries at Artisan and Village Level, Industries at Small Scale Level and Industries at Medium or Large Scale Level. The improvement in the manufacturing technique should be an important aspect of inducement of modern technology in rural areas. The traditional technologies will have to be modified or reoriented to suit the real needs. It is recommended that adequate care be taken of the Artisan microindustry level which requires substantial Governmental institutional assistance both in terms of finance and marketing. (Refer Section II)

It is recommended to establish agricultural machinery industries in rural areas on three distinct levels of sophistication - Artisan or Village Blacksmith Level, Rural Small Scale Industries Level and Rural Medium or Large Scale Industries Level (Section II and IV). The products to be manufactured at distinct level of sophistication require a "product grouping" to be based on appropriate level of technology of manufacture for Hand Tools, Simple Implements, Animal Drawn Imple-

ments and Power Operated Machinery. This matching of technology is essential from the techno-economic viability of machinery manufacture in rural areas (Refer Section 1V).

The industries operating at Technology Level I (Artisan) and Technology Level II (Small Scale Industries) referred in Section II are especially recommended to be promoted for rural industrial development. These two sectors create employment at an accelerated rate and produce diverse tools, parts, components and products even for larger industries in agricultural sector.

Therefore, the Government policy will be to promote industries in Artisan, Small Scale and Medium/Large Scale agricultural machinery industries in the rural areas. It is recommended that such policy should promote technological criteria at three industry levels and to be based on Appropriate Choice of Machine Tools and Equipment, Appropriate Choice of Manufacturing Techniques, Enlargement of Supporting Ancillary Engineering Industries, with Minimum Factory Manufacturing Programme. (Refer Section IV)

One of the important aspects of rural industrial development will be to introduce Government policy on import substitution and promotion of subcontracting arrangement within the rural industries. The creation of greater industrial co-operation can be achieved by the installation of ancillary industries and engineering common service facilities in greater rural areas. (Refer Section VII)

It is recommended that the Government should promote large agricultural machinery industries as a launching pad for small industries in rural areas. Such policy should spell out guidelines for interlinkage of industries with Institutional and Technological infrastructure within the rural areas. (Refer Section VII)

In order to accelerate interlinked development of agricultural machinery industries in rural areas, it is recommended that the Government should set up an Agricultural Machinery Board which will be a high policy making body to formulate accelerated adaptation and absorption of imported technology, development of domestic technology and assist the rural industries in transfer of both imported and domestic technology through institutional and technological infrastructure (Refer Section VI and VII).

It is recommended to create an Agricultural Machinery Industries Development Corporation an autonomous and parastatal body responsible to the Agricultural Machinery Board, whose function will be to promote agricultural machinery industries in rural areas by way of finance, industrial estates, assistance in feasibility studies, taxes, etc. (Refer Section VIII)

For interlinking development in the rural areas, it is recommended to install an Agricultural Machinery and Allied Engineering Industries Development Centre under the Agricultural Machinery Industries Development Corporation.

Such development centre will create institutional and technological interlinkage through the extension of common-management services, product development design service, procurement, finance and marketing service, rural training programmes and courses, technological advisory service, engineering common service facilities e.g. Foundry, Forging, Heat-treatment, etc. This will bring the rural agricultural machinery industries closer for a greater rural development. (Refer Section VI, VII and VIII)

Creation of Research and Development Centres for the accelerated development of local agricultural machinery and equipment is a real need for rural industrialization. Such R + D Centre should jointly report to Agricultural Machinery Board and Agricultural Machinery Industries Development Corporation and should function in close co-operation with the rural industries. (Refer Section IX)

It is essential to formulate a National Technology Plan for interlinked development of rural agricultural machinery industries. (Refer Fig. 38, Section IX) Such plan must clearly spell out the objectives of interlinked development of agricultural machinery industries in rural areas. To formulate guidelines for integrated development programmes for agricultural machinery industries at national and regional levels will be the important development aspect of the national technology plan.

The promotion of greater co-operation among the developing countries for integrated development programmes of agricultural machinery will bring a new dimension for greater rural industrial development in the developing countries (Refer Section IX).

SECTION I

TRENDS IN AGRICULTURAL PRODUCTION AND AGRICULTURAL MECHANIZATION

(i) Trends in Agricultural Production

During the past three decades one of the major problems most of the developing countries encourntered had been a recurrent imbalance between agricultural food production and ever growing population of the societies. However, during 1976 there had been a distinct improvement in the immediate situation of world food and agriculture particularly in the developing countries.

Due to the excellent harvests in 1976, food prices tended to ease, and food consumption and cereal stock levels improved in developing countries. In spite of various steps taken by many developing countries in recent years to increase agricultural output and productivity most of the recent production increase can be attributed to better weather condition.

In the world review of food production FAO categorically commented that * "The long term trend in food production in the developing countries remains disappointingly inadequate in relation to the need to improve nutritional levels. The recent trends in World Trade in Agricultural Products have been unfavourable for developing countries".

Trends in 1975-1976

The world food and agricultural production increased by only about 2% in 1975, but there was an encouraging rise of about 4% in the developing countries. In general FAO comments that the developing countries harvested good crops for the second year in succession, i.e. 1975-1976. It is worth-while to note that the global cereal production increased by 6-7% in 1976 in the developing countries alone. A comparative figure of world production of major food grains is shown in Figure 1.

Trends in 1977

The preliminary estimates indicate that both food and total agricultural production in the developing countries rose only by about 1-1.5% in 1977. In developing market economies, the increase in total agricultural

* State of Food and Agriculture 1976 (FAO)

WORLD PRODUCTION OF MAJOR FOOD GRAINS

Area	Barley				Maize				Rice				Wheat			
	1975		1976		1975		1976		1975		1976		1975		1976	
	Kg/Ha	1000 Mt	Kg/Ha	1000 Mt	Kg/Ha	1000 Mt	Kg/Ha	1000 Mt	Kg/Ha	1000 Mt	Kg/Ha	1000 Mt	Kg/Ha	1000 Mt	Kg/Ha	1000 Mt
World	1699	156539	2035	190383	2836	325055	2812	335391	2452	348017	2421	343276	1556	355932	1771	417291
Developed Countries	2654	67364	2593	64417	4681	187773	4705	193274	5840	25003	5405	22546	2196	142649	2237	153711
Developing Countries	1143	18125	1248	20636	1366	73866	1314	74157	1981	187515	1970	185609	1290	81455	1404	94719

Source: Monthly bulletin of Agricultural Economics and Statistics (FAO)

Figure - 1

production was slightly higher (1.5-2%) than that in food production.

In spite of the developing countries good agricultural harvests in 1975 and subsequent production increase, on average of 2.5% a year during the first half of the present decade, the result is alarming. This is because the population growth in the developing market economies is far greater than the 4% annual target of increased production of agriculture specified in the International Development Strategy (IDS) adopted for the Second United Nations Development Decade (DD2) and reaffirmed by the World Food Conference.

Present Trend of International Loans for Agricultural Development

The international assistance for agricultural development available for the developing countries showed an encouraging trend during the first half of the present decade. After a large increase in 1974, total official committments of external assistance to agriculture are estimated to have risen in 1975 by as much as 25% in real terms.

However, the recent figures available indicate that there may be a declining trend in the major source for loans after 1975. The two major sources of international loans for agriculture, the World Bank and the Development Assistance Committee (DAC) a bilateral source may have contributed to this declining trend after 1975. If these trends continue, it is unlikely that the reduced committments will be off set by the continued increase in OPEC aid to agriculture and by the establishment of the International Fund for Agricultural Development (IFAD).

(ii) Trends in Agricultural Mechanization

In general the trend in agricultural mechanization seems to be a highly complex behaviour. The various patterns of simple and sophisticated trends in mechanization, those usually practiced both in the developed and the developing world postulate the fact that the agricultural mechanization requires to be considered as a 'system'.

The application and usefulness of this system varies widely from country to country and region to region. Moreover, national and regional, political and socio-economic conditions have a great bearing on this everchanging system of mechanization.

In a world where geographical, echological and environmental patterns are so uneven, the rational trend in mechanization itself could not call for a systematic epoch of development. Therefore, the panoramic spectra of mechanisation shows a tremendous scatter from super mechanization in the developed world to absolute traditional use of hand tools in the farming world of the developing nations. Moreover the effects of the two past world wars coupled with the socio-economic constraints and imbalances between the rich and the poor worlds greatly affecting the uniform growth in mechanization.

On the other hand, the overall trend in agricultural mechanization in the developed world seems to be directed towards the replacement of agricultural labour by advanced systems of mechanization and to utilize the new agricultural products such as improved varieties of inputs, fertilizers, weed killers and insecticides. The overall trend of mechanization in the developed world can be summarized briefly as shown in Figure - 2.

Outlook of Mechanization in Developed Countries

The trend in the system of agricultural mechanization in developed countries seems to be based more and more on the usage of specialized and complex equipment designed for high powered operations. The general designs of the equipment are highly complex and the overall system of mechanization constitutes mechanical, electrical and hydraulic methods with inherent application of electromechanical and hydraulic servo systems becoming increasingly common. So much so that one or two famous companies have designed and manufactured remote controlled computerised tractors and combine-harvestors.

The growing industries in the developed world are now capable of producing complete ranges of agricultural machinery, broadly comprised of:

- mechanized equipment for land clearing and earth moving;
- mechanized equipment for cultivating soil;
- mechanized equipment for sowing, planting and distributing of fertilizers;
- mechanized equipment for irrigation and water supply;

Synopsis of trend in mechanisation in developed countries

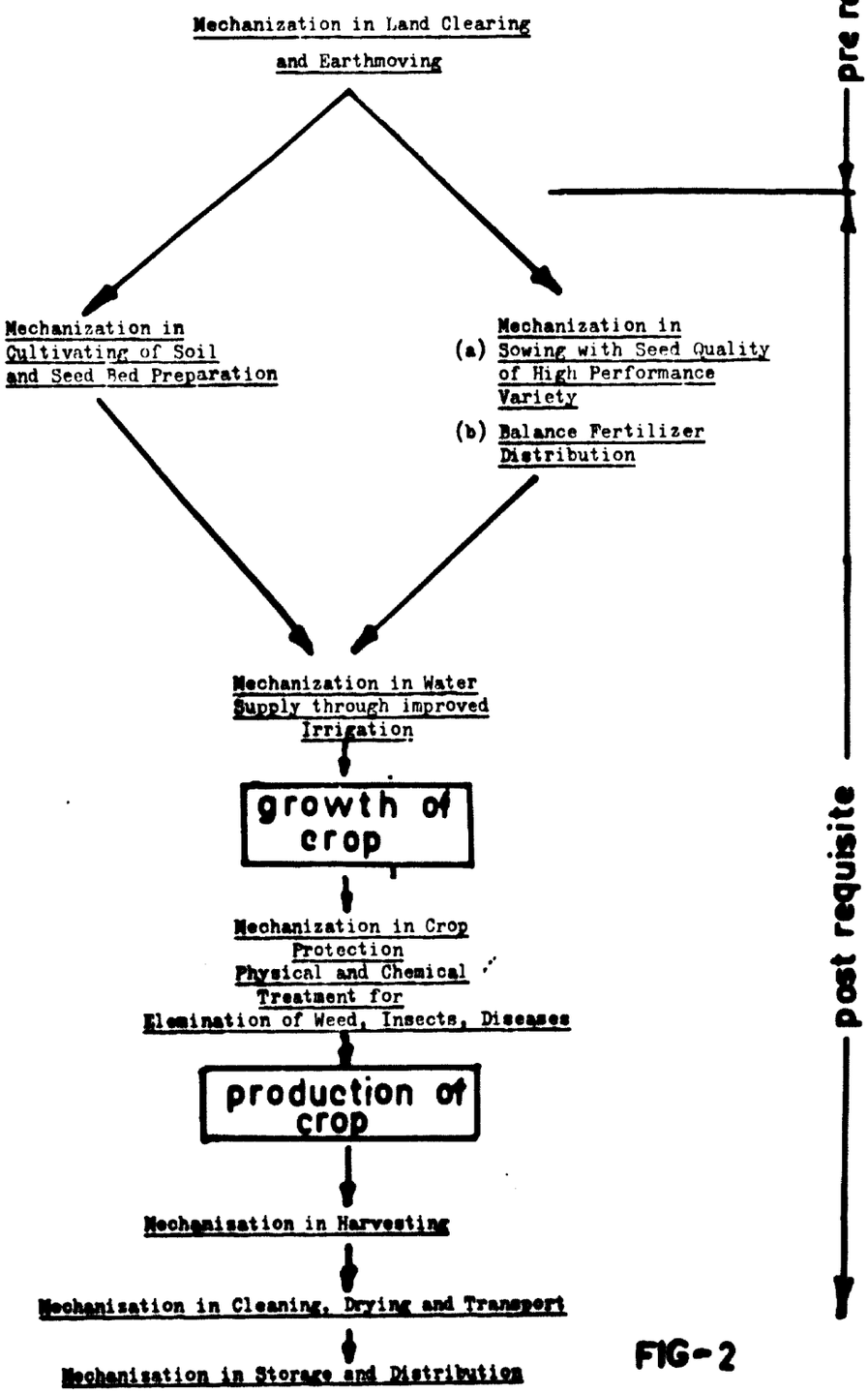

FIG-2

Synopsis of trend in mechanisation in developing countries

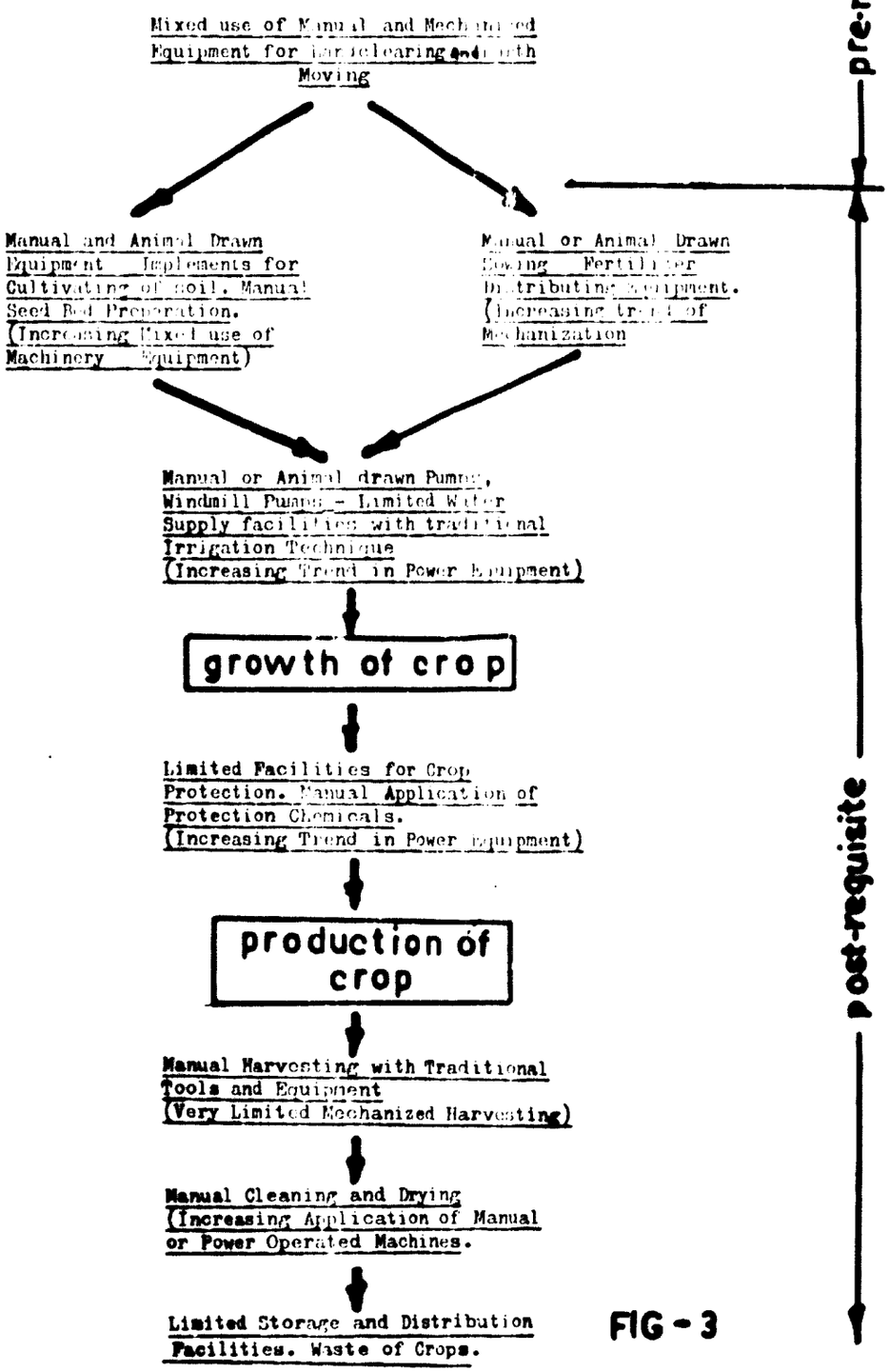

FIG - 3

INTERLINKAGE IN AGRICULTURAL MACHINERY INDUSTRY FOR RURAL INDUSTRIALIZATION IN DEVELOPING COUNTRIES

by

Aloke Kumar Mitra
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- mechanized equipment for crop protection (both physical and chemical);
- mechanized equipment for harvesting crops;
- mechanized equipment for threshing and cleaning of crops;
- mechanized equipment for crop processing;
- mechanized equipment for crop drying and storage;
- mechanized equipment for farm transportation and material handling and storage.

Outlook of Mechanization in Developing Countries

Notwithstanding what had been happening in the developed world, during the last two decades a great emphasis was given by the developing nations to mechanization and reorientation of the farming systems considering the relative costs of machinery, equipment, labour and the solvency of the farmers. It is estimated that about 60% of agricultural producers in developing countries are traditional users of hand tools and simple animal drawn equipment. In vast areas, irrigation is carried out mainly from seasonal rainfall. The cultivation techniques are often based on past conventional methods. To a great extent the manufacture of agricultural tools and equipment is often made at village level. Most of these tools are often modified to cater for the traditional demand. The overall trend in mechanization therefore can be divided into three distinct sectors in the developing countries:

Sector I - Manual System

- where farming is carried out with traditionally designed, wide varieties of hand tools: e.g. shovel, spades, spading fork, digging hooks and hoes, plough (ordinary and mould board type) single wheel hoe etc.

Sector II - Mixed-mechanization System

- where farmers use partly hand operated tools and partly a combination of animal drawn equipment and walking type power operated equipment e.g. animal drawn cultivator, animal drawn ridger, simple walking type power operated tillers. Sometimes mixed use of small tractors with subsequent farm operations by hand tools are often noticeable.

Sector III - Advanced Mechanization System

- where the farming is carried out with advanced power operated machinery, such as tractors up to 70 HP with associated equipment like disc plough - 2 or 3 furrow, tillers 9 and 11 tines, tiller seeding and attachments, paddy disc harrow, off-set disc harrow, sub soiler, multipurpose blade terracer, reversible ploughs, ridger, mounted disc harrow, seldom usage of combined harvester.

Although a great effort is made by many developing nations to produce modern farming equipment, mechanizable forms of agriculture are limited in many developing countries due to geographical, environmental and agrarian constraints coupled with socio-economic confusion prevailing in many parts of the developing world. The general trend of mechanization in the developing countries is shown in Figure 3.

Although the introduction of high-yielding seeds and fertilizers in developing countries has raised the agricultural production, often there is constraint in power and equipment which necessarily has an adverse effect on maximising production.

The table in Figure 4 describes breakdown of types of farming according to the various types of farm tools: hand-tools, hand or animal-drawn machines, power mechanization.

Geographical Zone	Proportion of labour spent in agriculture according to energy source		
	Human	Draught Animal	Engine
USA	0.01%	-	99.99%
Europe	0.39%	-	99.61%
Asia	26%	51%	23%
Africa	35%	7%	58%

Figure - 4

Source: A. Moens: Agricultural Mechanization in Asia Vol.III (Winter 76)

Note: International Trade in Agricultural Machinery and Estimated Demand for Agricultural Machinery are included in the Annex IV and V of this paper. The Figures 6 to 12 and Figures 15 and 16 are allocated for Annex IV and V of this report.

Data on the various types of agriculture: manual agriculture; animal draught and power mechanized agriculture

Source: CNEEMA L'agriculture et L'énergie dans le monde (433) Nov 1977

Heading / Pure type of agriculture	Manual type Agricult.	Mechanized animal draught Agr.	Power Mech. agriculture (supposed concentrated and totally power mech.	Overall world total
Agricultural area (only + forest excluded) in 10^6 ha	2900	700	900	4500
(in %)	(65)	(15)	(20)	(100)
Number of farmers in 10^6	240	64	16	320
(in %)	(75)	(20)	(5)	(100)
Population working in agri. (in economic terms) 10^6	460	260	50	770
(in %)	(60)	(33.5)	(6.5)	(100)
Surface A.A.U. per working person	6.3	2.7	18	5.8
Amount of equipment in service tons	17500,000	80500,000	172,000,000 (53) (inc. 17,5mil tractors of 40 ch)	275,000,000
(in %)	(6)	(31)		(100)
Annual consumption of fertilizers in 10^6 tons N	7.77	5.83	25.26	38.86
P_2O_5	3.42	3.42	15.94	22.78
K_2O	1.50	2.49	15.95	19.94
Total	12.69	11.74	57.16	81.58
(in %)	(15.6)	(14.4)	(70.1)	(100)
Kilograms of chemical fertilizer per hectar AAU per year	4.4	16.8	63.5	18.1
Primary energy consumption per year (10^6 ha)				
agr. working population	115	130	60	305
draught livestock	-	165	p.m.	165
material and fuel	6.9	27	170	205
chemical fertilizers	23.6	18.6	83.1	125
pesticides	1.5	0.6	4.4	6.5
other means of prod.	2.3	0.9	6.8	10
Total	150	345	325	820
(in %)	(18.3)	(42.1)	(39.6)	(100)

Figure - 5

A global picture of data on the various types of agriculture: animal drawn and power mechanized agriculture is shown in Figure - 5.

There are mixed opinions in the developing world as to whether these constraints can be overcome by the utilization of the available labour force or by greater investment in farm mechanization. Each developing country would require a greater study in detail at national, regional and farm level. The purpose of this paper would be to examine and explore the possibility of agricultural mechanization as prerequisite for interlinked rural industrialization in developing nations.

(iii) Potential for Appropriate Agricultural Machinery Based on National Mechanization Policy

The intensification of agricultural production envisages the application of systematic policies to enable the growth of mechanization through appropriate choice of power-making combinations for individual and co-operative farms. The composition and combination of various power equipment should be broadly based on:

- increasing the output of food grain per hectare of cultivated land;
- reducing the cost of production through a high level of productivity;
- maximizing the utilization of available land for farming.

In order to obtain a tangible result in increasing food production, the setting up of a National Mechanization Policy would be a paramount importance for the development of the agricultural industry both at national and farm level. Such a policy should promote and cultivate:

- greater output of food grain;
- greater utilization of inputs;
- greater avenues of employment either directly at farm level or through the creation or enlargement of industrial sector manufacturing agricultural machinery to suit local conditions;
- greater utilization of farm land ;

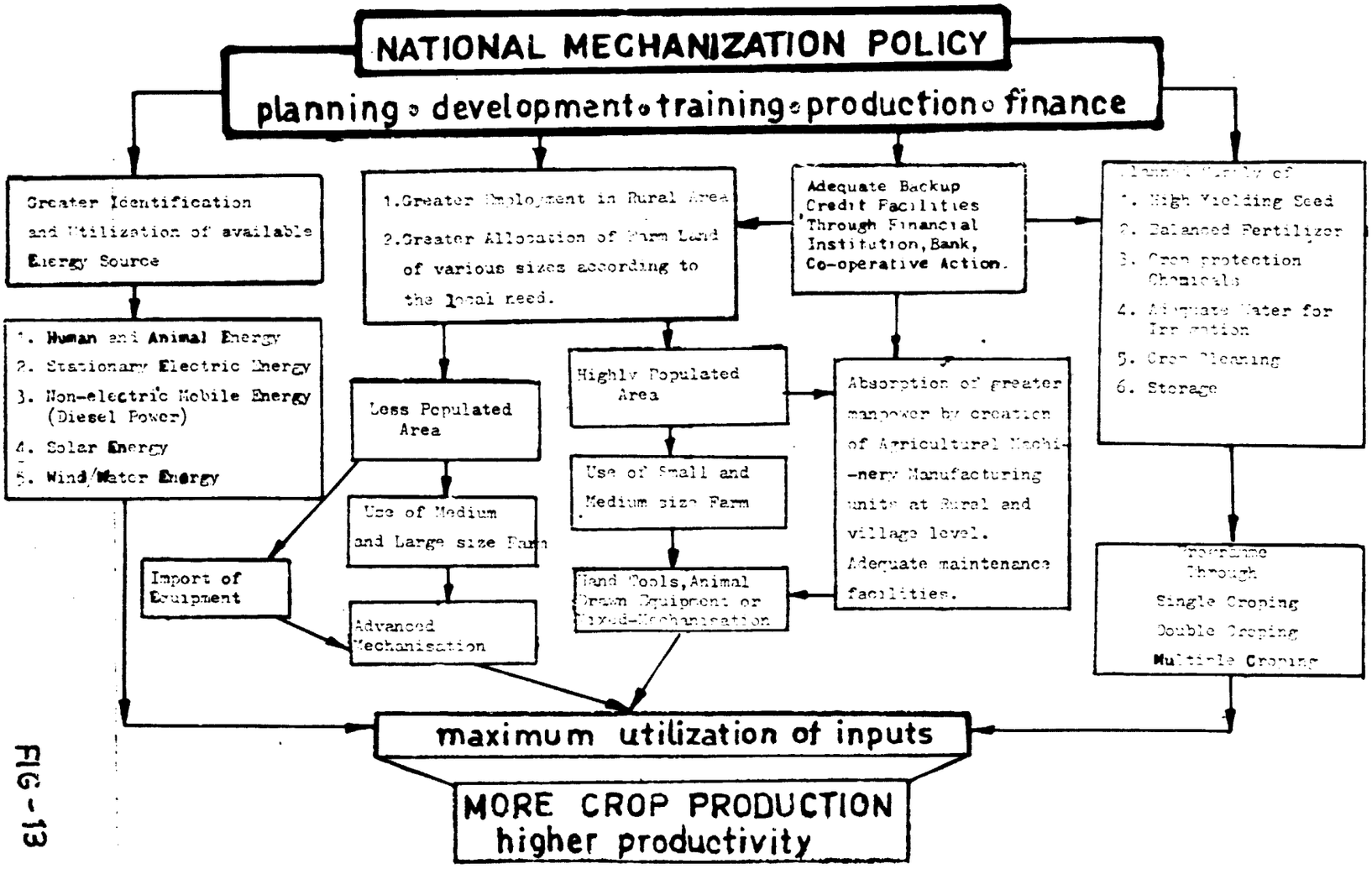

NATIONAL MECHANIZATION POLICY
planning • development • training • production • finance
Greater Identification and Utilization of available Energy Source
1. Human and Animal Energy
2. Stationary Electric Energy
3. Non-electric Mobile Energy (Diesel Power)
4. Solar Energy
5. Wind/Water Energy
1. Greater Employment in Rural Area
2. Greater Allocation of Farm Land of various sizes according to the local need.
Adequate Backup Credit Facilities Through Financial Institution, Bank, Co-operative Action.
1. High Yielding Seed
2. Balanced Fertilizer
3. Crop protection Chemicals
4. Adequate Water for Irrigation
5. Crop Planning
6. Storage
Less Populated Area
Highly Populated Area
Use of Medium and Large size Farm
Use of Small and Medium size Farm
Absorption of greater manpower by creation of Agricultural Machinery Manufacturing units at Rural and village level. Adequate maintenance facilities.
Import of Equipment
Advanced Mechanisation
Hand Tools, Animal Drawn Equipment or Mixed-Mechanisation
Single Croping
Double Croping
Multiple Croping
maximum utilization of inputs
MORE CROP PRODUCTION
higher productivity

FIG - 13

- greater utilization of available energy source;
- appropriate financial credit availability for farmers to enable timely purchase of inputs including machinery.

The enlargement of agricultural production requires a correct balanced package of inputs, e.g.

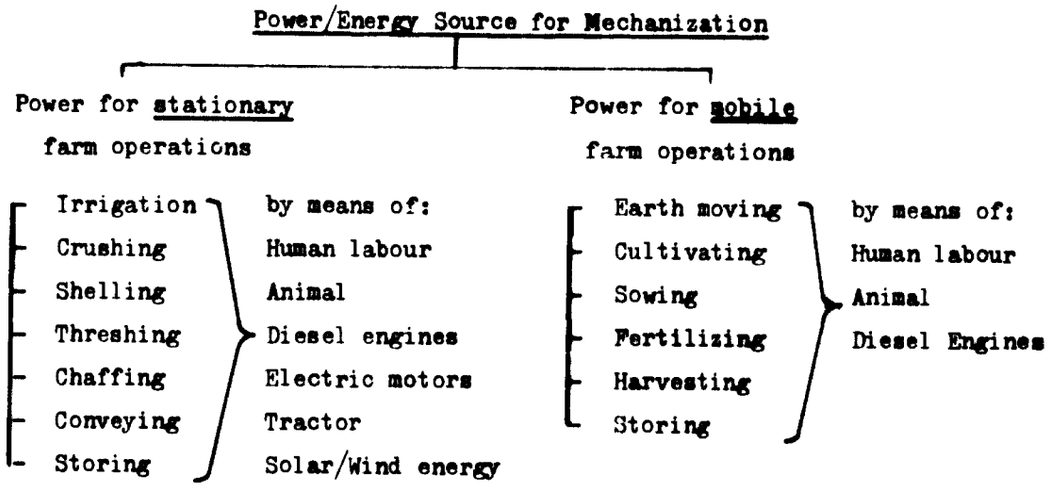
- high yielding seeds;
- balanced fertilizers;
- adequate irrigation facilities;
- adequate crop protection;
- optimum level of mechanization.

Each of these inputs has a mechanical counterpart. Therefore, detailed studies are required to find a right balance between the technical and biological need for the optimization of agricultural crop production at farm level. It is worth mentioning here that the rational process of mechanization is independent variable to the farm production and greatly attributed to the farm sizes. Therefore, before entering into the question of national mechanization policies, a closer look is needed at the overall farm distribution and holding policy of a particular country.

A flow diagram indicating the diverse rationals on which the foundation of national mechanization policy should be based upon is reflected in Figure - 1. In order to establish this, a clearer picture is needed for the potential of appropriate levels of mechanization required within the framework of national policy.

Source of Power for Mechanization

The basic requirement of mechanization of agricultural machinery calls for adequate energy or power supply at farm level. The power source and its relative application can be summarized as follows:



The concept of stationary power use is an unique feature of mechanization of individual farm for:

- releasing a part of human and animal labour during peak period;
- making timely operation possible;
- improving the efficiency of labour and other component input.

The appropriate choice of power requirement directly depends on farm sizes as explained in Figure - 14.

Farm size vs. Power source

Type of Farm	Human and Animal Labour	Walking Type Two Wheel Tractor up to 15 HP	Conventional Rider Tractor over 15 HP
Small farms $\leq$ 2 ha.	X	-	-
Medium farms $\leq$ 5 ha	X	X	X
Large farms $>$ 5 ha	-	X	X

Figure - 14

Note: Estimate of Investments in 1962 and Proposals for 1975 and 1985 (Figure 15) and Value of Agricultural Inputs in 1962 and Levels Proposed for 1985 (Figure 16) are included in Annex IV of this paper.

Mechanization Policy at Farm Level

Farm Size Below - 2 hectare

In these small farms where farming is carried out in a traditional way using hand tools and animal drawn equipment with little or no purchased inputs the mechanization policy should be based on:

- improved supply of high yield seeds and fertilizer through single or double croping;
- high quality spades, spading fork, digging hooks and hoes (chopping type and pulling type) shovel, ploughs single wheel hoe, etc.;
- animal drawn ridger, cultivator and ploughs;
- effective irrigation water supply through windmills up to 15 ft. lift, hand pumps up to 5 ft. lift, small electric or diesel operated pumps up to 15 ft. lift;
- hand drills, sickle, scythe, forks, rakes;
- hand operated threshers, crushers, etc.;
- storage bins up to 3 ton capacity.

Farm Size 2 to 5 hectare

These are medium size farms where farming is carried out either by animal drawn implements or by small tractor drawn equipment. Here the mechanization policy should broadly be based on:

- high quality high yield seeds and fertilizers for double and multiple cropping;
- power operated walking tillers, ploughs, etc. up to 15 HP;
- animal drawn implements or tractor drawn implements up to 15 HP;
- animal or power operated drillers, distributors;
- effective irrigation water supply through diesel or electric pump up to 6 HP;
- power operated walking harvester or animal drawn harvester;
- animal or power operated crushers, shellers, threshers, etc.;
- storage bins up to 5 tons capacity.

Farm Sizes Over 5 Hectare

These farms are regarded as large farms and mechanization policy here would be based more on application of power machinery. The agricultural machinery generally used is as follows:

- application of seed-irrigation-fertilizer technology with system of multiple cropping;
- application of mechanized cultivation based on conventional four wheel tractors with a capacity of 15 - 70 HP having PTO attachment to suit the following:
  - Disc plough: 2 and 3 furrow 26" diameter discs 3/16" thick
  - Mouldboard plough: 2 and 3 furrow fitted with disc coulters and skimmers;
  - 9 and 11 tine tiller - shovel capable to till up to 9";
  - Tiller seeding attachment;
  - Paddy disc attachment;
  - Off-set disc harrow;
  - Sub-soiler, etc.
- application of driller and distributor;
- effective irrigation water supply by diesel or electric driven pumps over 6 HP. Water supply can be obtained from national irrigation channel of network;
- power operated crop protection equipment;
- power operated combined harvester - 7 ft. to 15 ft.;
- power operated cleaner, thresher, drier;
- storage silos 10 to 1000 tons.

A study carried out jointly by FAO and the World Bank during 1970 showed clearly that small farms increased in number strikingly in developing countries with the growing pressure of population on land sources. For instance the number of farms smaller than 5 hectare doubled in India between 1950 and 1970, trebled in Brazil and quintupled in Iraq. If the national mechanization policy plays an important role in the developing countries, it is possible that these small farms need to be be provided with adequate low cost tools and agricultural equipment in order to create a super green revolution.

In order to provide adequate appropriate tools and equipment to these farms in developing countries a wide range of simple and low cost power equipment are needed which can be produced in the rural industries or even at small scale or artisan level.

The developing countries in tropical areas are traditional users of hand operated tools and tillage equipment. Many of these types of equipment are designed locally with traditional methods and technical skill, their application also varies from country to country.

The energy requirement for hand operated tools and hand operated cultivating equipment is therefore obviously dependant on the physical structure and the capacity of users, governed by social and environmental conditions:

- for cultivation to a depth of 250mm using spade — 100 man-day per hectare needed
- for primary tillage using a traditional hoe to a depth of 125mm — 30-50 man-days per hectare needed

If the above operations were carried out with ox-driven implements the cultivation time could be reduced to 5 and 15 man-days per hectare. Therefore, the trend of mechanization should be gradual development from:

Manual Farming
to
Manual/Animal Assisted Farming
to
Animal/Power Assisted Farming
to
Power Assisted Farming

Overall national mechanization policies should be based on how to achieve this gradual transition in the best possible way so that it takes place at an appropriate level of mechanization (discussed in Section III) which mainly depends on the energy source, farm size, skill, aspiration of the farmers, access to credit, availability of market and competence of the extension service.

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SECTION II

GENERAL OUTLOOK ON AGRICULTURAL MACHINERY INDUSTRY IN DEVELOPING COUNTRIES

The previous section examined the present trend in agricultural production, and the outlook of both agricultural mechanization and machinery industries in the developing countries with a special emphasis on the establishment of a national mechanization policy for the intensification of crop production.

This section will take a closer look for the identifications, conditions and the problems of existing agricultural machinery industries operating at various technology levels and will cover a broad summary of existing manufacturing facilities for the manufacture of agricultural machinery and equipment in the developing countries.

The developing countries economy is broadly based on more rural agricultural and limited levels of industrialization both in engineering and allied metalworking industries sectors. In a global concept, the agricultural machinery manufacturing industries form a part of engineering industries and are particularly related to the metal working sector. During the past two decades both in the developed and in the developing world the pattern of agriculture has changed considerably. Obviously, the need for improved agricultural machinery and equipment has created a new dimension and consequent expansion both in engineering and in metal-working industries sector.

Agricultural machinery and implements are important inputs to the whole agricultural process. Therefore, the agricultural machinery industry offers a greater choice of manufacturing technologies appropriate for the rapid growth of industrialization in the developing countries. Most of the developing countries have given priority to appropriate mechanization in agriculture and in many cases to local development of manufacturing agricultural machinery and equipment. Since the establishment of manufacturers of agricultural machinery

spread throughout the country-side, it has been of great significance to the opening of further avenues of employment for which the developing countries are really aspiring.

The agricultural machinery industry produces a large variety of products ranging from hand tools, animal drawn equipment, walking type power operated equipment, pumps, pipes, fertilizer distributors and sprayers. Power-making combination equipment, such as tractors, trailors, tillers, discploughs, engines, harvestors, threshers, storage bins, silos and many other types of grain transporting equipment - the manufacturing technology and related problems associated with it vary in kind and magnitude. The infrastructure requirement and method of manufacture differ substantially in this particular sector of industry. The manufacture and production facilities call for foundry, forging and sheetmetal work, general machine work, tool room work, heat treatment, metallurgy and purchasing of ancillary equipment like, motors, instruments, tyres, plastic products and hardware and many other diverse finished and semi-finished parts from associated industries at various levels.

Since the agricultural machinery industry is considered to be a basic industry, the Government policies in the developing countries particularly at national and regional level should give utmost consideration in respect of financing to investment promotion and marketing on the one hand and management, training, research and development on the other hand with special reference to the transfer of appropriate technology.

(i) <u>The Present and Future Trends in Developing and Least Developed Countries</u>

Both in the developing and in the least developed countries, the general trend in procurement of agricultural machinery are from three distinct sources:

- through importation
- through local manufacture with relative degree of import content
- through entire indigenous manufacture.

Due to the existence of potential internal markets, the natural trend in the developing countries is directed towards indigenous manufacture of local farm machinery at various industrial levels. The local approach of manufacturing simple and sophisticated equipment has gained a further momentum due to the increasing constraints such as availability of limited foreign exchange, increase in freight charges, non-availability of spare parts.

Source of Manufacturing Technology and Know-how in the Developing and Least Developed Countries

The recent consideration of manufacture of agricultural machinery in the developing and least developed countries are mainly based on the selection of technology and know-how available from the following four sources:

Item	Source of Technology	Observations
1	Through technical collaboration or joint venture with large or medium size progressive companies from developed or developing countries with equity and management participation.	Out of 75 major developing and least developed countries only 46 have adapted manufacturing machinery based on item 1 and 2.
2	Manufacture of machinery and equipment under licensing agreement where agreed royalties are paid on designs used, parts manufactured and sales turnover.	
3	Manufacture of machinery and equipment from adaptation and modification of well-known products without any foreign participation or legal approval	Figures are not available, but many countries have started manufacturing through this method due to the lack of import facilities and restriction of foreign exchange.

4	Manufacture of agricultural machinery entirely from the indigenous development and effort, maintaining traditional design features.	All the 75 major developing countries manufacture hand tools and small equipment based on item 4. Within this about 29 developing countries including least developed countries manufacture exclusively small hand tools and equipment at village and rural level. as shown in Figure 17

Present Level of Technology in Developing and Least Developed Countries

Careful examination shows that the present manufacture of agricultural machinery and equipment delineated from three distinct levels of technological sophistication as identified in the following categories in most of the developing and least developed countries.

However, there is also a relative change in the pattern of technology at various scales of manufacturing delimitation, which is greatly influenced by the product manufactured; volume of the product, method of production and the size of the enterprises.

The present sizes of the agricultural machinery manufacturing units observed in the developing countries are as follows:

- Family type of worker/ownership enterprises employ from 1 to 5 persons
- Small and medium scale enterprises employ from 30 to 200 persons
- Large scale enterprises employ over 200 persons.

Technology Level I (Family Type of Worker/Ownership)

Manufacture of agricultural equipment carried out by manual operations and very seldom is the application of power machinery. Products manufactured are simple agricultural handtools, hand operated implements and selected animal drawn implements. These establishments are mostly scattered from urban to village level. Some of the simple tools are shown in Figure 17.

Technology Level II (Small Scale Industries)

Manufacture of agricultural equipment is carried out mechanically on batch production basis - products manufactured are: animal drawn implements, medium or large volume hand tools, selected agricultural equipment; mainly pumps, crop protection equipment, sprayers etc. These small sized plants are situated in urban areas, seldom in the country-side and in industrial estates of specific rural areas.

Technology Level III (Large and Medium Scale Industries)

Manufacture of agricultural machinery and equipment by means of conventional, semi-automatic automatic and special purpose machine tools on a high volume, high precision and high investment basis. Products manufactured are agricultural power making combination machines e.g. tractors, tillers, ploughs, powertillers, disc ploughs, pumps, sprayers, storage bins etc. These large and medium plants or complexes are mostly situated in the urban or rural-urban border or in the industrial estates.

Typical examples of agricultural machinery manufacturing industries as found in most of the developing and least developed countries operating at different levels of technology indicating existing facilities within the plants.

Industries operating at Existing Technology Level I (Family, Artisan or Worker/Ownership Basis)

The great majority of these units are small workshops scattered in the vast rural and urban areas of 75 developing and least developed countries. Most of the owners are local blacksmiths and produce simple hand and animal drawn implements for the local farmers. Some of these tools are shown in Figure 17.

Present Technology Level I

1. Product	Spades, shovels, spading forks, ploughs, digging hooks, hoes, animal drawn equipment.
2. Design	Mostly for local need either by modifying equipment from a national supplier or by manufacturing cheap local replacement for conventional equipment.
3. Investment	Very small sometimes up to US$ 100 particularly in Least Developed Countries.
4. Finance and Working Capital	Receives very little assistance from the financial institutions, inadequate working capital, mainly depends on local money lenders with high borrowing rate.
5. Marketing	Depends only on local need, sometimes supply cheap tools to a greater market by undercutting the price. No systematic sales outlet for the product.
6. Management	Nill (family type operation).
7. Working Area	100 to 300 sq. ft.
8. Facilities	In many cases limited supply of water and electricity.
9. Material Used	Mostly mild steel EN1 series. Occasional use of M.S. Sheets, round and angle sections.
10. Machinery	Small handtools e.g. hammer, anvil chisel, hacksaw, small coal fired furnaces with hand operated blowers, pedal operated grinding wheel, occasional use of welding, drilling bending.
11. Production Technique	Objects and parts are produced manually. Hand forgings are predominant, no application of jig tools or batch production methods.
12. Process of Material	Due to the lack of proper steel and facilities carburising hardening or tempering does not exist.
13. Quality Control	Does not exist. Only by way of conventional ruler, measurements are carried out.
14. Employment	1 to 5 persons in each establishment, the sector provides a large number of employment in the rural areas.

A number of Governments in Asia, Western Asia, Latin America and Africa have given priority consideration to enlarge this sector through their national development plan.

Industries Operating at Existing Technology Level II (Small Scale Industries)

Out of 75 major developing and least developed countries only 46 countries are engaged in manufacturing agricultural machinery and implements based on Technology Level II. Most of these industries are situated in urban, rural-urban boarder areas and in industrial estates in the developing countries.

Present Technology Level II

1. Product	Animal drawn implements e.g. ploughs, tillers hoes, diggers, pumps, sprayers, etc. Also manufacture small agricultural hand tools on a batch production and competes with industries at technology Level I.
2. Design	Imitation of local design - Design adaptation and modification from well known product - Indigenous design supply from research and development centre of a particular country - According to customer requirement.
3. Investment	Widely varies from 5,000 US$ to 80,000 US $ or more.
4. Finance and Working Capital	Finance available from either private source or Government institutional loan. Banks extend the working capital, interest rate varies from country to country.
5. Marketing	There is a greater demand for these products. Individual enterprise markets their own product. Very little export market opportunity except for pumps and sprayers. Few countries in Asia export their products.

6.	Management	Most of these industries run on a line management. Ownership is based on individual or partnership basis. In many countries scientific management exists with different levels of responsibility, particularly in Asia, Near East and Latin America.
7.	Working Area	10,000 sq. ft. to 50,000 sq. ft.
8.	Facilities	Adequate power and water supply available.
9.	Material Used	Various shape castings grade 17 and various steels e.g. EN1, EN8, EN16, EN32, EN42 are commonly used either through import or local sources. Usage of galvanised M.S. Sheet, round, flat, angle and hexagonal sections quite common. Springs, bearings, hardware are imported except in few Asian and Latin American countries.
10.	Machinery	Power operated hammers, press, drilling machine, milling machine, electric and gas welding sets and all types of conventional machine tools and equipment, limited inspection equipment, electrical/ coal/ oil fired furnace, use of pneumatic system and spray paintings are usually available. Also hand operated flat roller bender and angle bender are commonly used.
11.	Production Technique	Application of welding Jig and fixtures are commonly used in fabrication. Production techniques are more job shop basis with minimum batch size. Assembly and sub-assembly are often introduced to increase production, application of incentive schemes are noticeable.
12.	Process of Material	Proper heat treatment facilities are available particularly in Asia, the Near East and Latin American Countries. Carburising and hardening are done on a scientific basis.

13. Quality Control	Inspection system exist in majority industries. Usage of micro-meter, height gauge, calipers is common. Quality deteriorates due to non-availability of correct material. Many Asian and near East countries produce their own raw material including few in Latin America.
14. Employment	Generally each individual industry employs from 30 to 200 persons.

An increasing number of industries operating at existing Technology Level II are coming up in the developing countries. There is also a greater trend in family enterprises in urban areas who are able to enlarge their activities and form small scale industry units operating at Technology Level II with Governmental assistance. This is very common in some countries as Asia, the Near East and Latin America.

Industries Operating at Existing Technology Level III (Large and Medium Scale Industries)

Out of 75 major developing and least developed countries only 20 countries are engaged in manufacturing agricultural machinery and implements based on existing Technology Level III. Most of these large industries and complexes are situated in the vicinity of the rural-urban borders or in industrial estates.

Present Technology Level III

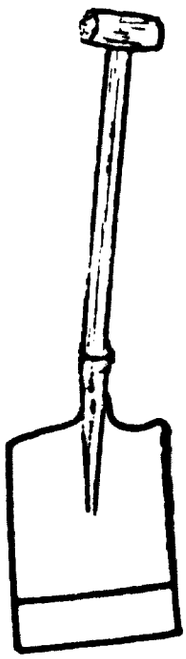
1. Product	Power-making combination machinery e.g. engines, tractors: 5hp, 25hp, 35hp, 65hp, tillers, discploughs 2-3 furrow, power tillers, pumps, sprayers, driller, distributor, storage bins, conveying equipment, threshers, shellers, etc.
2. Design	Most of the designs are procured under licensing or collaboration agreement with larger agricultural (foreign) machinery manufacturers. Many cases modifications of designs are allowed legally due to local manufacturing constraints.

3. Investments	Various according to the plant size mostly from US $100,000 to US $10,000,000 of even more. Capital is raised from joint venture with equity and loan from financial institutions or local or international banks.
4. Finance and Working Capital	Finance is available from the bank against the security of raw material and work in progress. Main sources of finance are national and international institutions, Government and local banks.
5. Marketing	The industries are equipped with country-wide network of marketing and sales outlets. Generally marketing operations are completely segregated from the factory operations. Productions are regulated according to demand.
6. Management	The entire management in administration and shop level are clearly identified and based on horizontal and vertical integration. Administration is divided into General Administration, Personnel, Purchase and Marketing. Factory Administration, Machine Shop, Tool Room, Fabrication Shop, Heat Treatment Shop, Assembly and Sub-assembly Shop, Inspection and Quality Control, Metallurgical Laboratory, including Design, Planning, Work-study, Production and Metal Control, Stores operation.
7. Factory Area	Administrative area 2,000 - 10,000 sq. ft. Manufacturing area 50,000 to 300,000 sq. ft. or more.
8. Facilities	Adequate power and water supply available. Separate air and steam supply - mostly based on centralized distribution. Crane, forklift, truck, hoists, stillage, pallets bins, etc. are often used.

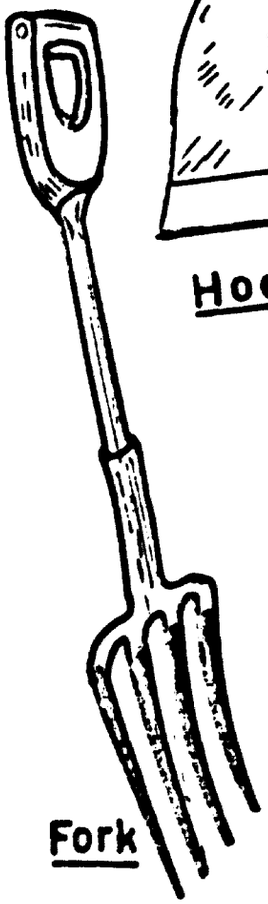
CONTENTS

9. Material Used	Most of the shape castings are procured from outside under mehanite or grade 17 specification. Malleable iron and spheroidal castings are often used. Steel rods of various sections EN1, EN1(a), and EN8 are used. Apart from this special high carbon steel ranging from EN16, EN24, EN32 and EN42 to 46 spring steel are used considerably. Also many parts and materials are purchased finished, e.g. bearings, brakes, wheels, hydraulic system, hardware instruments, electrical parts, piping, wire, fittings. Application of MS 16, 18, 20 SWG sheets are often used.
10. Machinery	Simple machines: Lathe (capstan and Turret or Copying), Drills Multispindle drills, Universal Milling Machines, Power forges and hammers, boring machines, Threading and Tapping Machines, Broaching Machines. Special purpose machines: Unit head machines, special tailor made machines e.g. for axel housing, gear box, centre housing, precision boring and fine boring machines, single spindle and multispindle bar and chuck automatic, Duplex or Triplex milling machines. Toolroom machines: Jig boring machines, jig grinding machines and lapping machines, die sinking machines, tool and cutter grinder. Inspection equipment, height gauge, optical equipment etc. Gear cutting: Hobbing machine, bevel gear generators, lapping machinery, carburising plant, hot press quenching machine. Heat treatment: Carburising plant, induction hardening machine, cyanide bath etc. Treatment plant: Pickling plant, degreasing plant, galvanising plant, phosphating plant, paint booths, paint dipping plant.

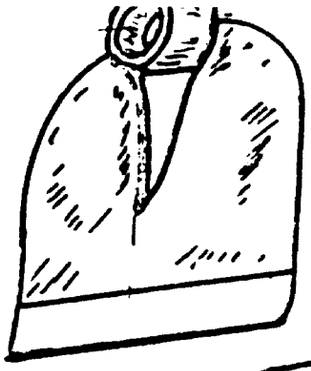
	Fabrication: Press brakes, eccentric press, hydraulic press, shears, CO_2 Welding, Submerge arc welding, conventional welding, bending and tube bending machines. Conveyors, electrical installation, steam and water installation, electrical substations, etc. Central Maintenance shop:
11. Production Technique	Based on (1) continuous production for high volume, (2) batch size production. Application of process sheets standard time, incentive scheme. Application of jig tools, fixtures both for machining and fabrication. Production is forecasted and controlled by planning, scheduling, manufacturing and follow-up through inspection and quality control. Design specifications are adheared to at all levels.
12. Process of Material	Carburising and nitriding for case hardening, through hardening and tempering. Shotpinning, induction hardening, etc. are carried out through special machines and equipment.
13. Quality Control	Special quality control sections are available with modern precision equipment: spectroscopic analysis of raw material, inspection equipment visual, optical and electronic. Statistical quality controls are introduced in mass production with a given level of tolerance. Both physical and chemical controls being incorporated.
14. Employment	Individual plant producing about 5,000 tractors and 3,000 mixed units of equipment per annum employs about 1,500 persons. Employment in these large and medium industries vary considerably from country to country.



Spade

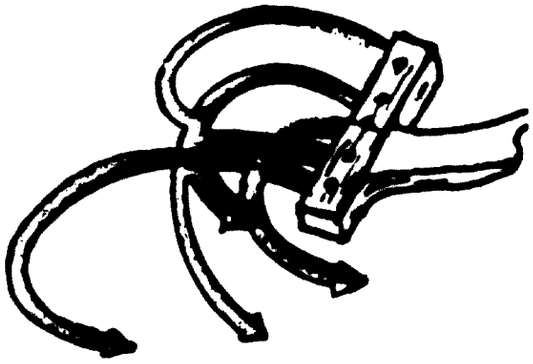


Fork

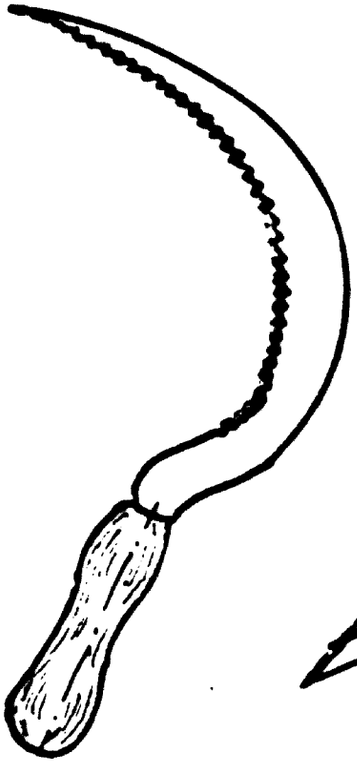


Hoe

Cultivator



Cultivator



Sickle

Scythe

Figure 17

From the above study it becomes apparent that there is a vast gap between the three levels of manufacturing industries for agricultural machinery generally existing in the developing countries. To some extent it is possible to improve the level of technology amongst these industries, particularly large capital, management and marketing outlay is required in order to improve the technology from second to third level. Moreover, it is necessary for the developing countries to modernise the existing industries operating at the first level of technology.

The Existing Problems of the Small Establishments Manufacturing Hand-tools etc. in Technology Level - I and their future trend

The establishments engaged in manufacturing hand tools and simple implements as described in Technology Level - I exist in greater number in all 75 major developing and least developed countries. In most cases they work under great handicaps, e.g.:

- lack of finance and steady market;
- lack of proper accounting system particularly costing, this incurs them into total loss and eventual close-down of the establishment;
- inadequate working area with limited facilities, in many cases electrical power does not exist;
- lack of modern management;
- lack of proper design;
- lack of suitable material particularly high carbon steel, hardware, etc.
- lack of machinery and equipment particularly power operated machines;
- lack of heat treatment facilities;
- lack of scientific production methods.

Individual skill and personal ability to work hard which keeps the entrepreneur in business. In order to improve this sector the following special considerations are needed:

- improvement of working conditions;
- bulk purchase of raw materials and subsequent distribution at cheaper price;

- financial assistance through credit for purchase of raw material and machinery based on intermediate technology level;
- subsidised water and electricity supply;
- introduction of product-mix operations;
- supply of proper modern designs through establishment of regional institutes for research and development centre;
- intensification of training facilities through mobile extension services.

The outlook for these industries in Asia, Latin America and particularly in Africa are not very encouraging. It is desirable that respective Governmental and International Institutions should offer adequate Technical and Financial assistance to this sector in order to maintain a steady growth and higher employment in this sector.

The Existing Problems in Small, Medium and Large Scale Industries Manufacturing Agricultural Machinery at Technology Level II and III and their future trend

The existing problems encountered in industries manufacturing agricultural machinery and equipment at technology Level-II andIII depict a somewhat different picture to that which has been described above. Out of seventy-five major developing and least developed countries, 46 and 20 countries, respectively, have attained the appropriate Technology Level-II and III that is 61% and 26% respectively. Moreover, there is a wide technological gap between these two levels of industries. The existing major problems can be summerised as follows:

- Lack of export market copportunities. Although a demand exists from local market, export earnings are very small compared with developed countries.
- Lack of suitable design - in many cases foreign collaborator supplied designs which need modification for local application.
- Installation of second-hand machinery without proper guaranteed supply of spare parts, this often leads to breakdowns in the plant.
- Lack of proper castings both ferrous and non-ferrous.
- Lack of automatic machinery, when such machinery is justifiable with regard to production volume.

- Lack of timely procurement of parts through subcontractors or foreign importers.
- Higher production cost due to low level of productivity.
- Poor plant maintenance due to lack of preventive maintenance schemes.
- Increasing prices of raw materials.
- Lack of technical personnel at middle management level.
- Lack of training facilities particularly at operators level.
- Lack of improvisation of correct tools and application of jigs, tools, and fixtures.
- Lack of working capital is prevalent in the majority of industries in developing countries.
- Lack of proper testing facilities for products before introduction onto the market.
- Replacement of high quality parts with a concession to manufacture from mild steel materials - this reduced the customers confidence.

There is no overall solution to the above problems. Individual agricultural machinery manufacturing units would have to analyse all the major problems hindering their production. Financial demand could be mitigated through various institutional facilities available both at national, regional or even international level. What would be more important - to invest adequate funds in training and maintenance. Due to import restriction many developing countries particularly in Asia, Latin America and the Near East have inherent indigenous demands for agricultural machinery - but this phase will not continue for long.

This is about the time when industries of the developing world should not only aspire to a high level of production but a greater consideration will have to be given to the quality of the products which the factories are turning over.

(ii) Summary of Existing Facilities for Manufacturing Agricultural Machinery

By separating the manufacturing industry of agricultural machinery into three levels of technology sophistication as described previously e.g. hand tools and simple implements, farm machinery and equipment, and lastly engines/tractors/implements one sees the manufacturing facilities which already exist in the developing and least developed countries are shown in Figure 18.

Figure 18.

Summary of Manufacturing Facilities for Agricultural Machinery and Equipment in Developing and Least Developed Countries According to Level of Technology

No.	Technology Level-I Hand Tools and Implements	Technology Level-II Animal drawn Farm Machinery and Equipment	Technology Level-III Engines, Tractors and Implements
1.	Afghanistan	Afghanistan	-
2.	Albania	Albania	-
3.	Algeria	Algeria	Algeria
4.	Argentina	Argentina	Argentina
5.	Bangladesh	Bangladesh	-
6.	Bolivia	-	-
7.	Brazil	Brazil	Brazil
8.	Burma	Burma	-
9.	Burundi	-	-
10.	Democratic Kampuchea	-	-
11.	Cameroon	-	-
12.	Central African Empire	-	-
13.	Central America	-	-
14.	Sri Lanka (Ceylon)	Sri Lanka (Ceylon)	-
15.	Chad	-	-
16.	Chile	Chile	-
17.	China	China	China
18.	Colombia	Colombia	-
19.	Congo	-	-
20.	Ecuador	Ecuador	-

	Technology Level-I	Technology Level-II	Technology Level-III
21.	El Salvador	El Salvador	-
22.	Ethiopia	-	-
23.	Fiji	-	-
24.	Ghana	Ghana	-
25.	Hungary	Hungary	Hungary
26.	India	India	India
27.	Indonesia	Indonesia	Indonesia
28.	Israel	Israel	Israel
29.	Iran	Iran	Iran
30.	Iraq	Iraq	Iraq
31.	Ivory Coast	-	-
32.	Jordan	-	-
33.	Kenya	Kenya	-
34.	Korea	Korea	Korea
35.	Laos	-	-
36.	Lebanon	Lebanon	-
37.	Liberia	-	-
38.	Libya	Lybia	-
39.	Madagascar	Madascar	-
40.	Malawi	-	-
41.	Malaysia	-	-
42.	Mali	Mali	-
43.	Mexico	Mexico	Mexico
44.	Morocco	-	-
45.	Nepal	-	-
46.	Nigeria	Nigeria	Nigeria
47.	Pakistan	Pakistan	Pakistan
48.	Paraguay	-	-
49.	Peru	-	-
50.	Philippines	Philippines	-
51.	Poland	Poland	Poland
52.	Rwanda	-	-
53.	Romania	Romania	Romania
54.	Saudi Arabia	-	-
55.	Senegal	Senegal	-
56.	Sierra Leone	-	-
57.	Singapore	Singapore	-
58.	Yemen	-	-
59.	Somalia	-	-

	Technology Level - I	Technology Level - II	Technology Level-III
60.	Sudan	Sudan	-
61.	Syria	Syria	-
62.	Swaziland	Swaziland	Swaziland
63.	Thailand	Thailand	-
64.	Togo	-	-
65.	Tunisia	Tunisia	-
66.	Turkey	Turkey	Turkey
67.	Tanzania	Tanzania	-
68.	Uganda	-	-
69.	Egypt	Egypt	Egypt
70.	Uruguay	Uruguay	-
71.	Venezuela	Venezuela	-
72.	Viet Nam	Viet Nam	-
73.	Yemen	-	-
74.	Yugoslavia	Yugoslavia	Yugoslavia
75.	Zambia	-	-

To what extent the appropriate level of technology in the agricultural machinery industry be improved upon in both developing and least developed countries, will mainly depend on how and in which pattern the infrastructure of the supporting mechanical and metalworking industries will develop and expand during the course of the next decade.

It is an accepted fact that most of the developing countries will continue to depend on imported material and parts from foreign countries or collaborators except in few industries in Asia, and in Latin America. Best examples can be seen in India, Braz China, Turkey where few industries operate at various technology levels use very few imported parts. But in a great many of the developing countries particularly the least developed countries the industries greatly depend on imported material or parts in order not to jeopardise their regular line of production. It is in this area where substantial study is necessary in order to explore the improvement in the relative technology level.

SECTION III

NEED FOR RATIONALE: IDENTIFICATION AND SELECTION OF MECHANIZATION PARAMETERS IN DEVELOPING COUNTRIES

The previous section was mainly devoted to the identification of various appropriate levels of technology in agricultural crop production, and also described the existing patterns of agricultural machinery manufacturing industries at various technology levels, with a general coverage of the present manufacturing facilities of machinery in the developing countries.

This section will identify the various input requirements in agricultural operations with particular reference to the appropriate selection of mechanization parameters at various technology levels. These parameters will be the major instruments for the decision making of the existing and future manufacture of agricultural machinery in developing countries.

Technological progress in agriculture tends to create a regional imbalance as well as to widen disparities between the rich and poor farmers particularly in the developing countries. Technological development is not uniform in all regions of the globe, as all regions do not grow the same crop and differ widely in terms of social and hydrological conditions. Until now the technological progress in the agricultural standards of developing countries has been mostly related to cereals. Therefore the development or enlargement of agricultural crop production requires definite Government policies in order to promote, establish and regulate the requirements for both agricultural industries and the engineering industries manufacturing agricultural and allied machinery products.

During the last two decades the developing countries made phenomenal progress in the field of agricultural production and particular attention was drawn towards agricultural mechanization.

It is true that the economies of developing countries are mostly characterised by the predominance of agriculture. During recent years most of the Governments of developing countries have been made aware of

the situation, that the growth rate of population is out smarting the agricultural food production to a greater extent. A majority of the developing countries Governments have already set out national development plans.

FAO in its provisional indicative world Plan for agricultural development (IWP) already envisaged the enormous challenge facing agriculture in the developing countries particularly in the least developed countries in 1985 when demand for food will increase by nearly 150% while the number of people directly dependent on agriculture will be increased by only 50%. The majority of the countries will depend on agricultural exports for their foreign exchange earnings. Therefore, agricultural production and development is of paramount importance to each Government of the developing countries. In a typical developing country, agriculture provides the largest source, not only of income but also of employment. In addition, it is the predominant source of foreign exchange earnings. Economic growth in this context is critically dependent upon a breakthrough in agriculture. Furthermore, the resources for development in the rest of the economy are to be generated out of an increase in output and income in agriculture. Frequently these countries have a very high man - land ratio and a fast growing population, and in addition to this, there is a vast rate of unemployment. The required industrialization growth rate which could not only reduce unemployment and underemployment but also absorb a growing labour force is beyond the limited resources as well as the organizational and managerial ability of a vast majority of the developing countries. Therefore, the employment opportunities must be expanded in the agricultural sector and related activities in the field of rural development.

Government Policies on Agricultural Development and Production of Crops - Integration of Agricultural Development into the Overall Development Policy of Developing Countries

Both the developing and the least developed countries are confronted with a common problem i.e. the promotion of the adjustment process of agriculture in a growing economy. In all developing countries there is a relative degree of misallocation of resources in agriculture. Because

of this, agriculture is incapable of achieving the increase in production necessary to feed an ever growing population and to earn sufficient foreign exchange in order to enlarge the economy.

Governmental Policy for Planning

The solutions to the above problems are difficult to achieve although comprehensive studies are being taken in the developing countries with a view to integrate the agricultural (regional, sectoral, macro and micro economic) planning within the overall economic policy of the Government. There is interdependence between Government's agricultural policy and planning. Thus the integrated planning of agricultural development implies two things:

- the integration of the economically oriented projects into the regional planning (horizontal) as well as into the sectoral, macro and micro economic planning (vertical) of a country;
- concern with an institution suitable for development in planning techno-economic projects both at national, regional and farm level.

A flow diagram showing how the overall Government policy in relation to the planning of agricultural development can be channeled out according to various input requirements is shown in Figure 19.

In order to create a greater impact on development in agricultural sectors, detailed Government policies relating to planning and particular need to be clearly understood at the very root, i.e. at farm level.

Government Policy in Promotion and Co-ordination of Input Resources through Effective Mechanization for Agricultural Development

One of the important aspects of agricultural development after the planning of techno-economic projects, is the Government's specific policy in relation to the promotion and co-ordination of existing and future resources through the process of mechanization for increased food production. Obviously the frame-work of such a policy would be on one hand, to identify the input resources and subsequent availability and supply of such resources to the farm level, and on the other hand to improve the Farm Management Plan to a greater degree in order to utilize the resources for optimizing the agricultural production as shown in Figure 20.

Figure 19

Government Policy of Agricultural Development and Production of Crops

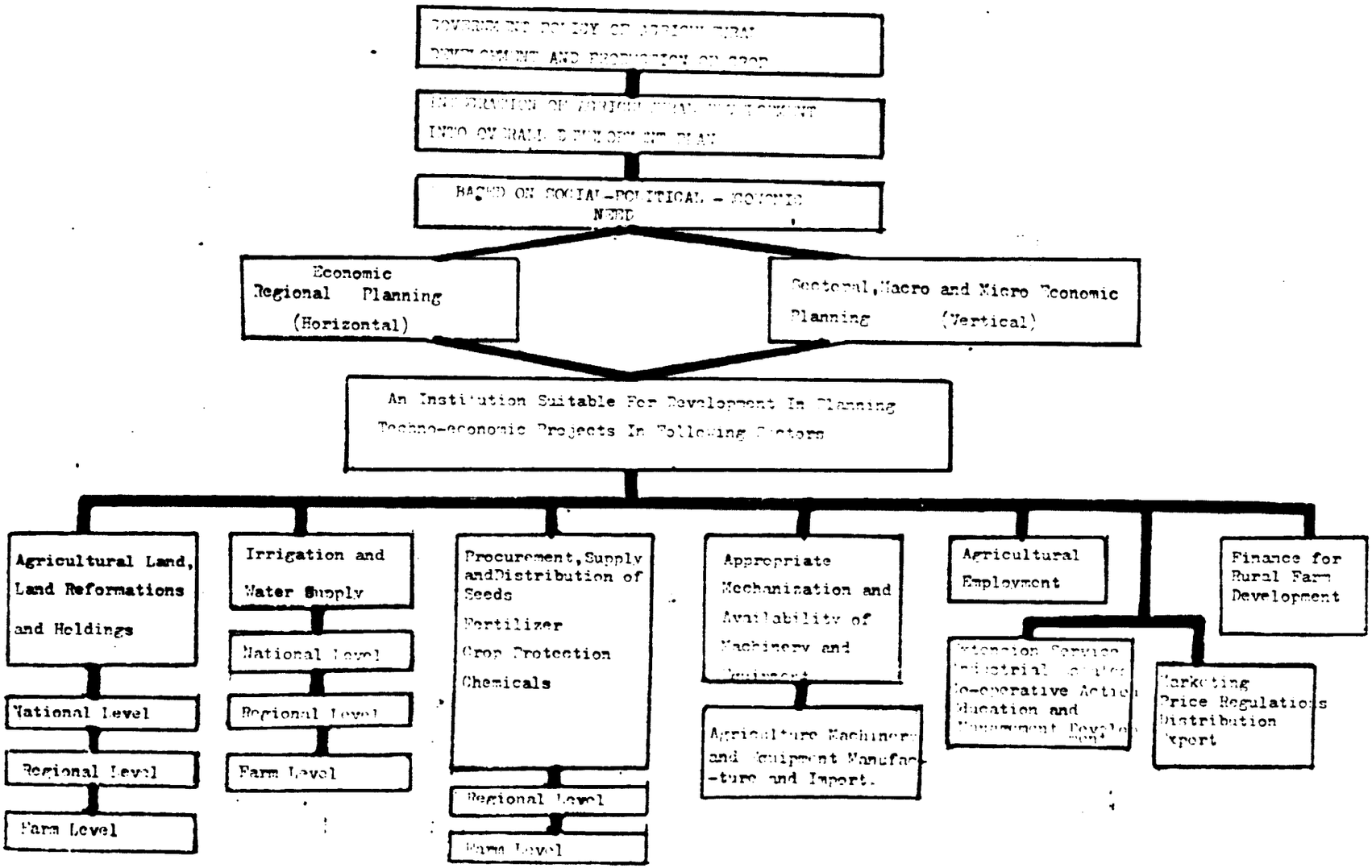
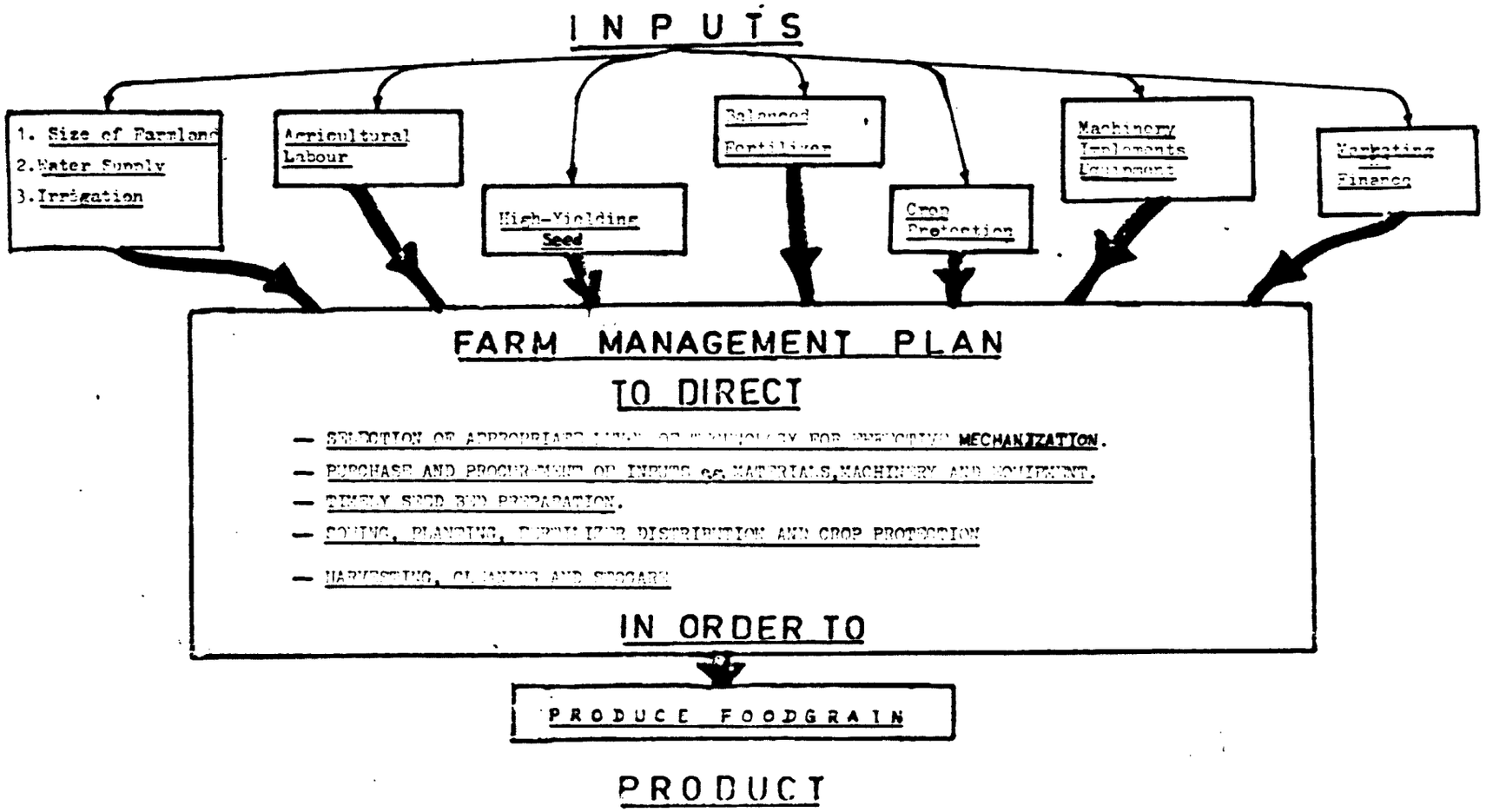


Figure 20

Flow Chart of Input and Output of Agricultural Production



The ever increasing demand for food grains particularly cereals can only be met by intensification of agricultural production by the wide spread adaption and application of the following:

- enlargement of agricultural crop bearing land with a definite policy for land holdings and reform;
- agricultural labour requirement through supply of labour from urban and rural market;
- introduction of new high yielding seeds;
- effective irrigation and adequate supply of water;
- application and distribution of nitrogenous fertilizer;
- introduction and scientific planned application of mechanized machinery inputs for the cultivation of soil and related agricultural operations;
- adequate supply of new varieties of crop protection resistant to the major pests and deseases;
- adequate facilities for drying, milling, transport and storage of food grains;
- sufficient facilities for marketing and distribution;
- adequate mechanism for price regulation.

Identification and Selection of Mechanization Parameters of Various Input Resources for Crop Production and Government Policy

Input - LAND, WATER and IRRIGATION

Land Size Requirement for Appropriate Mechanization Levels

The following are the farm sizes required for the effective use of machinery and equipment at various technology levels:

Farm size up to 2 Hectares	-	Mechanization based on Technology Level I
Farm size 2 to 5 Hectares	-	Mechanization based on Technology Level II
Farm size over 5 Hectares	-	Mechanization based on Technology Level III
Farm size over 50 Hectares	-	Mechanization based on Technology Level IV

Water Supply and Irrigation

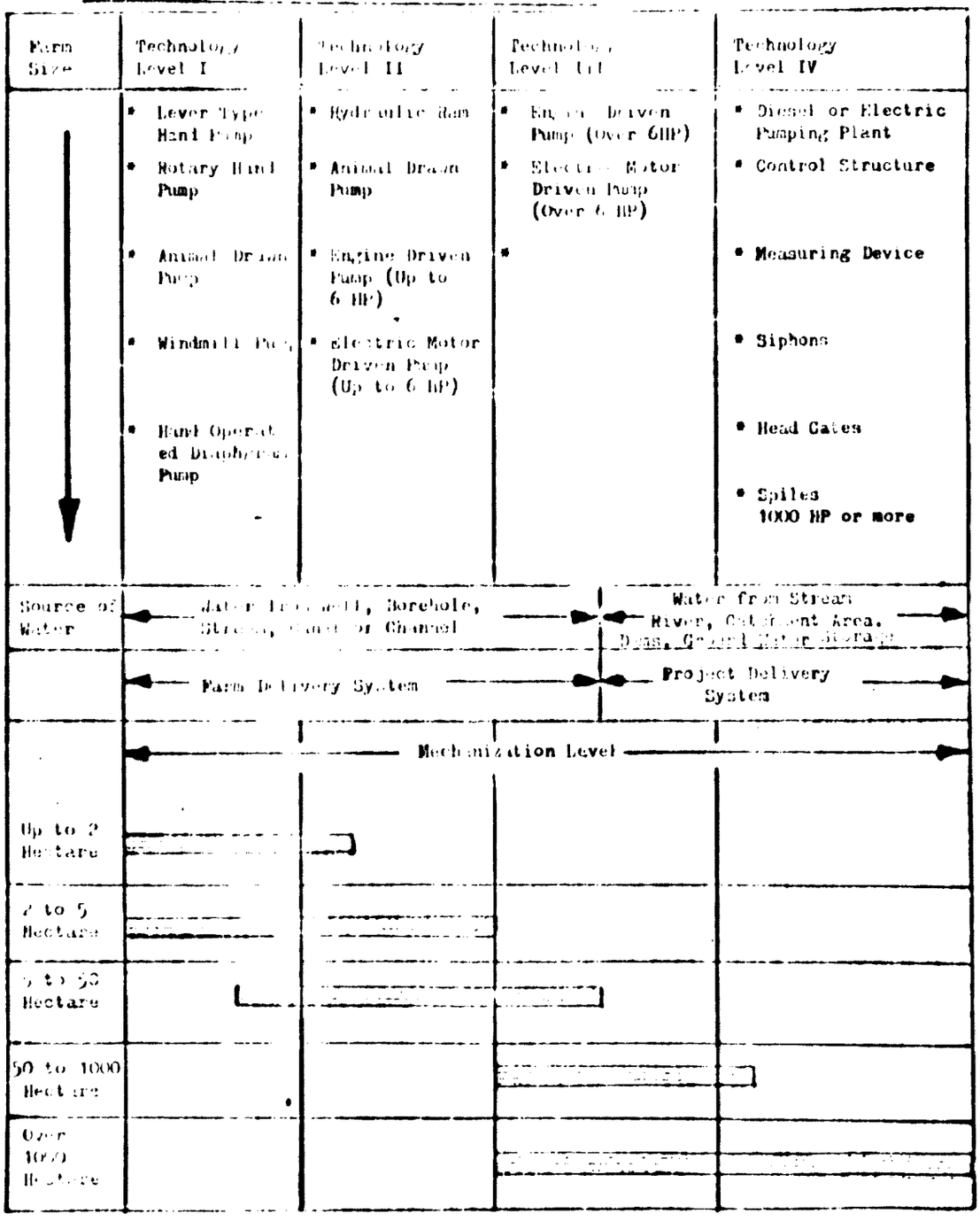
Irrigation is the practice of artificially applying water necessary to meet a soil moisture deficiency in the production of crops. Soils within the root-zone of the crop are limited as to the amount of water they can store at any one time. Different soils have different water holding abilities and different crops have different root-zones. There are many problems such as: when to irrigate, the quantity needed and how to apply it. Water for irrigation must be of usable quality and must be available when it is needed. The majority of the developing countries particularly the small farmers rely greatly on the timely rainfall of the season. Therefore, mechanization of water supplies and irrigation systems are absolutely necessary for the rapid intensification of agricultural production of crops.

Mechanization Level for Availability of Water Supply for Irrigation

The equipment required for the mechanization of water supplies and irrigation can be divided into four different levels of technology. As stated before, the farm mechanization is independent variable to the production function but greatly related to farm sizes. The four technology levels are indicated in Figure 21.

Technology Level - I	:	Simple Equipment i.e. hand and foot pumps, animal drawn pumps, windmill pumps;
Technology Level - II	:	Hydraulic rams, animal drawn pumps, small engine or electric motor driven pumps up to 5 - 6 HP;
Technology Level - III	:	Engine driven or electric motor driven pumps over 6 HP;
Technology Level - IV	:	Diesel or electric pumping plants, control structure, measuring device, siphons, checkdams, head gates, spiles, etc. over 1000 HP.

MECHANIZATION LEVEL FOR AVAILABILITY OF WATER SUPPLY & IRRIGATION



Specification of Pumps are shown in Figures 21(a) and 21(b)

Figure 21

Water Supply Equipment Manual, Animal Drawn or Wind Powered Pumps

Item	Application	Description	Lift	Discharge	Delivery
1.	Manual	Hand pumps (lever operated)	20 ft. 24 ft.	400 gph 600 gph	- -
2.	Manual	Lift and force pump (lever type)	30 ft.	1000 gph	40 ft.
3.	Manual	Foot operated diaphragm	30 ft.	1000 - 1400 gph	50-60 ft.
4.	Manual	Semi-rotary pump (foot valve is required lift more than 6 ft.)	30 ft.	200 - 1300 gph	75 ft.
5.	Manual	Wheel or rotary pump (can be used in deep well)	100 ft.	500 gph	-
6.	Manual	Foot operated	8 to 12 ft.	4000 - 4500 gph	-
7.	Animal	Chain Pump	40 ft.	3000 - 4000 gph	-
8.	Wind	Windmill pump capacity 4 m/h	-	specially designed	-

Figure 21 (a)

Water Supply Power Operated Equipment - Petrol, Diesel or Electric Motor Operated Pumps

Item	Application	Description	Total Head	Discharge
1.	Petrol engine	Lightweight centrifugal pump with engine	53 ft.	88 gph
2.	Diesel engine 3-5 HP single cylinder	Centrifugal pump coupled with engine	90 ft.	up to 6,000 gph
3.	Diesel engine 5 - 10 HP	Centrifugal pump with water cooled engine	80 ft.	up to 10,000 gph

Figure 21 (b)

Irrigation Equipment

The following are the different types of equipment required for irrigation:

1.	Sprinkler sets, 5 row, 7 row and 10 row
2.	Nozzle sizes for sprinklers from 1/8" to 1/32" vary from 25 psi to 55 psi
3.	Ring infiltrometer set
4.	Channels, pipes, etc.

Different types of Irrigation

There are three main types of irrigation techniaues:

1.	Furrow Method Irrigation:	for all cultivated crops including few close grwoing crops
2.	Boarder or Flood Irrigation:	for all close growing crops and raw crops
3.	Sprinkler Irrigation:	for small seasonal quantities of irrigation water needed for high yield.

Required Pump Capacity for Irrigation

The required pump capacity for an irrigation system can be computed by the formula:

$$Q = 10872 \frac{Ad}{FH} \text{ gallons per hour}$$

where Q = discharge gph.

A = design area, hectare

F = number of days permitted for operation, days

H = average number of hours of operation, hours

In the rotation system the capacity must be estimated for the peak period.

Technical Data for Pump Selection

Source of water supply - well, borehole, or stream.

Well or borehole:
(i) depth of well or borehole;
(ii) output required.

A Stream:
(i) total fall and distance in which obtainable
(ii) quantity of water available (maximum/minimum)
(iii) quantity of water to be raised
(iv) height to be raised
(v) length of delivery

Government Policy Regarding Land, Water Supply and Irrigation for Agricultural Development

The Government policy concerning the effective utilization of land and water resources is of paramount importance to the intensification of agricultural production. An integrated approach to land and water supply development would be ideal. This policy can be framed and implemented in the following way.

1. The establishment of a high level land and water use authority in every country which will be responsible for planning, surveying introducing regulations and control measures to prevent the misuse of resources and will also be responsible for project evaluation, investment and implementation at national, regional and farm level. The investment required for land and water supply development is relatively high compared to other input investments.

2. Administrative restructuring for the elemination of all duplicating and overlapping arrangements dealing with irrigation and land development must be introduced at Government level.

3. A consolidated evaluation of land and water potential in terms of present land use, climate, soil, topography, locations including surface and ground water supplies and in particular flood control and subsequent redistribution of water would have to be carried out within the framework of Government policy.

4. Establishment of an irrigation and drainage infrastructure, which should include adequate water delivery systems to all cultivating lands through the following methods:

- suitable river-valley obstruction and subsequent diversion of water in agricultural fields;
- creation of large catchment areas for effective use of rainwater;
- installation of national and regional canals, channels and water pipelines (desert countries).

Greater distribution of water through:

- installation of large number of wells;
- supply of pumps powered by diesel, electric or windmills for adequate supply of water at farm level;
- mass-scale distribution of hand pumps;
- flood control (at national and regional level).

Supporting infrastructure facilities for the management aspects of efficient irrigation and economic use of water would plough a new furrow in the development of agricultural production.

- A comprehensive plan is required for enlargement of cultivation land (particularly crop bearing) by reducing the proportion of pasture and forest land. If land available for forestation is limited, greater care should be taken in introducing multicropping instead of reducing forest areas.
- A realistic formulation of optimum ranges of land sizes in order to introduce effective mechanization schemes is urgently needed in the developing countries.
- Introduction of a proper realistic land reform system considering social, political and traditional behavioural aspects of farmers. The implementation of such reform should be carried out with close co-operation and active participation of farmers at village level.

The land use in developing countries by region as reflected in the Provisional IWP by FAO, 1970.

LAND USE IN DEVELOPING COUNTRIES BY REGION

	China	*South and South-east Asia*	*Near East and North Africa*	*Africa south of Sahara*	*Latin America*
Percentages of total land area:					
Arable land	11	24	7	7	6
Permanent pasture	18	11	17	32	24
Forested land	8	35	5	27	48
Other	63	30	71	34	22
Total	100	100	100	100	100
Of which: potentially cultivable land*	..	2	4	3	3
Irrigated land as percentage of arable land	68	21	24	1	8
Area sown in a given year as percentage of arable land:					
Irrigated	147	110	75	100	75
Non-irrigated		95	50	40	50

* Information from the *F.A.O. Yearbook, 1965*, Table 1. Only potentially cultivable land in countries specifying such land is included.

Sources: *F.A.O. Yearbook* and *Provisional Indicative World Plan* (1970).

Figure 22

The Scope for Intensification of Land Use

Amongst all developing countries, South and South-East Asia share a greater area of cultivated land than any other developing region. The intensification of land use by higher utilization of cultivated land can be established in the following way:

- expansion of the sown area by the introduction of multiple cropping;
- elimination of fallow land by increase of irrigation facilities by increased labour force;
- change from natural grazing to produce fodder.

INPUTS - HIGH YIELDING SEED - FERTILIZER - CROP PROTECTION CHEMICALS

Identification of Input Materials for Crop Production

This section will deal with the input material such as high yielding seed, fertilizer, plant protection chemicals and the application of these materials with mechanical equipment, required by the farmer in order to intensify the crop production.

The capital investment requirement for these implements and equipment is far less than the relatively high capital investment required in land and water development.

The main objective of this section will be to identify the various input materials required for agricultural crop production and to explore the selection of appropriate technology which will induce the correct level of mechanization in order to intensify crop production in the developing countries.

The input materials for crops, are seed, fertilizer, chemicals for plant protection, machinery and equipment for sowing, distribution, spreading and many other related operations during crop production. The main sources of the procurement of input materials in developing countries are either from imported resources or from locally available seeds from breeders, chemical and fertilizer from industries or in combination of imported resources and locally available resources. The application of input materials needs mechanized conterparts e.g. equipment and implements through which the farmer is able to intensify his production.

Therefore, before the introduction of mechanization for input materials, a closer look is needed as how to make these materials available both quantity and quality-wise (<u>with speoial emphasis on expenditure in research, extension service, marketing facilities or the costs in credit</u>) to the farmers.

The actual production and development of seed breeding, fertilizer and chemicals is beyond the scope of the present study. The present study will be limited to the exploration of various types of equipment required in order to set about a reasonable mechanization level during crop production, with regard to input materials particularly for the developing countries.

The new 'high-yielding' varieties of cereals from which intensification of crop production can take place in two ways:

- by increasing the magnitude of the energy inputs to high yielding crops;
- by taking several crops from the same area in a year.

'High yielding' varieties of cereals are developed to be responsible to high standards of farming. They are characterised by their linear increase in yield by the application of nitrogenous fertilizers up to at least 100 kg. nitrogen per hectare where there is sufficient moisture in the soil.

The Equipment and Implement Requirement for the Application of Input Materials

Seed - Sowing and planting equipment - manual, animal drawn or power operated

Fertilizer - Distributing equipment - manual, animal drawn or power operated

Crop Protection Chemicals - Spreading equipment - manual or power operated

Mechanization Level for Application of Input Material
(Seed - Fertilizer - Crop Protection)

The equipment needed for the mechanization of application of input material e.g. seed, fertilizer and crop protection chemicals can be divided into four different levels of technology as indicated in Figure 21.

SEED:

Technology Level I	- Simple manual equipment e.g. walking stick planter, push type wheel seeder, seed drills and wheeel hoe, multi-hopper seeder.
Technology Level II	- Animal drawn seeder, animal drawn multi-hopper seeder.
Technology Level III	- Walking tractor drawn seed driller up to 75 HP or rider tractor drawn seed drill up to 30 HP.
Technology Level IV	- Rider tractor drawn seed drill over 30 HP.

Figure 23

MECHANIZATION LEVEL FOR THE APPLICATION OF INPUT MATERIAL SEED-FERTILIZER-CROP PROTECTION

Farm Size	Input Material	Operation	Technology Level- I	Technology Level-II	Technology Level - III	Technology Level- IV
	Seed	Sowing Planting	1.Walking Stick Planter 2.Mannual Wheel Seeder 3.Manual Seed Drill and Wheel Hoe 4.Manual Multihopper Seeder	1.Animal Drawn Seeder 2.Animal Drawn Multi Hopper Seeder	1.Walking Tractor drawn seed drill upto 7.5 HP 2.Rider Tractor drawn seed drill upto 30 HP	Rider Tractor Drawn Seed Drill over 30 HP
	Fertil-izer	Distribu-tion	1. Manual Single Fertilizer Drill 2. Manual Seed cum Fertilizer Drill (Two, three or four row)	Animal Drawn Seed cum Fertilizer Drill	1.Walking Tractor Drawn Seed cum Fertilizer Drill upto 7.5 HP 2.Rider Tractor Drawn Seed cum Fertilizer Drill upto 30 HP	Rider Tractor Drawn Seed cum Fertilizer Dril over 30 HP
	Protec-tion	Spreading	1.Hand Held Granules Applicator. 2.Hand Type Plunger Duster. 3.Rotary Hand Duster 4.Hand Pump Sprayer.	same as Level-I Continuous pressure hand or shoulder sprayer.	1.Motorised Granules Applicator. 2.Shoulder Type Power Duster with Wide Dusting Attachment 3.Shoulder Type Blower Duster 4.Shoulder Type Power Spray	Aircraft operated Blower/Sprayer Same as level-III

Mechanization Level

up to 2 hectare	
2 to 5 hectare	
5 to 50 hectare	
50 or more hectare	

FERTILIZER:

Technology Level I	- Simple manual equipment e.g. Single fertilizer drill, manual seed cum fertilizer drill (two row, three row, four row).
Technology Level II	- Animal drawn seed cum fertilizer drill.
Technology Level III	- Walking tractor drawn seed cum fertilizer drill up to 30 HP.
Technology Level IV	- Rider tractor drawn fertilizer cum seed drill over 30 HP.

CROP PROTECTION:

more common in cash crops e.g. cotton, coffee, cocoa, vegetables

Technology Level I	- Simple hand held: a) granuler applicator b) plunger dusters c) pump sprayers
Technology Level II	- Same as above and continuous pressure hand or shoulder sprayer.
Technology Level III	- Motorized granules applicator, shoulder type power duster with wide dusting attachment, shoulder type blower duster, shoulder type power spray.
Technology Level IV	- Aircraft operated blower/sprayers (same as technology level III)

Mechanization of sowing, planting, distribution and spreading of seed, fertilizers and protection chemicals respectively at various technology levels is shown in Figure 23 against various farm sizes.

Government Policy Regarding Production and Development of Seed, Fertilizer and Crop Protection Chemicals

Good seed is the foundation for good crops. Balanced fertilizer with water in soil intensify the production process and accepted resistant to pests and diseases protect the crops up to the peak period of harvest. All these three ingrediants during the cereal production are essentially needed.

Therefore, a definite Government policy is required particularly in the developing and least developed countries for the availability of these input materials to the farmers in forms of quantity, quality and price at the appropriate time when their usage are unique in the agricultural operation.

In order to achieve this the Government policy particularly in the least developed countries will be to promote the local production or importation of these input materials with a suitable distribution system in such a pattern that the farmers will be able to obtain these input materials at the right time and at a favourable price depending upon the solvency of the farmers.

This can be achieved in the following ways:

A. Government Policy on Seed Production and Distribution

1. Certified seed production units or establishments both in private and public sectors based on:

a) large land holdings

b) co-operative basis

for the production and development of high yielding seeds.

These units will cultivate, process and store the high yielding varieties of seeds. Moreover, there should be adequate facilities for the employment of trained personnel for advising the small and medium scale farmers on seed production and protection techniques, including quality control, measurers of crop isolation and inspection seed testing and seed certification.

2. Financial assistance to seed Breeders and Farmers

The Governments financial assistance can be channeled to the following recipients who are directly involved in seed production.

a) seed breeders or farmers

b) non-governmental and private agencies e.g. seed co-operatives, seed growers association.

The financial assistance can be by way of:

a) Loans (with very little interest)

b) Tax exemption

c) Low land rents

d) Crop and seed insurance scheme

e) Direct subsidy or outright grant

3. Extension Service, Research and Development

Here the Government policy will be based more on an institutional level by creation of:

a) extension service facilities

b) mobile service faoilities

c) research and development laboratories

The purpose of the extension facilities will be providing to the farmers of informal education to help them to solve their own problems. It is imperative on the part of a Government in the developing countries, to install research and development laboratories at least at regional level to promote and foster in the production of high yielding varieties of seed for a better intensifioation of food produotion.

B. Government Polioy on Fertilizer Production and Distribution

1. Fertilizer manufacture is a capital intensive projeot. The main functions of fertilizer industries are:

a) production

b) distribution

c) uee

a) Production aspeot of fertilizers

Different Governments have different views of manufaoturing fertilizers indigenously. There ie a great demand for fertilizers in all developing countries. Details are available in IWP reports from FAO. Considering the general plan for industrialization in developing oountries and the tight foreign exohange situation existing in most of theee oountries, a valid case can be made for indigenous manufaoture of fertilizere in each oountry.

A large majority of Governments in large developing oountries have plans to meet the rapid demand for fertilizere as muoh as poseible from indigenous manufacturing eources. The only exception is for potash which has not been discovered in many developing oountries. The fertilizer industries are oriented on a high capital outlay and low labour ratio. Therefore, the Government policy will be endorsed for greater planning with detailed teohno-eoonomic analyeis, foreign exchange situation etc. before embarking on the indigenous manufacture of fertilizers. The Government polioy on fertilizer production oan be based on:

a) Import of fertilizer where adequate facilities are not available;

b) Setting up of fertilizer plant in private or public sector industries;

c) Setting up of fertilizer plants with co-operative institutions (Governmental or non-Governmental)

d) Setting up of fertilizer plants on a joint venture basis with a foreign collaborator and single or joint participation of public, private or co-operative institutions;

e) Setting up of small fertilizer plants at village level (these mini plants are not economical and a greater study is needed in conjunction with local conditions).

Fertilizers can be regarded as an important key to modern crop production and will play a greater role in most of the developing and least developed countries for many years to come. The uses and distribution of fertilizers are greatly connected to a relative degree of public, private and co-operat participation in most of the developing countries. Therefore the Government policy should be on the one hand to increase the production of fertilizer and on the other hand to plan and implement a proper distribution network in such a way that the fertilizer reaches the small farmers in good time with a favourable price. This can be organized by global procurement of fertilizer and eventual distribution through:

a) distribution centres at regional level
b) distribution centres at village level
c) co-operative distribution centres

Improved transport facilities and effective storage of fertiliser is of paramount importance in the distribution process. Therefore, an effective Government policy is required in the transport operation particularly at village level where adequate means are not available in developing and particularly in least developed countries.

2. Government Policy for Improved Credit and Credit Organizations is essentially needed for effective availability of fertilizers to the farmers. Financial assistance to the farmers can be extended for the purchase of fertilizer in the following ways:

a) by cash subsidy

b) by outright grant (in least developed areas)

c) by interest free loan to the poor farmers.

This can be organized through an effective Government policy by the allocation of suitable funds in the national budget. The allocation of these funds can be channelled through:

a) Extension services of existing private and public banks

b) Government or non-Governmental co-operative institutions.

The financial insolvency of small farmers particularly in least developed countries needs greater consideration from Governments to see that these credit institutions should be at the doorsteps of the farmers in order to create a super green revolution.

C. Government Policy on Crop Protection

In developing and least developed countries growing crops suffer from extensive loss and wide spread damage due to diseases, attack and injury by insects, rodents, and other animal pests and through the presence of weeds which compete for soil nutrients, water, light etc., and which create greater problems during cultivation and harvesting.

Therefore, a comprehensive Government policy is needed for the control measures in crop production by:

a) widespread education to farmers on seed treatment and crop protection techniques;

b) availability of chemicals for crop protection either through import or through local manufacture;

c) availability of crop protection equipment to the farmers either through import or through the local manufacture of the equipment.

Government policy to overcome main obstacles to increase use of crop protection measures:

a) The benefits of chemical crop protection measures are limited in respect of most traditional varieties except as curative measures. The government policy will be to educate farmers regarding the use of crop protection chemicals before the hazards start.

b) Crop protection techniques require technical skills more difficult to acquire than in the case of improved seed or fertilizers. The incorrect chemical use is often toxic to man or animal and improper use of pesticides and spraying equipment can result in hazzard and fatal accidents. Uneducated farmers often lack in knowledge for the use of these sophisticated products. Therefore the Government policy should be to install extension services at village level, when technical people should actually demonstrate the use of crop protection techniques to farmers. All chemical use must be approved by the agricultural section of the board of standards, and the Government laboratories will provide free services for the analysis of chemicals to be used by the farmers.

c) Government policy will be to organize joint crop protection programmes in co-operation with farmers at village level.

d) For timely protection of crops the Government policy will be orientated to install greater numbers of crop protection units adequately manned by technical staff, chemicals and equipment in order to render sufficient extension service. This needs greater allocation of Government funds.

e) Most of the crop protection chemicals are imported items. Government policy should be to take adequate measures not to allow the monopoly of the importation of the chemicals and equipment by few importers. Price regulation will indeed be an effective solution for this.

f) The Government should release adequate and timely foreign exchange necessary to produce the crop protection chemicals and equipment particularly in the least developed countries.

INPUT: MACHINERY-IMPLEMENTS-EQUIPMENTS-EQUIPMENT for CULTIVATION of SOIL-HARVESTING-CROP CLEANING-CROP DRYING AND STORAGE

This section will deal with the identification of machinery and equipment for cultivation and seed bed preparation of soil, harvesting, cleaning and storage of crops and the application of these machinery and equipment in order to intensify crop production. Therefore, the

Figure 24

MECHANIZATION LEVEL FOR CULTIVATION OF SOIL

Farm Size	Operation	Technology Level -I	Technology Level - II	Technology Level- III
↓	Cultivation of soil and seed bed preparation.	1.Hand Cultivating Tools Hand Spades, Digging Forks and Hoes Hand Cultivators. 2.Push Type Hand Tools Wheel Hoe, Hand Pushed Cultivators Manual Weeder (Sizes of these hand tools vary widely in different countries	1.Animal Drawn Equipment (Integrated unit or tool bar attachment) -Cultivator Tines. -Fixed Mouldboard Ploughs. -Reversible Mouldboard Ploughs. - Ridging Ploughs. -Disc Harrow, Adjustable Harrow. -Fixed Tooth Harrow. -Root Crop Lifter. - Land Levelling Blade. 2.Animal Drawn Wet Land Puddlers. 3.Animal Drawn Rollers. 4.(2-wheel) Walking Tractors with Power Tillers, Cultivators, Rotary Cultivators, Motor Hoes, Harrow Ridger, Puddlers. Power upto 7 to 8 HP	1.Rider Tractors (4-wheel) 15 to 70 HP with PTO shaft. 2.Disc Plough 2 and 3 Furrow 3.Mouldboard Plough 2 and 3 Furrow 4.Tiller - 9 and 11 tines with seeding attachment. 5.Paddy Disc Harrow 6.Off-set Disc Harrow 7.Sub-Soiler 8,Multipurpose Blade Terracer 9.Reversible Plough 10.Mounted Disc Harrow 11.Ridger 12.Rice Puddlers. (Preferable between 30 to 70 HP)
		← Mechanization Level →		
up to 2 hectare				
2 to 5 hectare				
5 to 50 hectare				
50 nor more hectare				

main object of thie section will be to identify and to establish the level of mechanization by appropriate selection of different technology in order to explore a line of mechanization based on:

A. Selection of different machinery and equipment for mechanization of crop production at various technology level (see Figures 24, 25, 26 and 27)

B. Selection of combination of various technology levels for different agricultural operations (see Figures 28, 29,30,31) achieved in developing countries, e.g. Asia, Africa and Latin America.

The input of machinery and equipment for crop production are: hand toole, manual cultivating implements, tractors, tillers, disc plough, crop cleaning equipment, harvesting machines, storage bins and silos. The main source of procurement for these machinery and equipment particularly in the developing countries are from the following sources:

a) by importation
b) by local manufacture
c) by local manufacture with import content.

As mentioned before the farm mecahnization is an independant variable to production function but greatly related to the farm eizes. Moreover, the power input also has great significanoe to farm eizes. Therefore, the sslection of agricultural machinery and equipment for orop produotion should be based on the eize of the farm and the type of machinery and equipment to suit a particular level of technology. In developing, particularly in the least developed countries, the eelection of machinery for crop produotion should be based on higher levels of mechanization than what is being practiced now.

A. Selsction of Different Machinery and Equipment for Mechanization of Crop Production at Various Technology Levels

1. Mechanization Level for Cultivation of Soil and Seed Bed Prsparation

The machinery and equipment required for the cultivation of soil and seed bed preparation oan be divided into thrse different levels of technology practised in developing countriee.

Technology Level I	- Simple equipment hand cultivating tools, push type hand tools
Technology Level II	- Animal drawn equipment and implements, walking tractor (2 wheel) with equipment and implement up to 7 - 8 HP
Technology Level III	- Riding tractors (4 wheel) with associate implements and equipment - 15 HP to 70 HP.

Details of mechanization levels are shown in Figure 24 against different farm sizes.

2. Mechanization Level for Harvesting of Crops

The machinery and equipment required for harvesting agricultural crops can be divided into three different levels of technology practiced in developing countries.

Technology Level I	- Simple tools, matchets, harvesting knives, hand cutters.
Technology Level II	- Walking type hand operated power reaper - engine capacity 50 cc.
	- Walking type hand operated power brush cutters engine capacity 40 cc.
	- Power reaper cum brush cutter - engine capacity 55 cc.
	- Walking type power operated harvestor binder
	- Two wheeled mower tractor -9HP
Technology Level III	- Scoop type combine harvester - trailed with auxiliary engine 20 - 30 HP - 7 ft. cut.
	- Narrow body wide cut combine harvester driven with tractor PTO, Engine 35 - 50 HP - 12 ft. cut.
	- Self propelled combine harvester - engine - 50 - 150 HP - 16 ft. cut.
	- Forge Harvester

The details of mechanization levels are shown in Figure 25 against different farm sizes.

MECHANIZATION LEVEL FOR HARVESTING OF CROP

Farm Size	Operation	Technology Level- I	Technology Level - II	Technology Level - III
↓	Harvesting	Hand Tools: 1. Hatchets 2. Harvesting Knives (Sickles plain and serrated edge) Grass Hooks (short and long handles) Scythes, Scythettes) 3. Hand held rice cutter (sizes of these hand tools very widely in in different countries)	1. Hand operated Power Reaper. Engine capacity upto 50 cc 2. Hand operated Power Brush Cutters Engine capacity upto 40 cc 3. Power Reaper cum Brush Cutter Engine size upto 55 cc 4. (Two wheel) Walking Type Harvester Binder. Engine size upto 10 HP 1 wheel - 1 row reaping 2 wheel - 1 row reaping 2 wheel - 2 row reaping 5. Two wheel Mower Tractor upto 9 HP	1. Scoop Type Combined Harvester -trailed with auxiliary engine 20 to 30 HP 7 ft.cut. 2. Narrow Body Wide Cut Combined Harvestor driven by tractor PTO Engine 35 to 50 HP 12 ft.cut 3. Self Propelled Combine Harvester- Engine size 50 to 150 HP 16 ft.cut 4. Forged Harvester.
		← Mechanization Level →		
up to 2 hectare				
2 to 5 hectare				
5 to 50 hectare				
50 or more hectare				

Figure 25

MECHANIZATION LEVEL FOR CROP CLEANING

Farm Size	Operation	Technology Level – I	Technology Level – II	Technology Level – III
	Threshing	1. Hand operated Rotary Thresher 2. Paddle operated Rotary Thresher upto 1000 kg/day	1. Animal Drawn Stone Threshing Roller 2. Animal Drawn Serrated Disc Thresher.	Power operated Thresher upto 5 HP 400 kg / hour
	Shelling	Hand operated Sheller 150 kg/hour	Power operated Sheller upto 2 HP 600 kg maize / hour	Power operated Sheller 2 HP to 6 HP 1500 kg maize / hour max.
	Cleaning	1. Fan type Hand Winnower. 2. Bicycle type Paddle Winnower.	Power perat d Winnower upto 1 HP 500 kg/ hour	1. Power operated Winnower from 1 to 5 HP 1000 kg/hour max. 2. Moto ised Thresher cum Winnower upto 7 HP 2000kg/hour rice 4000kg/hour maize
		Mechanization Level →		
up to 2 hectare				
2 to 5 hectare				
5 to 50 hectare				
50 or more hectare				

Figure 20

3. Mechanization Level of Crop Cleaning, Shelling and Threshing

The machinery and equipment required for orop cleaning, shelling and threshing can be divided into three different levels of technology practioed in developing countries.

Technology Level I	- Simple hand and pedal operated rotary threeher up to 1000 kg. of grain/day
	- Hand operated sheller - 150 kg. grain/hour
	- Fan type hand winnower
Technology Level II	- Animal drawn stone threshing roller
	- Animal drawn serrated disc thresher
	- Power operated sheller up to 2 HP
	- Power operated winnower up to 1 HP
Teohnology Level III	- Power operated threshar up to 5 HP
	- Power operated sheller 2-6 HP
	- Power operated winnower from 1-5 HP
	- Motorised threeher cum winnower up to 7 HP

The detaile of meohanization levels are shown in Figure 26 against different farm sizes.

4. Mechanization Level for Crop Drying and Storage

The machinery and equipment required for orop drying and storage can be divided into three different levels of teohnology practioed in developing countries.

Technology Level I	- Simple natural drying of crops by sun light or artificial firing of wood in order to generate hot air
	- Storage techniques are used usch as jute sacks, wooden container underground pits, cement rooms.
Technology Level II	- Drying by power operated batch drier with oil fire burner - 1 ton grain/ 6 hours - 7 HP Motor
	- Storage by oircular grain silos - 5 tons.

MECHANIZATION LEVEL FOR CROP DRYING & STORAGE

Farm Size	Operation	Technology Level – I	Technology Level – II	Technology Level – III
	Drying	Natural Drying by (1) Exposing to sunlight (2) Application of hot air by burning wood	Batch Dryer with oil fired burner and motorised blower 1 Ton grain / 6 hour 7 HP motor	Continuous drier with oil fired burner and motorised blower 50 Tons/ day
	Storage	(1) Jute Sacks – 50 kg (2) Wooden Container upto 200 kg (3) Underground pit upto 3 Tons(not suitable unless there is concrete wall)	(1) Circular grain silos of wooden construction and steel ribs upto 5Tons. (2) Plastic silos – 2 Tons. (3) Sheet metal storage bins upto 1Ton capacity	(1) Concrete silos capacity 5 to 50 Tons (2) Fabricated steel silos upto 1000 Tons (3) Mobile silos upto 20 Tons
		Mechanization Level →		
up to 2 hectare				
2 to 5 hectare				
5 to 50 hectare				
50 or more hectare				

Figure 27

Technology Level III	- Continuous drier with oil fired burner 50 ton/day - Concrete storage silos 5 - 500 tons capacity Fabricated steel silos up to 1000 tons capacity Mobile silos up to 20 ton capacity.

The details of mechanization levels are shown in Figure 27 against different farm sizes.

B. Selection and Combination of Various Technology Levels for Different Agricultural Operations Achieved in Developing Countries

The technology levels established in the foregoing section for various mechanization systems of crop production, should be considered as an indicative summary based on general usage of agricultural machinery and equipment in developing and least developed countries. In order to set a precise 'tailor made' system for mechanization of farm operations based at different technology levels one needs a greater elaborated study considering all aspects of local conditions such as: type of crop to be produced, soil conditions, skill (labour), farm sizes etc. Nevertheless, a definite attempt has been made at least to set an objective level of technologies those are visible in the developing world.

This section will portray the actual progress made, and existing level of mechanization attained by developing countries in different farming operations. The line mechanization in various agricultural operations for the crop production is shown in Figures 28, 29, 30 and 31 in South and South East Asia, Near East and North Africa, Africa South Sahara, Latin America. These mechanization charts only depict an indicative illustration, a greater study would be needed to attain statistical figures indicating the actual population of machinery and equipment situated in the farms of the developing world. Obviously this will be an enormous operational study and beyond the limited scope of this paper.

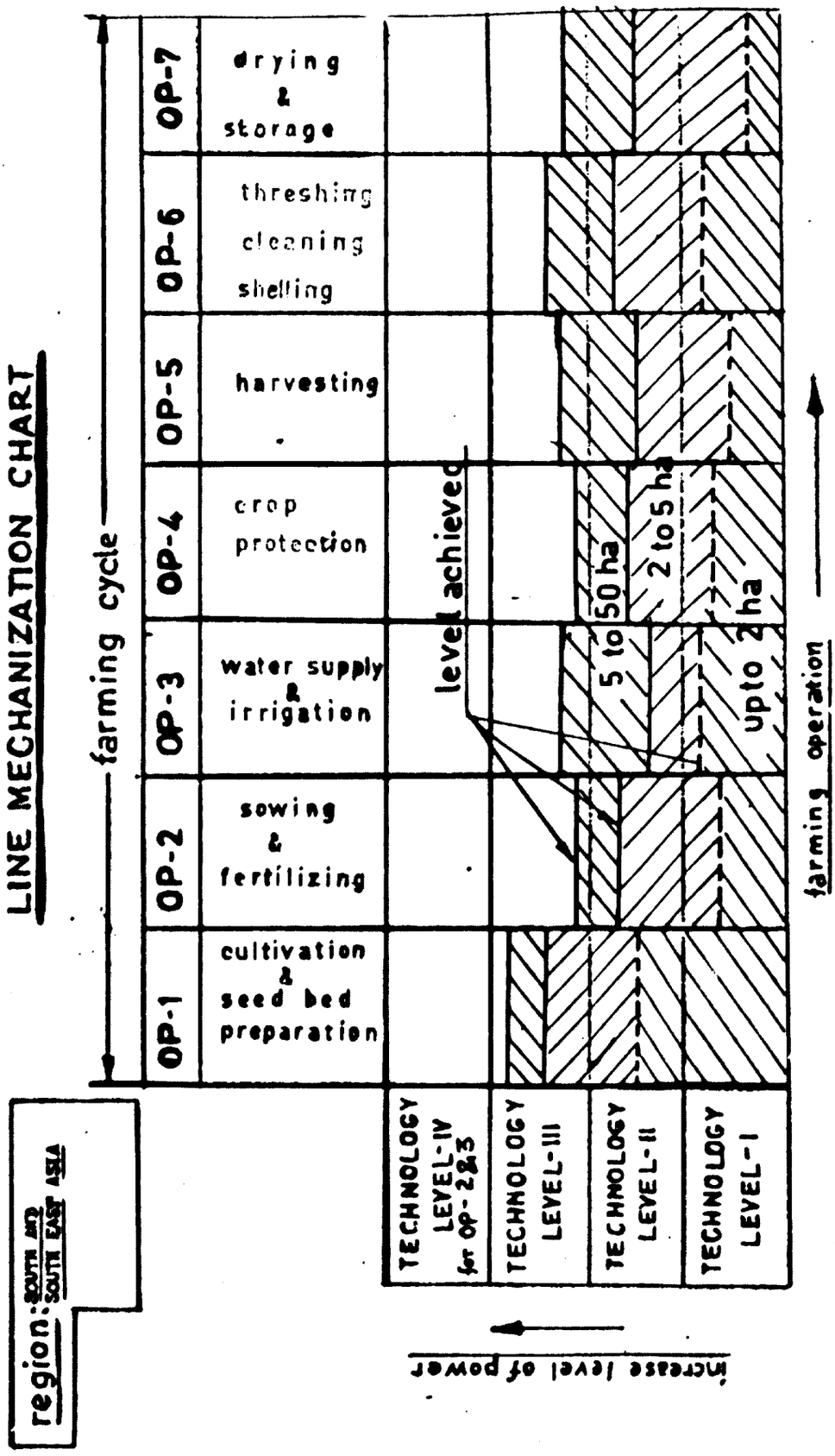

LINE MECHANIZATION CHART
region: SOUTH AND SOUTH EAST ASIA
farming cycle
OP-1
cultivation & seed bed preparation
OP-2
sowing & fertilizing
OP-3
water supply & irrigation
OP-4
crop protection
OP-5
harvesting
OP-6
threshing cleaning shelling
OP-7
drying & storage
level achieved
5 to 50 ha
2 to 5 ha
upto 2 ha
farming operation
TECHNOLOGY LEVEL-IV for OP-2&3
TECHNOLOGY LEVEL-III
TECHNOLOGY LEVEL-II
TECHNOLOGY LEVEL-I
increase level of power

Figure 26

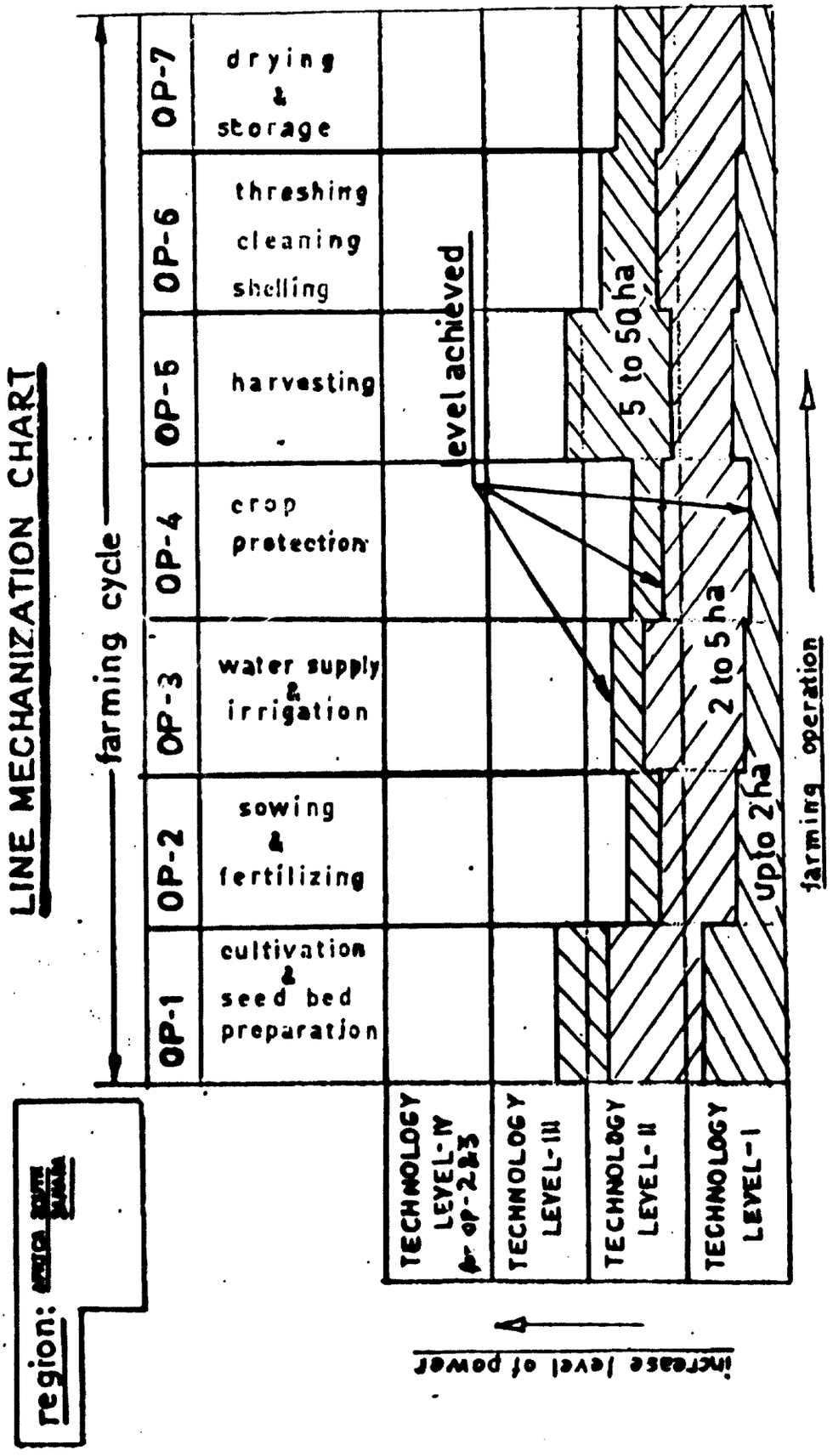

LINE MECHANIZATION CHART
region:
farming cycle
OP-1
cultivation & seed bed preparation
OP-2
sowing & fertilizing
OP-3
water supply & irrigation
OP-4
crop protection
OP-5
harvesting
OP-6
threshing cleaning shelling
OP-7
drying & storage
level achieved
5 to 50 ha
2 to 5 ha
upto 2 ha
farming operation
TECHNOLOGY LEVEL-IV & OP-2&3
TECHNOLOGY LEVEL-III
TECHNOLOGY LEVEL-II
TECHNOLOGY LEVEL-I
increase level of power

Figure 29

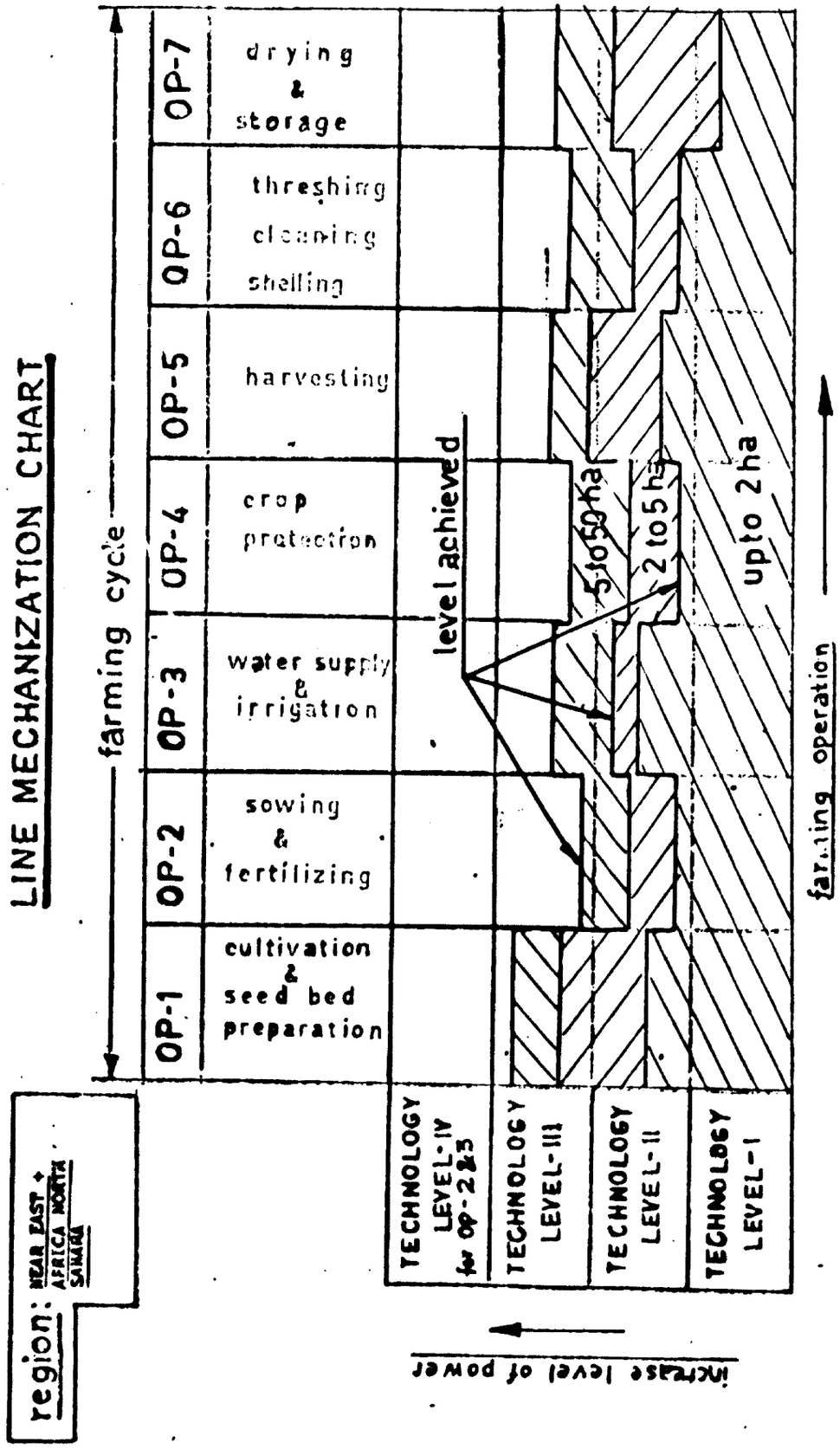

LINE MECHANIZATION CHART
region: NEAR EAST + AFRICA NORTH SAHARA
farming cycle
OP-1
cultivation & seed bed preparation
OP-2
sowing & fertilizing
OP-3
water supply & irrigation
OP-4
crop protection
OP-5
harvesting
OP-6
threshing cleaning shelling
OP-7
drying & storage
level achieved
5 to 50 ha
2 to 5 ha
upto 2 ha
farming operation
TECHNOLOGY LEVEL-IV for OP-2&3
TECHNOLOGY LEVEL-III
TECHNOLOGY LEVEL-II
TECHNOLOGY LEVEL-I
increase level of power

Figure 30

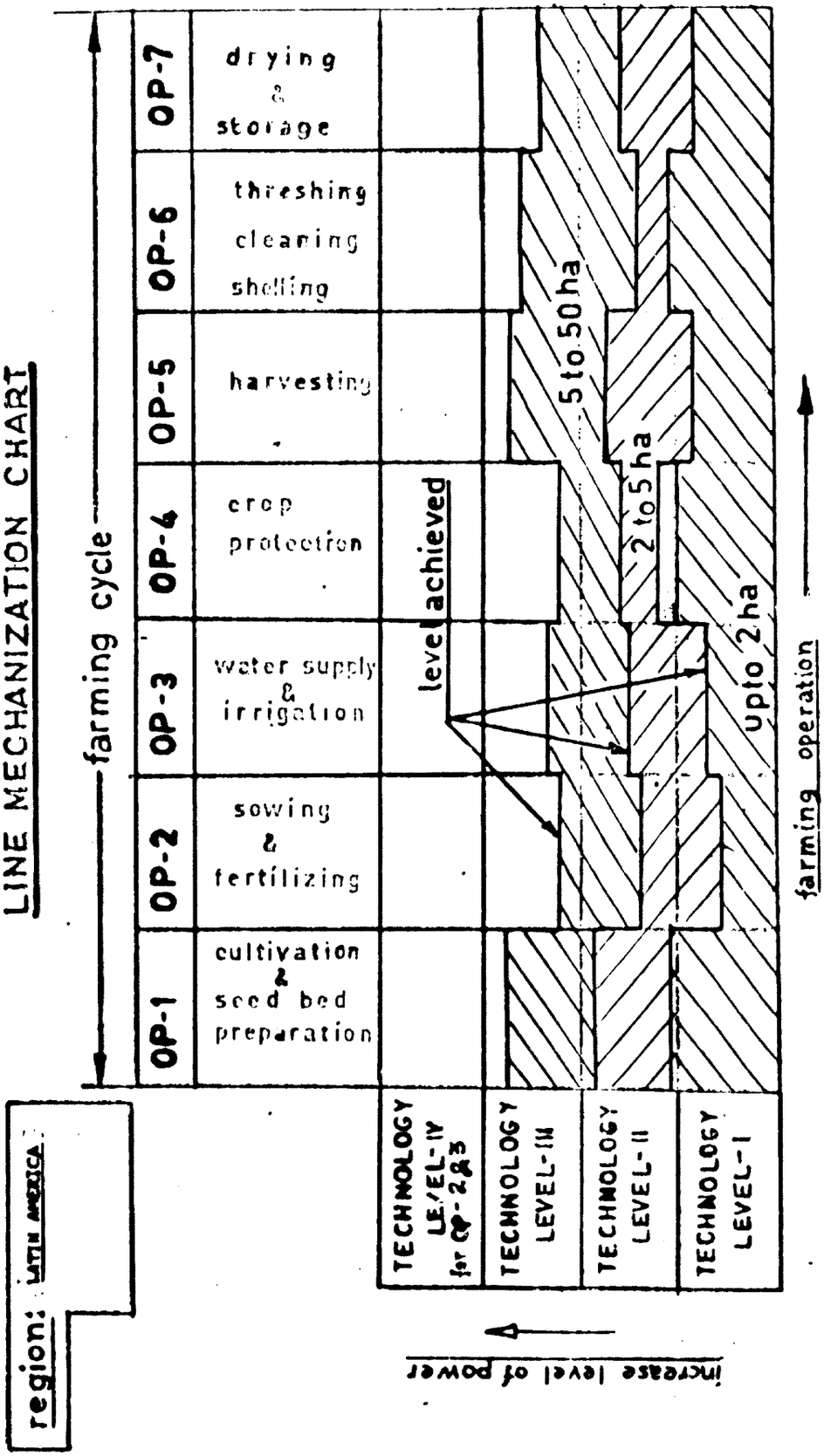

LINE MECHANIZATION CHART
region: LATIN AMERICA
farming cycle
OP-1
cultivation & seed bed preparation
OP-2
sowing & fertilizing
OP-3
water supply & irrigation
OP-4
crop protection
OP-5
harvesting
OP-6
threshing clearing shelling
OP-7
drying & storage
level achieved
5 to 50 ha
2 to 5 ha
upto 2 ha
farming operation
TECHNOLOGY LEVEL-IV for OP-2&3
TECHNOLOGY LEVEL-III
TECHNOLOGY LEVEL-II
TECHNOLOGY LEVEL-I
increase level of power

Figure 31

The current approach to this study explores or at least indicates the existance of line mechanization systems in farming operations in the developing countries which may signify the attainment of a relative degree of appropriate technology based on human, animal and power operated equipment.

In the selection of a particular system of line mechanization, apart from the technical aspect, there are some economic factors to be considered, based mainly on the availability of power sources, farm sizes and the solvency of the farmers. For instance in many parts of the developing world a pair of animals are cheaper than a modern tractor. So the obvious question will be why not select the mechanization system based on animal power or with mixed power available from both animal and tractor? The answer to this question is however not as simple as it may look due to the fact it involves a greater study of the local conditions, available skill of farmers and the environmental conditions. Therefore, the present study will open up a new line of approach in the mechanization policy based on the selection of appropriate levels of technology in developing oountries.

The study reveals that it is possible to have a mechanization system by part utilization of human and animal power together with power operated machinery and equipment based on appropriate technology levels as indicated in Fugure 28, 29, 30 and 31.

In order to select a suitable line of mechanization the following assessments are woth considering before ooming to a final proposal.

- existing practice and level of teohnology available in the farm;
- a realistic inventory of all equipment and facilities available including animal resources;
- observe the various basic farm operations, usage of tools and equipment partioularly the methods of water supply and orop protection;
- ascertain the size of the farm, crop to be produced and availability of manpower;

- draw up a realistic need for machinery and equipment required taking into account the availability of skilled and unskilled labour, the availability of animal and mechanical and electrical power, the solvency of farmers and lastly the farm sizes.
- select a technology level for each farm operation as shown in Figures 23 to 27 and prepare a line mechanization system for a particular crop production.

Government Policy on Line Mechanization

In developing and particularly in the least developed countries there is a greater trend towards mixed mechanization e.g. the level of technology which induces the application of both human, animal and power driven equipment for agricultural operations. The introduction of new techniques, both biological and mechanical may increase rural incomes and employment through:

- increased crop intensity
- expanded crop area
- increased yield
- reduced costs
- a shifting to higher value of crops (if necessary)

Although the mechanization is often associated with large scale tractorization in farm operations, nevertheless considerable potential exists for use of animal power and selective mechanization for specific agricultural operations in the developing countries. Moreover, the development of mechanization has frequently been focused on only one option such as either tractor purchase or tractor-hire scheme, instead of examining a range of alternative package of mechanical technology.

Therefore, the Government's specific policy would be needed not only for the promotional aspects but also to encourage the implementation of agricultural mechanization within the overall context of rural development. Such a policy can be directed towards the creation of:

a) Infrastructure facilities for the establishment of general guidelines on mechanization policies based on:

- extension of local manufacture of agricultural machinery and equipment with or without imported material content;
- research, design, development and adaptation of agricultural machinery;
- release of sufficient foreign exchange for importation of agricultural machinery which is not locally available;
- direct encouragement for the creation and expansion of engineering industries (private and public sector) in rural areas and artisan workshops, blacksmiths, welders at the village level supporting the requirements for agricultural machinery.

b) Identification of specific equipment required which can be operated by means of animal, wind or mechanical power

- identification of industries which may take up local manufacture of selected equipment developed through local design and research.

c) A programme for financial assistance by way of:

- agricultural machinery hiring scheme;
- scheme for hire purchase with low interest rate;
- outright grant for machinery and equipment particularly in the most backward areas;
- liberal loan facilities with low interest rate for purchasing of machinery and equipment;
- subsidy on fuel oil, electricity for power machinery and fodder for animal which are directly used in agricultural mechanization;
- duty free importation of agricultural machinery;
- release of foreign exchange for the immediate need of spare parts to be imported duty free.

d) A comprehensive training programme at regional and farm level by:

- adequate facilities for training on (i) farm management, (ii) use of appropriate technology (iii) marketing; (iv) mechanization;
- adequate maintenance training through preventive maintenance plans;
- specialized training on sophisticated machinery and equipment;
- technical education for farmers with special reference to the selection of line mechanization;
- practical demonstration of modern machinery and equipment at farm level;

e) Creation of experimental farms for crop production based on various levels of mechanization.

f) Procurement of machinery and equipment on a co-operative footing.

INPUT: Agricultural Labour, Finance and Marketing

Agricultural Labour and Employment

Agricultural labour is an important input to the agricultural production operation. The labour requirements for agricultural operations are broadly based on:

- production output required
- farm size
- level of technology
- location.

Agricultural labour is available mostly from the rural labour market, as shown in **Figure 32.** The term labour market can be defined as a mechanism which decides the allocation of labour between activities and remuneration received for such activities. The rural labour industries are mostly based on small scale and family type enterprises in most of the developing countries. In general, significant parts of the labour force of developing countries are self employed in subsistance production and are not offered to a market for remunerations. This section of the labour force engaged in subsistance production offers activity amongst themselves and thereby creates a labour market.

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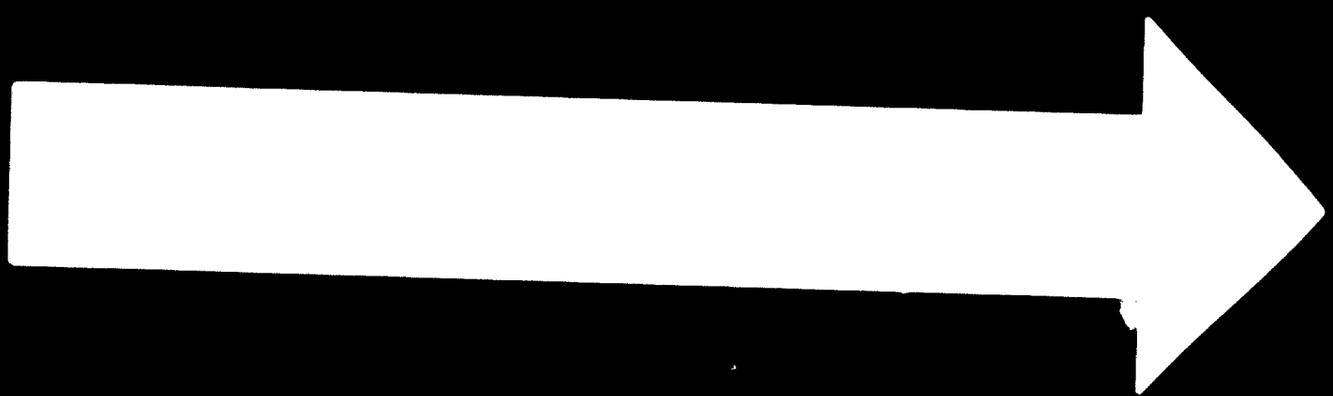

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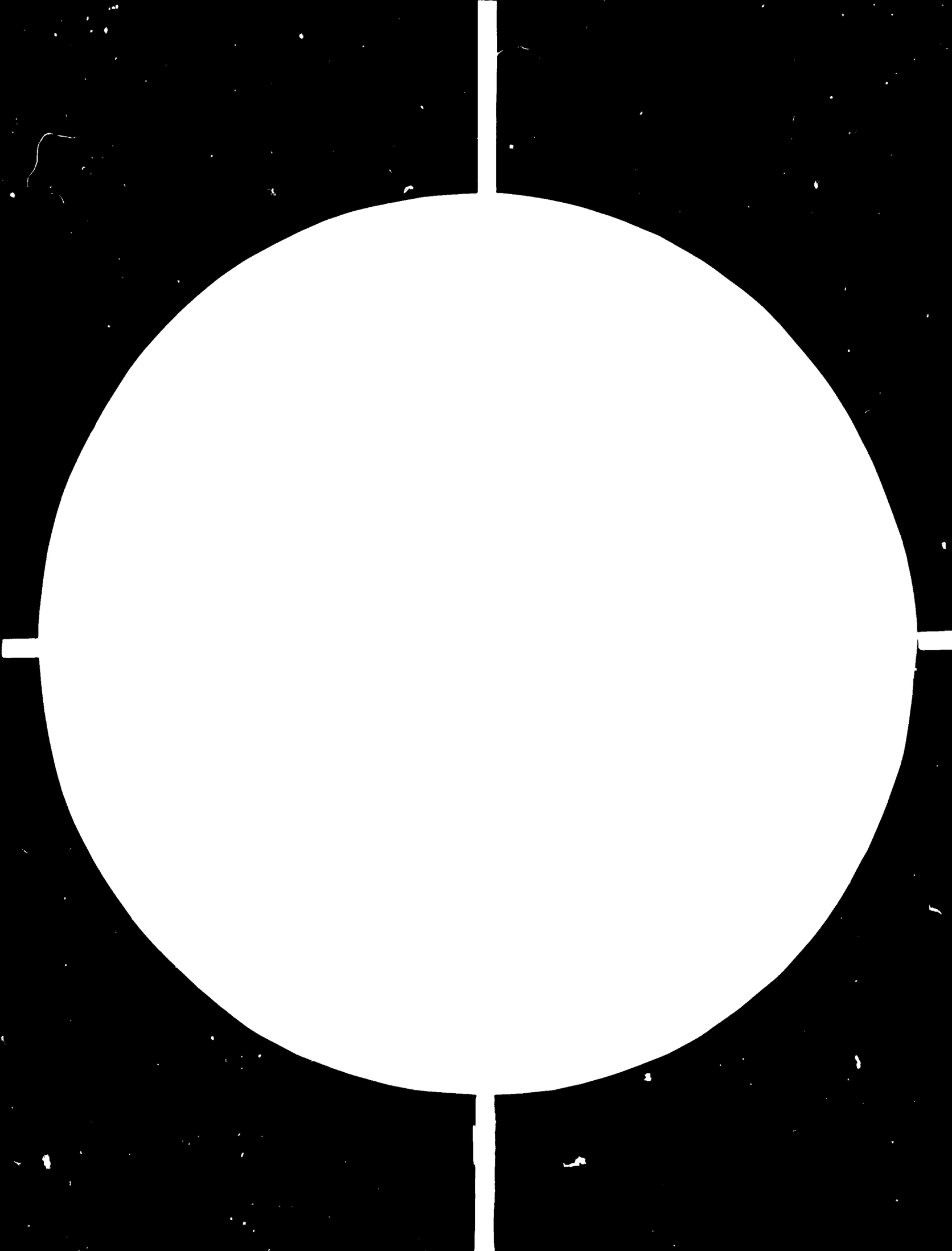

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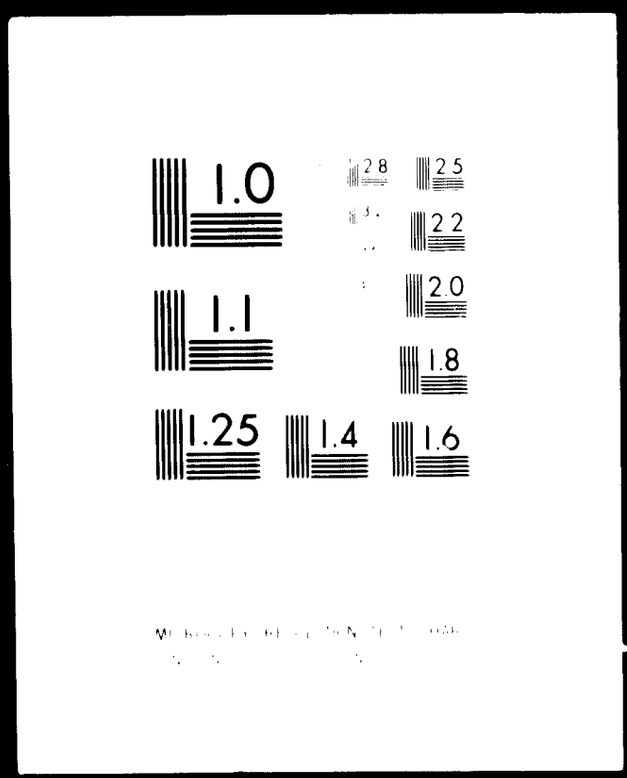

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Survey of equipment-Operationwise at Technology Level-I

Figure 33

Farm Area	Farming Operation	Machinery and equipment with possible specification
Up to 2 Hectares	Cultivation, and seed bed preparation	1. Manual cultivating tools - handspades, digging fork and hoes, hand hoe, hand cultivator. 2. Push type hand tools - wheel hoe, handpushed cultivators, manual weeder.
	Sowing and Planting	Manual walking stick planter Manual Wheel Seeder Manual seed drill and wheel hoe, manual multihopper seeder
	Fertilizer distribution	Manual seed cum fertilizer drill (two, three, four rows) Manual single fertilizer drill
	Water supply and Irrigation	Lever type hand pump, Rotary hand pump, Animal drawn pump, Wind mill pump
	Crop protection	Hand held granules applicator, Hand type plunger dusters, Rotary hand dusters, Hand pump sprayers
	Harvesting	Hand tools: Hatchets, Harvesting knives, Sickles (plain and serrated edges), Grass hooks, (short and long handle), Scythes, Scythettes, Hand held rice cutter.
	Crop cleaning	Fan type hand winnower, Bicycle type pedaled winnower.
	Crop threshing	Hand operated rotary thresher, pedaled operated rotary thresher - 400 kg. grain/hour.
	Crop shelling	Hand operated sheller -150 kg/hour
	Crop drying	Natural drying by sunlight, Drying by wood fire.
	Crop storage	Jute sacks - 50 kg., Wooden container up to 200 kg., Underground pit 3 tons, Cemented rooms or closed sheds

Summary of Equipment-Operationwise at Technology Level -II

Figure 33 (a)

2 to 5 hectare	Cultivation and seed bed preparation	1. Animal drawn equipment integrated or tool bar attachments for (a) Cultivator tines, (b) Fixed mouldboard ploughs, (c) Reversible mould board ploughs, (d) Ridging ploughs, (e) Disc harrow, adjustable Harrow, (f) Fixed tooth harrow, (g) Root crop lifter, (h) Land levelling blade. 2. Animal drawn wetland puddlers 3. Animal drawn rollers 4. (2 wheel) Walking tractors with power tillers, Cultivators, Rotary cultivators, Motor hoes, Harrow, Ridger, Puddlers. Up to 7-8 HP.
	Sowing and planting	Animal drawn seeder, Animal drawn multihopper seeder
	Fertilizer distribution	Animal drawn seed cum fertilizer drill
	Water supply and Irrigation	Hydralic ram, Animal drawn pumps (equivalent to 2 HP), Engine driven pumps up to 6 HP, Electric motor driven pumps up to 6 HP.
	Crop protection	Same as Technology Level I and continuous pressure hand or shoulder sprayer
	Harvesting	1. Hand operated power reaper engine capacity up to 50 cc. 2. Hand operated power brush cutters - engine capacity up to 40 cc. 3. Power reaper cum brush cutter engine capacity 55 cc. 4. Two wheel walking type harvester Binder - engine capacity up to 10HP (1 wheel - 1 row reaping 2 wheel - 1 row reaping 2 wheel - 2 row reaping) 5. Two wheel mower tractor up to 9 HP
	Crop Cleaning	Power operated winnower up to 1 HP - 500 kg/hour
	Crop Threshing	1. Animal drawn stone threshing roller. 2. Animal drawn serrated disc thresher.

2 to 5 hectare	Crop Shelling	Power operated sheller up to 2 HP - 600 kg. maize/hour.
	Crop Drying	Batch dryer with oil fired burner and motorised blower 1 ton grain/6 hr., 6 HP motor.
	Crop Storage	Circular grain silos of wooden construction and steel ribs up to 5 tons. Plastic silos - 2 tons Sheet metal storage bins up to 1 ton.

Summary of Equipment Operationwise at Technology Level -III

Figure 33 (b)

Farm size	Farm Operation	Machinery and equipment with possible specification
5 to 50 hectare	Cultivation and seed bed preparation	1. Rider tractor (4 wheel) with Hydraulic system and PTO. Diesel or Petrol Engine 15 HP to 80 HP. 2. Disc plough - 2 furrow and 3 furrow. 3. Mouldboard plough - 2 furrow and 3 furrow. 4. Tiller - 9 and 11 tines with or without seeding attachments. 5. Paddy disc harrow 6. Off-set disc harrow 7. Sub soiler 8. Multipurpose blade terracer 9. Reversible plough 10. Mounted disc harrow 11. Ridger 12. Rice puddlers (above implements should be associated with Tractor - 30 to 70 HP.
	Sowing and Planting	Rider tractor drawn seed drill over 30 HP.
	Fertilizer Distribution	Rider tractor drawn fertilizer cum seed drill over 30 HP.

5 to 50 hectare	Water Supply and Irrigation	Engine driven pumps and electric motor driven pumps over 6 HP.
	Crop protection	Motorised granules applicator, Shoulder type power duster with wide dusting attachment, Shoulder type blower duster, Shoulder type power spray.
	Harvesting	1. Scoop type combine harvestor - trailed with auxiliary engine 20-25 HP - 7 feet cut. 2. Narrow body wide cut combine harvester driven by tractor PTO engine size - 35-50 HP - 12 feet cut. 3. Self propelled combine harvester - engine size - 50-150 HP, 16 feet cut. 4. Forge harvester
	Crop cleaning	Power operated winnower from 1 HP to 5 HP - maximum 1000 kg./hour, Motorized thresher cum winnower up to 7 HP 2000 kg/hr. (rice) 4000 kg/hr. (maize)
	Crop threshing	Power operated thresher up to 5 HP - 400 kg/hour.
	Crop shelling	Power operated sheller 2-6 HP Maximum 1500 kg. Maize/hour.
	Crop drying	Continuous drier with oil fired burner and motorized blower 50 tons/day.
	Crop storage	1. Concrete silos capacity 5 - 500 tons. 2. Fabricated steel silos up to 1000 tons capacity. 3. Mobile silos up to 20 tons.

Summary of Equipment-Operationwise at Technology Level -IV

Figure 33 (c)

Farm size	Farm operation	Machinery and equipment with possible specification
Over 50 Hectare		All operations require machinery at technology level III except the following
	Water supply and Irrigation	Technology Level III and Diesel or Electric Pumping Plant, Control Structure, Measuring Device, Siphons, Check Dams, Headgates, Spiles etc. 1000 hp and more.
	Sowing and Planting	Rider tractor drawn seed drill over 30 HP
	Fertilizer and distribution	Rider tractor drawn fertilizer cum seed drill over 30 HP.
	Crop Protection	Aircraft operated blower/sprayer.

The above indicative grouping of products has been carried out on basis of appropriate technology suitable for the developing countries. The details of which are explained in Section III. Careful examination of the above grouping shows a gradual transition from simple technology using hand tools to very sophisticated application of technology embodied with power machinery at higher levels in accordance with different farm sizes. In the event of selecting a particular technology having appropriate machinery and equipment for agricultural operations, a careful assessment is needed of the overlapping technologies in the vacinity of different farm sizes. (Refer Figure 23 to 27 in Section III.) The above study for the product grouping is an indicative one and actual grouping of the machinery and equipment products needs greater consideration of working conditions, economic use of machinery, availability of labour force and solvency of the farmers in the developing countries.

Techno-Economic Profiles at Three Industry Levels Based on Selected Products - Product Volume - Manufacturing Technology

The simplicity, sophistication and complexity of agricultural machinery and equipment requires different infrastructure facilities e.g. factory size, machine tools and equipment, optimum labour requirement and manufacturing techniques, etc. The production is also limited by the choice of machine tools and equipment and their productive capacities. For instance, a high powered - high productive machine tool can be capable of producing an optimum production as rated by the makers. Therefore, there is a close relation between the production volume, choice and capacity of machine tools and equipment, and size of investment required. Most of the industries in the developing countries are labour intensive, therefore the selection of machine tools and equipment bears paramount impact over the deployment of labour force particularly in the least developed countries where automation is regarded as social and industrial taboo.

The techno-economic profiles for the manufacture of agricultural machinery and equipment attached to the annex of this paper highlights four important aspects:

- Careful selection of product grouping based on manufacturing sophistication;
- Convenience and viability of manufacturing these products at different levels of rural industries;
- Methodical selections of machine tools and equipment for optimizing employment potential particularly in rural areas;
- Basic minimum investment required for particular levels of industry (artisan, small scale and medium/large scale).

To illustrate the complete range of techno-economic profiles for all agricultural machinery products is beyond the scope of this paper. Therefore, only three techno-economic manufacturing profiles are being evaluated as described below:

(i) Profile for the manufacture of selected simple hand tools describes product mixed implements e.g. Spade, Tinned how, Fork, Sickle indicating annual production turnover of 4,000 units all types. The machinery

selected for the production of these hand tools are either manually operated (where no electricity supply exists) or simple power operated machine tools at artisan level employing 4-10 persons.

(ii) Profile for the manufacture of selected animal drawn implements describes product mixed implement e.g. Single hand wheel hoe, Animal drawn disc harrow, Animal drawn mouldboard plough, indicating annual production turnover of 3.000 units all types. The machinery selected for the production of these implements are of relatively higher in sophistication. This type of industry can be installed at rural Small Scale Level employing about 70 persons.

(iii) Profile for the manufacture of advanced agricultural power machinery e.g. tractor indicates an annual production of 3,500 units. The machinery selected for the production of tractors require conventional machine tools and special purpose machine tools. This type of industry can be installed at urban/rural boarder areas employing about 500 persons.

Each profile gives basic information on size of plant required for the particular production line and discusses the salient features of the industry, its marketing problems and outlets. Moreover, the profiles indicate the approximate estimated amount of capital needed to establish a plant of specific capacity and indicates an estimate of the annual costs by categories, of running the plant at full capacity.

It also provides a plant layout, approximate requirement of machinery, equipment, tools, jigs, and fixtures with overall information on investment requirement.

In addition to this the profiles describe an indicative analysis to a potential investor to take initial steps in the process of deciding whether to embark on a particular project mentioned. In some cases the best step may be simple, in others they may be complicated, requiring full scale feasibility studies by experts. The profiles indicate the major factors to be considered in making such studies and recommend a systematic guide line for making cost estimates applicable to the local conditions.

It is true that the conditions in different areas or country vary and can create constraints on the effective running of plant, machinery and equipment, material used, utilization of power, fuel, water, transport and availability of finished and semifinished parts of various sizes both in quantity and quality. The local cost may also vary for raw material, labour, plant and machinery. Therefore, these selective techno-economic profiles indicate an order of magnitude in terms of costs, finally point out the way to making a sizeable assessment of actual situation and to promote investment decisions.

The Technological Criteria at Three Industry Levels is broadly based on:

- Machine tools requirement;
- Production techniques;
- Supporting services;
- Minimum factory manufacturing programme.

A summary list outlining these important aspects of technological criteria is tabulated in Figure - 34. The attempt has been made to illustrate the basic difference in technological criteria at various industry levels for the manufacture of agricultural machinery and implements in the developing countries.

Summary of Technological Criteria in Three Industry Levels

Industry Level	Machine Tools	Production Techniques	Supporting Industries	Minimum factory manufacturing programme
Artisan Level	Mostly manually operated machine tools, application of simple conventional machines e.g. turning, drilling, grinding, welding, etc.	More manual operations based on job shop production with limited batch size. Dominent feature is hand forging with heat treatment.	1. Hardware industries 2. Woodworking industries	Mostly customers requirement, minimum batch production can be introduced, large product mix is essential.
Rural small scale industry level	Conventional machine tools, e.g. drilling, milling, arc welding, hammer forge, inspection tools, etc.	Based on minimum batch production with advanced heat treatment facilities. Process planning, method study, setting of standards quality control etc. can be introduced. Use of jig, tools and fixtures particularly welding fixtures.	1. Disc Manufacturing Industry 2. Foundry and Steel Industry 3. Hardware industry 4. Jig and tool manufacturing industry.	Minimum economic batch size of production programme is required. Medium product mix is essential
Rural medium/large scale industry level	Conventional, Automatic and special purpose machine tools are required e.g. 1. Drilling, milling, boring machines. 2. Bar automatic, chuck automatic etc. 3. Unit head special purpose machine tools.	Continuous, batch and split batch production system incorporating economic batch loading, process planning, estimation, setting of standards, quality control and rigid inspection, production and material control, wide application of jigs, tools fixtures, including welding fixtures, advanced tooling-high speed and carbide etc.	1. Foundry (grey cast iron, malleable, spheroidal iron) 2. Forging and die casting 3. Tyres, wheel and rim manufacturing unit. 4. Sheet metal and press work industry. 5. Gear cutting and transmission shaft manufacturing units. 6. Electrical and instrument manufacturing units. 7. Steering wheel and automotive parts manufacturing unit. 8. Hardware industries 9. Rubber manufacturing industries. 10. Paint manufacturing industries.	A minimum manufacturing programme is required. With economic batch loading of each part to be manufactured.

Figure -34

Comparative Study of Techno-economic Profiles for Manufacture of Agricultural Implements at Three Industry Levels (Figure -35)

Industry Level	Artisan/village level industry		Rural small scale industry	Rural/ medium/large scale industry
	Plant with no electric source	Plant with electric source		
Product	Spade, Hoe Fork, Sickle	Spade, Hoe Fork, Sickle	Single hand wheel how Animal drawn disc harrow Animal drawn mould board plough	4-wheel Tractor
Material	Carbon steel, wood, Hardware, Sheet metal and Sections.	Carbon Steel, Wood, Hardware, Sheetmetal and Sections	Mild Steel, Cast iron, Carbon steel, Hardware, Wood Paints Sheetmetal and Sections, Sub-contracted parts.	Grey Cast iron, Malleable iron, High carbon steel, Free cutting steel, Forge steel, Spring steel, Sheetmetal, Sections, Paints, Bought finished and Imported parts.
Manufacture of components	Indigenous	Indigenous	Indigenous	Indigenous 40% Bought out Local finished -30% Import - 30%
Annual Production	4000 units	12,000 units	10,000 units	3,600 units
Manpower	4	9	66	514
Machinery and Equipment	Simple manually operated machines and tools	Simple power operated conventional machine tools	Medium Power operated conventional machine tools	Conventional, automatic and special purpose machine tools
Production Techniques	Manual Operated	Manual operation with limited batch size production	Batch size production with jigs and fixtures	Continuous, batch size and split batch production with jigs, tools, fixtures advanced cutting tools.
Factory/ Area	300 sq. ft.	1200 sq. ft.	42,000 sq.ft	144,500 sq. ft.

Figure 35

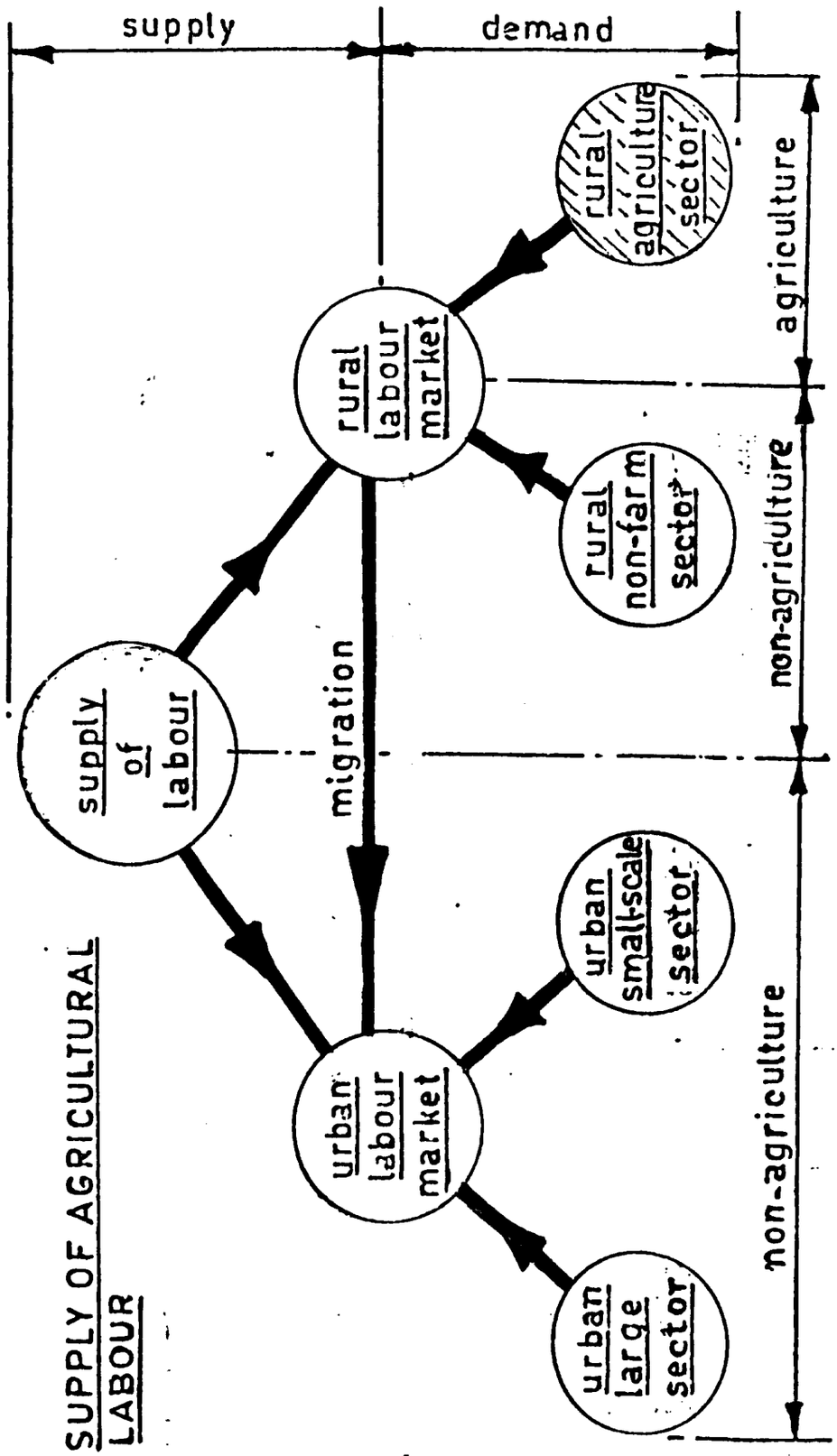

supply
demand
rural agriculture sector
rural labour market
rural non-farm sector
agriculture
non-agriculture
supply of labour
migration
urban small-scale sector
urban labour market
urban large sector
non-agriculture
SUPPLY OF AGRICULTURAL LABOUR

Figure 32

Fixed Capital Investment	US$6,100	US$21,200	US$388,200	US$5,800,000
Working Capital Investment	US$2,100	US$6,500	US$127,500	US$2,750,000
Total Investment	US$8,200	US$27,700	US$515,700	US$8,550,000
Electric Power	-	38 KVA	75KVA	3,000KVA
Annual Manufacturing cost	US$8,890	US$28,875	US$553,500	US$13,380,000
Annual Sales turnover	US$10,000	US$30,000	US$640,000	US$14,000,000
Profit before tax	US$1,100	US$1,125	US$86,500	US$620,000
Investment /Labour ratio	US$ 2050/man	US$ 3077/man	US$ 7,813.63/man	US$ 16,624.20/man
Marketing and sales	Directly to farmers	Through wholesale distributor or directly to farmers	Through agents or wholesale distributors.	Country wide distributors or agents with adequate facilities for spare parts supply servicing and training.

Figure - 35

The comparative study of the techno-economic manufacturing profiles shown in Figure -35 reveals wider gaps amongst the industries scattered from the village to rural and rural to rural/urban boarders in terms of plant size, employment, investment requirement and particularly the methodology and application of manufacturing technique with respect to the availability of machine tools for the manufacture of agricultural machinery and equipment. In order to bridge the gaps amongst these industries, where investment/labour ratio varies from US$ 2,050 at artisan level to US$ 16,634 at the industries situated in the rural/urban boarder areas, a closer and integrated rural development plan is envisaged particularly in the industrial sectors through the following measures:

(a) Greater subcontracting arrangements from the small and medium sized industries to the artisan or village blacksmith type establishments. The subcontracted items can be levers, hooks, elbows, hardware, tines, shovels, links, pins, hubs, brackets, welded parts, etc.

(b) Creation of greater industrial co-operation, where the medium sized industries could offer machinery, equipment, raw material, design, process sheet, cost calculation, etc. to the small scale rural units for the supply of simple parts for their assembly line.

For such co-operation and industrial transaction, mutual consideration must be extended for the relative price adjustment in cost calculation in terms of machinery and raw material supplied. The larger industries should not exploit the small establishments owing to their large infrastructure, political and social pull. If such co-operation is extended the larger industries in rural areas will procure parts at cheaper prices and will allow the small units to create further avenues of off-farm employment in rural areas.

(c) Greater incorporation of supporting ancillary engineering industries in the rural or in the vicinity of rural/urban boarders in order to enlarge the off-farm activities in rural areas and to facilitate agricultural machinery and implement production to a higher degree by increasing the indigenous manufacturing components and parts. The artisan and small scale industries even the medium size industries cannot afford to install these supporting ancillary industries within their plants due to the relative high investment/labour ratio and the magnitude of sophistication involved in the technology.

The following supporting industries are needed in order to facilitate the agricultural machinery and implement manufacturing operation in rural areas as follows:

- Integrated foundry, forging and diecasting plants;
- Integrated plant for hardware components and parts;
- Agricultural disc manufacturing plant;
- Integrated sheet metal and press work plant;
- Toolroom and tool maintenance plant;
- Woodworking and pattern making plant;
- Integrated plant for galvanising, perkerising, electro plating etc.
- Integrated plant for spur and hypoid gear manufacture;
- Integrated plant for heat treatment;
- Integrated plant for the manufacture of automotive parts and accessories;
- Integrated parts for the manufacture of tyres and rubber products;
- Integrated plant for the manufacture of electrical components;
- Integrated plant for the manufacture of instruments and gauges;
- Integrated plant for the prototype manufacture and development.

These supporting industries will have to play a greater roll in rural industrial development and require considerable magnitude of investment in terms of finance, machinery and equipment, technical know-how, training and employment.

SECTION V

AN APPROACH TO LOCAL MANUFACTURE OF AGRICULTURAL MACHINERY

The previous section described generally the products type and scale of industries needed in the rural areas for the manufacture of agricultural machinery and equipment highlighting the levels of industry, product to be manufactured, requirement of machinery and equipment, the simple and sophisticated manufacturing techniques at various levels of operations, and an identification of supporting engineering and ancillary services required for the overall manufacturing facilities in the rural industries. Moreover, the selected techno-economic manufacturing profiles illustrated the size of investment and manpower required for such industry level in the rural areas.

The present section will highlight the role of industries in the rural development and a systematic approach to local manufacture of agricultural machinery and equipment within the framework of technological and institutional linkage among the rural industries.

(A) Role of Small and Medium Industries in Rural Development and Its Limitations

The artisan, small scale and medium scale industries devoted to manufacture of agricultural machinery and equipment play a dominant role in the rural development programme. The enlargement, nurishment and promotion of these off-farm activities in the rural areas provide three important development aspects:

(1) Social improvement;
(2) Economic improvement;
(3) Overall balance of rural/urban industrial activities and effort to retarde migration of labour force from the rural to urban areas.

(1) Social improvement can be achieved through:

Encouragement of indigenous entrepreneurship by way of relatively large participation of individuals in the management and operation of small establishments and thereby improve the productivity by means of personal effort for raising operational funds and effective use of such capital into marketable finished products.

Improvement of the level of traditional industry. In majority of the developing countries, manufacturing establishments at artisan level are of traditional type. The identification of these traditional skills and timely injection of capital, modern machinery, equipment, improved technical training and improvement of marketing activities can improve the overall performances of these units which will pave the way for greater industrial development in the rural areas.

Enlargement of employment in rural areas by creation of greater number of these units in artisan and small scale sector a large number of employment can be created in the rural areas. It is an accepted fact that the infrastructure facilities and capital outlay are relatively smaller in these sectors of industries as compared to the large establishments. Individual drive and entrepreneurship of the owners of these units create rapid industrial activities and thereby enlarge the avenues of further employment in rural areas.

(2) Economic improvement can be achieved through:

Disposition and disparsal of industry. In developing countries, there is a natural trend of establishing industries in urban areas. This is creating enormous problems by overstraining the infrastructure facilities which greatly affect the production. Therefore, a rational approach will be to encourage the artisan and small scale industries to grow in the rural areas with a planned disparsal and disposition programme. These small units in rural areas will be able to supply parts and components to the large urbanindustries as the wages and overheads are relatively smaller in rural industrial operations. Disparsal of these small scale units will improve the working conditions in greater rural areas through the extension of roads, housing, electricity, water supply and many other aminities of modern industrial life.

Diversification of products and establishments of new product lines. An artisan and small scale industries have locational and operational flexibilities, the methods of diversification and introduction of new product lines are more suitable in rural small industries. Through import substitution and enlarging the process of subcontracting through the rural small scale industries, a greater off-farm activities can be

created with less investment and greater output of production. This type of ancillary development in rural small scale sector creates an overall stability in both large ans small scale industry sector.

Greater utilisation of resources and capital formation in rural areas. In developing countries, greater utilisation of resources (e.g. raw materials and labour force) can only be possible by the creation of more rural artisan and small scale industries. Due to the individual attention, interest and saving, there exists a great potential for capital formation in off-farm industrial activities in the rural areas. It is very common in the developing countries that the capital invested in the rural industries come from family savings which would otherwise remain idle or used up for purchasing urban consumer luxury goods. Small industries because of their capital limitations make use of every bit of available resources for higher productivity with minimum wastage, thus create a greater saving and capital formation collectively.

(3) Overall balance of rural/urban industrial activities and effort to retard migration from rural to urban area.

As discussed in Section III under the heading "Government Policy on Agricultural Employment in Rural Areas" there exists a greater tendency in developing countries for migration of rural labour force to urban area for employment opportunities. This creates an imbalance in the stability of the labour market particularly in the rural areas. Therefore, a greater attention is needed in creation of more off-farm activities through the establishments of more artisan, small scale and medium scale industries in the rural areas. This will retard the migration of labour force from rural to urban labour market and will thus create a balance in rural/urban industrial labour deployment. This is very essential for the rapid growth of rural development. Therefore, the overall development plan must constitute a certain pattern of incentive and wage stabilisation in the rural industrial sector, in order to preserve the rural labour force for the best use of rural development.

Therefore, the role of small and medium size industries in rural areas will be to retard migration of labour force to urban areas and to increase the off-farm activities in the industrial sector of rural areas. This will create greater volume of capital formations upon which the effigy of rural industrialisation can be built upon.

Limitations In the Development of Rural Industrialisation

However, whatever is mentioned in the previous paragraphs, there exists certain limitations for the expansion of artisan and small scale industries in rural areas. These constraints can be summarised as below:

- lack of timely credit facilities;
- lack of acquiring machinery and raw materials;
- lack of appropriate product design;
- lack of suitable factory premises;
- lack of technological and managerial know-how;
- lack of trained manpower;
- lack of marketing facilities;
- lack of quality standard.

Each one of the above constraints creates special difficulties for small enterprises during the industrial operation in the rural areas, which have to compete with large industries both in price and quality. Therefore an integrated development programme is needed which would cater for technological and institutional facilities by creation of a linkage system in rural industrial level.

(B) Capital Intensive Large Industries and Ancillary Industry Development

Capital intensive large industries manufacturing agricultural sophisticated machinery and equipment need a careful consideration of the following aspects of industrial operations in rural areas:

- right choice of industry in the rural areas considering all the constraints involved during manufacturing operations;
- correct product line where substantial parts can be procured from limited importation and maximum procurement from indigenous plant manufacture, ancillary industries, small scale and artisan enterprises in the rural areas.

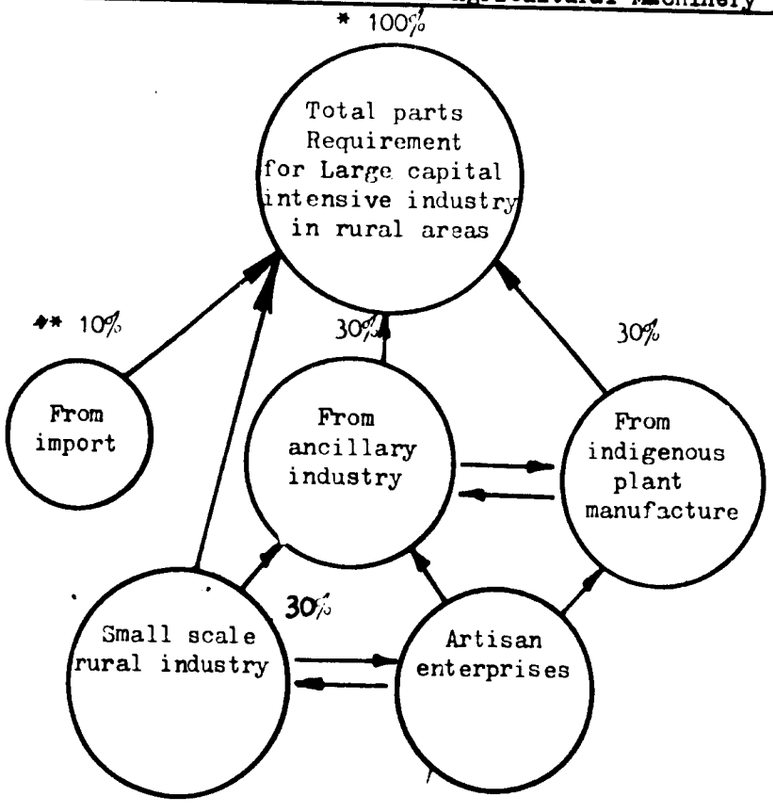
- capital needed (not only for the own plant but also for the ancillary units involved in manufacturing parts);
- the right machinery and equipment and material;
- most efficient production process;
- adequate facilities for workers' training;
- marketing network;
- repair and plant maintenance facilities.

Therefore, capital intensive larger industry engaged in the manufacture of agricultural machinery and equipment in the rural areas, needs substantial number of ancillary industries in order to procure parts for assembly requirement those cannot otherwise be produced economically within the plant capacity. On the other hand the majority of the small establishments greatly depend on the larger industries and the ancillary industries for their subsistance living in the rural areas.

As discussed before in the previous section, the rural industrial development needs simultaneous development and actual expansion of all artisan, small scale, medium scale, ancillary and large capital intensive industries. They are all interdependent on each other either to a limited or to a greater extent. A closer co-operation amongst these industries in rural areas will definitely create a new dimension to the overall industrial development.

The introduction of manufacture of sophisticated agricultural machinery needs not only the procurement of various categories of parts and components from the indigenous manufacture within the large capital intensive plant, but also greater procurement is needed from the ancillary and small scale disparsed industries throughout the rural areas. This is shown in Techno-Economic Profile No. III attached to the annex of this paper and in Figure - 36.

Parts Procurement Policy Chart for Agricultural Machinery Industry in Rural Areas



* -% represent the value of total manufacturing cost

** - import can be in the form of raw material or finished components.

Figure - 36

Typical parts procurement policy in a large capital intensive agricultural machinery industry in rural areas.

A break up of procurement chart for the parts and components required for a large capital intensive plant situated in rural areas is shown in Figure 36. An arbitrary breakdown of percentage of parts procurements, is shown for illustration purpose.

As indicated above, the effect of the involvement of large capital intensive industry in rural areas manufacturing agricultural machinery and equipment can be summarised below:

- it introduces new product line to the small scale and ancillary industries which cannot be produced economically within the plant facilities of large industry;
- it encourages the creation of ancillary industries which play a greater part in subcontracting and spare part manufacturing operation;

- it provides and generates a greater number of skilled personnel in rural areas particularly in the small scale sector. Some of these skilled people after a while starts their own enterprises for the supply of parts and thus creates a chain reaction in employment pattern;
- it encourages the small industries by supplying specific machinery and equipment and raw material in order to procure parts at a cheaper price;
- it absorbs the greater number of labour force in rural areas who would have otherwise be migrated in the urban areas;
- it provides a greater opportunity for training and produces personnel at higher and middle management cadre;
- it extends marketing facilities given to the artisan level;
- it improves the living conditions in rural areas.

(C) An Approach to Interlinkage - Technical - Institutional

The rural industries unlike the industries situated in the urban areas faces many difficulties in management, technical and marketing operations. This has already been discussed in detail in Section II under the heading "Existing Problems in the Rural Industries" (refer page 44) manufacturing agricultural machinery and equipment.

In order to promote and foster the activities of these artisan, small scale and medium size including the ancillary industries in the rural areas the creation of an institutional and technological linkage will be a paramount importance to the overall development of all these disparsed industries in the rural areas particularly at the village level. The primary facilities these industries require in rural areas are Investment and Finance, Appropriate Machinery and Technology and Promotion of Marketing the products.

This can best be mitigated by the creation of an institutional infrastructure within the rural area. Obviously, this requires both the Governmental and Non-governmental institutional participation in order to promote the rural industrial development.

In agricultural industries most of the farms are based on family owned concerns with self employed family labour and use technology relatively oriented on labour intensive techniques (such as use of small tools and implements) and depend largely on indigenous resources.

The rural labour market can be examined in a supply and demand framework at three levels of aggregation as shown in Figure 32.

a) Scope and function of rural labour market at micro level in developing countries

Here the demand for labour in rural areas depends on:

- seasonability
- effective demand for output
- production technique employed mostly manual oriented.

The supply of labour at micro level is also determined by the following factors:

- health and nutrition
- family participation in the labour force
- mobility of labour force between farms and non-farm jobs.

b) Scope and function of rural labour market at urban level in developing countries

Here the rural-urban migration takes place mostly for the non-farm jobs in urban areas and is the principle linkage between rural and urban labour markets which determines the supply of labour in rural areas.

c) Scope and function of the labour market at macro level in developing countries

Here the labour market is integrated in a wide range of production activities. On the supply side of macro level the critical aspect of labour supply is related to the overall rate of growth of the population.

It is true that the rural labour force has been traditionally identified with agricultural activity, it has always included a segment that gains a livelihood from off-farm activities. Interest in this segment of the rural labour force has increased recently since one of the objectives of rural development in a majority of the developing countries

Therefore, a complete network of an institutional infrastructure can be designed and implemented in order to bring about a more cohesive development in the greater rural areas by the diffusion of technological and institutional assistance. This can be achieved in the following manner and is shown in Figure -37.

(a) Requirement of Institutional Infrastructure for the development of agricultural machinery and allied engineering industries in the rural areas.

(b) This Infrastructure can be manifested through the creation and the installation of:

Agricultural Machinery and Allied Engineering Industries Development Centre.

(c) Non-governmental Institutional participation in the development centres through the formulation of:

(1) National and Regional Professional Agricultural Engineering Institutions;

(2) National and Regional Agricultural Machinery and Implement and Allied Equipment Manufacturers' Association.

(d) Governmental Institutional participation in the development centre through the formulation of:

- Industrial extension services;
- Financing of projects;
- Industrial Estates;
- Co-operative action;
- Regional and sub-regional section for industrial promotions;
- Establishment of standard Institutes.

AGRICULTURAL MACHINERY AND ALLIED ENGINEERING INDUSTRIES DEVELOPMENT CENTRE

Struoture of the Centre is shown in Figure -37.

The Centre should be composed of three sections:

(a) Institutional Services;

(b) Technological Common Services;

(c) Promotion and establishment of anoillary industries services.

Flow Chart of Agricultural Machinery and Allied Engineering Industries Development Centre

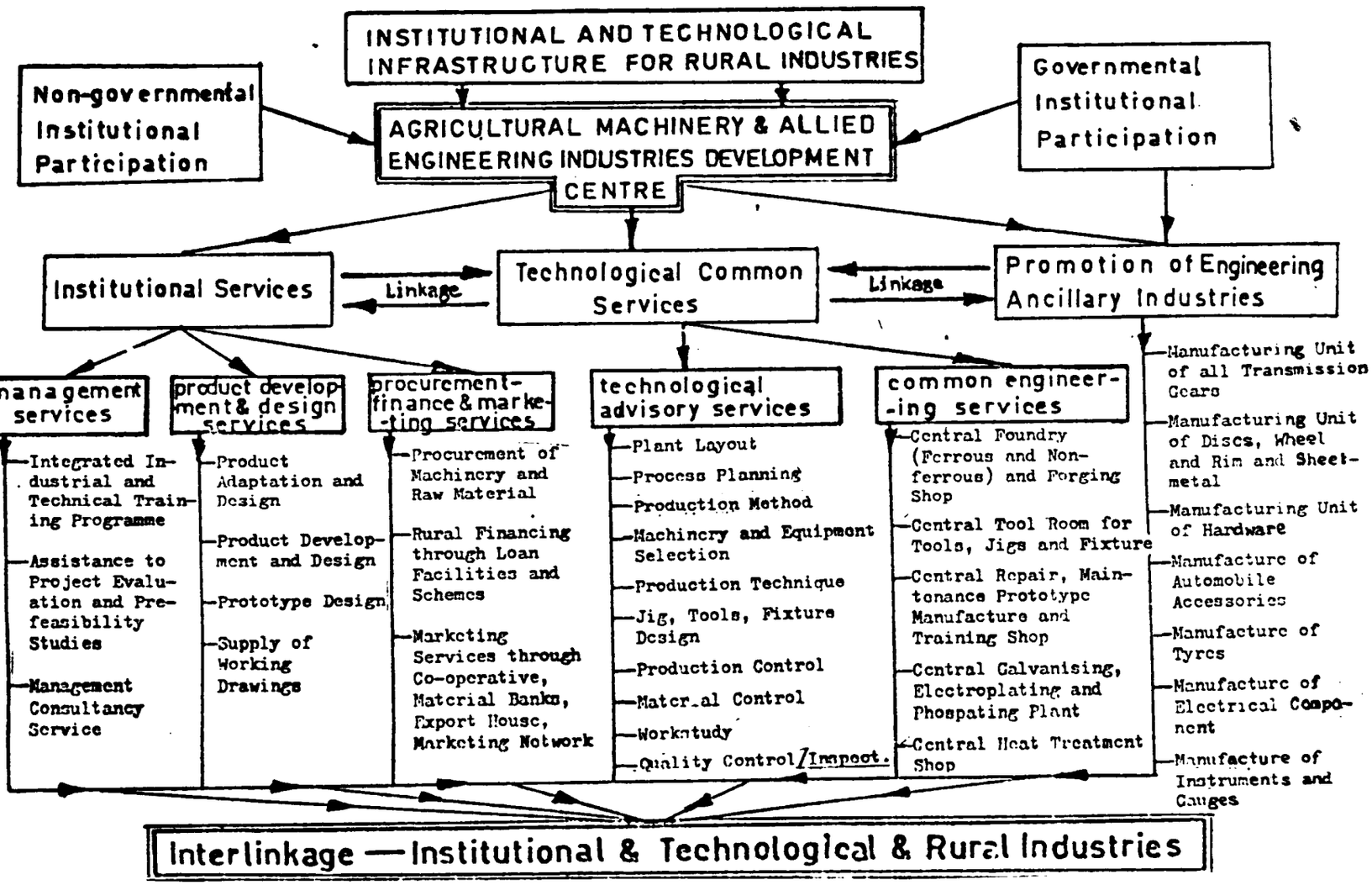


FIG-37

(a) Institutional Services will include:(details will be discussed in Section VI)

- Management Services;
- Product Development and Design Service;
- Procurement, Finance and Marketing Service.

(b) Technological Common Services will include: (details will be discussed in Section VII)

- Technological Advisory Services
- Common Engineering Services

Common Engineering Servicee facilities will include:

- Central Foundry (Ferrous and Non-ferrous) and Forging Shop;
- Central Tool Room for Tools, Jigs and Fixtures;
- Central Repair, Maintenance, Prototype Manufacture and Training Shop;
- Central Galvanising, Electroplating, and Phosphating Shop;
- Central Heat Treatment Shop.

(c) Ancillary Industries Promotional Services

The function of thie service will be to encourage the entrepreneurs to establish the following factories in the rural areas:

(1) Manufacture of all Tr.nemission Gears;
(2) Manufacture of Sheetmetal work, Wheele and Rims, Diecs;
(3) Manufacture of Hardware;
(4) Manufacture of Automobile Accessories;
(5) Manufacture of Tyres;
(6) Manufacture of Electrical Componente;
(7) Manufacture of Instruments and Gauges;
- and many other industriee required for agricultural machinery industry.

The institutional and technological facilities extended through such a development centre will not only improve the stability and performance of the local industries engaged in the manufacture of agricultural machinery and equipment, it will also open up various sectional integration through the exchange of technological and commercial transfusion of knowledge and experience for a greater industrial development in the rural areas.

It is a well accepted fact that the industries in the rural areas are not only handicaped in their industrial activity in the field of technology, but a great set back often noticed in the availability of managerial and skilled manpower. No doubt an Agricultural Machinery and Equipment and Allied Engineering Development Centre of this order will definitely create a greater impact on the rural industrial development programme through which the artisan, small scale and medium/large scale industries will receive comprehensive and ad hoc assistance in marketing, management and technological fields. This will open up a new door to the rural-urban industrial co-operation and pave the way for the enlargement of rural industrial sector.

SECTION VI

INTERLINKAGE IN INSTITUTIONAL INFRASTRUCTURE IN THE DEVELOPMENT OF AGRICULTURAL MACHINERY IN RURAL AREAS

The previous section was devoted mainly to the role of artisan, small scale and medium/large scale industries in rural industrial development and explored possible interlinkage between institutional and technological infrastructure that could accelerate a greater industrial development in the rural area.

This section will elaborate and examine the function of the institutional infrastructure through the proposed establishment of "Agricultural Machinery and Allied Engineering Industries Development Centre" and possible interlinkage of various institutional services within the framework of the proposed development centre.

The Institutional Services of the development centre will be composed of:

A. Management Services
B. Product Development and Design Service
C. Procurement, Finance and Marketing Service

The structure of the institutional services and its appropriate interlinkage between the various sections is shown in Figure -37, Section V.

A. Management Services and Its Function

The institutional management services of the development centre will be devoted to the following services for the rural industrial sector.

(1) Integrated Industrial Management and Technical Training Programme for Rural Areas will offer the following:

a) Management Appreciation Courses will be aimed at training of management of proprietors and managers of small scale and medium size industries. The training subjects will cover principles and practice of management, production management, productivity, financial and cost accounting, cost analysis, budgetary and standard costing, purchasing, store keeping, inventory control, production control, advertising and publicity, industrial laws and labour welfare.

b) Specialised Training Courses in production, financial and marketing management with special reference to cost accountancy, and bookkeeping.

c) Ad-hoc Intensive Training Courses on subjects like workstudy, quality control, inspection, product design, adaptation technique, transfer and selection of appropriate technology, marketing, standardisation, etc.

The duration of the above training course should be designed according to the need of individual country.

Technical Management Training Programme will be aimed at intensification of all round technical training in the rural industries through the extension of the centre's training activities to:

- artisans skilled and semi-skilled;
- small scale supervisory personnel, skilled and semi-skilled;
- medium and large size technical middle management, skilled and semi-skilled;

with a view to improving their skill and capabilities, to produce and handle tools, equipment, jigs, fixtures, etc.

The technical management training programme will include the following:

a) Comprehensive Shop Practice Training Courses which will include - Foundry Shop Practice, Carpentry and Pattern Making Shop Practice, Forging and Blacksmithing Shop Practice, Tool Room Practice, Maintenance and Preventive Maintenance Shop Practice, Electrical Shop Practice, Welding, Sheetmetal and Press Shop Practice.

b) Trade-oriented special courses for tool-maker, fitter, turner, welder, sheetmetal fabricator, pattern maker, electrician, plumber, etc.

c) Process-oriented courses for metallurgy and heat treatment, painting, shot blasting, metal pre-treatment, e.g. phosphating, galvanising, electroplating, etc.

d) Blue print reading courses, drawing and design courses.

e) Quality control, shop inspection and standardisation courses.

Technical Training through Mobile Workshops

The mobile workshops attached to the development centre will render comprehensive on-the-spot training to the artisan skilled and unskilled workers in the rural areas.

(2) Assistance to Project Evaluation, Pre-investment and Feasibility Studies for Prospective Entrepreneurs

The centre will render comprehensive assistance to the entrepreneurs who are interested in a specific agricultural machinery manufacturing project, through the preparation of:

- Project evaluation and market survey
- Pre-investment and feasibility study
- Choice of appropriate technology
- Choice of machinery and equipment.

(3) Management Consultancy Service

The development centre will be able to render management consultancy service to the artisan and small scale industries in rural areas, who require ad-hoc or on-the-spot services on specific industrial and manufacturing problems. The service can even be extended to a comprehensive plant study, covering various aspects of finance, production and sales by qualified technical staff.

B. Product Development and Design Service

The development centre for Agricultural Machinery and Allied Engineering Industries will have a Product Development and Design Service for the rural industries. The service will formulate and extend:

(1) Accelerated adaptation and absorption of imported technology;
(2) Development of domestic technology;
(3) Assist the rural industries in transfer of both imported and domestic technology through:
   - development of product adaptation
   - design of new products with high indigenous content of parts
   - supply of product drawings, designs and specifications
   - supply of working drawings considering the availability of machinery and equipment in the rural industries
   - plan for prototype manufacture.

For example, the centre may endeavour to develop the design of a suitable low-cost tractor based on:

- direct injection diesel engine up to 15 HP;
- having a simple gear or belt driven transmission system;
- three point linkage can be operated through either mechanical or hydraulic means;
- the body of the tractor can be designed either by cast housings or through the section-welded-fabrication;
- the speed of the tractor can be either a one-speed or two-speed version.

The manufacture of such a prototype can be organised in conjunction with the technological common services facilities (refer Figure -37) of the development centre and the local industries who are interested in such products. This will be the method of interlinkage between the institutional and the technological services within the development centre and the industries.

C. Procurement, Finance and Marketing Services

The procurement, finance and marketing will be three important backup services of the development centre to facilitate the effective operation and economic viability of the rural industries.

Procurement of Machinery and Raw Materials

Due to the tight foreign exchange situation, most of the developing countries are facing a critical situation for obtaining machinery and raw materials for the industries, particularly in the rural areas.

The development centre will be able to assist the rural industries for obtaining the machinery and raw materials through:

- selection and specification of correct materials needed or suggestion of alternate material in the event suggested material is not available;
- selection of appropriate machinery and equipment.

The development centre will be able to assist the rural industries by introducing a Bulk Purchase System in close co-operation with the Private Importers, Government Institutional Agencies and the Local Industries. It is difficult for the small scale industries, particularly in the rural areas, to keep a high stock of raw materials for their ensuing production. Minimum stock control is imperative. Therefore, the development centre will be in a position to survey the actual demand and quantity of raw materials needed by the artisan and small scale

industries in the rural areas. After ascertaining the actual demand, the development centre will be able to assist the industries in two ways:

- procurement through bulk purchase scheme;
- procurement through Governmental Agencies, private importers or co-operative footings.

With regard to machinery and equipment, the development centre will be able to assist the industries by way of:

- hire purchase scheme;
- supply machinery and equipment through Government aid scheme to the backward areas;
- recommending the financial institution for obtaining the funds for machinery and equipment for small industries;
- allowing the small industries to make use of common engineering service facilities available within the centre with a nominal cost.

This will create an internal linkage between institutional and technological services of the development centre and external linkage with the industries.

The development centre will make a machinery and equipment inventory diary for all the dispersed small industries in rural areas.

Finance and Marketing Service

The rural small industries need finance and marketing facilities. Without these two facilities the industries cannot survive in the rural areas. The Agricultural Machinery and Allied Engineering Industries Development Centre can organise the following schemes for the small and medium size industries in rural areas:

Financial Scheme and Services

- assistance to loan facilities from commercial, private or state-owned banks for purchase of raw material, machinery and equipment;
- a cash credit account, i.e. payment of advance against pledge goods. Such a scheme can be designed by the development centre and can be operative by the banks.
- assistance to raise specific finance for particular projects through the financial institutions;

- bringing the banks and the credit institutions closer to the industries;
- recommend Government for the extension of credit guarantee schemes and various other financial schemes in order to promote the activities of the industries in the rural areas;
- recommend Government for the extension of subsidy, partiuularly on the interest rates payable by the industries in backward regions.

Marketing Schemes and Services

The development centre can extend institutional marketing facilities and services to the rural industries through the following means:

- introduction of co-operative marketing scheme;
- intensivication of sub-contracting system and facilities so that industries in the rural areas will depend more on each other for the procurement of parts and accessories;
- introduction of Materials Bank for small scale industries in rural areas;
- to establish sales centres throughout the country or region;
- to establish common display centres where small scale industries' products can be displayed both in national and international centres;
- creation of a Marketing and Export House in the rural areas where small industries up to artisan level will be able to obtain marketing and sales information and facilities;
- preparation of a Manufacturers and Sellers Directory which will be distributed to all the urban and rural market;
- assisting the rural industries for the participation in national and international exhibitions (with product and representatives) from rural industries;
- creation of a joint marketing advisory board with the participation of Governmental, non-governmantal and representatives of rural industries to promote and foster marketing and sales throughout the country.

is to encourage its growth by the creation of additional rural non-agricultural employment. This policy serves not only to raise labour productivity in agricultural labour force, but also to reduce the migration from rural to urban areas, which causes problems of urban congestion, overcrowding and unemployment in many developing countries.

A. The Government Policy on Agricultural Employment in Rural Areas

In order to create a general stability of employment in the rural areas and to reduce unemployment a definite Government policy is required for the development of rural agricultural and off-farm activities in developing countries. The Government policy on such nature should be channeled out through the overall development plan for rural areas in the following way:

- expansion of direct agricultural activities in rural areas in order to achieve a greater absorption of labour supply for the available rural labour market;
- promotion through various incentive measures for the enlargement and creation of small scale and family type off-farm industries in rural areas. The orientation of these industries can be either small manufacturing units producing agricultural equipment and tools or industries engaged purely in off-farm activities. The product of these off-farm activities can be marketed in the urban areas.
- Government's effective measures are required to reduce the wage differential between rural and urban labour markets by introducing minimum wage rates in rural areas. This in effect will reduce the out-migration of rural labour forces to the urban areas.
- Government's specific development policy is required for the enlargement of massive rural education schemes, improvement of living conditions at farm level and adequate facilities for the supply of necessary commodities of life in rural areas to make it more attractive for the labour force to remain in rural areas.

Therefore the employment opportunities must be expanded in the agricultural and off-farm activities in the rural areas through an integrated rural industrial and agricultural development paln.

Therefore, the institutional linkage amongst Management Service, Product Development and Design Service and Procurement, Finance and Marketing Service will create a new dimension in the rural industrial development, through a centre which will cater for all-round assistance in the specific fields of engineering and will pave the way for a greater industrial development in the rural areas.

SECTION VII

INTERLINKAGE IN TECHNOLOGICAL ASPECTS IN DEVELOPMENT OF AGRICULTURAL MACHINERY IN RURAL AREAS

The interlinkage within the institutional services of proposed Agricultural Machinery and Allied Engineering Industries Development Centre was the main theme of discussion in the previous section.

This section will define and elaborate the interlinkage within the Technological Common Services and Institutional promotion of the Ancillary Industries for greater development of agricultural machinery industry in the rural areas.

The Technological Common Services of the development centre will be composed of:

A. Technological Advisory Services

B. Common Engineering Services

C. Promotion of Ancillary Industries

The structure of the Technological Common Services and its appropriate interlinkage between the various sections is shown in Figure -37, (Section V).

A. Technological Advisory Services

The Technological Advisory Services of the development centre will extend the following facilities to the rural industries engaged in manufacture agricultural machinery and equipment and also to the allied engineering and ancillary industries in the greater rural areas.

The Technological Advisory Services will include the following:

Plant Layout

The development centre will assist the existing and proposed new industries in rural areas by providing them with the plant layout to any individual enterprise. The plant layout will include flow diagram, disposition of various sections within the plant with machinery, equipment and facilities.

Process Planning

The development centre will assist the local industries who are in need of process planning. The process planning will include, estimated production, man-hour available for each part to be manufactured, break up of each operation for each machine or process, set an estimated time based on M.T.M. or P.M.T.S. or previous standard or actual calculation of machine time, indicate the type of machine, jigs, tools and fixture required, requirement of pre-machined shape of material and specification, and to set a floor to floor estimated time.

Production Methods

This is a very important aspect of manufacturing the parts, production methods include requirements of jigs, tools, fixture and equipment to facilitate the production of parts in effective and economical ways. The development centre will be able to assist the small units by preparing drawings for simple jigs, tools and fixtures. Standard for the methods of production can also be established.

Machinery and Equipment Selection

The development centre will be in a position to advise the small industries in the rural areas about the selection of machinery and equipment to suit the available facilities both in terms of finance and skill of workmen. The centre will be able to advise the particular machine required with speed, feed, depth of cut, power requirement for a component to be manufactured.

Production Technique

The development centre will be able to guide the small industries in the rural areas of modern techniques of manufacturing process. For instance application of pnumatic clamping heads for holding the workpiece in the fixture, application of carbide formed tools, throwaway carbide tip tools with the speed, feed, depth cut requirements, technique of metal processing, technique of heat treatment, etc.

Jigs, Tools and Fixture Designs

Jigs, tools and fixtures play an important role in the manufacture of quantitative and qualitative interchangeable parts in the metal sector. Improper jigs, tools, fixture designs often generate wastage and eventual heavy loss in business, through scraps. The development centre will assist the small companies in designing the simple jigs,

tools and fixture and if possible subsequent manufacture of these with Common Engineering Services facilities sections within the development centre itself. This will create an interlinkage within the sections of the centre.

Production Control

Another important funcion of the development centre will be to encourage the small and medium size industries to introduce production control system. Production control includes, planning, scheduling, dispatching and follow-up. Production control is an important aspect of production management. The centre will be able to assist the industries for the formulation of:

- control charts or bar charts;
- machine loading chart;
- route cards with process sheets;
- master scheduling and scheduling in various departments;
- preparation of job cards and shop order;
- scientific follow-up incorporating production recording system.

Material Control

The centre will be able to assist the small industries in material control and effective utilization of materials during production process. Material control includes:

- economic batch size of production;
- ordering and receiving of materials with minimum level of stock;
- material requirement forecast;
- stores raw material inventory control;
- introduction of perpetual inventory through "Kardex" system;
- stores organisation;
- material handling and facilities for storage during work in progress.

Work Study

For medium size and small scale industries work study is an important aspect of increasing the productivity. Work study involves:

- work measurement
- method study.

The development centre will be able to assist the industries with the technique of work measurement through time study, production study and systematic method study for a particular production operation. The centre can supply visiting time study and methods engineer to various small and medium size industries in rural areas. Through the work study a definite scheme for incentive can be formulated by the centre based on:

- speed and effort rating;
- measured day work;
- group incentive based on group performance, etc.;
- piece rate system.

Quality Control and Inspection

Quality of a product cannot be created at the final stage of manufacturing process. Quality is within the product. Therefore, quality control is an important and most vulnerable operation in the production process. The development centre will be able to assist the small firms for the introduction of a good quality control system. This requires:

- provision of caliper, micrometer, depth gauge, height gauge, etc.;
- design of special production inspection gauges e.g. gap gauge, plug gauge, thread gauge, etc.;
- quality control charts with upper and lower limit for quality control;
- statistical quality control for bar or chuck atuomatic machines;
- inspection and control of tool geometry and technology involved in it;
- improvisation of special inspection tools;
- training of inspectors and quality control engineer.

All these above mentioned technological advisory services are required for the improvement in the performance of the rural industries manufacturing agricultural machinry and equipment.

The small firms in the rural areas particularly in the least developed countries cannot afford to maintain expensive technical staff for all the engineering sections of the plant. Therefore, a common technological advisory service through the proposed development centre will assist these small establishments to manufacture quality and acceptable products with minimum cost of production.

B. Common Engineering Services

The Common Engineering Service facilities for the manufacture of agricultural machinery and equipment will be the real backbone of the rural industrial development. It will be the launching pad for all basic requirements for the manufacture of indigenous parts for the industries in the rural sector. These units of engineering common services are extremely capital intensive and manufacturing activities require high sophistication skill and from machine and manpower and therefore need special attention and consideration.

As explained before, the small, medium and even the large factories in the rural areas cannot afford to install all the machinery and equipment required for the manufacturing activities. It is often economical to procure certain parts either in finished or in semifinished condition from the outside industries through subcontracting or direct purchase. In order to promote the industrial activities by attracting a greater number of manufacturing units from the urban areas and simultaneous assistance to the local engineering industries, it is proposed to install the following Common Engineering Services and facilities within the institutional arrangement in the rural areas. This can be achieved through the incorporation of these common services in the proposed Agricultural Maohinery and Allied Engineering Industries Development Centre. Therefore, an institutional and technological linkage can be established amongst the various sections of the development centre and a greater number of industries scattered all over the rural areas.

This institutional and technological facility will render a comprehensive technological, manufacturing and commercial assistance particularly to the small industries manufacturing agricultural machinery and equipment in the rural areas.

This section will outline the general requirements for various engineering establishments and industries from the Common Engineering Services of the development centre. These are as follows:

*** CentralFoundry (Ferrous and Non-ferrous) and Forging Shop

*** Central Tool Room for Tools, Jigs and Fixtures

*** Central Repair, Maintenanoe, Prototype Manufacture and Training Shop

*** CentralGalvanising, Electroplating and Phosphating Shop

*** Central Heat Treatment Shop

*** ESTABLISHMENT OF CENTRAL FOUNDRY AND FORGING SHOP

The establishment of a Central Foundry and Forging Shop is a basic requirement for all manufacturing units in the metal sector of the rural industries and particularly for the manufacture of agricultural machinery and equipment and will form a Common Engineering Services facilities within the development centre.

- Ferrous Foundry (Cast Iron, Steel, etc.)
- Non-ferrous Foundry (Brass, Aluminium, etc.)

Therefore, the central foundry will produce Cast Iron, S.G. Iron, Malleable Iron, Forging Steel, Brass, Aluminium. These materials are essentially needed for any metalworking industry development and particularly for the manufacture of agricultural machinery and equipment in the rural areas.

Criteria for Minimum Factory Production of Ferrous Foundry

The minimum factory production of Grey Cast Iron and Steel ingot production will be:

- 20,000 tons of liquid metal per annum, i.e. 60 tons of liquid metal per day, considering 250 working days per year.

Raw materials for the foundry will be:

- Scrap Steel, Pig Iron.

The production of various grey cast iron and steel requirement will be as follows:

1. High duty Grey Iron for casting - 5,000 tons/year (Grade 17 or Mehanite specification)
2. S.G. Iron and Malleable Iron - 9,000 tons/year
3. Steel Castings - 1,000 tons/year
4. Special Steel ingots for forging - 5,000 tons/year.

Equipment for the Ferrous and Ferro-alloy Foundry

(a) Ferrous Melting Shop

(i) Direct Arc Melting Furnace 8 tons/batch capacity complete with electrical transformer 3000/4000 KVA capacity with 11 KV, 3 Phase, 50 c/s supply. Furnace should be suitable for operation with basic and acid linings.

(ii) Mains Frequency Induction Melting Furnace 4-5 tons/batch capacity with power input 1000/2000 KW for melting of iron and steel. H.T. Power required - 11 KW, 3 Phase, 50 c/s. L.T. Power required - 415 V, 3 Phase, 50 c/s

(iii) E.O.T. Crane - 20 meter span, 10 ton capacity

(iv) Electromagnetic Discs - 1.25 meter (4 ft.) diameter for lifting the iron for charging

(v) Platform and Weighing bridge - 10 ton

(vi) Immersion Type Pyrometer for measuring liquid metal up to 2000° C

(vii) Optical Pyrometer - 1200° C to 2000° C

(viii) Combined bottom and tip pouring ladles 10 ton, 5, 3 and 1 ton capacity. Hand shanks sizes 50 kg., 100 kg., 250 kg.

(ix) Muffled Furnace for preheating of Ferro-alloys, oil fired or electrically heated temperature rise up to 800° C to 1000° C

(x) 10 ton capacity of Induction Metal holding furnace about 500 KW Power input for super heating the metal.

(xi) Continuous heat treatment furnace for heat treating the Malleable Cast Iron range up to 1000° C.

(b) Moulding Shop

(i) Continuous Mixer - 10 tons/hour

(ii) Vibratory Shake, Precrusher, Vibratory Conveyor, Overband Magnetic Separator, Surge Hopper

(iii) Complete set of core makers and moulders tools, cope boxes, etc.

(iv) Pneumatic Moulding Machines

(v) Stationary Sand Slinger with Ramming Cap

(vi) Roller Conveyors, Jib Cranes, standard Steel Bins, Moulders hand tools, etc. Rolled steel fabricated mould boxes.

(c) Fettling Shop

Fettling machines and equipment

(d) Pattern Shop

Band saw machine, planning machine, crosscut circular saw, combined Disc Bobbin sander, wood turning lathes, Pillar Drilling Machines Hand Tools.

(e) Maintenance Shop

Turning and screw cutting lathe, chucking lathe, radial arm drilling machine, shaping machine, planning machine, boring machine and tools.

(f) Common Service for Foundry

(i) Electric Substation
(ii) Air Compressor Set
(iii) Oil Tanks, Water Reservoir, Pipelines
(iv) Dust and Fume Disposal System
(v) Forklift Truck, etc.

(g) Testing Laboratory

Chemical Section, Sand Testing Section, Mechanical Testing Section, Metallography Section, Heat Treatment Section, Non-destructive Section to be equipped with all machinery and equipment.

Criteria for Minimum Factory Production of Non-ferrous Foundry

The minimum facotry production of non-ferrous castings will be for various parts of pumps, crop protection equipment and tractors.

- Installed capacity - 1000 tons per year for Brass
  - 300 tons per year for Aluminium.

The production of various Brass and Aluminium will be:

- 60% Cu + 40% Zn (Brass) - 750 tons/year
- 80% Cu + 20% Zn (Bell Metal) - 250 tons/year
- Aluminium Alloy - 300 tons/year

Equipment for Non-ferrous Foundry

(a) Non-ferrous Melting Shop

(i) Oil fired cruoible furnaces (for gravity casting) - 3 - off fitted with air control atuomatic burner, etc., including chimney

(ii) Hot Chamber Die Casting Machine with high pressure plunger goose neck attachment
Locking capacity - 130 tons
Plunger diameter $1\frac{1}{2}$", Area 1.76 sq.in.
Pressure on metal - $7\frac{1}{2}$ tons
Volume per shot - 13 cu.in.
Weight per shot - Aluminium - 1.25 lbs.
Weight per shot - Brass - 3.9 lbs.

(iii) Automatic sand core making machine (Duplex type) for gravity casting

(iv) Automatic shell moulding machine (Duplex type) for gravity casting

(v) Beryllium-Copper Steel Dies

(vi) Hand Shanks - 1 kg., 2 kg., 5 kg., capacities. Core keeping trolleys.

(b) Fettling Shop
Fettling Machines (Pneumatic Type)

(o) Trimming Section
Trimming Machines, Belt and Sanders, etc.

(d) Other facilities will be from the main ferrous foundry shop.

Forging Shop

Criteria for Minimum Factory Production in Forging Shop

Minimum factory production of forging shop will be 5000 tons of finished forged/year, i.e. 20 tons of forged parts/day, 250 working days/year.

Equipment for Forging Shop

(a) Forge Plant
(i) Hammer Forging Machine - 80 ton capacity for hot forge up to 20 kg. forge part
(ii) Upset Forging Machine - 40 ton capacity (for hot forge)
(iii) Drop Forging Machine - 40 ton capacity (for hot forge)

(b) Heat Treatment Shop
(i) Preheating Furnace up to 1600° C oil fired or electrical heating with thermostat control
(ii) Anneling Furnace

Agricultural Finance and Marketing

Agricultural finance and marketing are important pivots for promoting and fostering agricultural crop production.

Most of the agricultural finance comes from credit. As an important factor of production, credit must play an important role for equitable distribution of the increasing agricultural income. It should be used for creation of productive employment in order to absorb growing numbers of unemployed labour in the agricultural sectors of developing countries. The function of credit systems in agricultural sectors needs organizational abilities and skilled human resources through the creation of appropriate institutional infrastructure. On the other hand an efficient agricultural marketing system must perform a variety of functions simultaneously. It must provide a timely supply of inputs for agricultural operations and distribute the seasonal agricultural output to the processors and consumers at a set time and at minimum cost.

Therefore, agricultural marketing must mobilise the market supplies from fixed production and then integrate the local markets into national markets.

Credit and marketing functions are closely linked with each other. Improved and expanded markets for agricultural output increases the demand for credit as well as increased the farmers ability to repay the credit. Expanded credit facilities create demands for input and increase the marketel surplus, provides an increased return on investment in market facilities.

Therefore, proper credit and marketing policies are of paramount importance for agricultural transformation. An efficient agricultural marketing system requires:

- physical infrastructure for transport, storage, facilities for marketing and processing;
- financial institutions capable to offer adequate credit with reasonable interest rate;
- communication network;
- entrepreneurial and managerial manpower;
- facilities for market research;
- minimum quantum of constraints on administrative procedure particularly with the Government departments.

(c) Billet Cutting Shop

Gas cutting machine, part of machine, shearing machine, abrasive cutter and pedestal grinder.

(d) Inspection and Metallurgical Laboratory

This will be part of Central Foundry.

(e) Mechanical Handling

Forklift Truck, EOT Crane, Bins, Weighing Scale up to 5 tons.

Material Specification for Forging Tools and Dies

During forging operation there are three main causes for tool deterioration:

- pressure
- abrasion
- heat.

The problem is more serious for the dies, since these are in more intimate contact with the hot material and far greater period of contact. Ferro-alloy e.g. Tungsten and Chromium are the two alloying elements found to be the most effective for the selection of die material.

Composition of Die Steel for Forging

Carbon - 0.4 to 0.5%
Tungsten - 18%
Chromium - 3 - 4%
Rest Iron.

Alternatively

Carbon - 0.8 to 0.9%
Chromium - 3 to 4%
Manganese - 0.5 to 0.6%
Rest Iron

Heat treatment of the tools according to the manufacturers recommendation.

*** ESTABLISHMENT OF CENTRAL TOOL ROOM FOR MANUFACTURE OF JIGS, TOOLS, FIXTURE AND PRECISION SPARE PARTS

The role of central tool room in the rural areas will be to provide the rural industries with:

(i) Manufacture of jigs, tools, fixtures for production facilities;

(ii) To train highly skilled tool makers;

(iii) Maintenance of all special purpose tools;

(iv) Manufacture of precision spare parts for the industry.

The tool room will be geared for precision work up to 0.00001" and surface finish up to 0.2 of 1 micro inch.

Criteria for Minimum Factory Production

The tool room will be capable to handle yearly:

- 10,000 units of small and simple tool grinding
- 1,000 milling cutters grinding and lapping including H.S.S. and Carbide Tipped Tools;
- 500 Jigs and Fixtures weighing 100 tons;
- 1000 Simple Jigs and Fixtures - 100 tons;
- 200 Sharpening of Broaches;
- 500 Special Gear Cutters Grinding

Essential Machinery and Equipment for Tool Room (Detailed specifications are reflected only for special machines in tool room work)

Tool Room High Precision Machines

(i) Jig Boring Machine with all accessories

Boring and Facing Head, Boring Bars, Collect Chucks, Internal Micrometer, Depth Measuring attachment, Auto positioning Jig Boring Machine capable of sensing position to an accuracy of 0.00002". In order to give extensive scope of precision machining, the machine should be equipped with:

- two dimensional tracer controlled copy milling
- automatic profile generation
- auxiliary horizontal boring spindle
- automatic selection of co-ordinate
- automatic quill retraction system

Specification - work table - 60" x 30"
work table longitudinal traverse - 45"
work table cross traverse - 26"
Spindle speeds (stepless) - 40 - 2000 r.p.m.
Spindle feeds (8 up and down) - 0.0005" to 0.012"/per spindle revolution

(ii) Precision Universal Grinding Machine with Accessories

Height of Centres - 6", Distance between Centres - 24" to 60"
Wheel speeds (2) - 1561 - 1910 r.p.m.
Work speeds (4) 40-200 r.p.m.
Table Speeds -3" to 192"/min.
Wheel head infeed - 0.003" to 0.0002"
Work head swivel - 90° right - 45° left
Wheel head swivel - 90° right - 90° left
Underslide swivel - 90° right - 90° left

(iii) Tool Room Die Sinking Machine (Duplex Head Type) with electro-hydraulic tracer control

Table Size - 48" x 24"
Maximum Depth of Die - 10"
Maximum length of Die - 20"
Maximum width of Die - 20"
Spindle speeds - 30 to 1800 r.p.m.
Horizontal, Vertical - 0.25" to 20"/minute and transverse travel
Automatic Horizontal and vertical step feed - 0.010" to 3" in inch/stroke

(iv) Precision Cylindrical Grinding Machine with internal grinding attachment

Max. wheel diameter - 20"
Max. wheel width - 4"
Height of Centres - 6½"
Capacity between centres - 24" - 72"
Wheel speeds(2) 955 - 1205 r.p.m.
Work speed (6) 16 to 235 r.p.m.
Table speed - 3" to 240"/min.

(v) Optical Dividing Head

Calibration can be up to 2 seconds. Maximum distance between centres - 18"

(vi) High Precision Gauge Grinding Machine

(specification items will be as above)

(vii) Precision Internal Grinding Machine

(specification items will be as above)

(viii) Precision Surface Grinding Machine

Longitudinal traverse - 22"
Cross Traverse - 8"
Maximum height from table to Centre Spindle - 16½"
Working table - 20" x 8"

(ix) Universal Milling Machine with Accessories (standard machine)

(x) Universal Horizontal Boring Machine (standard machine)

(xi) Precision Lathe with all Accessories (standard Machine)

(xii) Precision Universal Broach Sharpening Machine
Suitable for both internal and surface broaches. Maximum length 80", micro-feed attachment and built in frequency changer.

(xiii) Precision Twist Drill Grinder with Attachment
For grinding twist drills both LS and RH, high speed steel and carbide tipped dia. 1/32" to 3".

(xiv) Precision Automatic Face Mill Grinder
For grinding a lapping face mill cutters (LH and RH) tips for HSS and tungsten carbide. Milling cutter diameter - 6" to 12", Maximum grinding wheel size - 10" x $\frac{1}{2}$" x $1\frac{1}{2}$" Bore.

(xv) Double Ended Grinding and Lapping Machine with Angle Plate and Table (Parallel Face)
Maximum wheel size 8" x 3"
Wheel size for lapping 6" x $\frac{1}{2}$"

(xvi) Precision Turning Lathe with Cross Slide Swivel for Turret
(xvii) Standard Upright Drilling Machine
(xviii) Standard Radial Arm Drilling Machine
(xix) Standard Knee Type Milling Machine
(xx) Standard Shaping Machine
(xxi) Double Ended Grinding Machine
(xxii) Double Ended Polishing Machine
(xxiii) Band Saw with Endless Saw Blade
(xxiv) Electric Arc Welding Machine up to 800 Amps

} Standard Medium Size Machine

(xxv) Electric Spot Welding Machine up to 3/8" Thickness to be welded

(xxvi) Precision Surface Table - 36" x 36" - 1/2 ton weight

(xxvii) Working Surface Table - 24" x 24" - 200 kilo weight

(xxviii) Heat Treatment Furnace
36" x 20" x 20" - Temperature up to 1600° C. Electrically heated.

(xxix) Quenching Tank - 36" x 36" x 36"
Fitters bench, vices, universal vices, hand tools, drill sets, expanding rearmer set, rearmers, taps, drills, etc.

(xxx) Measuring Instruments

(a) Horizontal High Precision Optical Comparator

Total range of scale - ± 0.005"

Graduation of scale - 0.00005"

Vertical movement of workpiece - $3\frac{3}{8}$"

External maximum diameter 4"

maximum distance 6"

Minimum pitch diameter gauged 25/32"

Facilities for rapidly and accurately checking external and internal plain cylindrical gauges, screwing gauges.

(b) Tool Makers Microsoope

With compound table, field of view, work centre cradel, vee-support, protractor ocular.

(c) Precision Slip Gauges (3 sets required)

1 set of 81 pieces comprising (RS888)

Range	Steps	Pieces	Grade
0.1001 in. - 0.1009 in.	0.0001 in.	9	For Workshop For Inspection For Calibration
0.101 in. - 0.149 in.	0.001 in.	49	
0.05 in. - 0.95 in.	0.05	19	
1 in, 2 in, 3 in, 4 in.	-	4	

(d) Universal Test Indicator Set

Dial Indicator, Back Plunger with 1.5 mm. (1/16")and radius anvil

Graduation - 0.001 in.

Reading - 0-100 or 0-50-0

Range - 0 to 0.2 inches

(e) Lever Type Dial Indicator

(f) Standard Reference Vernier

(g) Vernier Depth Gauge

Open vernier reading direct to 0.001 in.

(h) Vernier Height Gauges

Capacity from 0 to 36 inches

Capacity from 0 to 18 inches

(i) Base Tangert Caliper

Capacity up to 4 inches

Reading to 0.001 inches

(j) Vernier Calipers, Squares, Engineers Squares, Bevel Protractor, Combination Set, Small Hole Gauge, Telescopic Gauge, End Measuring Micrometer Set, Depth Gauge Micrometer, Internal Micrometer, Hand Grip Deep Frame Micrometer, Thread Measuring Tools and Micrometer

*** CENTRAL REPAIR, MAINTENANCE, PROTOTYPE MANUFACTURE AND TRAINING SHOP

This common engineering service facilities will provide allround maintenance facilities to the small and medium size firms in the rural areas. With the available machinery and equipment it will be possible for the development centre to manufacture prototype agricultural products designed by the product development and design services section. More over an extended training facilities can be provided in this section so that the workers in the rural areas will receive all round practical training on manufacture, repair, maintenance of the plant. In this way a linkage can be established amongst the design and engineering sections of the development centre and the linkage between the industries and the development centre as a whole.

Central Repair, Maintenance, Prototype Manufacture and Training Shop

Minimum Machinery and Equipment Required

(i) Lathe for turning and screw cutting-
Maximum swing over bed- 36"
Capacity between centres - 72"
Maximum length of threads - 6"
Maximum diameter of thread - 6"
Maximum pitch - 5 threads/inch

(ii) Capstan Lathe with Hex-Turret and All Accessories
Diameter of hole through spindle - $2\frac{1}{2}$"
Maximum swing under overhead support - $13\frac{1}{2}$"
Maximum distance of spindle flange to turret - $33\frac{1}{2}$"
Maximum length of bar stock-8"

(iii) Universal Milling Machine with Compound Dividing Head and Vertical Milling Attachment

Capacity - 30" x 8" x 20"

Speeds - 18 ranging 26 to 1250 r.p.m.

Feeds - 18 from $\frac{1}{2}$ to 30 i.p.m., $9\frac{1}{2}$" diameter Universal Dividing Head

(iv) Knee Type Milling Machine with Dividing Head

Capacity - 30" x 8" x 20"

Speeds - 18 ranging from 26 to 1250 r.p.m.

Feeds - 18 from $\frac{1}{2}$ to 30 i.p.m.

(v) Horizontal Boring Machine with Sliding Head and Swiveling Work Table

Maximum diameter face and bore - 60"

Spindle traverse vertical - $7\frac{1}{2}$" to $65\frac{1}{2}$"

Revolving table - 48" x 48", maximum distance facing slide to boring stay - 140"

(vi) Cylindrical Grinding Machine with Internal Grinding Attachment

Grinding wheel size - 20" x 2" dia. x 8"

Maximum diameter ground - 10"

Maximum length between centres - 72"

Roll face length - 48" wt. of Roll - 350 lbs. (maximum)

(vii) Surface Grinding Machine with Magnetic Table

Size of table - 20" x 8"

Lognitudinal Travel - 22"

Transverse Travel - 8"

Grinding Wheel - 8" diameter

(viii) Radial Arm Drilling Machine with Universal Table

6 ft. spindle radius, capacity - 3" diameter in M.S.

Speeds - 15 to 1500 r.p.m. - 17 steps

Feeds - 0.004 to 0.030 i.p.r. 6 steps

(ix) Upright Drilling Machine

Capacity - 3" diameter in M.S.

Speeds - 15 to 1500 r.p.m. - 17 steps

Feeds - 0.004 to 0.030 i.p.r. - 6 steps

(x) Gear Hobbing Machine with Accessories

Maximum distance - centre of work spindle to centre of Hob Arbour $5\frac{1}{2}$"

Hob Arbour diameter $1\frac{1}{4}$"

Maximum hob outside diameter 4"

Maximum DP module Cast Iron or Steel 4 to 16

(xi) Gear Shaving Machine with Accessories

Capacity - 18" diameter

Pitch Diameter - 1 to 18 inches

Outside Diameter maximum - 18.875

DP or Module - 4 to 16, Cutter diameter - 9", Maximum face width straight 10", Maximum crown width - 6"

(xii) Vertical Lathe with Turret Slide Arrangement and Side Tool Attachment

Table diameter - 36"

Maximum diameter of work - 44"

Down feed of turret tool head - 24"

Vertical traverse of side tool - 30"

(xiii) Heat Treatment Furnace

Oil fired or electrically heated heat treatment furnace maximum temperature up to 1200° C with thermostat control.

(xiv) Quenching Tank

Steel Fabricated Tank - 36" x 36" x 36"

(xv) Press Brake

Maximum bending pressure - 50 tons

Effective work length - 100"

Width of table - 8"

Stoke - 0 to 4", Number of stoke/min. 9

(xvi) Eccentric Press

Capacity - 50 tons

Blank thickness up to - 1/8" in MS

(xvii) Tube Bending Machine

Maximum of tube diameter - 2" in M.S.

(xviii) Nibbling Machine

Maximum tensile strenght of plate - 50 tons/sq. in

Edge cutting - up to 1/8"

No. of stroke per minute - 2800 to 1400

Maximum circular cutting - 28" diameter

(xx) Shearing Machine

Shear in mild steel plate - up to 15/32"

Shearing length - 100"

Strokes per minute - 15

(xxi) Hydraulic Press

Table size - 24" x 24" capacity - 5 tons

(xxii) Electric Arc Welding Set
Maximum current - 500 amps.

(xxiii) Electric Spot Welding Set
Maximum thickness of material M.S. - $\frac{1}{4}$"

(xxiv) Oxyacytilene Welding Set
(standard)

(xxv) Profile Gas Cutting Machine
Maximum size to be cut - 48" diameter

(xxvi) Crankshaft Turning Machine
Crankshaft size - length - 30", Pin. diameter - 3"

(xxvii) Crankshaft Grinding Machine
Crankshaft size - length 30", Pin. Diameter - 3"

(xxviii) Portable Tools and Equipment
Drilling, grinding, trimming, etc.

(xxix) Electrical Measuring Equipment and Maintenance Equipment

Common Services for Maintenance Section

(i) Electrically driven compressor set
(ii) Water tank, oil tank and pipeline
(iii) Electric substation
(iv) Forklift trucks, cranes, etc.
(v) Fitters Bench, cupboards, etc.

Machinery for Training

Medium and Small size:
Lathes, milling machines, drilling machines, welding machines, boring machines and also to use all the machinery in the maintenance shop for practical training.

*** ESTABLISHMENT OF CENTRAL GALVANISING, ELECTROPLATING AND PHOSPHATING PLANT

The above processes are used to protect the surface of the components associated with the agricultural machinery and equipment. It is difficult for the small firms in rural areas to install in their own plant the metal surface treatment machinery which are generally capital intensive

and beyond the means of small establishments. In order to facilitate this service amongst the industries in rural areas, the development centre can install such a plant for common engineering use.

Electroplating Process

The process of metal surface treatment will be as follows:

(a) Bright Zinc Plate, Passivate and Bleach

Any conventional Bright Zinc Plating Process to give a minimum thickness of 0.0003" and passivated with a conventional chrom type passivating solution and bleached to give a zinc coating of good appearance which will withstand 48 hour Acetic Acid Salt Spray ASTM B. 287.

(b) Copper and Nickel Plate

Any conventional Copper Plating Process followed by a conventional nickel plating process to give a minimum thickness of 0.0006" of good appearance.

(c) Copper , Nickel and Chrom Plate

Any conventional Copper Plating Process followed by a conventional chrom plating process to give a resultant thickness of 0.0006" to conform with BS. 1224 of good appearance.

(d) Phosphate, Stain and Oil Process

Any conventional phosphating process, providing it conforms with a particular weight, dyed by any approved water stain and sealed by any approved oil to give corrosion protection specified by manufacturer.

(e) Parcolubrize Process

Phosphate with parcolubrize and seal with an approved lubricating oil to give a good corrosion protection surface.

Plating Shop

1. Parkolubrize . Bonderise and Copper Plating

(i)	Bonderising Vat 4' x 3' x 3' Deep	- 1 off.
(ii)	Hot Swill Vats	- 3 off.
(iii)	Trichlorethylene degreasers	- 1 off.
(iv)	Copper plate vats 6' x 3' x 3' deep	- 1 off.
(v)	Hoists and runways	- 2 off.
(vi)	Parkolubrizing vats - 3' x 3' x 3'	- 1 off.
	6' x 3' x 3'	- 1 off.

Credit and Marketing System in Traditional Agriculture in Developing Countries

In traditional agriculture, capital i.e. credit plays a relatively less important role than land and labour. Very often it is observed that the land clearing, levelling etc. which are capital intensive operations, are done by use of family labour. Finance is required for the purchase of inputs except labour and is insignificant. Finance in traditional agriculture is mainly used for maintenance rather than expansion of agricultural activities.

The finance is mostly available from money lenders, village traders, middle men, friends and relatives. It is used for storage, marketing and processing of agricultural surplus to provide a year round supply to the consumers. The credit also plays an important role in the mitigation of cash needs of the farmers. Particularly in the subsistence agriculture which are more numerous in developing countries, these needs are often larger than the income. Because of the closer relationship of the household and farm enterprises it is very difficult to ascertain the production and consumption needs of the farmer, so there is a high uncertainty in repayment of the loans.

Credit Facilities in Modern Agriculture

The intensification of agricultural production needs large infusions of credit facilities to finance:

a) Working Capital
- purchased inputs, e.g. seed, fertilizer crop protection chemicals etc.
- wages for agricultural labour use;
- payments for services, water electricity, fuel oil etc.
- purchase of animal fodder.

b) Fixed Capital
- procurement of machinery and equipment
- purchase of land and other facilities
- purchase of spare parts and expenses on maintenance.

Therefore, modern agriculture requires proper estimation of credit for timely and adequate supplies of inputs, repayment arrangements according to the ability and solvency of the farmers, effective machinery for recovery of loans, adequate marketing facilities.

Traditional credit and marketing systems are often unable to meet these requirements. Therefore, modernization of agriculture needs

Power Requirement

The vat loads depend on the number of components per jig and the number of jigs loaded to the vats.

Total capacity - 500 amps

For Copper Plating - 25 to 30 amps per sq. ft. for the calculation of vat loading

Estimated Process time -

Parkolubrize - 15 to 25 minutes/vat.

Copper Plating for carburising - 30 minutes/vat.

2. Bright Zinc, Copper, Nickel and Chrome Plating

(i)	Trichlorethylene degreaser	- 1 off.
(ii)	Zinc Plating Vats 6' x 3' x 3'	- 1 off.
(iii)	Galvanised hot swill vat 3'x3'x3'	- 1 off.
(iv)	Galvanised hot swill vat 6'x3'x3'	- 1 off.
(v)	Galvanised cold swill vat. 3' x 3' x 3'	- 1 off.
(vi)	Stainless Steel Nitric Acid vat. 3' x 2' x 3'	- 1 off.
(vii)	Stainless Steel Nitric Acid vat. 4' x 3' x 3'	- 1 off.
(viii)	Stainless Steel Proseal vat. 3' x 3' x 3'	- 1 off.
(ix)	Copper Plating vat. 6' x 3' x 3'	- 1 off.
(x)	Zinc Plating Barrel	- 1 off.
(xi)	Nickel Plating vats. - 6' x 3' x 3'	- 1 off.
(xii)	Chrom Plating vats 6' x 3' x 3'	- 1 off.
(xiii)	Rinsing vats 3' x 3' x 3'	- 6 off.
(xiv)	Various air taps, benches, vices, jigs, hoists, etc.	

Estimated Process Time

Bright Zinc Plating - 15 minutes

Barrel Zinc Plating - 60 minutes

Copper Plating, Ni and Cr. - 60 minutes to give a thickness 0.0006

The electroplating shops need a suitable chemical laboratory with equipment for the analysis of chemical and treated surface properties of parts.

The section will be able to cater for processing the following parts: Chisel, tines, discs, gears, pinion, etc. for phosphating and gear lever, bolts, nuts, rods, caps and many other parts for bright zinc plating or Ni. Cr. plating of tractors and implements and for other industries in the rural area.

*** ESTABLISHMENT OF CENTRAL HEAT TREATMENT PLANT

Heat treatment is the essential requirement to condition the steel parts in order to sustain greater load bearing characteristics and to increase the surface hardness for greater resistance to abrasion and wear. Substantial parts of agricultural machinery and equipment needs heat treatment e.g. chisels, tines, discs, transmission shafts, gears, cams, springs, connecting rods, etc. Heat treatment equipment are also capital intensive and require high degree of chemical and metallurgical attention and consideration. In agricultural machinery and equipment, the certain parts require three types of heat treatment.

(1) Surface hardening and tempering to give a required surface hardness
(2) Through hardening and tempering to give a specific hardness within the material of the parts.
(3) Anneling - to reduce the hardness in order to continue further machining operations.

Considering the magnitude of engineering and technical skill involved during the heat treatment process, it is desirable if a central heat treatment shop can be installed within the framework of the development centre as a part of Common Engineering Service Facilities for rural industries. Small and medium size industries will be able to heat treat their parts and components without having individual investment. The centre will also provide the technological know-how through the technological advisory services and will thus create a linkage between advisory services and engineering common services and the local industries require the heat treated parts.

Essential Machinery and Equipment Required for Central Heat Treatment Shop

1. Normalising and Anneling Shop
   (i) Continuous Normalising Furnace
   (ii) Trolleys (overhand rails)
   (iii) Hand Trays and Stillages for storing.

   Process time 15 minutes.

2. Carburising by Pack Hardening Process

This is the usual method of case-hardening and is the most economical for "deep" cases or for parts which require grinding after hardening. This is most suitable for artisan and small scale level.

The process require:

(i) Charcoal grains of $\frac{1}{4}$" size to $\frac{1}{2}$" size
(ii) Pack hardening boxes - 12" x 18" x 12"
(iii) Oil fired furnace up to 900°C size - 36" x 36" x 36"
(iv) Water or Oil Quenching Tank - 48" x 48" x 48"
(v) $\frac{1}{4}$ Ton Hoist

Case Depth
- up to - 0.040" at 900°C for four hours
  for small pieces up to 1" x 1" x 1"
- up to - 0.040" at 900°C for 8 to 12 hours
  for relatively large pieces to be carburised

Case-Hardening Steels and Heat Treatment

The following are the general case hardening steel used in Agricultural Machinery Industries.

Specification	Refine	Quench	Harden	Quench
EN 32A	870/900°C	Water or Oil	760/780°C	Water
EN 32C	870/900°C	Water or Oil	760/780°C	Water
EN 32M	870/900°C	Water or Oil	760/780°C	Water
EN 361	850/880°C	Water or Oil	780/820°C	Oil
EN 362	850/880°C	Water or Oil	780/820°C	Oil

3. Carburising, Hardening and Tempering Shop

(i) Carburising furnace with endothermic generator using propane and town gas (if available)
(ii) Hardening furnace oil fired or electrically heated
(iii) Oil Quenching vats
(iv) Water Quenching vats
(v) Trychlorethylene Degreasers vat
(vi) Mobile crane
(vii) Hoists for degreasers
(viii) Cooling conveyer

Case Depth Achieved

0.010 inch - 1 hour

0.025 inch - 2 hours

0.035 inch - 3 hours

0.035 to 0.070 inch - 6 hours

0.070 to 0.085 inch - 10 hours

0.085 to 0.100 inch - 14 to 24 hours

Salt Tempering

(ix) Salt type tempering furnace

(x) Trychlorethylene Degreasers Vat.

Tempering time - 60 minutes

4. Induction Hardening Shop

(i) 145-KW Hardening Furnace

(ii) 75-KW Tempering Furnace

(iii) 60-KW Tempering Furnace

(iv) Oil Quenching Tank

(v) Water Quenching Tank

(vi) Washing Plant

(vii) Electric Grab Crane

Alternatively

(i) Open Hearth Hand Controlled Hardening Furnace

(ii) Oil Quenching Vats

(iii) Water Quenching Vats

5. Cyanide and Nutral Salt Hardening and Tempering Shop

This is for very small parts to be heat treated by batch size.

(i) Twin 24" cyanide pots

(ii) Trichlorethylene degreaser vat.

(iii) Pre-heating pots

(iv) Oil Quenching vats

(v) Water Quenching vats

(vi) Benches for wiring and jigging for degreasing

Case depth	-	Minutes
0.005 inch	-	30
0.010 inch	-	60
0.015 inch	-	90
0.020 inch	-	120
0.025 inch	-	150
0.030 inch	-	180
0.035 inch	-	210
0.040 inch	-	240

Tempering After Cyanide Treatment

(vii) 55 KW Tempering Furnace or

(viii) Continuous Salt Type Tempering Furnace

(ix) Loading trolleys

C. Promotion of Ancillary Industries in Rural Areas

In order to promote the ancillary industries which will supply the components, parts and units to the agricultural machinery and equipment manufacturing units in rural areas need substantial assistance from government institutional facilities extending:

- Industrial extension services
- Financing of projects
- Industrial Estates
- Co-operative action
- Regional and sub-regional section for industrial promotion

In close co-operation with the development centre and government institutional participation, individual investors (both in private and public sector) can install the following manufacturing units for the supply of parts and components to the agricultural machinery and equipment manufacturing units in the rural areas.

- Manufacture of all types of transmission gears including crown-wheel and pinion for tractors;
- Manufacture of Discs, wheel and rim and sheet metal components;
- Manufacture of Hardware e.g. bolts, nuts, springs, hooks, chains, etc.;
- Manufacture of automobile accessories e.g. air filter, oil filter, silencer, gaskets, etc.
- Manufacture of electrical components and accessories, horn, dynamo, starter, etc.
- Manufacture of instruments and gauges.

Therefore, from the above discussion one can conclude that a definite interlinkage is required amongst the institutional, technological, ancillary industries and the dispersed industries manufacturing agricultural machinery and equipment in the rural areas.

The effective means of such aninterlinkage will best be achieved through the installation of an "Agricultural Machinery and Allied Engineering Industries Development Centre" which will be a turning wheel of the rural industrial development.

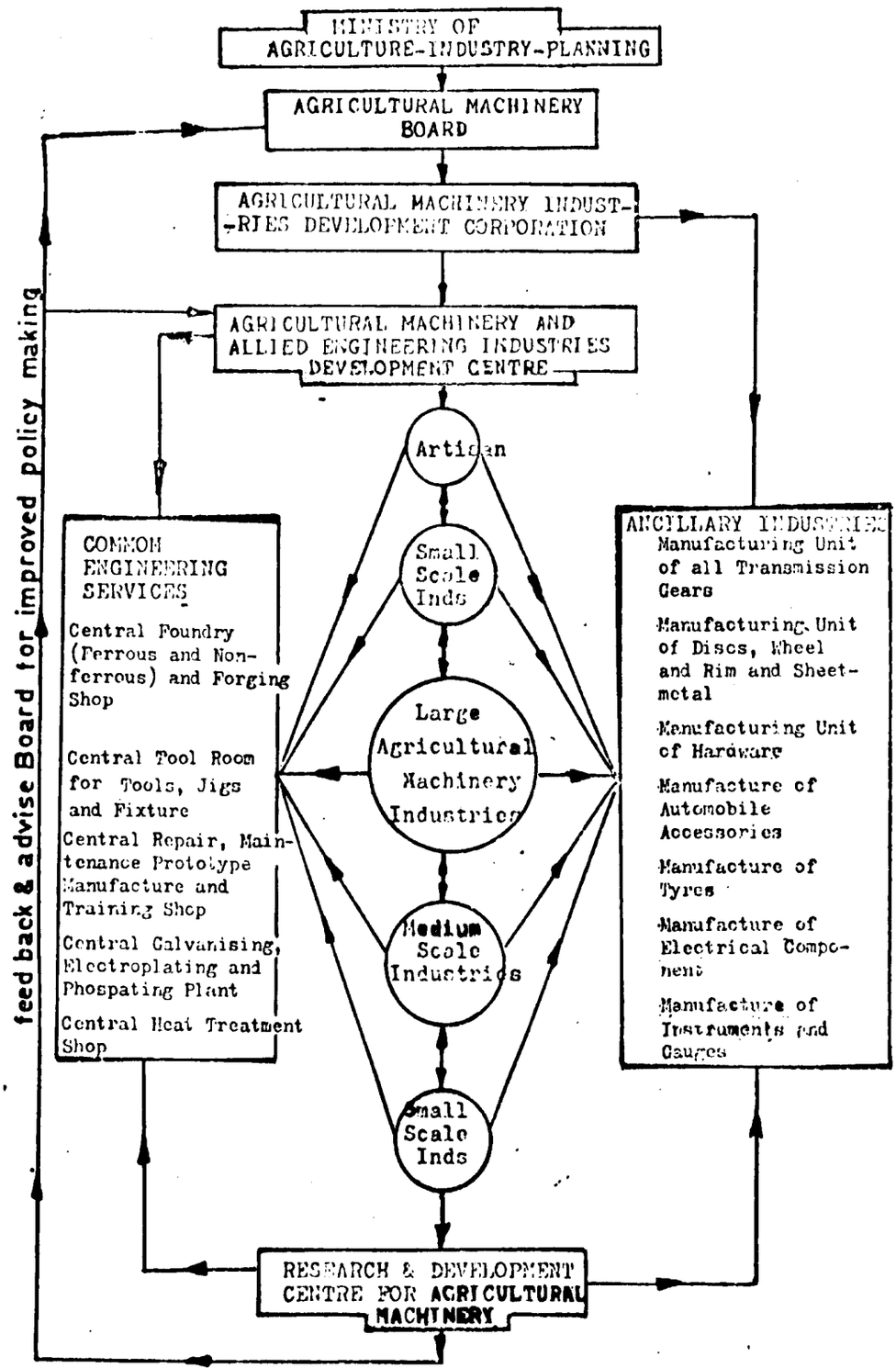
SECTION VIII

NEED FOR A NATIONAL POLICY AND PLANNING FOR INTERLINKED DEVELOPMENT OF AGRICULTURAL MACHINERY INDUSTRY

The previous section identified the interlinkage in technological development of agricultural machinery and equipment in the rural areas, through the establishment of linkage system in technological advisory services and the engineering common services facilities extended through the installation of proposed "Agricultural Machinery and Allied Engineering Industries Development Centre". The purpose of such a development centre will render all round technical and engineering services and facilities to the effective running of the rural industries.

This section will examine the need for a national planning and policy for interlinked development of agricultural machinery and allied engineering industries in the rural areas.

The agricultural machinery industries produces many diverse products ranging from simple hand tools to sophisticated power equipment. So there exists a basic requirement of technological choice for the selection and implementation of appropriate manufacturing technology for the industries in the developing countries. Therefore, a comprehensive planning and policies are envisaged for the overall development of the agricultural machinery industries in the rural areas. The national planning for the technological and manufacturing aspects of industrial development require an overall deliberation from a high level Governmental authority. In order to formulate such a comprehensive plan for systematic development of agricultural machinery and allied engineering industries in the rural areas, there is a need for a national planning for technological and manufacturing development of agricultural machinery industries in the developing countries. Formulation of such planning can be established through the creation of an "Agricultural Machinery Board" a high powered body under the Ministry of Agriculture, Planning and Industries, whose main function will be to formulate national planning for technological and manufacturing development of Agricultural Machinery Industries. The Agricultural Machinery Board will be responsible to formulate the national policy based upon: (Refer Figure 38)



Interlinked Development of Agricultural Machinery Industries in Rural Areas

FIGURE -- 38

- the identification of technological need for agricultural machinery industries both in rural and urban areas;
- the development of a technological infrastructure for the centralised or decentralised growth of technology coupled with wide spread technological information system, technological services and know-how;
- the installation of an institutional system for accelerated adoption, acquisition and absorption of technology considered most appropriate under local conditions;
- such institutional system should provide:
  a) accelerated adaption and absorption of imported technology,
  b) development of domestic technology,
  c) assist the industries particularly in the rural areas in transfer of both imported and domestic technology;
- research and development plan for the growth of domestic technology for the ultimate transfer to the local industries for indigenous manufacture;
- such planning and policies should provide a guideline in terms of fiscal and regulatory device to encourage domestic technological development and allow sufficient import of foreign technology (in terms of process and manufacturing techniques) in most critical sectors of development

In order to promote and implement the national technological and manufacturing policies set out by the Agricultural Machinery Board, there is a requirement for an infrastructural facility at national level. This can best be achieved by the installation of an "Agricultural Machinery Industries Development Corporation" an autonomous and parastatal body for the promotion and development of agricultural machinery industries within the guideline policies of the Agricultural Machinery Board.

(i) National Technology Plan

The implementation of national technology plan set out by the Agricultural Machinery Board will be carried out by the "Agricultural Machinery Industries Development Corporation" whose main function will be the following:

- to define and set various technology requirement at various levels of industries in order to manufacture agricultural machinery and implements under best local conditions as indicated in Section IV under the heading Summary of Technological Criteria in Three Industry Levels in page 103.

- assist the industries for the requirement of plant size, infrastructure facilities (electric, water, sanitation, etc), machine tools, equipment and metal working processes, specification of material and products through identification of product and definite volume of manufacturing programme at each technology level;

- a comprehensive survey of existing agricultural machinery industry and possible future demand for improved machine tools, equipment and manufacturing process based on appropriate technology level best suited in the rural areas;

- formulate a comprehensive and cohesive plan with a definite time target for the product identification and development of agricultural machinery best suited for the local conditions particularly in the rural areas;

- such a plan should elaborate and reflect definite manufacturing programme, complete range of agricultural machinery, implements and associated equipments with their respective parts and components on the basis of:
  1) accelerated manufacture of idigenous parts and components
  2) promotion of co-operative manufacture of parts through the interlinkage of technological institutional service facilities and small, medium and large industries in the rural areas
  3) promotion of indigenous subcontracting through the interlinkage of manufacturing units
  4) allow imports of raw material, parts and components in a gradual reduced order to complete the assembly of indigenous manufactured items
  5) Import of complete agricultural machinery which are required and cannot be produced within the target expansion programme of agricultural machinery industries development paln.

- transmit and co-ordinate the comprehensive technology expansion plan for agricultural machinery industry to the overall development plan of the country in order to ascertain the overall requirement of agricultural machinery industries need from the rest of the engineering and allied industries section;
- set a national plan and target for the requirement of managerial and skilled workmen and to develop a comprehensive training plan for the skilled, semi-skilled and unskilled manpower in order to supply these labour force to the agricultural machinery manufacturing industries particularly in the rural areas;
- plan an institutional and technological interlinkage amongst the rural industries through the establishment of "Agricultural Machinery and Allied Engineering Industries Development Centre" as described in Section V, VI and VII.

Therefore, the national technological plan for the interlinked development should be carried out at an institutional level through such organisations who will be able to draw confidence from both the private and public sector industries. The proposed Agricultural Machinery Industries Development Corporation will be the most suitable institution for executing such a development plan set out by the Agricultural Machinery Board for greater rural industrialisation in the developing countries.

(ii) Government Policies to Promote Interlinkage

The Government overall policies to promote interlinking development in the rural areas will be established through the Agricultural Machinery Industries Development Corporation and Agricultural Machinery and Allied Engineering Industries Development Centre where the former will be the organisation responsible for promotional, taxes, legislative and financial aspects of interlinking development and the latter will be the real executing organisation for institutional and technological aspects of interlinking development for the rural industries.

introduction of institutional channels for credit and marketing.

B. Government Policy on Agricultural Credit System

The Government policy should be oriented either to develop new credit institutions or to use existing institutions specifically to meet the needs of the small farmers.

Therefore, the Government policy will be to set up a "Small Farmer Credit Institution", either directly in private or public sectors or through the co-operative credit banks in order to:

- plan simple lending procedures ;
- ensure and examine the credit needs of the farmer so as to assure repayment;
- extend guaranteed supply of low cost credit to a large section of agricultural population, particularly small farmers;
- provide timely credit and inputs;
- increase the interest rates on deposit so that the farmers will have natural urge for saving;
- interest on the credit should be anywhere between ½% to 4% annually and particularly in backward areas a cash subsidy should be extended on credit interest;
- extend credit with little or no interest if technical innovations are highly profitable. Profitability of innovations improve the ability of the small farmers to pay interest costs;
- extend insurance on approved credit in case of draught, natural hazards, cyclone, etc. where widespread damage to food grain occurs.

C. Government Policy on Marketing

In order to improve and expand the marketing system of agricultural product, a comprehensive Government policy is required to encourage the marketing aspects of agricultural outputs in the developing countries. The marketing performance can be encouraged in the following areas:

- private marketing system
- autonomous and semi-autonomous marketing system
- co-operative marketing system.

Manufacturing and Technological Interlinkage

The Government policy for the manufacture and technological linkage will be channeled out through the activities of the development Centre as described in section VII.

1. Promotion of Technological Advisory Services where rural industries will receive all round technical assistance.

2. Incorporation of Common Engineering Service facilities through direct Government investment where industries in rural areas will be able to obtain castings, forgings, precision tools and equipment, jigs and fixtures, proper heat treatment facilities and metal surface treatment facilities at a reasonable price. These engineering manufacturing facilities will encourage the rural industries to improve their performance and allow more new industries to establish in the rural areas.

3. Creation of more ancillary small scale and medium scale industries under the auspices of Agricultural Machinery Industries Development Corporation. Without the ancillary industries the agricultural machinery industries cannot exist in the rural areas. Ancillary industries produce wide variety of parts and accessories e.g. agricultural discs, wheels and rims, electrical accessories, fittings, batteries, tyres, pipes, hardware, filter, gaskets, belts, bearings, electric motors and a large number of diverse parts and components. The Government policy will be to encourage the development of these industries both in private and public sectors by:

   - accommodating these ancillary industries in the industrial estates of the rural area with nominal rent;
   - offering financial incentives and direct encouragement in financial participation for investment in plant, maohinery and equipment;
   - liberlising the import facilities for machinery and raw materials which cannot be obtained locally;
   - providing adequate training facilities through the development Centre and training institutes.

The ancillary industries will be able to subcontract many parts and components to the Artisan and small industries in the rural areas.

4. Co-operative manufacturing programme can be established through the Governmental policy for co-operative development in rural areas. Here the Government can supply prototype design developed and manufactured by the development Centre to the small industries in rural areas. So a number of establishments can group together on a co-operative basis where manufacturing and assembly line can be established for the production of certain agricultural machinery.

5. Establishment of Research and Development Centres for agricultural machinery and equipment in the rural areas. The research and development Centre will be responsible to the Agricultural Machinery Board and Agricultural Machinery and Allied Engineering Industries Development Centre. This arrangement will create a feed back policy to the Board for improved national development planning. The Government policy will be to provide necessary finance and know-hows for the effective running of the Research and Development Centres.

6. For technological interlinkage the Government should encourage subcontracting among the local industries by:

   - regulating imported parts and components
   - import substitution
   - providing necessary raw materials for rural industries, either through import or through the local agents

7. The Government policy will be to introduce standardisation of parts and components including the products to be manufactured in the rural areas. This will create a greater stabilisation in rural industries in manufacturing operations and processes.

Institutional Interlinkage

The Government policy to promote institutional interlinkage will be channeled out through the Agricultural Machinery and Allied Industries Development Centre as describes in Section VI.

1. Extending Management Services to the rural industries particularly in the Artisan and small scale level (as described in Section VI).

2. Extending facilities for product development and design services to the rural industries particularly to the Artisan and small scale and medium size industries. This activity of the development Centre will be linked up with the Government Research and Development Centres for prototype design and manufacture of agricultural machinery and equipment which will ultimately be handed over to the rural industries.

3. The Government policy will be to create adequate facilities for the procurement of Raw Material and Marketing Services for interlinked development. This can best be achieved by the establishment of:

   - Raw Material Banks in rural areas
   - Co-operative marketing institutions
   - Marketing and Export Houses
   - Organising Seminars and Exhibitions for the products from rural industries.

4. Creation of Industrial Estates in the rural areas by the Government will be the most suitable means of bringing the ancillary and small scale and medium scale industries closer for effective interlinking development. This will create a greater sub-contracting process amongst the rural industries engaged in manufacturing agricultural machinery and equipment and greater usage of machinery and equipment amongst the industries which will improve the productivity of the rural industries.

Administrative Interlinkage

The Government policy to promote administrative interlinkage will be through the joint participation of Department of Agriculture and Industry under respective Ministries and Agricultural Machinery Industries Development Corporation. The Government policy for the interlinked development of administrative aspects will be as follows:

1. Registration of all industries and establishments manufacturing agricultural machinery and equipment in rural areas.

2. Creation of a common dairy for all machinery and equipment available in the rural industries and supply such dairy to all the rural industrias so that the availability of machinery will be ascertained easily amongst the rural industries as and when they require.

3. Publication of an Agricultural Industries Directory outlining all the industries with:
   - Name, Address, Phone Number
   - Director or owners name
   - Product or range of products with specification
   - Facilities available for machinery and processes
   - Facilities required for machinery and processes.

   Such a directory should be available free of cost for marketing and subcontracting promotion in rural areas.

4. To introduce administrative procedure of importation of Machinery and Equipment, Import Substitution and restriction of imported products and goods which can be locally manufactured in rural industries.

5. To provide factory inspectors to ascertain the local problems and to pursue implementation of factory laws in the industries in rural areas.

6. To introduce factory laws and safety measures.

7. To co-ordinate with relevant Government departments to extend utility services e.g. electricity, water, sanitation, road, etc. to greater rural areas for industrial development.

8. Introduction of technical monthly bulletin in local language to keep the industries abreast with modern agricultural industries development.

9. To introduce weights and measures standard and the standards for Products, Machinery and Equipment and Materials for the rural industries.

Taxes and Legislative Interlinkage

The Government policy on taxes and legislative interlinked development will be outlined in the following items:

1. Introduction of common taxation system for all rural industries, this will include tax-rebate for new industries and special reduced taxation for Artisan and small scale industries in rural areas.

2. Introduction Labour Laws for all rural industries.

3. Introduction of safety regulations and minimum safety precautions needed for the industries.

4. Introduction of factory laws for rural industries.

5. Introduction of welfare schemes for the workers of the rural industries.

6. Special tax-exemptions for the industries in backward areas.

7. Special reduced import duties and tariff for industries in baokward areas.

8. Introduction of manufacturing and licensing procedures for:
   - Foreign industries under collaboration agreement
   - Indigenous industries

9. Regulation for the import of raw materials and special facilities for backward areas.

Financial Interlinkage

The Government policy on financial interlinkage will be based on following financial facilities extended to the rural industries.

1. Government loan scheme for rural industrial development.
2. Financial assistance through state financial corporations and rural banks.
3. Bringing the private and public banks closer to the rural industries.
4. Credit guarantee schemes for local and export market opportunities for rural industries.

5. Supply of machinery and equipment on hire purchase scheme.

6. Outright grant for machinery and equipment in backward areas for greater industrial development.

7. Government financial subsidy to the industries in rural areas.

8. Government subsidy on transport specially in deep rural areas where transport is expensive.

9. Liberal import policy and duty- free machinery, equipment and material for the industries in backward areas.

10. Liberal finance for working capital requirement for Artisan and small scale industries in rural areas.

(iii) Administrative Implementation Mechanism for Interlinked Development of Agricultural Machinery Industry

The administrative implementation mechanism based on national policy and planning for interlinked development of agricultural machinery industries should be established as indicated in the flow diagram outlined in Figure 38.

(a) Formulation of Policy and Planning will be implemented by:

Agricultural Machinery Board

The highest planning and policy making body will be composed of Ministeries of Agriculture, Industry, Planning, Finance and Labour and Employment, and the Director of the Research and Development Centre, Director of Agricultural Machinery Industries Development Corporation.

(b) Development and promotion of industries according to the directives from Agricultural Machinery Board will be implemented through Figure - 38.

Agricultural Machinery Industries Development Corporation

Such a development corporation will be an autonomous and parastatal organization whose function will be the promotional aspects of all rural industrial development for agricultural machinery industries, particularly development of ancillary industries. Through the development corporation adequate facilities will be extended to the rural industries particularly, investment promotion, finance, factory allocation, facilities, etc. The development corporation will

be composed of the representatives from:

- Ministries of Agriculture, Industries, Planning, Finance, Labour and Employment Public Works
- Private and Public Sector industrialists
- Government Departments and Agencies involved in agricultural machinery industries development, e.g. Department of Agriculture, Industry, etc.
- Non-Governmental agencies and institutes and Research and Development Centres, Chamber of Commerce and Industry
- Director of the proposed Agriculture Machinery and Allied Engineering Industries Development Centre

(c) Execution of promotion and interlinking facilities will be implemented by (Figure - 37 and 38)

Agricultural Machinery and Allied Engineering Industries Development Centre

The development centre will be the real backbone of the interlinked development of agricultural machinery industries in the rural areas. The function of the centre has already been discussed in detail in Section VI, VII, and VIII. The running of the Engineering Common Services will be directly under the Centre and will be financed by the Government through the Agricultural Machinery Industries Development Corporation. The development centre will be composed of:

- Board of Directors (from private and public sector industries)
- Managing Director and administrative staffs.

(d) Development of Agricultural Machinery and Equipment to suit under local conditions will be carried out through (Figure - 38)

Research and Development Centre for Agricultural Machinery and Equipment

- Research and Development Centre will run in close co-operation with Agricultural Machinery and Allied Engineering Industries Development Centre and the local industries engaged in manufacturing agricultural machinery and equipment in rural areas. The Research and Development Centre will report to the Agricultural Machinery Board the highest policy making body of the Government at national level.

(iv) Entrepreneurship Promotion

Promotion of entrepreneurship is one of the most important aspects of interlinked development policy in the rural areas. The promotion of entrepreneurships require certain special concessions by the Government in order to accelerate industrial development particularly in the rural areas. This is to encourage the individual who has reasonable capital and interest to set up industry, new industrial units and expansion of existing enterprises in rural areas by way of following facilities:

- Special Credit Facilities

  The difficulty in obtaining credit is the most serious impediment for the promotion of entrepreneurship in rural areas because this limits the ability to obtain services and materials to operate the enterprise. Capital is required for an entrepreneur to acquire machinery, equipment, factory premises for the day to day management of his business. Therefore, appropriate credit facilities are required for the promotion of entrepreneurship in agricultural machinery industries in rural areas.

- Acquiring Machinery and Raw Material

  Entrepreneurship promotion requires appropriate oredit and incentives for the purchase of machinery and raw materials by individual or small firms intend to manufacture agricultural machinery and equipment.

- Factory Accommodation

  Another important aspect of entrepreneurship promotion is the availability of ready factory accommodation for an entrepreneur to start up industry. Setting up factory building particularly in the rural areas need infrastructure facilities. Therefore, planned factory accommodation through industrial estates will be an important milestone for the promotion of entrepreneurship in the rural areas.

- Trained Manpower

  This is also an important aspect to promote entrepreneurship in the rural areas. It is difficult to obtain trained manpower in rural areas. Through training schemes and programmes it is possible to enlarge the availability of trained manpower in rural areas. The availability of adequate trained manpower will attrack the

entrepreneur to establish industries in the rural areas.

- Marketing

Lack of marketing facilities particularly in the rural areas, disallow the entrepreneur to set up establishment. Therefore, entrepreneurship promotion requires establishment of adequate marketing facilities in the rural areas. The marketing promotion can be organized by the creation of following facilities:

- Co-operative marketing operation
- Government Whole Sale and Retail Centres
- Marketing and Export Houses

The entrepreneurship promotion needs an atmosphere of confidence for the necessary manufacturing facilities in rural industrial investment. Promotion of entrepreneurship requires a definite Government policy particularly in rural areas. The impremention of such a policy is not an easy matter, it requires a realistic planning for the overall requirement of industrial growth in the rural areas.

Therefore there is a need for an interlinked development approach based on a national policy and planning for the agricultural machinery industries in rural areas.

SECTION IX

GUIDELINES FOR INTEGRATED PROGRAMMES ON DEVELOPMENT OF AGRICULTURAL MACHINERY

The previous section explored the interlinked development of Agricultural Machinery Industries in rural areas with a particular emphasis on the formulation of a national technology plan in order to promote industrialisation in the rural areas.

This section will describe guidelines for integrated development programmes for agricultural machinery. The guidelines for the integrated development programmes envisage a planned and stage development of the following aspects those are considered to be the appropriate steps for the development of agricultural machinery and equipment.

- Integrated programme for the development of design and prototype manufacture of agricultural machinery best suited for local conditions.
- Integrated programme for the manufacture of agricultural machinery within the available manufacturing resources of the country.
- Integrated programme for the development of maintenance of agricultural machinery and equipment.

Considering the above aspects are the basic steps towards the development of agricultural machinery and equipment, a definite assessment and consideration is needed on the following criteria e.g.:

- Identification and actual requirement of agricultural machinery and equipment based on approved sophistication and mechanization policy of the country ideally suited under local conditions. A product grouping as outlined in Section IV needs to be established under following conditions.
  - (a) Crop to be produced.
  - (b) Application of other input materials.
  - (c) Application of machinery and equipment according to the selected level of technology e.g.
    - i) Agricultural Hand Tools and Manually operated Equipment
    - ii) Agricultural Animal Drawn Machinery and Implements
    - iii) Agricultural Power operated Machinery and Equipment

Relative efficiency and advantages of the above systems are beyond the scope of discussion in this paper, but the above systems are predominantly visible in developing countries. Nevertheless the Government's promotional measures for the improvement and expansion of marketing systems should be considered in the following light:

- to minimize costs of distribution;
- to reduce spatial and seasonal price fluctions;
- to handle efficiently the increased marketable surplus;
- to introduce greater administrative powers and measures for marketing, procurement and distribution;
- to introduce the standardization of weights and measures particularly in the least developed countries.

To summarise, the inclination towards the development of farm mechanization alone cannot solve the problems of the intensification of food production, it is necessary to promote and foster improved farm management, improved credit facilities and efficient marketing systems for the farmers which will no doubt plough a new furrow towards an overall agricultural improvement in rural areas.

- Establishment of product grouping will lead to the formulation of a systematic and integrated development programme of agricultural machinery based on the selection of appropriate technology to suit:

  (a) Local development programme of indigenous design incorporating drawings of assembly, sub-assembly and parts of selected agricultural machinery those are to be manufactured locally.

  (b) Local development programme for agricultural machinery based on partly indigenous and partly imported designs for local manufacture.

  (c) Local development programme for agricultural machinery based on adaptation of foreign design either on licensing or on collaboration agreement for local manufacture.

  (d) Programme for import of agricultural machinery those cannot be developed locally and required by the farmers.

Therefore, development of agricultural machinery and equipment demands a dynamic plan for the establishment of Research and Development Centres and integrated development programmes at National and Regional Levels. Moreover an Institutional co-operation among the developing countries will create a new dimension in the development of agricultural machinery for the developing world.

(I) Integrated Programme at National Level

As discussed in Section III, technological development is not uniform in all developing countries, as all regions do not grow the same crop and differ widely in terms of social and hydrological conditions, Moreover, the pattern of industrial development is not uniform among the developing countries. It has already been focused in Section IV, the development of agricultural machinery requires supporting and ancillary engineering manufacturing facilities. Therefore, integrated programmes for the development of agricultural machinery at National Level calls for:

(a) development programmes for the agricultural machinery to be used for agricultural operations.

(b) development programmes for the industries which will be responsible for the manufacture of agricultural machinery particularly in rural areas.

These two development programmes need to be matched and synchronised at National Level. Therefore, programming at National Level should broadly be based on:

- Creation of a programming group under Agricultural Machinery Industries Development Corporation;
- State the objectives i.e. the type of agricultural machinery required, sophistication of such machinery, quantity requirement over a given period of time through:
  a) imported design and indigenous manufacturing programme,
  b) partial imported design and partial indigenous manufacturing programme with import content parts.
- Programme elaborately to achieve the above objectives;
- Sequence the activities of the programme as listed above;
- Allocate such resources as factory site, materials, equipment and manpower to each of the activities on a first pass basis, that is, subject to later revision;
- Estimate the time and cost required to accomplish each activity of the programme and to achieve the objectives;
- Revise the programme until an acceptable total programme is evolved;
- Advise the Research and Development Centres regarding the total integrated programmes for the design and prototype manufacture;
- Allow the institutional and technological framework with the co-operation of the rural industries as suggested in Section VIII to implement, monitor and control the programmes.

Integrated Programmes at National Level in Developing Countries

The integrated programmes for the development of agricultural machinery at National Level can be divided according to the level of industrialisation achieved in various regions of developing countries.

- In the Least Developed Countries
- In Intermediate Developed Countries
- In Relatively Advanced Developed Countries

Least Developed Countries

In the least developed countries the development programmes at National Level for the agricultural machinery should be based on:

- development and manufacture of hand tools, hand operated machines, animal drawn equipment, harvesting tools, storage bins etc. as described in product grouping in Section IV, Technology Level I and II;
- establishment of institutional and technological framework as described in Section VI, VII, VIII;
- national repair and maintenance activities and comprehensive training programme.

Intermediate Developed Countries

In the intermediate developed countries the development programmes at National Level should be based on:

- improvement of existing hand tools and hand operated machines and animal drawn implements as described in product grouping in Section IV, Technology Level I;
- development of pumps, threshers, crop protection equipment and selected tractor drawn equipment and implements as described in Section IV, Technology Level II.
- re-inforcing existing facilities in development and manufacturing sector by adaptation, prototype manufacture, testing, repair and maintenance of existing machinery.
- establishment of institutional infrastructure as outlined in Section VI, VII and VIII.

Relatively Advanced Developed Countries

In relatively advanced developed countries the development programme at National Level should be based on:

- development of hand tools, pumps, engines, implements, crop protection equipment, trailors, storage, silos, power operated threshers, cleaners etc. as described in the product grouping in Section IV, Technology Level, I, II and III.

- licensing or foreign collaboration for the development of local manufacture of tractors, power tillers, engines, combine harvesters, dryers, crop handling equipment, special implements, etc. as described in product grouping in Section IV, Technology Level III and IV;
- design and development of low cost small tractors and power tillers;
- establishment of ancillary industries for the manufacture of discs, wheel and rim, tyres, transmission gear, etc. as described in Section VII;
- institutional and technological assistance in design, development and prototype fabrication, repair and maintenance, as described in Section V, VI and VII;
- establishment of Research and Development Centres for agricultural machinery and equipment as described in Section VIII.

(II) Integrated Programme at Regional Level in Developing Countries

In recent years consideration has been given in certain regions, especially in Africa, Latin America, Middle East and South - South East Asia to form regional and sub-regional Centres for development of agricultural machinery and equipment. At regional and sub-regional level, the integrated programme for development of agricultural machinery and equipment can best be carried out.

- regional development and design centres where particular development of agricultural machinery can be carried out for the benefit of group of countries in that region;
- regional pilot plant for development of agricultural machinery;
- regional co-operation of exchange of information for the development of agricultural machinery.

(III) Integrated Development Programme and Co-operation Among Developing Countries

The close co-operation among the developing countries for the development of agricultural machinery and equipment can best be established through:

- transfer of design of agricultural machinery from one country to the other where environmental and working conditions are alike and the equipment are well suited for local farming conditions;

- joint development programme for the manufacture of agricultural machinery and equipment between developing countries;
- information exchange in the field of research and development;
- licensing and financial participation among the developing countries for the manufacture of agricultural machinery and equipment on a joint venture basis;
- import and export of ancillary parts, e.g. discs, gears, engines etc. among the developing countries particularly in the soft currency areas;
- extension of institutional and research and development linkage among the developing countries.

The integrated programmes for the development of agricultural machinery and equipment will not only assist a plan development of machinery in the developing world, it will create a greater area of rural industrialisation and off-farm activities which will create a substantial capital formation in rural areas for greater prosperity in the rural life.

A N N E X

ANNEX - I

Profile of Agricultural Hand Tools Manufacture at Artisan Level in Developing Countries.

ANNEX - II

Profile of the Manufacture of Implements for Agricultural Crop Production in Rural Small Scale Level in Developing Countries.

ANNEX - III

Profile for the Manufacture of Medium Size 4-Wheel Tractor at Rural Medium/Large Scale Engineering Level in Developing Countries.

ANNEX - IV

Estimated Demand for Agricultural Machinery in Developing Countries.

ANNEX - V

International Trade in Agricultural Machinery.

SUMMARY OF PROFILE I

AGRICULTURAL HAND TOOLS MANUFACTURE AT ARTISAN LEVEL

Product Description

Hand Tools - selected products e.g. spade, hoe, fork, sickle

Overall Evaluation

These simple tools for agricultural operation are mostly used by the small farmers in the developing countries. In urban areas these are used for gardening work it is rather difficult for the plant of this size to export, prospect depends on potential demand within local or regional area, local market requirement possibilities should be carefully surveyed.

Market Aspect

1. Users: Small farmers holding less than 2 hectare or for garden work.
2. Method of sales: Can be sold directly to the farmers or through wholesale distributor.
3. Market potential: Home - for local markets within the country
   Export - very limited.
4. Requirement of Feasibility study: may not be necessary.
5. Expert Assistance: May be required if modern machinery is used.
   Expert advice on heat treatment can improve on product quality.
6. Joint venture: Not recommended.
7. Linkage with other industry: Woodworking industries or local carpenters.

PROFILE OF AGRICULTURAL HAND TOOLS MANUFACTURE AT ARTISAN LEVEL

1. Product

Manufacture of spade, hoe, fork, sickle

2. Product specification (selected four product mix)

Product	Specification
Spade	Blade and shank sinze- overall length 20", blade size - 8" x 6" weight - 1.5kg.
Hoe (tined)	Maximum length of tine - 10", width - 6", tine diameter - $\frac{1}{2}$" weight 1kg.
Fork	Weeding fork - 3 prongs, length 14", width 7" dia of prong 5/8", tang bore - $1\frac{1}{4}$" dia min.- $2\frac{1}{2}$" max. weight 2kg.
Sickle	Length - 9", max width 1", handle - 5", weight - $\frac{1}{2}$ kg.

3. Material Specification

Material specification for hand tools will be as follows:

SAE - 1078, Carbon - 0.72 to 0.85
Maganese - 0.30 to 0.60

The material is suitable for forge and heat treatment.

4. Production Volume

	Manually operated machine tools No. Electric power available		Electric power operated machine tools- supply 30kw, 50/c/s single phase 220/240 AC	
	Prod./day/shift	*Annual Prod.	Prod./day/shift	*Annual Prod.
Spade	4	1,000	12	3,000
Hoe	4	1,000	12	3,000
Fork	4	1,000	12	3,000
Sickle	4	1,000	12	3,000
	16	4,000units	48	12,000units

* Annual production based on 250 working days - 8 hours shift.

5. Manpower Requirement - Direct labour:

Item	Category	Shop without electrical power	Shop with electrical power
1.	Skilled	3 (including owner)	5 (including owner)
2.	Semi-skilled	-	2
3.	Unskilled	1	1
- Indirect Labour:			
1.	Skilled	-	1(Accounts clerk)
2.	Semi-skilled	-	-
3.	Unskilled	-	-
Total	Manpower	4	9

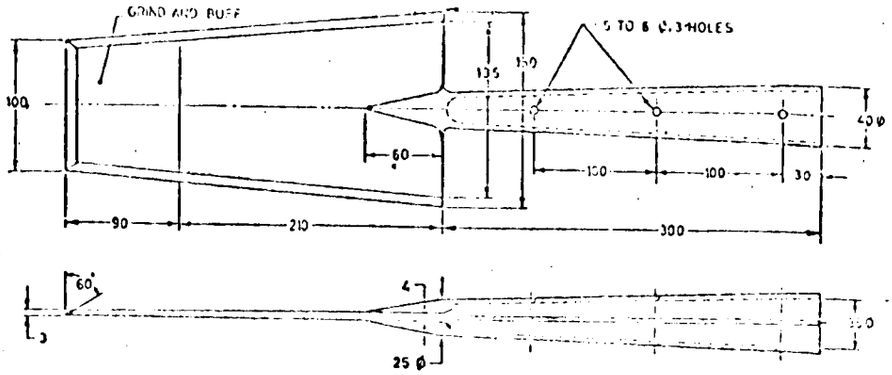
6. Floor Area

Shop without electrical supply	Shop with electrical supply
20ft x 15 ft = 300 sq. ft.	40ft. x 30ft. = 1,200 sq. ft.

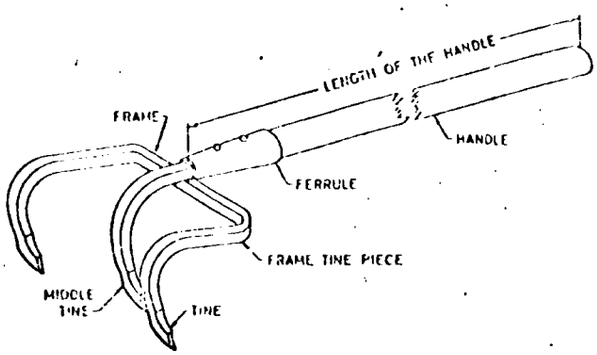
Ref. Fig. (2&3) for layout plan

7. Machinery and Equipment - Estimated cost Refer Fig (2&3) for layout plan

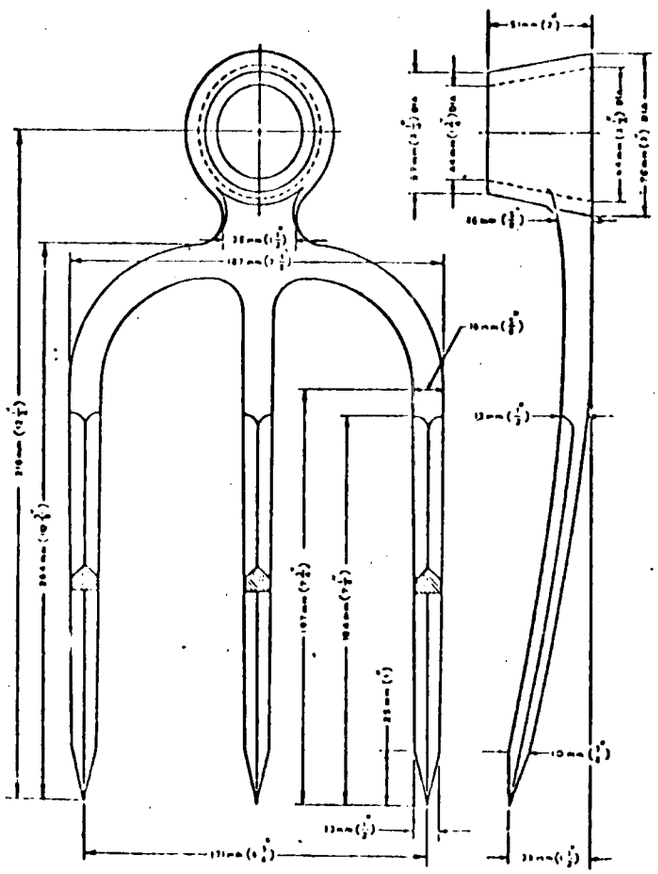
Power Supply	Hand operated Machine Tools (electricity not available)			Electrically operated machine tools		
	NIL			30kw, 50c/s single phase 220/240v AC		
Item	Description	No Off.	Price US $ estimated	Description	No Off.	Price US $ estimated
1	Hand shear 12"	1	200	Power shear $\frac{1}{4}$"	1	500
2	Coal fired furnace with hand bellow type blower 24" x 24" x 18"	1	2200	Oil fired or coal fired furnace $\frac{1}{2}$hp. 24x24x18"	1	5000



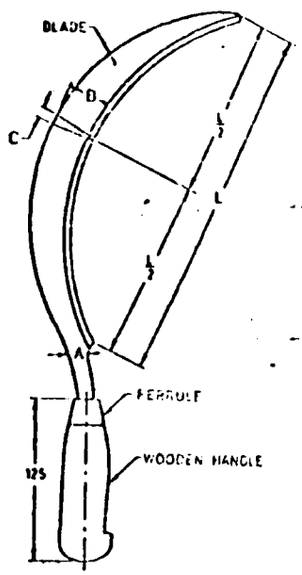
Flat Spade



Fork



Three Tined Hand Hoe



Sickle

FIG - 1

Layout of village Blacksmith Shop for production of agricultural hand tools. (without electricity supply)

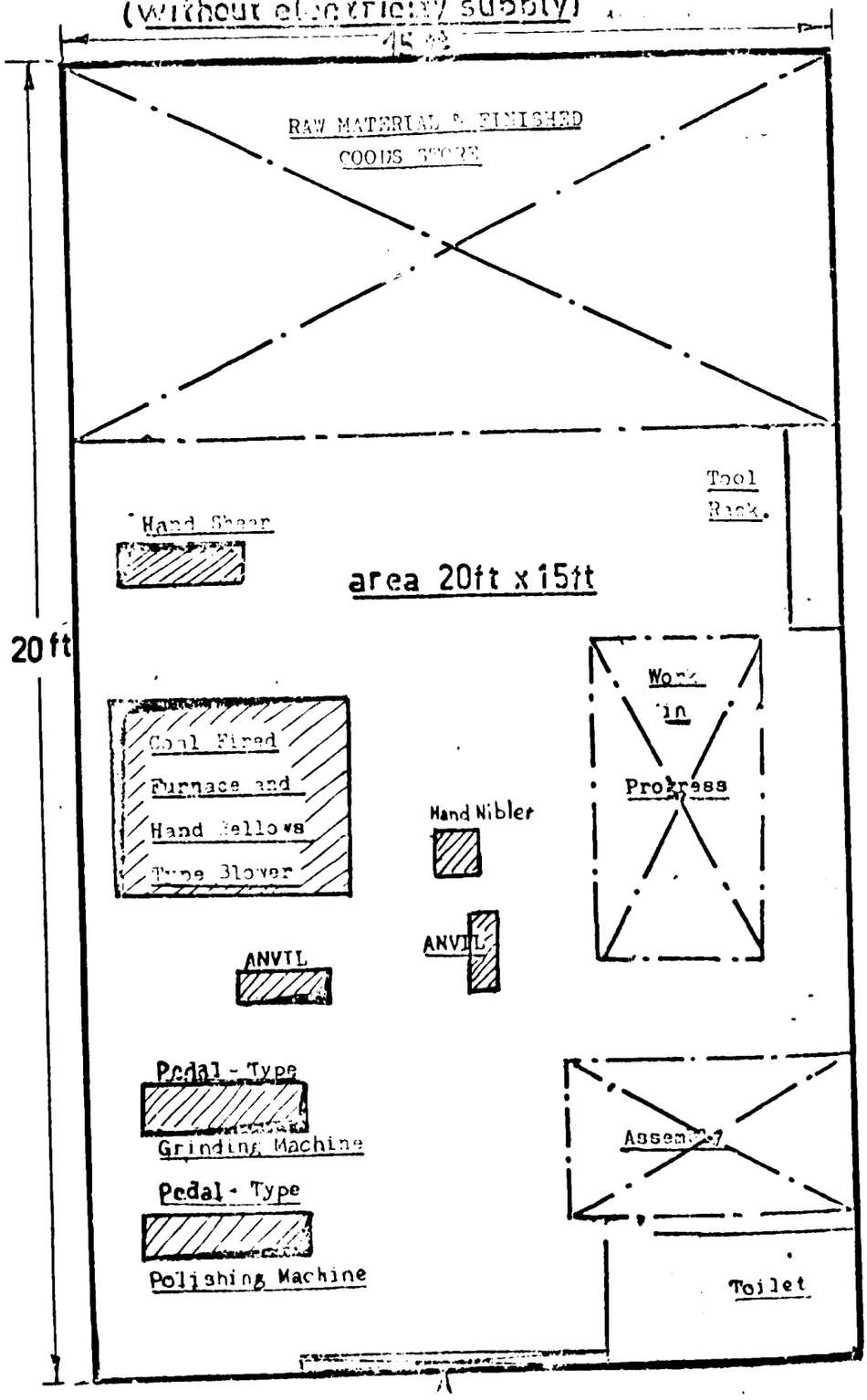


FIG-2

SECTION IV

TECHNO-ECONOMIC MANUFACTURING PROFILES ON SELECTED PRODUCTS

The previous section mainly explored the input requirements in agricultural operations for crop production and selection of mechanization parameters at various technology levels related to various farm sizes in developing countries.

This section will be devoted to formulate techno-economic manufacturing profiles on selected product groups, based on product identification, production volume, production and manufacturing techniques at various industry levels, and selection criteria for machine tools, equipment, supporting facilities for the manufacture of agricultural machinery and equipment in developing countries.

Product Groups and Justification for Rationale

As described in section III, during the selection of mechanization parameters, the machinery and equipment required for various agricultural operations differs widely at distinct technology levels. Therefore, the following is a summary of the agricultural machinery and equipment in the form of product groups at various technology levels for crop production.

Layout of Blacksmith Shop for production of agricultural hand tools at artisan level

(electric supply available)

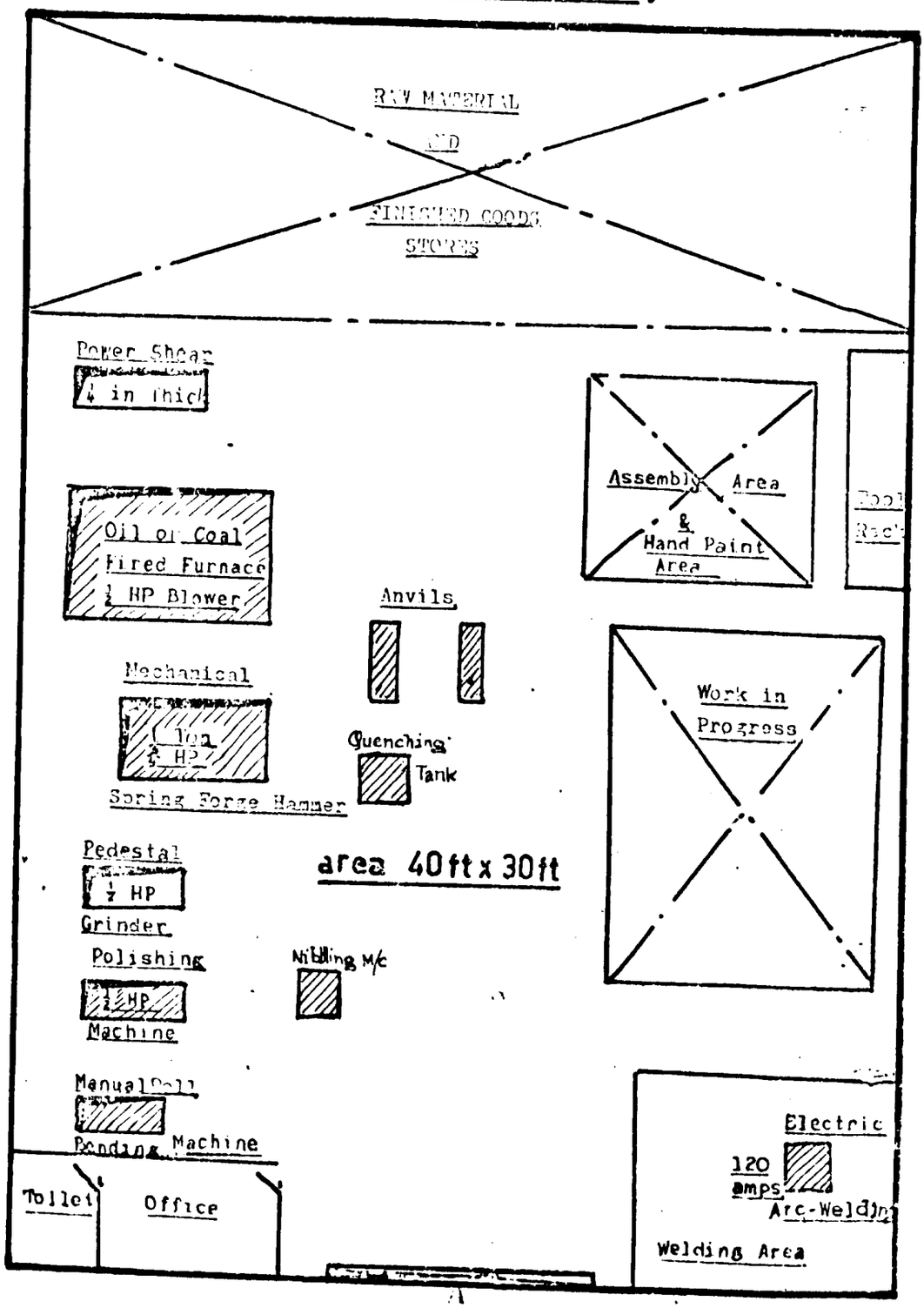


FIG-3

Item	Description	No Off.	Price US $ estimated	Description	No Off.	Price US $ estimated
3	Anvil with pedestal 200kg	2	200	Mechanical spring forge hammer 1ton 3/4 hp	1	4000
4	Quenching tank 24"x24"x24"	1	300	Quenching tank 36"x36"x36"	1	500
5	Pedal type grinding machine 12" wheel	1	100	Anvils with pedestal 200kg	2	200
6	Pedal type polishing machine	1	100	Double ended pedestal grinder $\frac{1}{2}$hp 12" wheel	1	400
7	Hand nibbler - $\frac{1}{4}$"	1	200	Double ended polishing machine $\frac{1}{2}$hp	1	400
8	Blacksmith's tools and conventional tools	set	600	Manual roll bending machine	1	200
9	Miscellenous	-	300	Electric arc welding machine 120 amps	1	200
10	-	-	-	Blacksmith's tools, $\frac{1}{2}$" portable drill, paint can and brushes	set	600
11	-	-	-	Miscellenous	-	500
Total cost US $			4000	Total cost US $		12,500

8. Investment Requirement

	Basic Investment	Shop with no elect. supp.	shop with elect. supp.
(A)	Fixed Capital	US $	US $
(a)	Land	-	-
(b)	Building cost		
	US$5.00/sq. ft. - 300sq.ft.	1,500	-
	US$5.00/sq. ft. - 1200 "	-	6,000
(c)	Furniture, fittings, racks etc.	300	600
(d)	Machinery and equipment	4,000	12,500

	Basic Investment	Shop with no elect. supp.	Shop with elect. supp.
(A)	Fixed Capital	US $	US $
(e)	Electrical installation	-	1,000
(f)	Erection	50	300
(G)	Transport (cart or trolley)	100	500
(h)	Contingencies	150	300
	Fixed capital total US $	6,100	21,200
(B)	Working Capital		
(a)	Direct material (3 months)	815	2,370
(b)	Labour (3 months)	950	2,875
(c)	Indirect costs	300	600
(d)	Training costs	-	500
(e)	Contingencies	35	155
	Working capital total US $	2,100	6,500
(C)	Total Investment required (excluding cost of Land) C= (A + B) US $	8,200	27,700

9. Annual Manufacturing Cost

9.A Direct Material Cost

MOW - Manufactured own shop

BOF - Bought out finished

IMP - Imported Steel price → US$ 300/metric ton

Item	MOW	BOF	IMP	Weight of blade Sizekg	Unit Raw Material Cost 30¢/kg	Shop without Electric Supply			Shop with electrical supply		
						Prod/ Year	Tot. Mat.	Cost US $	Prod/ Year	Tot. Mat.	Cost US $
Spade	X	-	-	1.5	300	1,000	1,500	450	3,000	4,500	1,350
Hoe	X	-	-	1.0	300	1,000	1,000	330	3,000	3,000	900
Fork	X	-	-	2.0	300	1,000	2,000	600	3,000	6,000	1,800
Sickle	X	-	-	0.5	300	1,000	500	150	3,000	1,500	450
Sub-total						4,000	5,000	1,530	12,000	15,000	4,500

Item	EOW	BOP	IMP	Weight of blade Sizes	Unit Raw Material Cost 30c/kg	Shop without Electric Supply			Shop with electrical supply		
						Prod/Year	Tot. Mat.	Cost US $	Prod/Year	Tot. Mat.	Cost US $
Wooden handle	-	X	-	-	40C	3,000	-	1200	9,000	-	3,600
Handle (sickle)	-	X	-	-	10C	1,000	-	100	3,000	-	300
Nails + furrels	-	X	-	-	-	-	-	200	-	-	400
15% Scrap for steel								230			675
Total direct material cost US$								3,260			9,475

9B Indirect Material Cost

Indirect items	4000 Units/year Cost US$	12000 Units/year Cost US$
Lubricants, coolants, etc	30	50
Maintenance and spare parts	200	1,000
Paints, office supplies	200	500
Total indirect costs	430	1,550

9C Power, Fuel and Water Cost

Item	Shop without electricity supply Cost US$/Year	Shop with electricity supply Cost US$/Year
Power 30kw, at 60,000kwh	-	2,500
Fuel + coal/oil	550	1,000
Water	50	100
Total	600	3,600

9D Transport cost

External transport	200 US$/year	500US$/year

9E Labour Cost

Category	Shop without electric supply			Shop with electric supply		
	No Off	Rate/year US$	Total wage per year US $	No Off	Rate/year US$	Total wage /year US $
Direct Labour Skilled	3	1000	3000	5	1500	7500
Semi-skilled	-	-	-	2	1000	2000
Un-skilled	1	800	800	1	800	800
Sub-total	4		3800	8		10300
Indirect labour -	-	-	-	1	1200	1200
-	-	-	-	-	-	-
Sub-total	4		3800	9		11500

9F Summary - Annual Manufacturing Cost

	Costs	Shop without elect.	Shop with electricity
		Costs US $	Costs US $
9-A	Direct material	3,260	9,475
9-B	Indirect material	430	1,550
9-C	Power, fuel, water	600	3,600
9-D	Transport	200	500
9-E	Labour Cost	3800	11,500
Total annual manufacturing cost		8,290	26,625

10. Annual Sales Turnover

Product	Unit Selling Price US$	Shop without electric.		Shop with electric.	
		Units/year	Sales/year US $	Units/year	Sales/year US $
Spade	2.50	1000	2500	3000	7500
Hoe	3.00	1000	3000	3000	9000
Fork	3.00	1000	3000	3000	9000
Sickle	1.50	1000	1500	3000	4500
		4000	10000	12000	30000

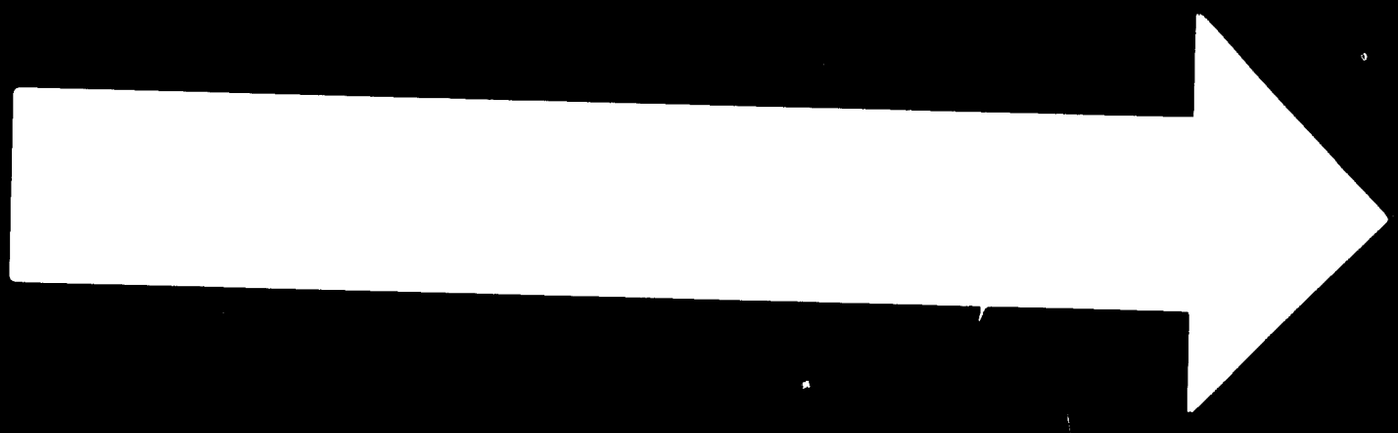
11. Total Annual Manufacturing Cost

	Shop without electric.	Shop with electric.
	Annual costs US $	Annual Costs US $
(a) Total manufacturing cost (refer 9-F)	8,290	26,625
(b) Total sales cost	200	1,000
(c) Depreciation of fixed capital 10%	400	1,250
Total annual cost US$	8,890	28,875

12. Profit

	Shop without elec. supply US $	Shop with Electric. supply US $
Annual sales turnover	10,000	30,000
Total Annual Costs	8,890	28,875
Profit (before tax)	1,110	1,125

G-13



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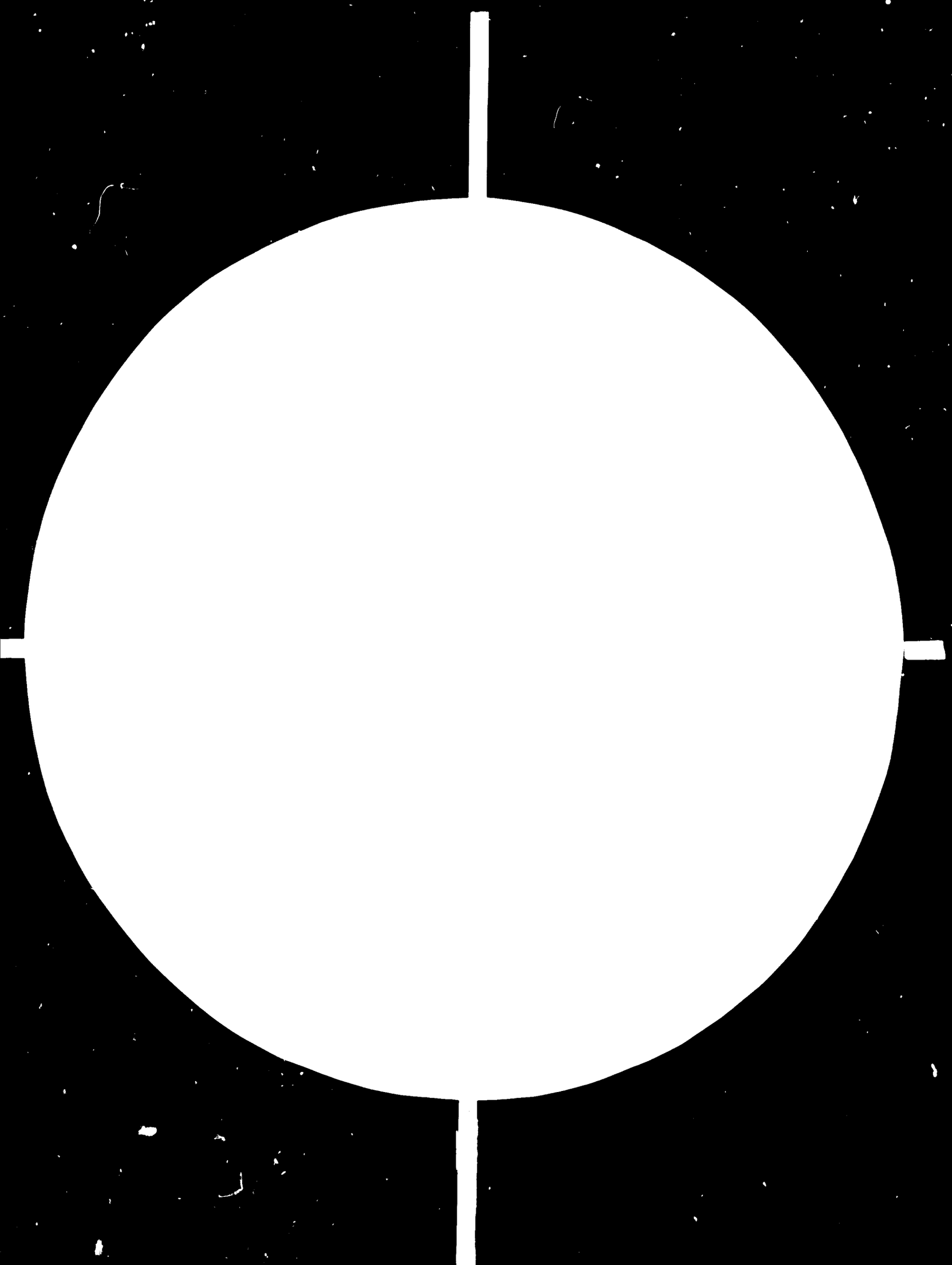

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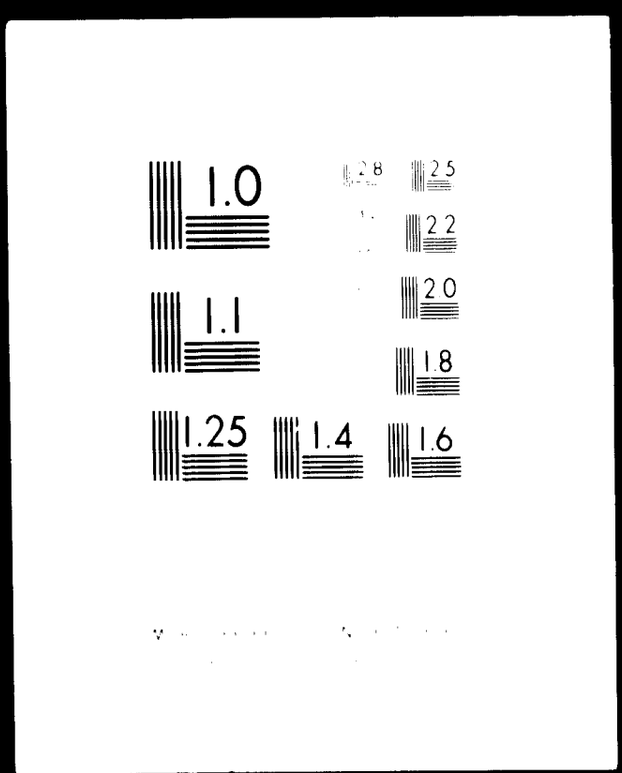

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C

Item	Area	Description	No	Estimated Cost US $
16	Tool Room + Maintenance	Universal milling machine Arbour size - 1"dia Table size 3ftx1ft	1	8,000
17		Universal cutter grinder up to 12" milling cutter	1	9,000
18		Surface table	1	800
19		Gauges + tools	set	1,500
20		Maintenance equipment	set	1,500
21	Inspection	Inspection tools, table etc.	set	2,000
22	Welding + Fabrication Shop	Electric arc welding 250 amps	2	1,000
23		Press brake - 10ft long 5 ton	1	6,000
24		Eccentric press, 35 ton gap 4"	1	8,000
25		Welding fixture and jigs	set	2,000
26		Manual roll bending machine up to 1" dia rod cold.	1	150
27	Sub assembly	Drilling machine upright - up to 1"dia in MS	1	2,500
28		Portable grinder 6" dia wheel	2	300
29		Portable drill gun $\frac{1}{2}$HP	2	600
30		Sub assembly fixtures	set	500
31	Paint room	Pneumatic spray, paint equipment etc.	set	300
32	Compressor	Motor compressor set complete 300cuft/min,line pressure 80 psi	set	10,000
33	Stores	Racks, stillage, pallets	set	8,000
34	Mechanical Handling Equipment	Forklift truck- 1 ton	1	8,000
35		$\frac{1}{2}$ ton hoists	6	6,000
36		Hydraulic pallet truck	2	800
		Total machinery + equipment cost		134,150

8. Investment Requirement - Basic investment

A	Fixed Capital	Cost US $
a	Land	-
b	Building cost: (i) administrative block 2000sqft at 5$/sqft.	10,000
	(ii) factory building - 40000sqft at $5/sqft.	200,000
c	Furniture + fittings including drawing office equipment and office equipment	20,000
d	Machinery and equipment	134,150
e	Electrical Installations	10,000
f	Erection	5,000
g	Transport car + van (1 ton)	8,000
h	Contingencies	1,050
A	Total	388,200
B	Working Capital	
a	Direct material (3 months)	97,500
b	Direct labour (3 months)	20,275
c	Indirect costs (3 months)	3,500
d	Training cost	5,000
e	Contingencies	1,225
B	Total	127,500
C	Total Investment Required excluding Land (C = A + B) US $	515,700

9. Annual Manufacturing Cost

MOW - Manufactured own shop

BOF - Bought out finshed

IMP - Import

Steel price estimated at US$ 500 per metric ton

9. A Direct Material cost

Description	Parts group	MOW	BOF	IMP	Units Cost US $	Total Unit cost	Annual Quant-ity	Total Material cost US$
1 Single wheel hand hoe	MS handles	X	-	-	2.00	-	-	-
	MS fork	X	-	-	1.00	-	-	-
	Hoe frame	X	-	-	1.50	-	-	-
	Shovel	X	-	-	2.50	-	-	-
	Toeing hook	X	-	-	0.50	-	-	-
	Y-bracket	X	-	-	0.50	-	-	-
	Axel shaft	X	-	-	2.00	-	-	-
	CI wheel	X	X	-	5.00	-	-	-
	Wooden grip	-	X	-	0.50	-	-	-
	Bolts, Nuts,	-	X	X	0.50	16	6,000	96,000
2 Animal drawn disc harrow	Beam frame	X	-	-	8.00	-	-	-
	Disc axelshaft	X	-	-	8.00	-	-	-
	Middle tin shovel	X	-	-	9.00	-	-	-
	Gang angle mechanism	X	-	-	10.00	-	-	-
	Seat arrang.	X	-	-	5.00	-	-	-
	Disc hub	X	X	-	5.00	-	-	-
	Hub bracket	X	X	-	5.00	-	-	-
	CI wheel + back rest				3.00	-	-	-
	Disc-3/16"x18" or $\frac{1}{4}$" x18"or inside bevel 7/32" x 18"	-	X	-	20.00	-	-	-
	Bearings	-	-	X	20.00	-	-	-
	Bolts/nuts/ washer	-	-	X	5.00	98	2,000	196,000

Description	Parts group	MOW	BOF	IMP	Units Cost US $	Total Unit Cost	Annual Quant-ity	Total Material Cost US$
3 Animal drawn mouldboard plough	MS handle	X	-	-	3.00	-	-	-
	Steel beam	X	-	-	3.00	-	-	-
	Steel mould-board + share	X	-	-	10.00	-	-	-
	Bracket	X	-	-	2.00	-	-	-
	Landside	X	-	-	1.00	-	-	-
	chain ring + shackle	X	X	-	1.00	-	-	-
	Ridging body	X	-	-	4.00	-	-	-
	CI Gauge wheel	X	X	-	5.00	-	-	-
	Bearing			X	4.00	-	-	-
	Bolts/nuts/ washers			X	2.00	35	2,000	70,000
	Total US $							362,000
	Scrap allowance US $							18,000
	Raw material cost (annual) US $							380,000

9.B Indirect Material cost

Indirect costs	Yearly Cost US $
1 Lubricants, coolant	400
2 Maintenance, spareparts	2,000
3 Paints	8,000
4 Office supplies, telephone etc.	3,000
5 Sundries	600
Total indirect costs	14,000

9.C Power, Fuel + Water cost

Item	Cost US$
Power - 80hp + light 3,000 kwh	5,000
Fuel Oil	2,000
Water	500
Total	7,500

9. D. Transport

Item	Cost US $
Operating cost of Car and 1 ton van	2,000

9. E. Labour Cost

	Category	No. Off.	Pay out/year US $	Total wage US $
Direct labour	Skilled	29	1,000	29,000
	Semi-skilled	14	800	11,200
	Unskilled	5	500	2,500
Indirect labour	Manager	1	5,000	5,000
	Accountant	1	4,000	4,000
	Sales exec.	1	4,000	4,000
	Development Eng./Designer	1	4,000	4,000
	Superintendant	1	3,000	3,000
	Jig + Tool Designer	1	3,000	3,000
	Foreman	3	2,000	6,000
	Secretary	1	1,000	1,000
	Charge hand	2	1,500	3,000
	Clerk	2	1,000	2,000
	Store + tools	3	800	2,400
	Security	1	1,000	1,000
Total annual labour cost US$				81,100

9. F. Summary Annual Manufacturing Cost

9. A Direct Material Cost	390,000
9. B Indirect Material cost	14,000
9. C Power, Fuel, Water	7,500
9. D Transport cost	2,000
9. E Labour cost	81,000
Total manufacturing cost US$	494,500

10 Annual Sales Turnover

	Product	Unit Selling Price Exworks	Annual Product.	Total Sales (exfactory) US $
1.	Single hand wheel hoe	US$ 30	6000	180,000
2.	Animal drawn disc harrow	US$150	2000	300,000
3.	Animal drawn mouldboard plough	US$ 80	2000	160,000
			Gross Annual Sales	640,000

11. Total Annual Cost (excluding profit)

		US $
1.	Total Manufacturing cost refer 9F	494,500
2.	Total sales cost	20,000
3.	Depreciation of fixed capital 10% per Annum	39,000
	Total annual cost US $	553,500

12. Profit

Annual sales turnover	US$ 640,000
Total Annual Cost	US$ 553,500
Profit (before tax)	US$ 86,500

SUMMARY OF PROFILE III

AGRICULTURAL POWER MACHINERY MANUFACTURE AT RURAL MEDIUM/LARGE SCALE INDUSTRY LEVEL IN DEVELOPING COUNTRIES

Product Description

Medium size 4-wheel tractor powered by direct injection diesel engine capable of producing 40HP at 2500rpm.

Overall Evaluation

This product is used by farmers having 5 hectares of land or more, for all purpose agricultural operations in developing countries. It is possible for plants of this size to export their products.
The successful operation of a plant of this size requires:

(a) Support of ancilliary industries e.g. foundry, forging, sheet metal fabrication industry and many others

(b) Comprehensive training of management and workers (skilled) at various levels

(c) Systematic marketing and distribution network

The viability prospects of this size product depends on potential demand within the country or neighbouring countries and country wide marketing possibilities should be carefully examined and surveyed.

Market Aspect

1. Users:- Farmers, for agricultural operation
   Industries for transport with trailers
   Forestry, and many others

2. Method of sales:- The sales and marketing should be carried out through authorised distributors of dealers with sales and after sales facilities such as, stocking of spare parts, servicing facilities, training facilities etc.

3. Market potential:- Home: in local and national markets within the country.
Export: good possibilities within the neighbouring developing countries.

4. Requirement for feasibility studies:- Thorough pre-feasibility studies are necessary before investment decisions are made.

5. Expert Assistance:- Required in the following areas:-
- Preparation of marketing and feasibility study
- Product design and development
- Training of technical manpower

— Training on heat treatment and metallurgy.

— In actual operation and installation of machinery and process sheet preparation.

— Marketing.

6. Joint Venture: Highly recommended.

7. Linkage with other industries: In order to procure semi-finished and bought out finished parts and components the following supporting industries are needed.

(a) Foundry - Grey cast iron, malleable cast iron, spheroidal cast iron.

(b) Forging and die casting.

(c) Tyres, wheels and rims manufacturing unit.

(d) Sheetmetal and presswork industries

(e) Gear cutting and transmission equipment manufacturing industries.

(f) Electrical and instrumental manufacturing industries.

(g) Steering wheel and automotive parts manufacturing industries.

(h) Brake shoe and clutch manufacturing industries.

(i) Spring and hardware manufacturing industries.

(j) Paint manufacturing industires.

(k) Rubber manufacturing industries.

PROFILE FOR THE MANUFACTURE OF MEDIUM SIZE 4 WHEEL TRACTOR AT RURAL MEDIUM/LARGE SCALE ENGINEERING LEVEL IN DEVELOPING COUNTRIES

1. Product:- Medium size tractor capable of producing 40hp at 2500rpm

2. Product specification:- (The specification is only indicative and does not conform to any manufacturer) Refer Figure - 1

Make - joint collaboration with a tractor company

No. of cylinder - 3

Engine - direct injection diesel engine

Maximum HP of engine- 40hp at 2500rpm

Compression ratio - 17.5:1

Road speed - 1 mph to 17.21mph.

Power take off - 6 spline shaft - $1\frac{3}{8}$ " dia.

Hydraulic system - with pressure control from 155 psi to 2400 psi

Working load (max) - 3000 lbs.

Dimension - overall width - 64"
overall length-110"
Overall height - 75"

Weight (without fuel and water) - 2800lbs

Fuel tank - 8 gallons, 36 liters.

3. Material Specification

There is wide application of various types of material in manufacture of tractors. The important materials used are (weightwise)

Castings- Malleable or grade 17 castings with mehanite specification

Steel - EN1(a), EN 8, EN16, EN24T, EN32(c), EX-42-46 round and various sections

Steel - castings according to BS specification

Steel sheet matal - 18 - 20 SWG

Most of these types of steel require hardening, case hardening and tempering.

Hardness - varies from 50 to 64 rockell 'c'

4. Production Volume

	Product Description	*Production/day	Production/year
1	Tractor 40 hp	14	3,500

* based on 250 working days 1 shift shown

5. Manpower requirement - Organization and Manpower Requirement

A Indirect Manpower - Management (Head Office)

	Board of Directors	No.Off	Total
1	Managing Director + Staff	1 + 3	4
2	Sales and marketing manager + staff	1 + 15	16
3	Chief Accountant + staff	1 + 9	10
4	Internal auditor	1	1
5	Manufacturing manager (to be inc. in factory indirect)	(1)	(1)
6	Chief product development engineer + Designer + Asst. Engineer + staff	1+2+3	6
7	Chief product training officer + staff	1 + 3	4
	Total Head Office Staff		41

	Management (Factory)	No. Off	Total
1.	Manufacturing Manager + Staff	1 + 3	4
2.	Chief Personnel Officer + staff	1 + 4	5
3.	Factory Accountant + staff	1 + 6	7
4.	Chief purchase Officer + Buyers + Clerks	1 +6+ 2	9
5.	Security Officer + Guards	1 + 5	6
6.	Chief Metallurgist + staff	1 + 2	3
7.	Chief Quality Controller + inspectors + clerk	1+12+1	14
8.	Chief Industrial Engineer + Method engineer + time study engineer + jig + tool designer + estimators + clerks	1+4+6+ 6+2+2	21
9.	Chief Planning Engineer + Asst. engineers/ process planners + estimators + clerk	1 +8+ 1	10
10.	Chief Production Controller + production supervisors + chasers + clerk + recorders	1+6+10 +2+6	25
11.	Chief Maintenance engineer + asst. engineer Mechanical + elec., skilled + semiskilled + unskilled labour + clerk	1+3+6 + 1	11
12	Chief training officer + staff	1 + 3	4

SUMMARY OF PROFILE II

AGRICULTURAL ANIMAL DRAWN IMPLEMENT MANUFACTURE AT RURAL SMALL SCALE INDUSTRY LEVEL

Product Description

Single hand wheel hoe, animal drawn disc harrow, animal drawn mould board plough.

Overall Evaluation

These products are mostly used by farmers in the developing and least developed countries. It is possible for the plants producing these size tools with technical know how to export their products. The viability of these industries in rural areas depends on the evaluation of demand by the farmers at local and national level - backed by a proper feasibility study and market survey study.

Market Aspects

1. Users: Medium farmers - up to 2 to 5 hectares of land.
2. Method of sales: Preferably to appoint selling agents both at village and national level. Attention will have to be given to spare parts supply. Agents or distributors can stock parts. Thereby the annual trunover can be increased.
3. Market potential: Home - in local and national markets within the country.
   Export - good possibility, can offer the products to exporting houses in the country.
4. Requirement of feasibility study: necessary before investment.
5. Expert Assistance: required in the following areas:
   1. Feasibility study
   2. Training
   3. Product design and product development
   4. Marketing
   5. Heat treatment and process.
6. Joint venture: recommended
7. Linkage with other industries:
   - Foundry, forge, stockist hardware industry.

	Superintendent Machine Shop No. I (see fig. 2 & 3) + clerk	1+2	3
a	Asst. Engineer + foreman + chargehand for section (A+B)	1+1+1	3
b	Asst. Engineer + foreman + chargehand for section (C+D)	1+1+1	3
c	Asst. Engineer + foreman + chargehand for section (E+F)	1+1+1	3
d	Asst. Engineer + foreman + chargehand for section (G+H)	1+1+1	3
e	Chargehand tool crib	1	1
	Superintendent Machine Shop Plant No. II (see fig. 4) + clerk	1+2	3
a	Asst. Engineer + foreman + chargehand section (J+K)	1+1+1	3
b	Asst. Engineer + foreman + chargehand section (L)	1+1+2	4
	Superintendent Assembly + Stores Plant III (see fig. 5) + clerk	1+3	4
a	Asst. Engineer + foreman + chargehand sub assembly + assembly	2+2+2	6
b	Chargehand Paint Booth	1	1
c	Asst. Engineer + foreman + chargehand + recorder of stores	1+3+7+4	15
d	Supervisor (packing + shipping) + clerk	1+1	2
	Cleaners, cook, canteen staff, welfare staff, drivers, mechanic	10	10
	Direct Manpower | Total Indirect Manpower →		223
1	Machine Shop I - operating 66 machines		
a	Skilled	66	66
b	Semi-skilled	40	40
c	Un-skilled	20	20
	Sub-total	126	126
2	Machine Shop II		
a	Skilled	40	40
b	Semi-skilled	40	40
c	Un-skilled	20	20
	Sub-total	100	100
3	Assembly Shop I		
a	Skilled	25	25
b	Semi-skilled	20	20
c	Un-skilled	20	20
	Sub-total	65	65
	Total Direct Labour →		291

Total direct labour	291
Total Indirect manpower	223
Total manpower	514

6. Floor Area (ref Fig -2 .)

Administrative area	4,000 sq.ft.	4,000 sq. ft.
Manufacturing area		
a Machine shop plant I	60,000 "	
b Machine shop plant II	40,000 "	
c Assembly shop plant III	40,000 "	140,000 "
d Substation	500 "	500 "
	Total -	145,000 "
For raw material castings and finished tractor stores additional open area		100,000 "
Total area		245,000 sq. ft.

7. Machinery and Equipment (Estimated cost) Ref. Fig. 3, 4, 5 for layout information

Item	Description of Machine	No.	Est. Total Price CIF in US $
A	Parting Off section A		
1	Automatic Hack Sawing- machine up to 6" dia in MS	1	1,000
2	Circular cutter saw upto 15" dia	2	2,000
3	Abrasive cutter 12" dia wheel	1	800
4	Belt abrasive grinder 8" width belt	1	300
5	Pedestal grinder (double ended) 12" dia wheel	2	800
6	Polishing machine (double ended)	2	200
B	Drilling + Milling Section (B)		
7	Upright drilling machine upto 2" in MS	2	10,000
8	Gang drilling machine with table size 60" x 15" 6 spindle head - 1" dia in MS	1	15,000

Item	Description of Machine	No.	Est Total Price CIF in US$
9	Automatic drill with tapping machine 1"dia in MS	1	10,000
10	Radial Arm Drill 36" head traverse 3" dia in MS	3	20,000
11	Turret Head Type drill with 5 turret position 1½" in MS	1	15,000
12	Universal milling machine with attachments 12" cutter dia table size 36"x18"	1	25,000
13	Knee type milling machine with attachments - 8" dia cutter - table size 30" x 12"	3	20,000
14	Keyway slot milling machine width of spline 5/8" surface table 40" x 10"	1	25,000
15	Spline shaft milling machine programming arrangements for odd an evenspline and both internal and external splines table size 24" x 6"	1	33,000
C	Turning Section		
16	Lathe - spindle dia 3", swing 24", centre gap - 30"	1	15,000
17	Lathe spindle dia 1", swing 15" centre gap - 18"	1	12,000
18	Capstan Lathe with attachments - spindle hole 2" dia, capstan slide 9"	3	30,000
19	Chucking capstan with all attachments max dia workpiece 12"- turret slide 9"	3	35,000
20	Double ended parting and centering machine spindle gap - 40"	1	8,000
D	Grinding, Boring, Broaching, Lapping + Honning Section		
21	Vertical surface grinding machine with rotary magnetic table max. grinding area - 6" grinding height 20" dia of wheel 30"	1	35,000
22	Surface grinding machine dia of wheel 24" Table size 30"x 24"		25,000
23	Centreless grinding machine wheel dia 24" max dia of work 2"	1	25,000
24	Cylindrical grinding machine- max workpiece 6" dia x 18" long	1	30,000
25	Internal cylindrical grinding machine - with face grinding attachment max bore - 13" max length - 12"	1	40,000
26	Spline shaft grinding machine - grinding length 30" grinding dia 6"	2	50,000
27	Speical purpose automatic fine boring machine (duplex) max bore dia 4" bore depth - 20"	2	120,000

Item	Description of Machine	No	Est. Total Price CIF US $
28	Horizontal boring machine - max bore 18" dia length 30"	1	60,000
29	Broaching machine - push type - max dia - 6" length 12"	1	30,000
30	Horizontal lapping machine table size 18 x 12" accuracy - 0.00004"	1	60,000
31	Vertical honningmachine max dia 6" hone depth 12"	1	35,000
E	Automatic Machines (turning)		
32	Single spindle bar automatic with automatic indexing - workpiece dia 2" length 4"	2	60,000
33	Single spindle bar automatic with automatic indexing workpiece dia 1" length 5"	8	320,000
34	Single spindle bar automatic with automatic indexing workpiece dia 1" length 6"	2	90,000
35	Single spindle bar automatic with automatic indexing workpiece $\frac{1}{2}$" length 8"	2	55,000
36	Single spindle chuck automatic with automatic indexing max. work dia 6"	-	40,000
37	Single spindle chuck automatic with automatic index max. work dia 3"	1	40,000
F	Automatic Profile - Turning Machines		
38	Automatic copying lathes with three cut recycling system max. dia 6" length 30"	2	70,000
39	Automatic copy milling machine max. table size 30" x 18"	1	60,000
G	Machines for Gearbox housing, Centre housing + lift cover housing		
40	Horizontal duplex milling machine- adjustable milling heads, with automatic quill retraction system for rough, semi-finish and finished cut surface worktable -100" x 20" longitudinal table travel - 80"	2	300,000
41	Portal frame milling machine with 3 adjustable millingheads with automatic quill retraction system and adjustable heads Table size 100" x 80" Longitudinal travel - 80	1	200,000
42	Multispindle drilling machine with bolster plate - 24 spindle tablesize 100" x 80" 1" dia in MS for each spindle	1	50,000
43	Automatic multispindle tapping machine 12 spindles up to $1\frac{1}{4}$" tap size		50,000

Item	Description of Machine	No	Estimated Total Price CIF US$
44	Horizontal deephole drilling machine up to $1\frac{1}{2}$" dia in MS length of hole 20"	1	35,000
45	Tunnel type washing machine for centre housing, gear box axel housing	1	20,000
H	Machines for Rear Axel Housing (LH + RH)		
46	Duplex multispindle drilling, facing machine with rotary indexing table - 24 spindles in each head. Table dia 75"	1	120,000
47	Duplex boring and facing machine Table size 72" x 36"	1	100,000
48	Jigs, tools, fixtures for heavy castings	set	150,000
49	Jigs, tools, fixtures for light parts	set	80,000
I	Heat Treatment, Galvanising, Electroplating		
50	25kw Induction hardening machine	1	30,000
51	150kw induction hardening machine	1	45,000
52	Heat treatment furnace oilfired with automatic control, thermostat	1	60,000
53	Cynide bath	1	1,000
54	Degreasing plant	1	
55	Quenching tanks	2	1,000
56	Galvanising plant/Electroplant	option	can be obtained from sub-contracting
57	Phosphating plant	1	10,000
J	Welding + Fabrication Section		
58	But welding machine 500 amps	1	5,000
59	Spot welding machine 800 amps	1	5,000
60	Arc welding machine 500 amps	2	4,000
61	Roll bending machine	1	1,000
62	2.5 ton press	1	10,000
63	10 ton press	1	20,000
64	Welding fixtures	set	5,000
K	Tool room		
65	High precision jig boring machine. Working table 40"x30" drilling 1 5/8" boring $3\frac{1}{4}$" in steel accuracy 0.00005" accuracy of setting 0.00002"	1	120,000
66	Universal cutter grinder cutter dia 9" work table 12"x12"	2	50,000

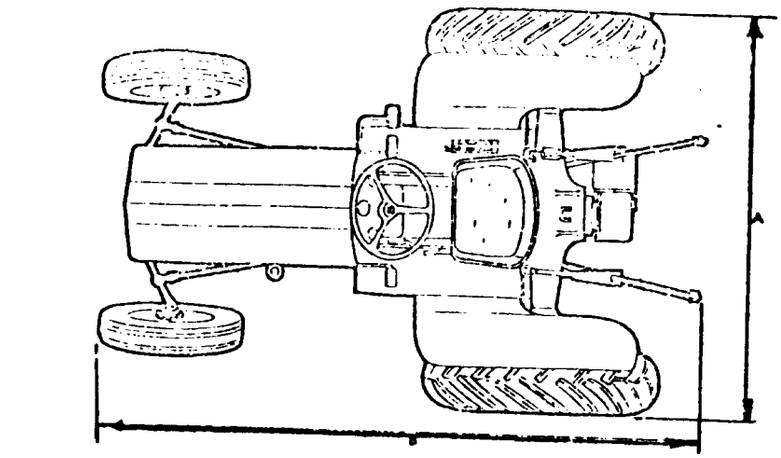
Item	Description of Machine	No.	Estimated Price CIF in US $
67	Precision internal grinder - bore up to 4" dia max chucking dia 13"	1	40,000
68	Twist drill grinder both LH + RH inc. steel and carbide tip up to $2\frac{1}{2}$" dia	2	5,000
69	1 Ton ram type hydraulic press	1	5,000
70	Tap grinding machine upto 1" tap	1	15,000
71	Universal broach sharpeneing machine (internal + surface broach) up to lenght 80"	1	35,000
72	Precision bench lathe up to 2" dia workpiece centregap - 15"	1	15,000
73	Universal milling machine with all indexing attachemnts and accessories max cutter dia 8" table size 36" x 24"	1	35,000
74	Circular band saw (steel band) width of steel blade band 3/4" work table 24" x 24"	1	5,000
75	Surface table 36"x36" 1ton weight	1	2,000
76	Slip gauge set	2	4,000
77	Wide range of measuring tools	set	5,000
78	5 ton air conditioner	1	4,000
79	Universal vice etc.	3	1,000
80	Special tools and cutters	set	5,000
81	Precision surface grinding machine dia of wheel 8" work table 18" x 12"	1	20,000
82	Precision cylindrical grinding machine max workpieces - 2"dia 24" long	1	45,000
L	Fitters Bench and Maintenancy Section		
83	Maintenance equipment	set	8,000
84	Welding set portable 250 amps	1	2,000
85	Oxyaceteline weldingset	3	2,000
86	Soldering + brasing equipment	6	500
87	Fitters benches with vice	6	1,000
88	Tools, equipment including carpentry.	set	4,000
89	Furnace oilfired	1	3,000
90	Electrical and water (pumping) maintenance equipment	set	1,500
M	Metallurgical Laboratory		
91	Spectrophotometer wave-length 8.80" to 36", tungsten + deuterous lamp absorption cell - fused quartz sensitivity better than $\pm$0.0002 at 0.004 absorbance	1	6,000
92	Microscope for metallographical exam. magnification 20-1000x	1	5,000

Item	Description of Machine	No.	Estimated Price CIF in US $
93	Brinell hardness testing machine with fine measuring microscope 25x possible load 500 - 750 -3000kg tolerance 1%	1	15,000
94	Vickers hardness tester for loads 0.10 - 10 kg, fine measuring microscope with magnification 200x	1	3,000
95	Various metallurgical equipment	set	4,000
96	Magnetic particle testing apparatus	2	8,000
N	Central Inspection Section		
97	Gear involute + lead testing tooth pitch module 1-17 diameter of base circle 1" to 2.35"	1	15,000
98	Double flank rolling tester dia of gear - 12" distance between axes 2.8" -16" precision 0.0004" enlargement - 200x300x400	1	6,000
99	Dynamic angle flank testing machine - modules 1-6	1	10,000
100	Electical tester for dynamo + starter		5,000
101	Universal measuring machine 16"x4"x6"		
102	Telesurf - (CIA - 0.000004" to 0.002") Horizontal enlargement 100.1 vertical enlargement 1,00,000:1	1	4,000
103	Appartus for sorting and mixed up parts	1	1,000
104	Inspection guages and equipment	set	5,000
105	Inspection tables 24"x24" - 800kg	8	5,000
106	Complete set of dial indicators etc	24 sets	3,000
107	Height guage, vernier caliper, depth gauges etc.	24 sets	3,000
O	Sub Assembly and Assembly fixtures		
108	For all parts where necessary	set	5,000
109	Assembly trolley	8	4,000
P	Paint Booth		
110	Compressory + spray paint equipment	2 sets	10,000
111	Water screen + heating system for drying	1 "	5,000
112	Electrostatic paint equipment	1"	10,000
Q	Compressor Set		
113	Complete air compressor set with water cooling etc. and pipelines, valves etc. line pressure 80psi, delivery 600 cu. Ft/ min.		30,000

Item	Description of Machine	NO.	Estimated Price CIF in US $
R	Mechanical Handling Equipment		
114	2 ton overhead crane for heavy casting area with gantry and installation	1	30,000
115	Fork lift truck - 2 ton	2	45,000
116	Stacker truck - 1ton	2	25,000
117	Pallet trucks - $\frac{1}{2}$ ton	6	10,000
118	Stillage pallets bins, racks	set	10,000
119	Hand pallet trucks	6	20,000
120	Self supporting hoists for machine - $\frac{1}{2}$ ton capacity	30	55,000
S	Stores equipment		
121	Bins, racks, cupboards, etc.	set	40,000
122	Kardex cabinets and system	set	5,000
123	Hydraulic testing equipment	set	5,000
124	Production tools	set	60,000
125	Spare parts (total) based on all machinery	set	250,000
	Total machinery + equipment		3,981.000

CIF Landed

4-wheel TRACTOR
powered by
Direct Injection Diesel Engine



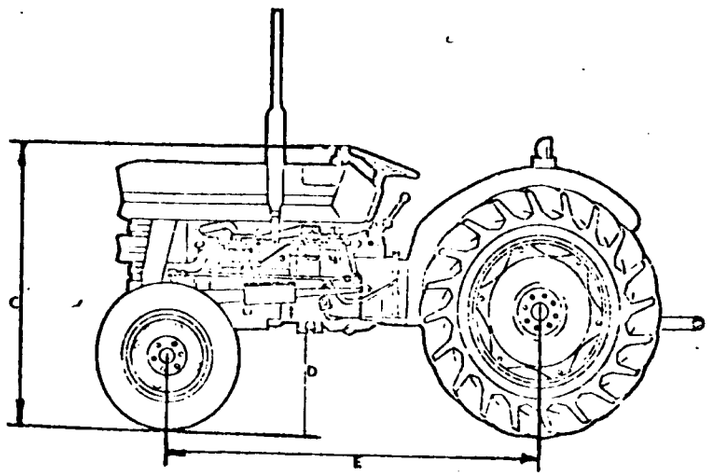


FIG - 1

FACTORY LAYOUT FOR MEDIUM SIZE TRACTOR PRODUCTION – 3500 tractors/year/1-shift 8 hours

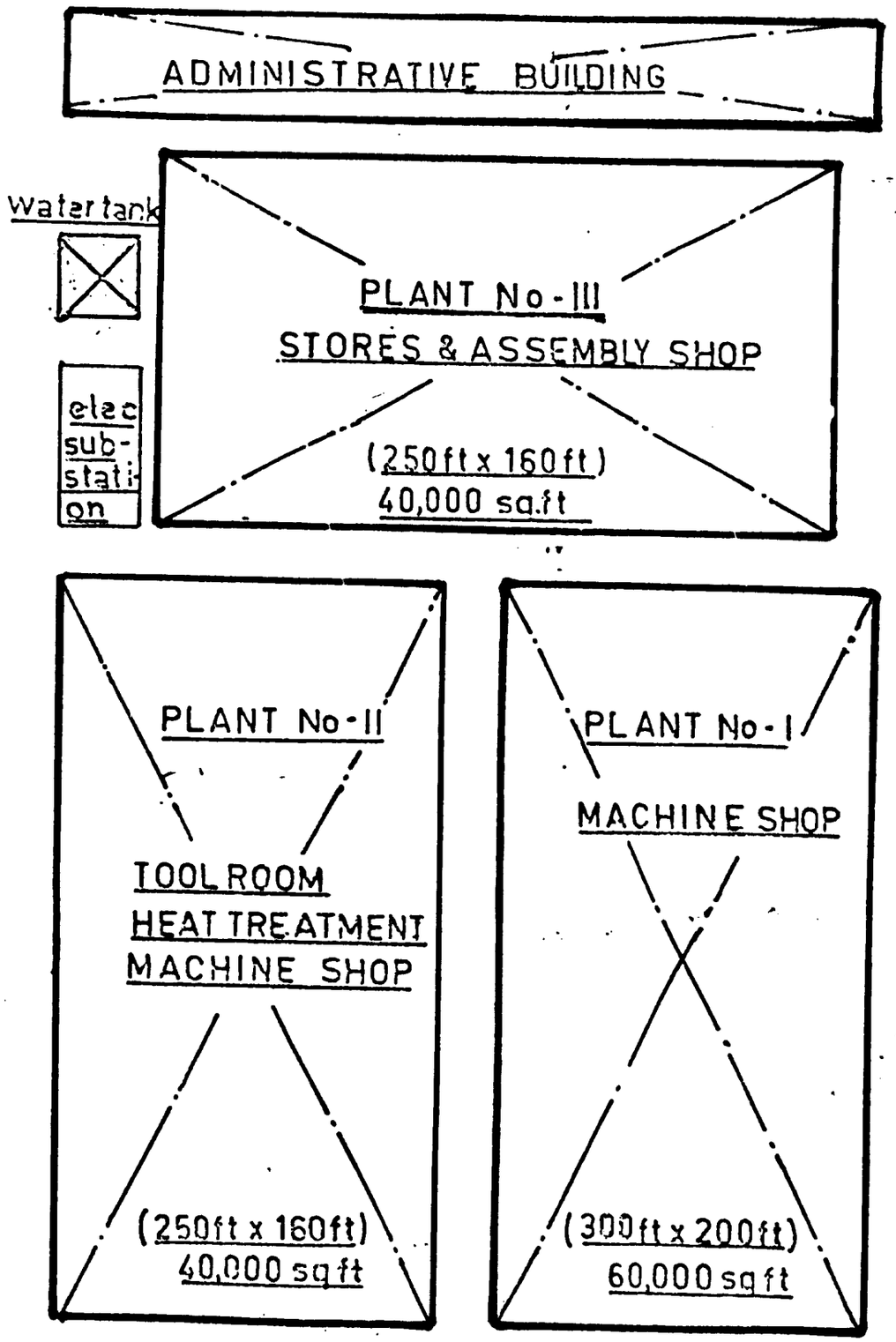


FIG-2

PROFILE OF THE MANUFACTURE OF IMPLEMENTS FOR AGRICULTURAL CROP PRODUCTION IN RURAL SMALL SCALE LEVELS

1. Product

(a) Manufacture of single hand wheel hoe
(b) Manufacture of animal drawn disc harrow
(c) Manufacture of animal drawn mould board plough

2. Product specifications (selected three product mixes)

Product	Specification
Single - hand wheel hoe	Weight 12kg, (option - 3 hoeblades or 3 cultivator tines or 3 ploughs)
Animal drawn disc harrow	Weight 50kg, Discs - 6 (No. of discs can be from 6-12) working width - 36" working depth - 3" (can be from $2\frac{1}{2}$ - 5") Output 0.25 hectare/hour
Animal drawn mouldboard plough	Weight - 35kg Furrow width - 5" -8" Furrow depth - $2\frac{1}{2}$" - 7"

3. Material Specifications

Agricultural Components	SAE No.	Carbon C	Manganes M
Implement Frame (Mildsteel)	1006-1008 -1010-1015	0.08-0.18	0.25-0.60
Springs	1065	0.60-0.70	0.60-0.90
Plough beam or tool bar	1070	0.65-0.75	0.60-0.90
Plough sares, sheetmetal	1074	0.70-0.80	0.50-0.80
Rake teeth	1078	0.72-0.85	0.30-0.60

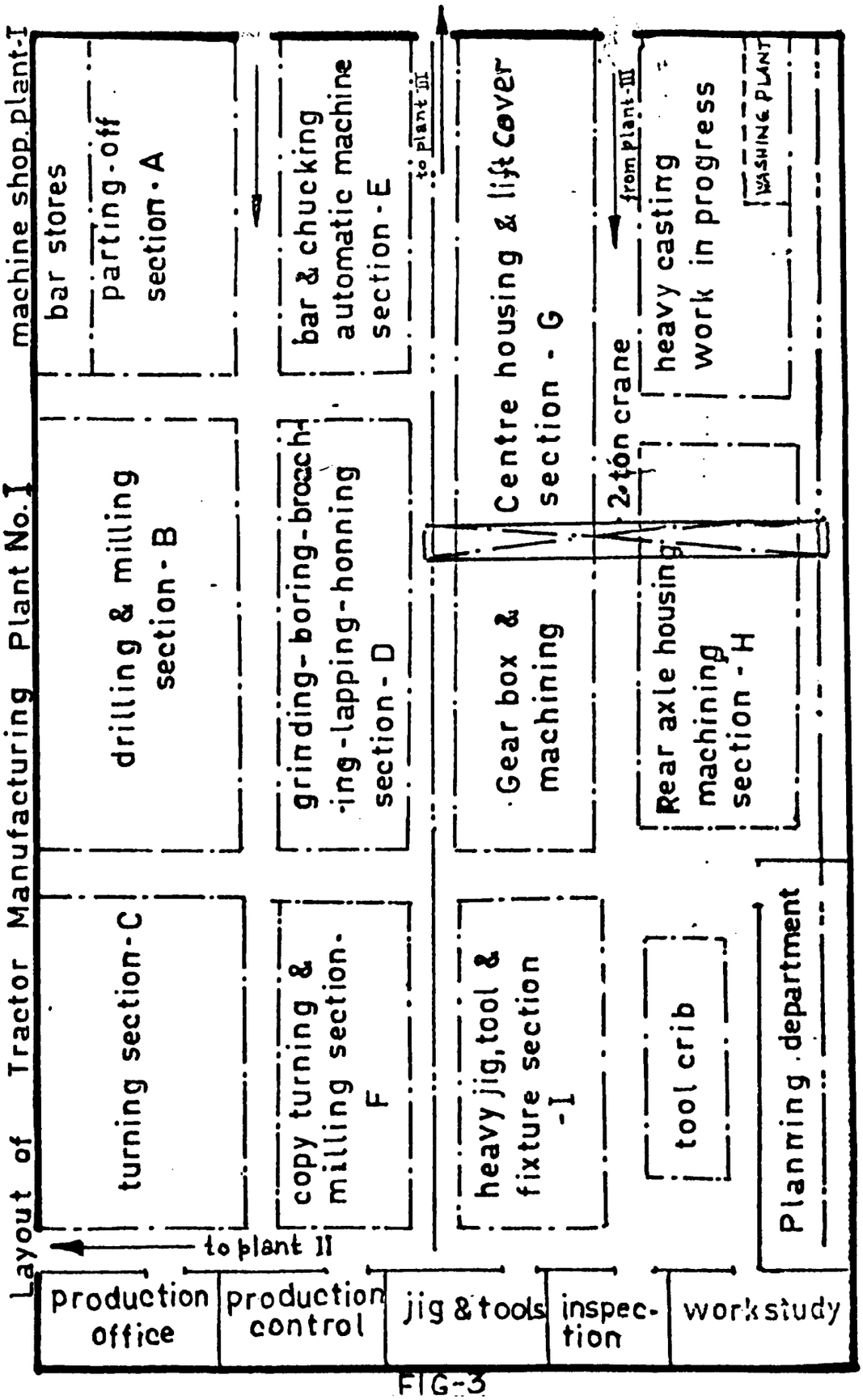

Layout of Tractor Manufacturing Plant No.I
machine shop plant-I
bar stores
parting-off section-A
drilling & milling section-B
turning section-C
bar & chucking automatic machine section-E
grinding-boring-broaching-lapping-honning section-D
copy turning & milling section-F
to plant III
Centre housing & lift Cover section-G
Gear box & machining
heavy jig, tool & fixture section -I
2-ton crane
from plant-III
heavy casting work in progress
WASHING PLANT
Rear axle housing machining section-H
tool crib
Planning department
to plant II
production office
production control
jig & tools
inspec-tion
work study

FIG-3

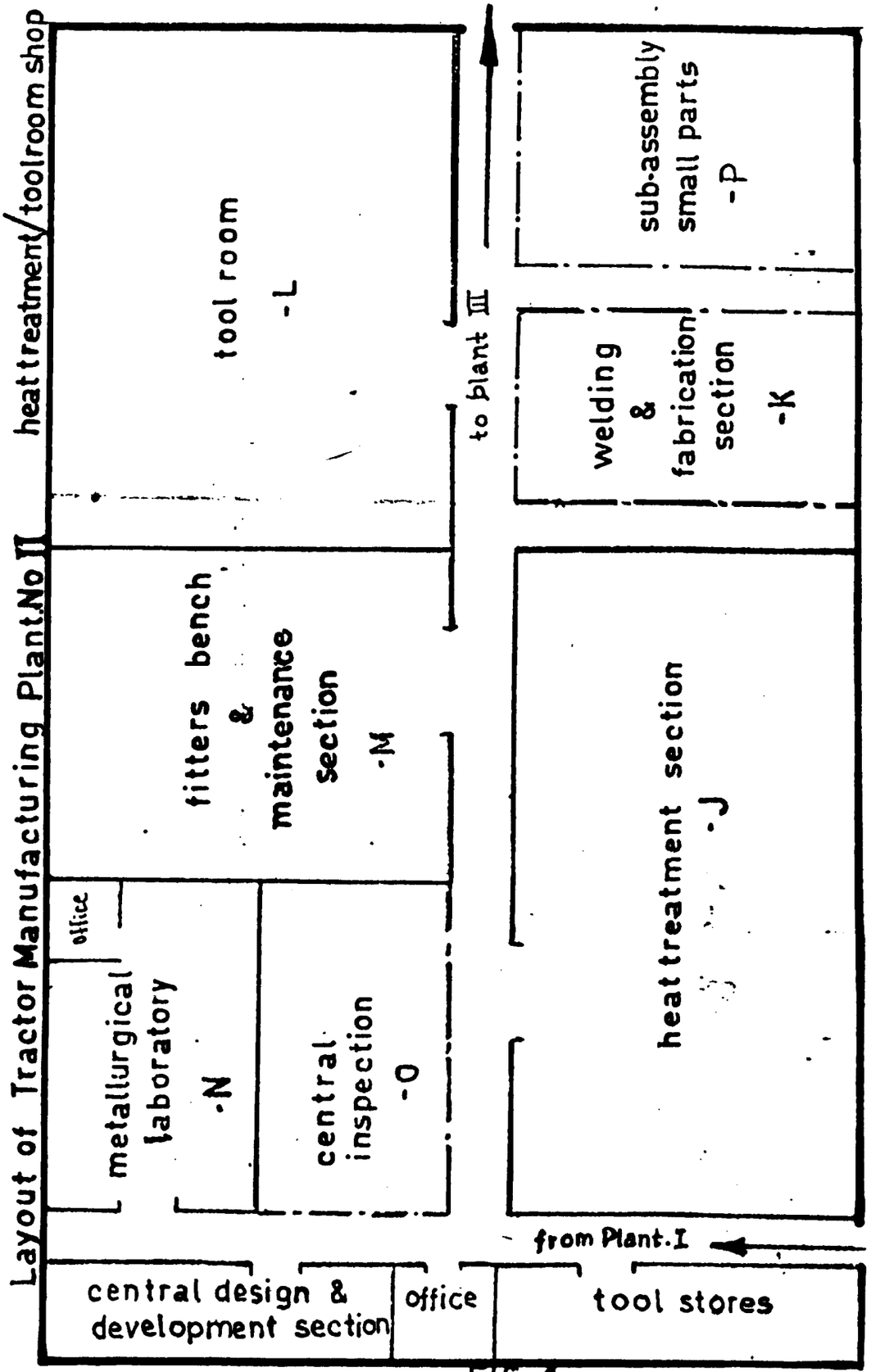

Layout of Tractor Manufacturing Plant No II
heat treatment/toolroom shop
tool room
-L
to plant III
sub-assembly
small parts
-P
welding
&
fabrication
section
-K
fitters bench
&
maintenance
section
-M
office
metallurgical
laboratory
-N
central
inspection
-O
heat treatment section
-J
from Plant.I
central design &
development section
office
tool stores

FIG-4

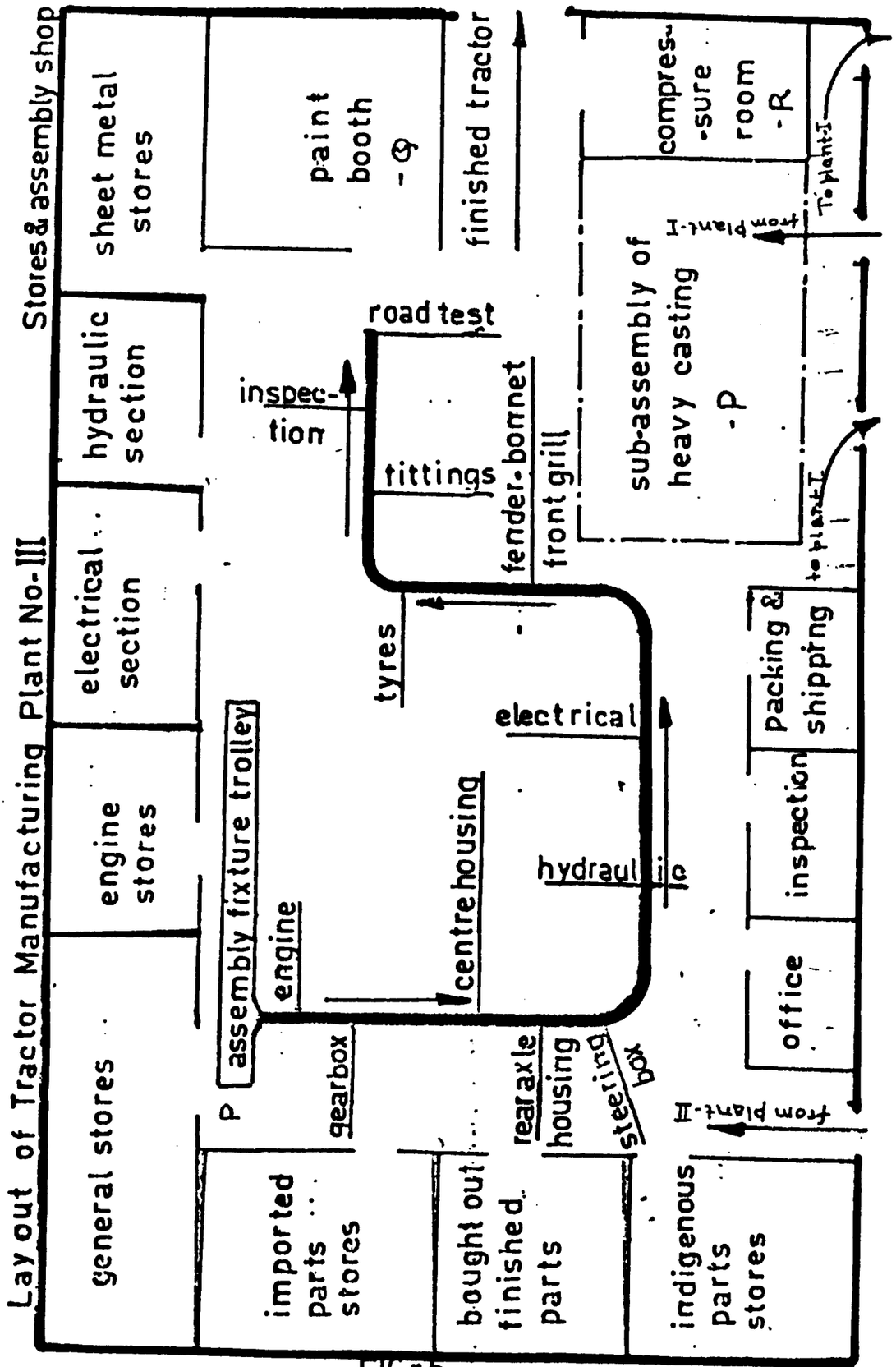

Layout of Tractor Manufacturing Plant No-III
Stores & assembly shop
general stores
engine stores
electrical section
hydraulic section
sheet metal stores
paint booth -Q
finished tractor
compres-sure room -R
To plant-I
from plant-I
sub-assembly of heavy casting -P
road test
inspec-tion
tittings
fender-bonnet
front grill
tyres
electrical
centre housing
hydraul ic
assembly fixture trolley
engine
P
gearbox
rear axle housing
steering box
packing & shipping
inspection
office
to plant-I
from plant-II
imported parts stores
bought out finished parts
indigenous parts stores

FIG-5

8. Investment Required

Basic investment

A	Fixed Capital	Cost US $
a	Land	-
b	Building cost i Administrative+ elect. sub-station + road	80,000
	ii Factory building 140,000 sqft. at US$ 6.00 Per sqft.	840,000
c	Furniture + fittings + Office equipment	60,000
d	Machinery and equipment	3,981.100
e	Electrical installation 3000 kva	60,000
f	Erection	50,000
g	Transport (2trucks, 12cars, 2vans + 1 crane)	170.000
h	Contingencies 10%	558,900
A total fixed capital US $		5,800,000
B	Working Capital	
a	Direct material (3 months)	2,100,000
b	Direct + indirect labour (3 months)	525,000
c	Training cost	25,000
d	contingencies	100,000
B	Total working capital	2,750,000
C	Total Investment Required excluding land (C=A+B)	8,550,000

9. Composition of Tractor based on major part grouping

MOW - Factory Manufactured Parts

BOF - Bought Out Finished

BOSF Bought Out Semi-Finished

IMP - Import

Indigenous manufacture of tractors needs the following supporting industries in the metal sector:

1. Foundry 2. Forging + die casting sheetmetal 3. Steel mills for sheet metal and sections

Item	Main Parts Group	Description	MOW	BOSF	B O F	I M P
010	Engine	Main engine, radiator fuel, lub oil, air intake, system, starter, dynamo/alternator incl. electricals			X	X
020	Lift cover + controls	Hydraulic lift cover housing, control shafts pins etc.	lift cover castings, control shaft pins	lift cover castings		
030	Gearbox housing	Housing, gears, splined shafts bearings, seals rings, yokes, clutch + clutch control, gear change lever + mechanism	Gear box housing shafts, yokes control levers, gear change lever	gear box casting forged shafts	X	X
040	Centre housing	Housing, differential, crown wheel and penion, bearing, splined shafts, PTO gears, seals etc.	centre housing and shafts	centre housing castings + forged shafts	X	X
050	Rear axel housing (LH+RH)	Housing, axels, shafts, rear brake drums brakes, brake controls. Bearings, seals dead weights.	rear axel housing (LH+RH) brake drums, axel shafts (LH+RH)	rear axel housing castings, forged axel shafts, break drums castings	X	X
060	Front suspension + front support	Front axels, stub shafts, front hubs, bearings, seals, dead weights.	Front axels, stub shafts, hubs, dead weights	Forged axels. die cast hubs	X	X

Item	Main Parts	Description	MOW	BOSF	B O F	I M P
070	Hydraulic pump + three point linkage	Hydraulic pump hydraulic cylinder and piston, draft and position control equip., shafts, pins etc. linkage, bars, pins chain.	Hydraulic cylinder, piston, draft + Position control equipment.	Forged body of cylinder		X
080	Steering box and linkages	Steering box steering wheel and linkages	linkages	forged linkages	X	X
090	Hand brake linkage + attachments	Hand brake, linkage etc.	Handbrake linkage		X	X
010	Pedals and Footsteps	Brake, throttle and clutch pedal controls + footsteps	brake, throttle, clutch pedal + foot step			
011	Sheetmetal and press work	Fuel tank, front bonnet, front grill, fenders, instrument panel exhaust pipe, tool box with lid			X	
012	Wheel + tyres	Front + rear wheel rims, tyres			X	X
013	Electrical Equipment	Front lights, rear lights, instruments, fuel, water, hydraulic wiring cutouts, battery, fuses etc.			X	X
014	Hardware	Bolts, Nuts, Studs washers, circlips, screws, sockets chains, etc.	Special bolts, nuts and studs		X	X
015	Toolkit	Spanners etc.			X	X

Summary of the parts to be manufactured indigenously

Item	Parts or group description	Type of Operation
1	Lift cover housing	Casting + machining
2	Gearbox housing	" "
3	Centre housing	" "
4	Rear axel housing (LH+RH)	" "
5	All trans mission shafts (simple or splinned)	Machinery + heat-treatment (heat treatment where recommended)
6.	Yokes, shift lever, gear change lever and mechanism	Die casting + machining
7	Rear Axel shafts (LH+RH)	Forging + machining + heat treatment
8	Brake drums	Casting + machining
9	Front stub axels (LH+RH)	Forging, machining + heat treatment
10	Front hubs	Casting + machining
11	Axel beams (front suspension)	Forging + machining
12	Link rods	" "
13	Linkbars	" "
14	Hydraulic cylinder	" "
15	Hydraulic cylinder piston	" "
16	Draft and position control equip.	Pressing, metal forming machining
17	Steering connection rods + links	Forging + machining
18	Clutch padel, brake pedal, and accelarator pedal, footstep	" "
19	Hand brake system	Machining
20	Special bolts, nuts, studs, pins and levers	Machining electorplating or galvanizing

Summary of parts to be manufactured indigeneously - in various phases of production.

The manufacturing programme and planning should be based on a phase out system:

Phase I 1. Lift cover housing

2. Gearbox housing, centre housing, rear axel housing

3. Brake drums, special bolts, nuts, studs, pins, levers and rods

4 All other parts to be procured either by boughtout finished locally or by import.

Phase II 5. All transmission shafts (simple + splined)

6. Yokes, shift lever, gear change levers and mechanisms

7. Rear axel shafts

8. Front axel stub, fronthub, link rods all other parts to be procured either by bought out finished or by import.

Phase III

9. Axel (front) beam, linkage bar

10. Hydraulic cylinder, hydraulic cylinder piston

11. Draft and position control equipment

12. Steering connection rods

13. Clutch padel, brake pedal, accelerator pedal

14. Hand brake system

all other parts to be procured either by bought out finished or by import

11. Estimated Manufacturing Cost

Based on 3500 tractors/year/1 shift - 8 hours basis

		Cost US$
a	Imported cost of parts (CIF to factory door)	5,600,000
b	Indigeneous parts with local or imported raw mat.	2,800,000
c	Total raw material cost	8,400,000
d	Labour costs	2,100,000
e	Overhead costs (incl. indirect material, power, fuel, water, lubricants, spare parts all others)	2,100,000
	Total annual manufacturing costs	12,600,000

12. Annual Sales Turnover (estimated)

Type	Unit selling Price Ex Factory US $	Production/Year	Total Annual Sales US $
40HP Tractor	4,000	3,500 units	14,000,000

13. Total Annual Cost (excluding profit) based on 3,500 tractors/year/ 1 shift.

a	Estimated Manufacturing cost	12,600,000
b	Total sales cost	200,000
c.	Depreciation of fixed capital at 10% per annum	580,000
	Total annual costs	US $13,380,000

14. Profit (before tax)

Annual sales turnover	US$	14,000,000
Total annual costs	US$	13,380,000
Profit before tax	US$	620,000

Annex -IV

ESTIMATED DEMAND FOR AGRICULTURAL MACHINERY

The global demand for agricultural machinery is difficult to forecast. The estimates for demand, on a national or international scale, are approximately the projections of the existing level of demand. Moreover, the physical demand for agricultural machinery in each country depends mainly upon:

- actual expansion of farmland for agricultural production;
- intensification of agricultural production through a planned national agricultural policy;
- replacement of existing agricultural machinery either due to obsolescence or technological change.

Various other economic factors which constrain the relative demand are lack of credit, low solvency of the farmers, non-availability or high price of agricultural inputs.

Power demand

The intensification of agricultural production creates a natural demand for input of mechanical energy which is needed in order to cultivate and prepare seed beds, and to plant weed and harvest crops. The total energy demand for crop production is not spread out uniformaly over the whole year, it is however concentrated in short periods during cultivating, sowing and harvesting time.

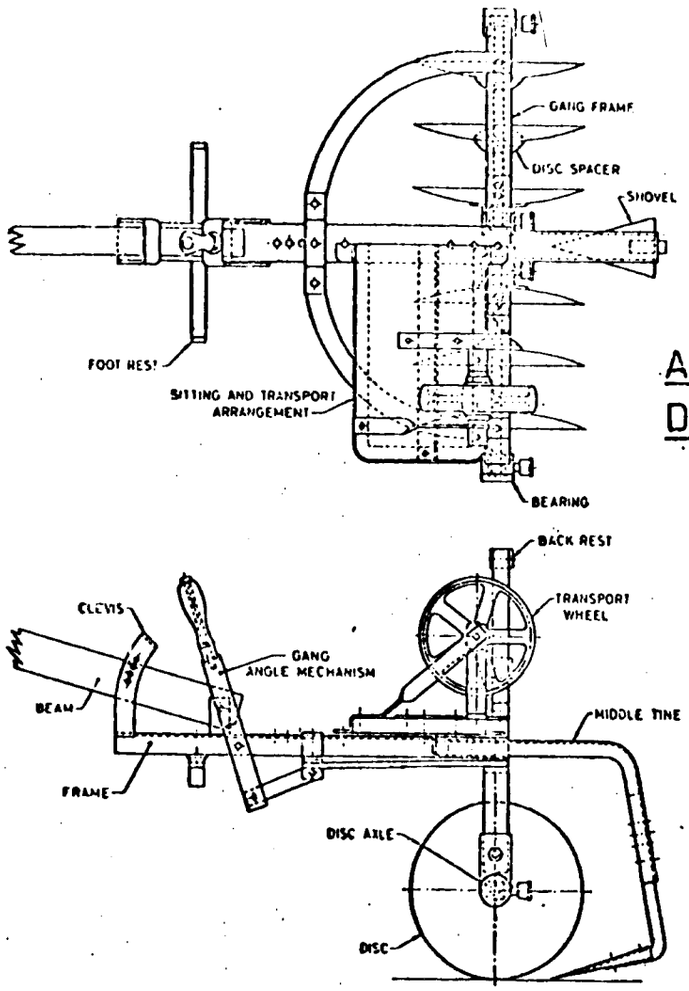
The figure of 0.5 HP per hectare is widely used as specific mechanical power which is required for agricultural mechanization. Its magnitude varies from country to country,

Specific mechanical power - 0.5 HP/ha
USA and Western Europe - 1.0 HP/ha
Japan - 3.0 HP/ha

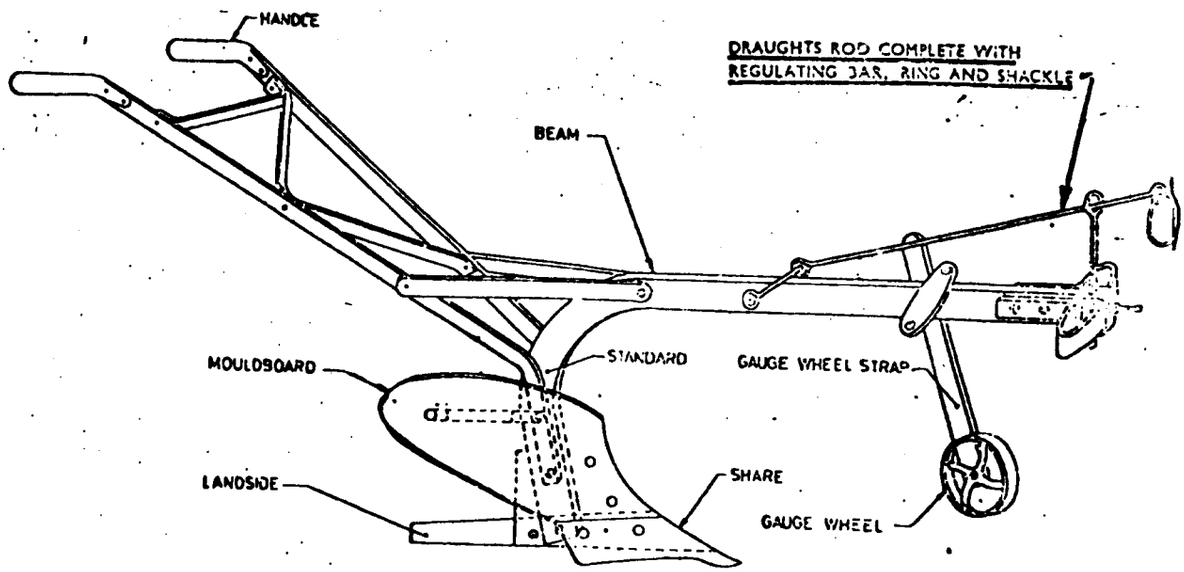
therefore, the gross demand for mechanical power.

P (HP) = Production Area (Hectare) x specific meohanized power (HP/ha)

In lands where multiple cropping is established the specific mechanized power oan be considered - 0.8 to 1.0 HP/ha.



Animal Drawn Disc Harrow



Animal Drawn Mouldboard Plough

FIG-1

Selection of Unit Power Package or Range of Packages

The simplest case is the one where it is possible to meet the demand for mechanical power in the field from one size of power package rated at Y_1 (HP). The cultivation equipment has the highest power demand, which may be calculated from the draft requirements and working speed of the common implements:

mould board ploughs	-	14 lb/in^2 of furrow slice
rotary tiller	-	20 lb/in of working width
spring tine cultivator	-	55 lb/tine
row planter	-	45 lb/row

The acceptable minimum speed of travel is approximately 2 miles per hour which leads to the following ratings:

$$\text{Engine (HP)} = \frac{\text{Pull (lb) x speed (m.p.h.)}}{375 \times n}$$

With an overall efficiency of power utilization between engine and implement (n) of 50%:

Single furrow ploughs, 8 in. wide x 8 in. deep	= 9.6 HP
Rotary tillers working 40 in. wide	= 8.6 HP
Spring tine cultivators working 40 in. wide	= 4.1 HP
Three row planters	= 1.5 HP

These caluclations indicate that for the cultivators with a single furrow mouldboard plough an acceptable engine rating should be 10 HP.

In actual fact with definite farm sizes and uniform operating conditions the majority of the implements can be manoeuvered by a major single power package.

Where animal drawn equipment is used the problem is rather different. The size of the power package is fixed by a pair of bullocks (0.8 HP) so with a given rating of implements the total number of animals required can be calculated. In this case the full capacity of the implement is severely constrained by the lower power available in the draft form and only at one speed. Estimate of the total number of power units (N) for single power packages:

$N_1 = \frac{P}{Y_1}$ where P = gross demand for Mechanical power, and

Y_1 = rating of power package (tractor)

In cases where there is a mixture of power packages, the proportions of different packages may be selected:

$$X = N_2 Y_2 + N_3 Y_3 + N_4 Y_4 + \ldots\ldots\ldots\ldots$$

IWP's Estimated Demand for Agricultural Machinery

In order to determine the annual rate of demand for agricultural machinery both at national and international level, the actual increase in farm land, rate of intensified agricultural production and replacement of machinery are of paramount importance for a realistic approach.

The provisional study of the IWP (Indicative World Plan) indicates the estimated demand for agricultural machinery and inputs for 1975 and 1985 for the major developing areas of the world, covering the following:

- estimate of investments proposal for both animal drawn and power mechanized equipment (Figure -15)
- estimated tractor requirements (Figure -15(a))
- estimated value of agricultural inputs (Figure -16)

Estimate of Investments for Agricultural Equipment (Figure -15)

- shows that there will be a great demand for power mechanized equipment in Latin America, Near East and Asia;
- in Africa the investment towards animal drawn equipment will be more predominant and in actual fact it will be raised from US$ 75 million to 90 million nearly 55% of total investment;
- in Latin America the picture is somewhat different and relates more towards investment in power-mechanized equipment. (95% of total investment in 1985);
- both Asian and the Near East developing countries the investment outlook is more inclined towards power mechanized equipment.

Estimated Demand for Tractors (Figure -15a)

IWP Figures for 1975 -1985 show:

- a proposed greater demand for 4-wheel tractors in Asia, the increase will be from 200,000 units to 970,000 units in 1985. Also an interesting feature is a 20% growth rate in 2-wheel tractors, probably for the incorporation of more mechanized systems where animal drawn farming exists;

Estimate of investments in 1962 and proposals for 1975 and 1985
(Source : Provisional study for the I.W.P.)

	1962		1975		1985	
	Value Millions of dollars	Percentage in relation to total investment	Value Millions of dollars	Percentage in relation to total investment	Value Millions of dollars	Percentage in relation to total investment
Africa (south of Sahara)						
A - Animal draught equipment	60	70	75	60	90	55
B - Power mechanized equipment	25	30	50	40	75	45
Total investments	85		125		165	
Latin America						
A - Animal draught equipment	115	20	80	10	50	5
B - Power mechanized equipment	435	80	720	90	1050	95
Total investments	550		800		1100	
Near East						
A - Animal draught equipment	25	36	30	26	35	21
B - Power mechanized equipment	45	64	85	74	135	79
Total investments	70		115		170	
Asia						
A - Animal draught equipment	425	86	483	59	545	28
B - Power mechanized equipment	70	14	340	41	1415	72
Total investments	495		825		1960	

A - Animal draught equipment and hand tools (not including the cost of draught animals)

B - Power mechanized equipment (tractors, equipment for tractors, combine harvester, etc.)

Figure 15

Number of tractors proposed (according to the provisional study of the I.W.P.)

	Number of tractors				
	Estimates	Proposals		Growth rates	
	1965	1975	1985	1965-75	1975-85
Latin America	376 000	570 000	810 000	4.3 %	3.6 %
Near East	35 000	71 000	117 000	7.3 %	5.1 %
North West Africa	36 000	49 000	65 000	3.1 %	2.9 %
Asia					
two wheel	19 000	109 000	700 000	19.1 %	20.0 %
four wheel	85 000	200 000	970 000	12.5 %	13.2 %
Africa south of Sahara	22 000	35 000	56 000	4.8 %	4.8 %

Proposed rate of annual tractor supply

	1965	1975			1985		
	Estimated total	As replace-ments	Proposed increase	Total	As replace-ments	Proposed increase	Tota
Latin America	43 000	43 000	23 000	66 000	66 000	27 000	93 000
Near East	5 000	6 000	5 000	11 000	11 000	6 000	17 000
Asia							
two wheel	3 500	6 000	26 000	32 000	43 000	167 000	210 000
four wheel	16 000	17 000	36 000	53 000	55 000	130 000	185 000
Africa south of Sahara	4 000	6 000	2 000	8 000	9 000	3 000	12 000
North West Africa	3 000	3 000	4 000	7 000	7 000	1 000	8 000
Total two wheel	3 500	6 000	26 000	32 000	43 000	167 000	210 000
four wheel	71 000	75 000	70 000	145 000	148 000	167 000	315 000

Only two wheel tractor figures for Asia are indicated since they are of little importance elsewhere.

Figure 15a

- in Latin America the demand for tractors will be somewhat less during 1975-85, because the present tractor population is higher in this area.
- in the Near East the estimated growth rate of tractor requirement will be in the region of 5.1% during 1975-1985.
- Africa (South and North of Sahara) the growth rate of the mechanization input will be 2.9% and 4.8% during 1975 to 1985. There will also be a greater demand for fertilizer and crop protection inputs (refer Figure -16).

All these above proposals for the demand for agricultural inputs show clearly that the requirements of mechanized farming are more predominent in Asia, Near East and Africa (North of Sahara) during the next decade.

The demand for the input particularly machinery and equipment in Latin America will be less due to the existing built-up of machinery and equipment which has reduced the demand to a great extent. In Africa (South of Sahara) a greater emphasis is needed for the improvement in farm mechanization as the demand rate for this input is not very encouraging during the next decade.

In order to intensify the crop production a comprehensive and cohesive national mechanization policy is needed particularly in the least developed countries where a greater attention is required for the utilization of manpower through mechanization and off-farm industrial activities in all agricultural and industrial sectors.

Value of agricultural inputs in 1962 and levels proposed for 1985

(Source : Provisional study for **Indicative World Plan**)

	Fertilizers		Seeds		Irrigation		Crop protection		Mechanization (1)		Total inputs		Percentage of inputs in relation to production	
	1962*	1985	1962*	1985	1962*	1985	1962*	1985	1962*	1985	1962*	1985	1962*	1985
Africa south of Sahara	14.2	180.4	295.0	412.1	—	—	13.6	309.0	27.0	101.2	349.8	1002.7	6.4	9.1
Asia	335.0	5180.9	868.6	1258.7	750.7	1186.0	20.4	1215.6	200.9	1153.9	2175.6	9995.3	9.8	18.9
Latin America (2)	218.3	1861.3	276.4	355.7	479.6	896.9	110.0	397.2	438.5	1031.8	1522.8	4542.9	17.1	25.7
Near East (3)	78.7	470.7	108.1	145.7	264.4	350.8	25.0	116.4	36.7	117.3	512.9	1200.9	18.6	19.2
North Africa	18.0	145.0	51.4	72.1	—	—	11.0	38.5	94.0	206.0	174.4	461.6	20.3	25.2
Total for these regions	664.2	7838.3	1599.5	2244.3	1494.7	2433.7	180.0	2076.9	797.1	2610.2	4735.5	17203.4	11.8	19.2

Growth rate of value of inputs from 1962 to 1985

Annual percentage

	Fertilizers	Seeds	Irrigation	Crop protection	Mechanization	Total inputs
Africa south of Sahara	11.7	1.5	–	14.5	5.9	4.7
Asia	12.6	1.6	2.0	19.4	7.9	6.9
Latin America (2)	9.8	1.1	2.8	5.7	3.8	4.9
Near East (3)	8.1	1.3	1.2	6.9	5.2	3.8
North Africa	11.0	1.7	–	6.5	4.0	5.0
Total for these regions	11.3	1.5	2.1	11.2	5.3	5.8

(1) A certain quantity is also used for animal husbandry.
(2) South America only.
(3) **Ten countries only not including Kuwait and Yemen.**

ANNEX -V

INTERNATIONAL TRADE IN AGRICULTURAL MACHINERY

The world trade in agricultural machinery is presently directed in three distinct markets.

- Trade among developed countries: - marked by an increase in the demand for mechanized equipment including specialised sophisticated farm machines and allied equipment.
- Trade between developed and developing countries: - oriented by a greater demand for agricultural machinery and equipment by way of export from the developed to the developing countries. The range of this type of machinery mainly consists of tractors and associated equipment engines, pumps with other irrigation equipment, etc.
- Trade among the developing countries: - this is a rather recent phenomena, oriented mainly on export of small and medium size tractors, pumps, animal drawn equipment, stationery crop protection equipment, handtools, etc.

The world trade in the ECE Bulletin of Statistics for 1975 - covers the export from 35 major exporting countries (out of which 14 are developing countries) which between them represents 99% of the world trade in agricultural machinery.

The Subsectors of the total world export of engineering products which includes agriculture and allied machinery and equipment in 1975 is described in the following table.

Total machinery non-electric	101,810.20 million US$ F.O.B.
Total electrical machinery	46,398,40 million US$ F.O.B.
Total transport equipment	88,775.50 million US$ F.O.B.
Total of above subsectors of engineering produots	236,984.10 million US$ F.O.B.

Figure -6

In order to evaluate the group actually covering the export of agricultural machinery and allied subgroups, the following distribution is worth considering during 1975.

Item	Subgroups	SITC No.	Export Price 1975 million US$ FOB
1.	Total Agricultural machinery for cultivating soil	712.12	3,353.30
2.	Total Tractors	712.5	4,371.70
3.	Total pump + centrifuges 6688.7 mill. US$-40% of this can be for agriculture	719.2	2,675.50
4.	Total internal combustion engines 7198.4 mill. US$-20% for agriculture	711.5	1,439.70
5.	Land Leveling machinery 7576.1 mill. US$-30% of this for agriculture	718.4	2,272.80
Total export of agricultural machinery excluding dairy farm equipment			14,113.00

Figure - 7

Therefore, in 1975 the value of world trade in machinery covering electric, non-electric and transport equipment amounted to 236,984 million US$ FOB. Within this global sum, the total trade in agricultural machinery (excluding dairy farm equipment) accounts for 14,113 million US$ FOB, i.e. 5.95% of world trade in electric, non-electric and transport equipment.

A detailed breakdown of total export of agricultural machinery and allied equipment is shown in Figure - 8.

The total world export trade in agricultural machinery in 1975 was 14,113 million US$ FOB of which 576.70 million US$ FOB was exported from developing countries. This is shown inFigure -9 which outlines various percentage exports of agricultural machinery and equipment from the developing countries.

Figure - 8

Price: US$ Million F.O.B.

TOTAL EXPORT OF AGRICULTURAL MACHINERY

Source of Data - ECE Bulletin of Statistics on World Trade in Engineering Products 1972— 1975

Global Export Figures

* Percentage = $\frac{\text{Developing Countries Export FOB US\$}}{\text{Global Export FOB US\$}}$ (for each subsector)

Item	Subject Group	SITC No.	1972	%	1973	%	1974	%	1975	%
1.	Agricultural Machinery for Cultivating Soil	712.12	1,298.1	-	1,813.6	-	2,496.5	-	3,352.3	-
2.	Tractors	712.5	1,697.0	-	2,191.2	-	2,854.1	-	4,371.7	-
3.	Pumps and Centrifuges— 40% of this can be for Agriculture	719.2	3,037.3 / 1,214.9	-	3,919.4 / 1,567.8	-	5,195.8 / 2,078.3	-	6,688.7 / 2,575.5	-
4.	Internal Combustion Engines - 20% of this can be for Agriculture	711.5	4,152.4 / 830.5	-	5,109.9 / 1,022.0	-	6,175.5 / 1,235.1	-	7,198.7 / 1,439.7	-
5.	Land Development Machines - 30% of this can be for Agriculture	718.4	3,041.2 / 912.4	-	3,918.3 / 1,175.5	-	5,422.9 / 1,626.9	-	7,576.1 / 2,272.8	-
	Total Global		5,952.9	-	7,770.1	-	10,290.9	-	14,112.0	-
	Export from Developing Countries									
1.	Agricultural Machinery for Cultivating Soil	712.12	62.2	4.8%	79.0	4.4%	73.1	2.9%	129.4	3.9%
2.	Tractors	712.5	37.7	2.2%	60.6	2.8%	69.8	2.5%	188.8	4.3%
3.	Pumps and Centrifuges - 40% of this can be for Agriculture	719.2	59.1 / 23.6	1.9%	100.7 / 40.3	2.6%	132.6 / 53.1	2.6%	206.6 / 82.6	3.1%
4.	Internal Combustion Engines - 20% of this can be for Agriculture	711.5	107.7 / 21.5	2.6%	154.2 / 30.8	3.0%	220.7 / 44.1	3.6%	388.2 / 77.6	5.4%
5.	Land Development Machines - 30% of this can be for Agriculture	718.4	189.1 / 56.7	6.2%	306.2 / 91.8	7.9%	238.3 / 71.5	4.4%	327.5 / 98.3	4.3%
	Total from Developing Countries		201.7	3.4%	302.5	3.9%	311.6	3.0%	576.7	4.1%

1975	Global Export	Export from Developing Countries
Total export -(million US$ FOB)	14,113	576.70
Tractors	31%	33%
Agricultural machinery for cultivating soil	24%	22%
Irrigation equipment	19%	14%
Internal combustion engines	10%	13%
Land developing machinery	19%	18%

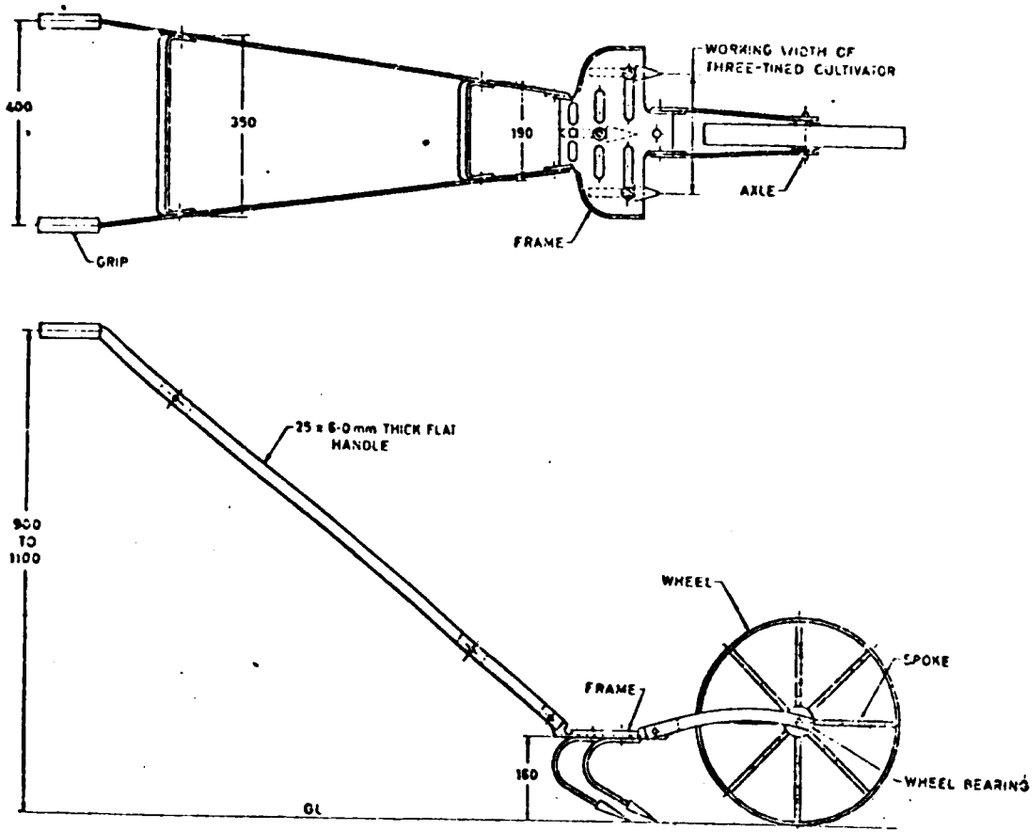
Figure - 9

Farm figure 8 and 9 - it appears that there was a greater demand for tractors and soil cultivating machinery globally during 1975, than in previous years. The Figure -10 shows the relative importance of exports from developing countries in world agricultural machinery exports from 1972 to 1975.

By examining Figures 8, 9, and 10 it appears that the developing countries participated very little in world export trade of agricultural machinery. During 1975, developing countries exported only 576.70 million US$ worth of agricultural machinery, i.e. 4.1% of global exports.

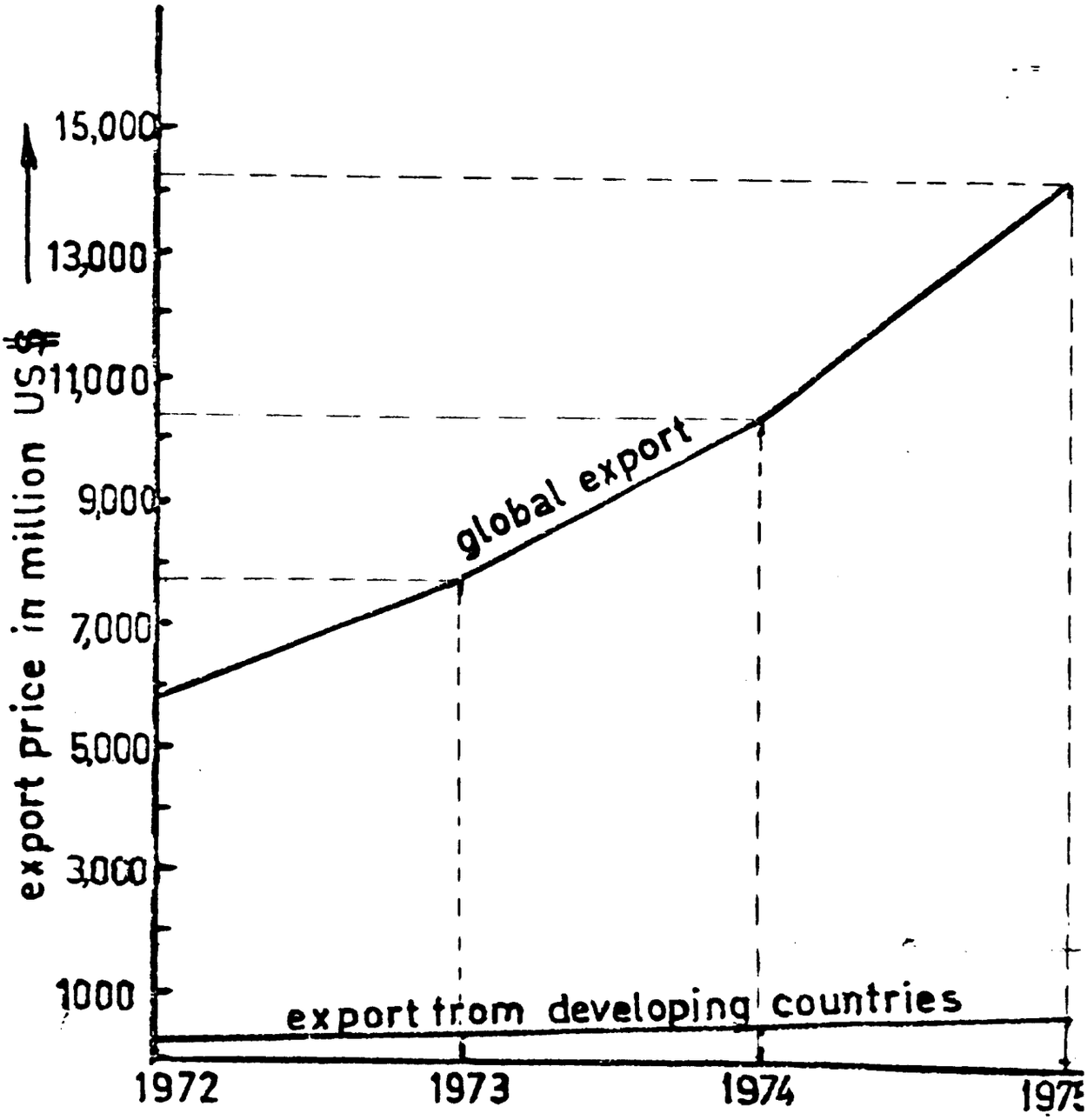
However, examining the export figures for tractors (Figure -8) it is noticed that while the exports from developed countries during 1972 - 1975 increased from 1,697 million US$ FOB in 1972 to 4,371.7 million US$ FOB in 1975 i.e. $2\frac{1}{2}$ times, exports from the developing countries during the same period increased from 37.7 million US$ FOB to 188.8 million US$ FOB which is a 5-fold increase.

On the other hand the percentage share of export of machinery for cultivating soil from developing countries dropped from 4.8% in 1972 to 3.9% in 1975. This can best be attributed to the fact that the developing countries increased their home demand which accounts for the



Wheel Hand Hoe

FIG-2



Export trend in Agricultural Machinery
(excluding dairy farm equipment)

FIG - 10

consequent fall in exports. During this period developed countries increased their share of exports in machinery for cultivating soil from 1,298.10 million US$ in 1972 to 3,352.30 million US$ in 1975. This indicates that there was a greater demand for soil cultivating machinery from the developed to the developing countries.

With regard to the various other agricultural machinery exported from the developing countries their performances can best be summarised from the table in Figure -8.

- export of pumps and centrifuges increased from 1.9% in 1972 to 3.1% in 1975 (nearly doubled);
- export of internal combustion engines increased from 2.6% in 1972 to 5.4% in 1975 (nearly doubled)
- export of land developing machinery dropped from 6.2% in 1972 to 4.3% in 1975.

Export of Agricultural Machinery from the Developed to the Developing Countries

Export to	1969 Mill. US$	1975 Mill. US$
Africa	127	553
Latin America	297	937
Asia	184	340
Middle East	184	523
Total exports to developing countries	608	2,353
Total exports from developed countries		13,535.3
% exports from developed to developing countries to total exports from developed countries		17.4%

Figure - 11

Share of exports from the developing countries absorbed by each developing zone.

Year	Africa	Latin America	Asia
1957	16%	59%	25%
1961	18.7%	54.9%	26.4%
1967	18.9%	38.1%	43.0%
1971	22.2%	42.4%	35.4%

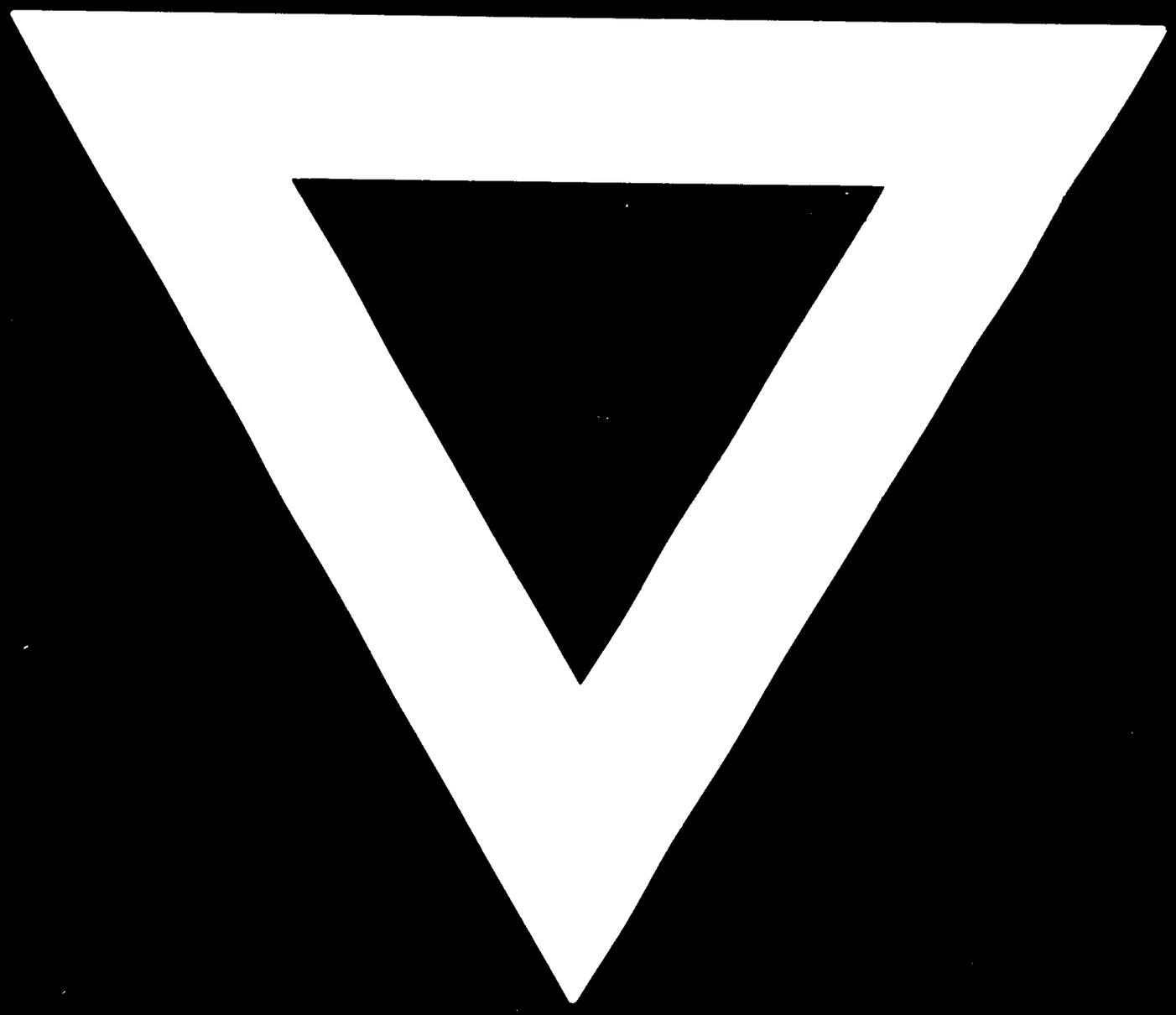
Figure - 12

By examining the Figures 9, 11 and 12 the following conclusions can be drawn:

- the relative share of demand from the developing countries for agricultural machinery correspond to only 17.4% of total exports from developed countries in 1975;
- the main portion of exports from the developed countries continued within the industrialized countries;
- the developing countries exported only 4.1% of the total exports of agricultural machinery;
- there was a growing trend in export of tractors from the developing countries due to the setting up of enhanced manufacturing programmes in certain countries in Asia, Latin America and Africa;
- there was a declining trend in the export of soil cultivating equipment from developing countries, as oompared to global exports in this subsector. This indicates that developing countries were not able to expand manufacturing activities to meet the local demand to same extent as they were able to do for tractors.
- there was a trend in heavy mechanization in the Middle East and oil producing countries by continued increases in the import of mechanized equipment from industrialized countries.

We regret that some of the pages in the microfiche copy of this report may not be up to the proper legibility standards, even though the best possible copy was used for preparing the master fiche

G-13



79.11.14

Agricultural Components	SAE No.	Carbon C	Manganes M
Scraper, bladcs, discs, Spring tooth harrow	1085	0.80-0.93	0.70-1.00
Mower + binder section twine holders, knotter discs	1086 + 1090	0.82-0.95 0.85-0.98	0.30-0.50 0.60-0.90

4. Production Volume

Item	Product Description	Production/day 1 shift=8hours	Production/year 250workingdays
(a)	Single hand wheel hoe	24	6000
(b)	Animal drawn disc harrow	8	2000
(c)	Animal drawn plough	8	2000

5. Labour Requirement - Direct Labour

Item	Area	Skilled	Semi-Skilled	Unskilled
1	Cutting off	-	1	-
2	Inspection	2	-	-
3	Forging + heat treatment	2	-	-
4	Toolroom + maintenance	3	1	-
5	Machine shop	9	2	1
6	Welding + fabrication	6	4	2
7	Sub assembly	2	4	1
8	Assembly	4	2	1
9	Paintshop	1	-	-
	Total direct	29	14	5

-Indirect Labour

Item	Area	Skilled	Semi-Skilled	Unskilled
10	Manager	1	-	-
11	Accountant	1	-	-
12	Sales executive	1	-	-
13	Development engineer/ designer	1	-	-
14	Superintendent	1	-	-
15	Jig + Tool designer	1	-	-
16	Foremen	3	-	-
17	Secretary	1	-	-
18	Charge hand	1	-	-
19	Stores + tool keeper	3	-	-
20	Security	1	-	-
21	Clerk	-	2	-
	Total indirect	16	2	-

Therefore total manpower =

Direct Manpower	48
Indirect manpower	18
total	66

6. Floor Area

Administrative Area - 2000 sq ft.

Manufacturing area - 40,000 sq. ft.

Layout of small scale agricultural implement manufacturing plant

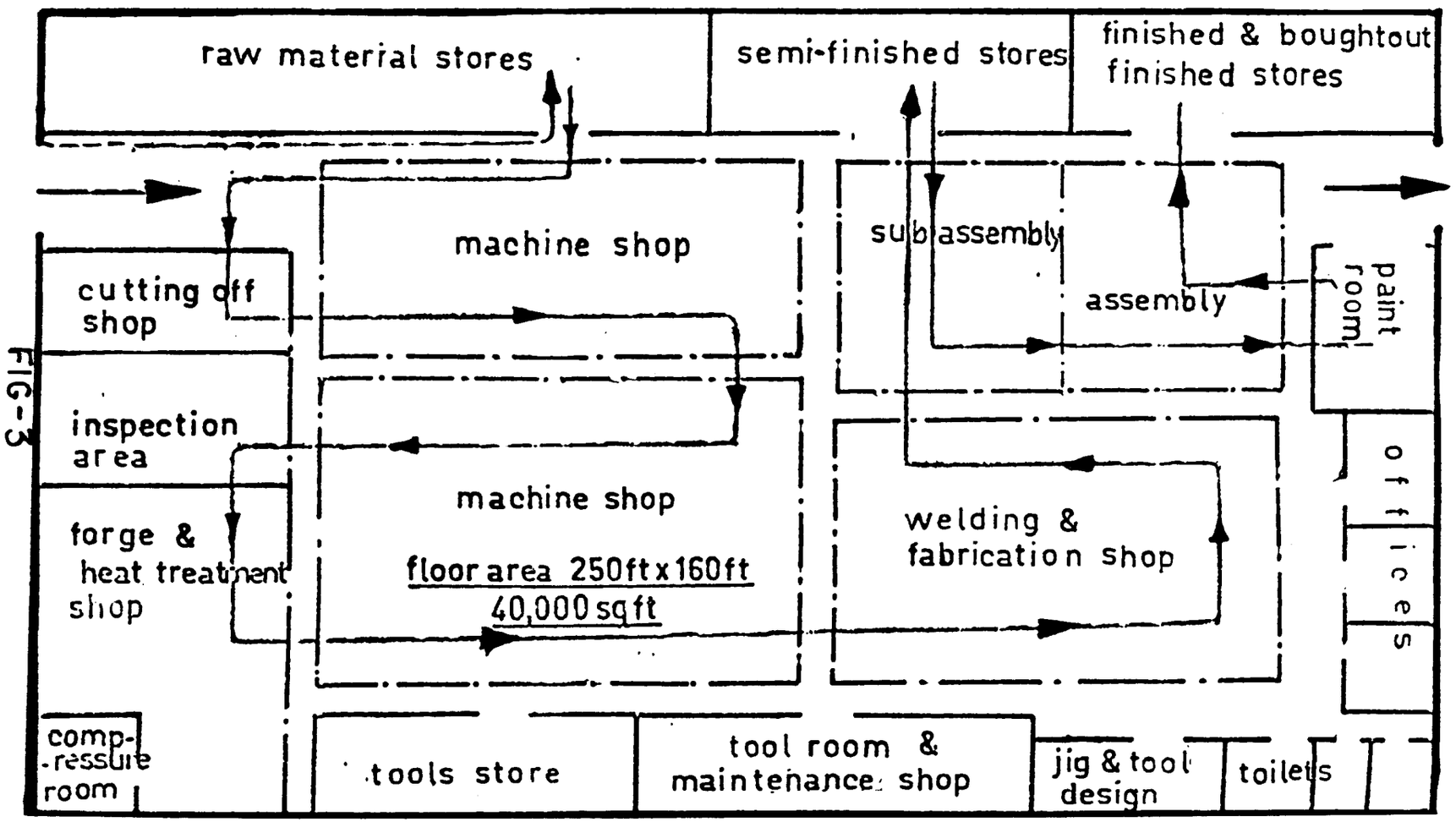


FIG-3

7. Machinery and Equipment (Estimated)

Ref: Fig (3) for layout information

Item	Area	Description	No.	Estimated cost US $
1.	Cutting shop	Power hacksaw Max round bar up to 3" dia.	1	1,000
2.		Abrasive cutter/grinder $\frac{1}{2}$hp - 8" wheel	1	800
3.		Hand shear - 12"dia	1	200
4	Forge and heat treatment shop	Mechanical hammer forge 50ton (for hot forge)	1	14,000
5		Oil fired furnace with blower 30x30x15"	1	5,000
6		Water quenching tank 3'x3'x3'	1	500
7		Oil quenching tank 3'x3'x3'	1	300
8		Anvils	2	200
9	Blacksmith's	tools	set	400
10	Machine shop	Pedestal grinder 12" wheel - double ended	2	800
11		Upright drilling machine 1"diain MS	1	5,000
12		Radial drilling machine 3'arm - $1\frac{1}{2}$" dia in MS	1	8,000
13		Lathe- Max bore 3" Swing - 18" Max length -36"		6,000
14		Capstan lathe with hex turret + attachment Swing 6" Gap 24"	1	9,000
15		Jigs and fixtures for parts	set	6,000