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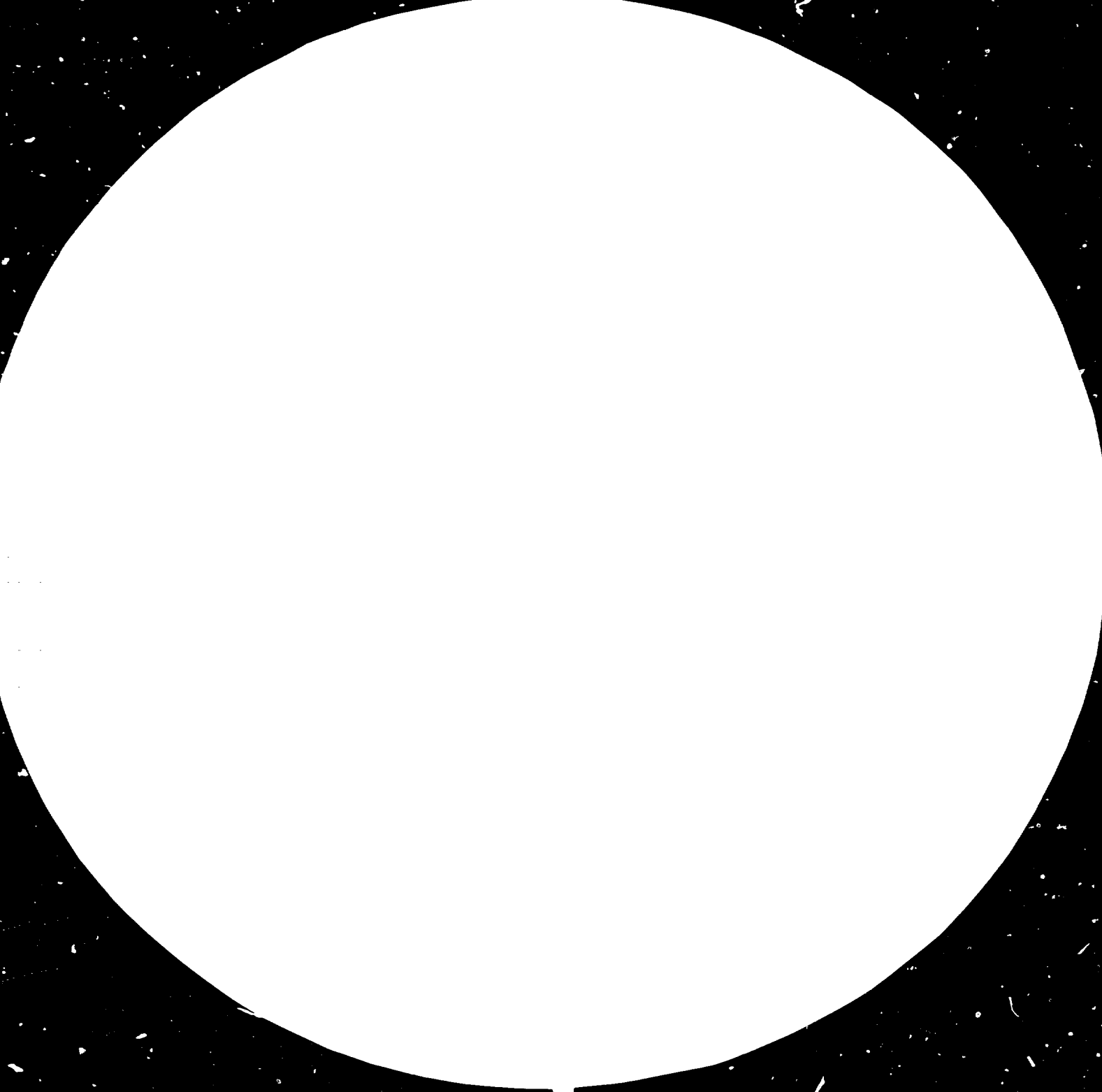

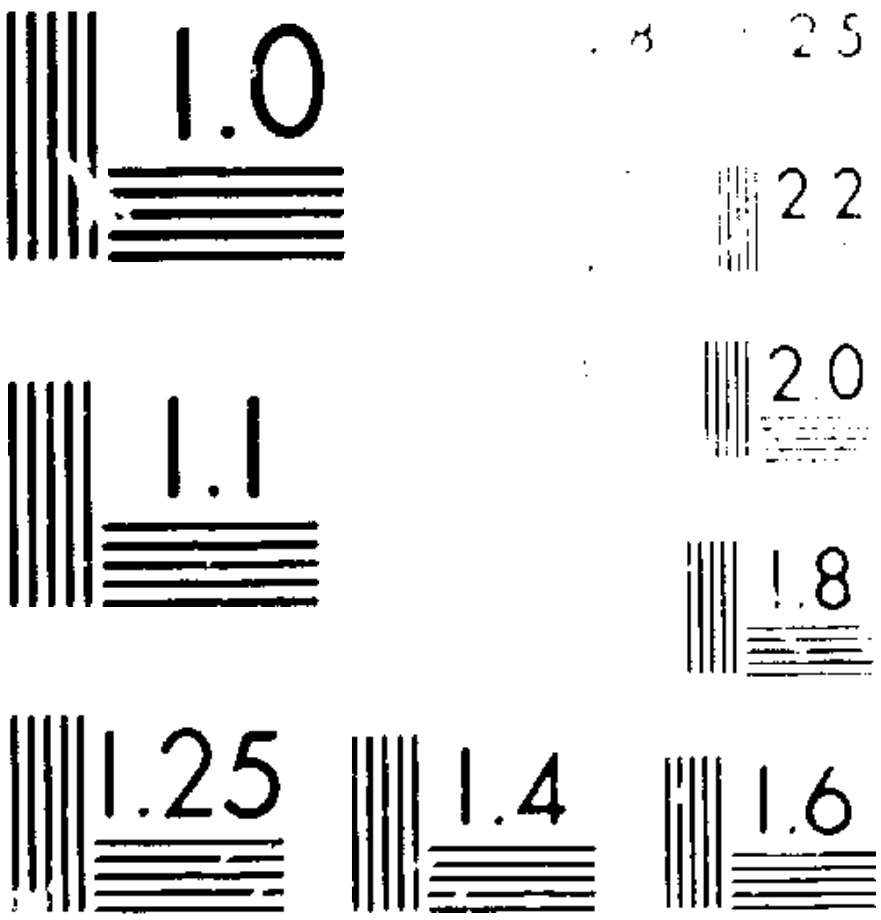
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PROFILES FOR UPGRADING THE PRODUCTION CAPABILITIES IN THE AGRICULTURAL MACHINERY INDUSTRY IN AFRICA*

prepared by

Messrs. Sores Inc.**

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** 1 Complex Desjardins, P.O. Box 64, Desjardins Postal Station, Montreal, Canada H5B 1B2.

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PART I: THE RATIONALE OF THE PROFILES FOR UPGRADING THE PRODUCTION CAPABILITIES IN THE AGRICULTURAL MACHINERY INDUSTRY IN AFRICA FROM LEVEL TO LEVEL

1.0 THE RATIONALE FOR UPGRADING THE PRODUCTION CAPABILITIES

The development of agricultural machinery industry in Africa, till now, has been mostly in terms of sporadic establishment of manufacturing units through foreign collaboration, with little contribution to the development of the local production capabilities. Attempts to develop this sector in the past were always initiated and discussed in terms of policy, strategy and planning, but never emphasizing and involving the important aspect of the local production. As a result the agricultural machinery industry in Africa, at present, is unable to produce adequate quantity and quality of simple equipment to meet the needs of the majority of farmers. The industry appears to have certain production capacities but seems to be limited in capabilities to produce the priority equipment needed.

It is time that the African countries break away from the traditional standard pattern of outright importation of technology and total dependence and continued reliance on outside sources in the development of this essential sector. The African countries should explore more innovative ways to develop the sector, based on the principles of self-reliance and co-operation among the countries; to explore the possibilities and potentialities to mobilize their resources, to utilize and enhance their existing technological capabilities and pool them up to complement each other's for mutual benefit and produce the equipment needed.

To realize the objective of the Lagos Plan of Action of attaining self-sufficiency in food by the production of sufficient quantities of agricultural tools and machines, there is an urgent need to upgrade the production capabilities, from the existing levels to higher levels, utilizing the local resources and technological capabilities, in order to meet the priority needs in the agricultural equipment through local production.

There are production capacities existing in the African countries. Some mechanical and metallurgical engineering facilities exist. The basic technologies have been acquired. But the production capabilities are not yet adequate. The present production of the equipment is not sufficient. The priority needs are in the simple and intermediate equipment. Therefore the main emphasis should be focused on how to produce this equipment utilizing the existing production facilities and technological skills and develop them progressively. One way is to upgrade the agricultural machinery sector and to accord to it the priority it deserves. To upgrade the production capabilities of the existing capacities at the enterprise level, through modest expansion, diversification into a higher category of product involving related basic technologies and new development, utilizing the existing facilities and skills and further developing them with additional inputs in terms of product know how, equipment and manpower, with minimum investments and resulting in quicker outputs.

Further, one may not promote, at the start, the consideration of the multitude of factors that one may desire to develop the industry. The problems may become too complex and there will be no start made. So, one may consider a "start-up" to break the present stagnation. Once a modest viable process of decision making and a modest additional production starts, then the situation will become self-sustaining and dynamic and countries can make next step decisions. In other words, through a methodology to upgrade existing production facilities, it is possible to keep the problems simple, which would facilitate quicker decisions on a modest scale that will act as a spring board for the next set of more complex decisions by the policy making bodies of the Government. However, to implement the upgrading process, certain policy and Government support would be necessary.

In view of the primary importance on increased food production and the priority on the equipment, the agricultural machinery sector should be given its due attention.

The industry, as it exists, is in different levels of production capability, as related to the manufacture of hand tools, manually operated machines, animal-drawn implements and some power operated implements and machines in the artisan, small and medium scales of production.

Hand tools are being produced by the artisans and in the small and medium scale industry including modern plants in some countries. But yet most countries are importing hand tools. There is an urgent need to be self sufficient in hand tools. The rural artisans should be upgraded and integrated into the industry and agriculture through organized aid and support programmes to produce not only hand tools but also more complex machinery and cater to the rural repair and maintenance needs. Forging is the major process for the manufacture of hand tools, and is also an important one for animal-drawn implements manufacture. There is an opportunity for the units producing hand tools to diversify into animal-drawn implements and simple manually operated machines. This could be a way to find an economic operation to meet the potential market.

Animal-drawn implements are manufactured in small and medium scale operations in several countries. Opportunity exists to extend this capability to other African countries. This would reduce the imports of this equipment and accelerate the process of mechanization. The technology required to manufacture tractor-drawn implement is similar to that of animal-drawn implements. When the capability is developed for animal-drawn implements it would easily lend itself for the manufacture of tractor-drawn implements.

While the manufacture of tractors and tractor-drawn implements is at an early stage of development and economy of scale might be a constraint for the development of tractor manufacture in many countries, the tractor-drawn implements and simple power operated equipment can be manufactured with additional inputs. As already

mentioned, since the technology of manufacture for animal-drawn implements is similar to that of tractor-drawn implements, the development of operations to manufacture tractor-drawn implements in combination with animal-drawn implements can be a way to find economic scale of operation to match the present narrow domestic markets in African countries. Sub-regional co-operation in trade and in production could be a great opportunity.

Based on the above rationale, three industrial profiles for upgrading the production capabilities are presented in this document. These profiles indicate the ways and means on how a country can upgrade the production capabilities from the existing level to the next higher level. Each profile focusses on the engineering and technology part of the requirements and its directly related factors such as financing, training, research and development and organization; as well as the operating facilities related to sources of supplies, R and D and marketing. However, other important factors to be considered in the formulation of an agricultural machinery industry programme are not specifically discussed, such as the need for machinery in Africa and the marketing and distribution policy. The three profiles present the upgrading requirements for the production of hand tools, animal-drawn implements and manually operated machines; tractor-drawn implements and simple power operated machines. The levels of production capability are defined in terms of product category and production scale. Countries, depending upon the existing level of production capability, can choose the various alternatives and possibilities related to the product categories and production scales. (Annex 1).

2.0 THE PRODUCTS

Considering the majority of the developing countries of Africa, - with due consideration to the size of holdings, the farm income, the agricultural technology at present farming level etc., the need for agricultural machinery, which may have a potential for local production are simple agricultural tools, animal-drawn implements, manually-operated equipment and simple low cost power-drawn implements. The following are broad-based categories.

Category 1:

Hand tools and simple manually-operated machines: hoes, forks, shovels, spades, axes, machette, cutlasses, sickles, scythes, knives, etc.; hand wheel-hoe, planters, seed-drills, etc.

Category 2:

Animal-drawn implements and manually-operated machines; ploughs, mould-board ploughs, ridgers, harrows, cultivators, planters, seed-drills, manure spreaders, etc.; threshers, choppers, shellers, grinders, mills, decorticators, etc.; dusters, sprayers, hand pumps, etc.; dryers, bins, carts, etc.

Category 3:

Tractor-drawn implements and simple power operated machines: ploughs, seed-drills, cultivators, harrows, disc-harrows, harvesters, etc.; threshers, choppers, shellers, grinders, mills, etc.; dusters, sprayers, pumps, etc.; dryers, silos, trailers, etc.

Category 4:

Tractors, combines, engines and other specialized equipment.

3.0 THE SCALE OF PRODUCTION

Artisanal production (scale 1)

Machining; no machining

pedestal grinder

Forging: hand forging
blacksmith hand tools, charcoal fired furnace with hand-blown bellows.

Heat-treatment: simple quenching
quenching tanks

Welding: possibly arc welding

Small-scale production (scale 2)

Batch quantity: small batch

Machining: simple machining
lathe, milling, drilling and shaping machines/grinding

Fabrication: simple sheet metal work
power shear, manually operated and power-operated roll-form machines, nibbling machines

Forging: small scale forging
oil fired forging hearth, tilting furnace, pneumatic forging hammer or spring forge without fixed dies

Heat-treatment: simple salt bath

Welding: arc welding with electrodes/shielded arc welding with wire

Casting: few castings required, in-plant casting facility not required.

Medium-scale production (scale 3)

Batch quantity: small to large batch

Machining: simple to complicated machining
universal machine tools, as in scale 2, but larger sizes

Fabrication: simple sheet metal work
machines as in scale 2, but larger sizes

Forging: small scale forging
forging equipment as in scale 2, but larger sizes
specialized forging equipment in the case of medium/large scale hand tools production

Welding: considerable welding, equipment similar to that in scale 2

Casting: in-plant casting facility can be considered

4.0 THE FOUR LEVELS OF PRODUCTION CAPABILITY

The agricultural machinery industry in Africa, in general, is in four levels of production capability. The grouping of the countries (Annex ii) is an indicative guide but not exhaustive or rigorous.

Level 1 - Production Capability

- Limited production of hand tools exists (category 1/limited range*);
- At artisan and small scale (scales 1 and 2);
- With inadequate production facilities;
- Inadequate engineering facilities (foundry, forging, heat-treatment,etc.);
- Countries will lay emphasis on local production of hand tools and simple manually-operated machinery (category 1, larger range* emphasized).

Level 2 - Production Capability

- Manufacture of limited hand tools, some manually-operated machines and some animal-drawn implements, exists (categories 1, 2);
- At artisan and small scale (a few countries at medium) (scales 1,2);

- With inadequate production facilities;

- Limited development of engineering facilities (inadequate);

- Countries will lay emphasis on local production of hand tools, manually-operated machines and animal-drawn implements. (categories 1 and 2 larger range* required).

Level 3 - Production Capability

- Manufacture of limited hand tools, some manually-operated machines and simple power-operated machines and limited tractor-drawn implements exists (categories 1, 2 and 3 limited range*);

- At artisan, small and medium scale (scales 1, 2 and 3);

- With inadequate production facilities;

- Adequate engineering facilities (adequate);

- In addition to hand tools animal-drawn implements, manually-operated and power-operated machines, countries will lay emphasis on local production of tractor-drawn implements (categories 1, 2 and 3 fuller range* required).

Level 4 - Production Capability

- In addition to items category 1, 2, 3 manufacture (assembly/limited parts production) of tractors and engines exists (categories 1, 2, 3 and 4/limited range);

- At artisan, small and medium scale (scales 1, 2 and 3);

- With adequate to good production facilities;

- Good engineering facilities (adequate to good);

- In addition to hand tools, animal-drawn implements, manually-operated and power-operated machines and tractor-drawn implements, countries (categories 1, 2 and 3 and 4/larger range required) (since the equipment required in the heavy mechanization model caters to the minority requirements of 5% land and

* The range, in each category of product, refers to the various tools, implements or machines required to form a complete package to cover all the essential agricultural operations to avoid bottlenecks in the agricultural production process (e.g.: equipment for tillage is produced but corresponding equipment for harvest, post-harvest and transport not produced).

1% farmers, upgrading to this level of production capability to produce tractors and engines is not considered in the discussion. Further, the choice of produts and production units in this range depends on the country and the technical collaborator).

5.0 PROFILES FOR UPGRADING

The profiles present the ways and means on how a country can upgrade the production capabilities from one level to the next higher level in terms of the product categories and production scales, such that countries, depending upon their existing level, can choose the various alternatives and possibilities related to the product categories and scale of production.

6.0 TO UPGRADE

A programme to upgrade existing facilities of engineering production units in general and agricultural machinery production units in principle will result in production of agricultural tools, implements and machinery at an early date with minimum investment. The output will be (a) increased production volume of presently produced product/products (b) and/or increased volume of production and diversification with additional new products (c) and/or increased value added. In all these aspects, the improvement of quality and reduction of production costs are to be inbuilt elements.

7.0 PROBLEMS OF THE INDUSTRY

A number of surveys, diagnostic analysis, fact finding missions, techno-economic analysis, etc. have been conducted in most of the developing countries of Africa on the status of engineering production sector in general, and agricultural machinery manufacturing units in particular. Many reports, technical documents, and manuals have been written highlighting the constraints, bottlenecks, problems of the manufacturing units. The present problems may be enumerated as follows:

At rural family units and small scale industry level, the problems are: (i) inadequate finance and unstable markets; (ii) lack of low-cost improved production facilities; (iii) lack of improved designs; (iv) lack of suitable materials, particularly high-carbon steel and hardware; (v) lack of suitable machinery and equipment and heat treatment facilities; (vi) lack of suitable production technologies.

At medium and large scale level the problems faced are somewhat different. However, main problems may be sumarized as follows:

(a) lack of sufficient internal markets and export outlets;

(b) lack of suitable designs. In many cases those supplied by foreign collaborators need modifications for local use;

(c) uncertainties in supply of spare parts, which often lead to machine breakdowns and plant stoppages;

(d) higher production costs caused by low productivity;

(e) increasing prices of raw materials;

(f) lack of technical personnel at the middle management level;

(g) lack of training facilities, particularly at the operator level;

(h) insufficient working capital;

(i) substitution of high-quality parts with lower-quality ones to save money. This is false economy and reduces customer satisfaction.

There is no overall solution to these problems. Individual agricultural machinery manufacturing units must analyse all of the major poblems that hinder their production. However, production expansion and product diversification could be achieved through modest upgrading of the facilities with appropriate organizational/management/training aspects at factory/industry level. In order to facilitate factory/industry management to undertake such upgrading, there is a need for the Government to provide appropriate incentives, benefits, facilities and institutional support with respect to engineering design, finance, common engineering facilities, training etc. as well as raw material supply, marketing facilities and technical guidance/services. This will call for the Government to establish a mechanism to provide these services to agricultural machinery production sector on a priority basis.

8.0 HOW TO UPGRADE

Although, more agricultural machinery could be produced either through establishment of new production units or by upgrading existing engineering/agricultural machinery industrial units, the following analysis is limited to the later proposition as it will result in quick outputs. It must be understood that action by individual factories/industries to expand/upgrade on a modest scale (which is quite logical and obvious) will not solve the national problems, but to promote, encourage and assist a number of existing units to upgrade will contribute towards meeting national agricultural machinery requirements fast with minimum investment at factory level.

- countries not producing any equipment to establish manufacture of hand tools and manually operated machines at artisanal and small scale engineering units.

- countries producing various equipment in various scales of production to upgrade the existing units in the following manner:

- to upgrade existing units producing hand tools to achieve increased volume of production and add manually operated machines to the product mix.

- to upgrade units producing hand tools and manually operated machines to diversify into animal-drawn implements and additional manually operated machines required to cover essential agricultural operations.

- to upgrade existing units producing animal-drawn implements to increase the volume of production adding additional implements.

- to upgrade units producing animal-drawn implements to diversify into simple tractor-drawn implements and power operated machines.

- The upgrading will also involve the following elements:

  - promotion of artisanal production.

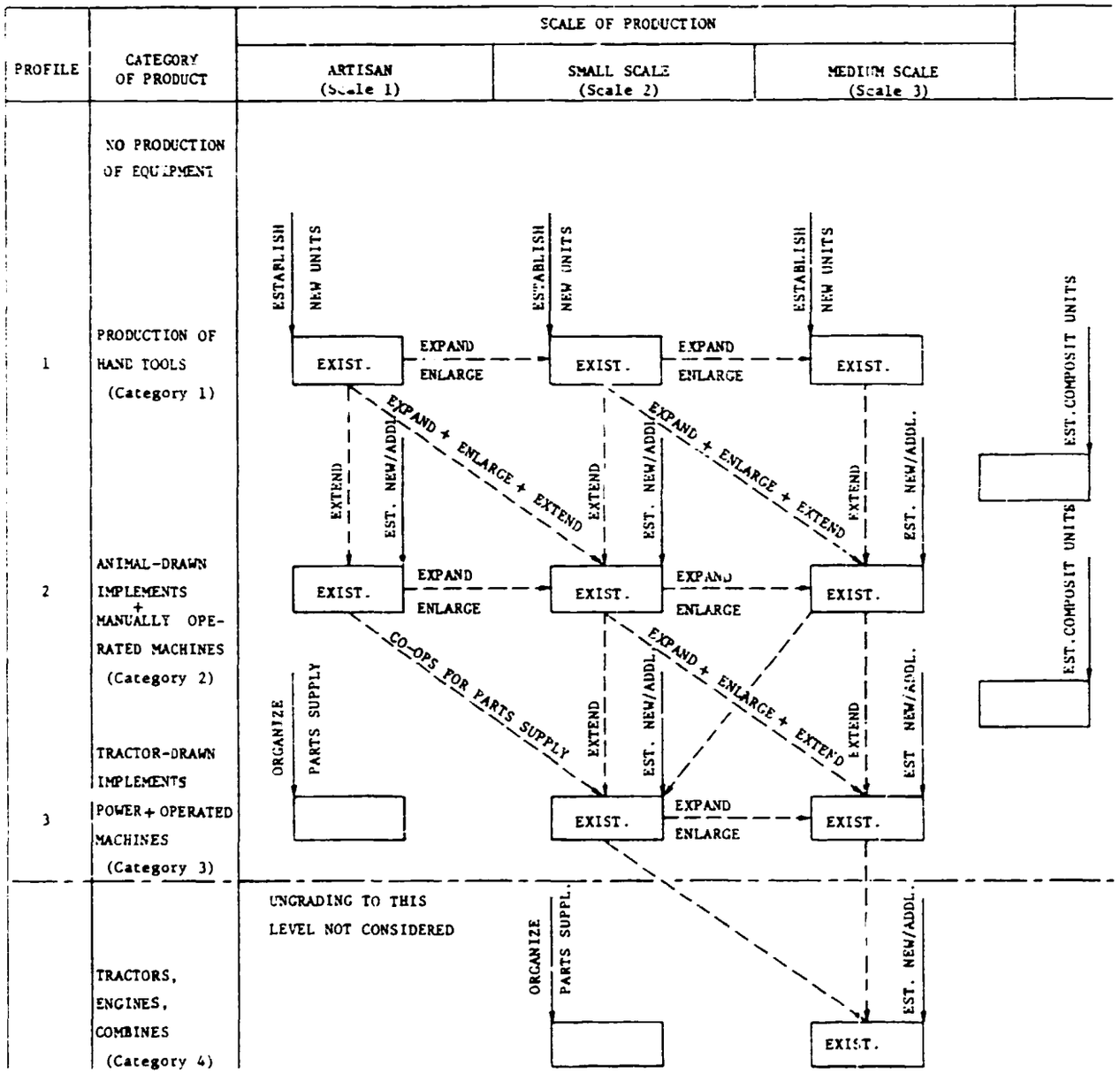
  - promotion of sub-contracting between production units and with ancillaries.

  - upgrading the basic facilities such as foundry, forge, heat treatment, etc.

Annex (i)

FIGURE 1

UPGRADING CHOICES



Annex (ii)

COUNTRIES OF LEVEL 1 PRODUCTION CAPABILITY

(classification is only indicative but not rigorous)

Annex (ii)a

COUNTRIES OF LEVEL PRODUCTION CAPABILITY

(classification is only indicative but not rigorous)

Annex (ii)b

COUNTRIES OF LEVEL 3 PRODUCTION CAPABILITY

(classification is only indicative but not rigorous)

Annex (ii)c

COUNTRIES OF LEVEL 4 PRODUCTION CAPABILITY

(classification is only indicative but not rigorous)

LEGEND

′ Manufacture of Tractors (Algeria, Egypt, Zimbabwe)

′ Assembly of Tractors (Morocco, Tunisia)

* Assembly/Phase I manufacture of Tractors under negotiation/just started (Ethiopia, Libya, Nigeria, Sudan, Tanzania)

\# Locally developed simple tractor assembly/manufacture with **imported** engine, transmission, steering, tyres (Swaziland)

PART II: REQUIREMENTS FOR UPGRADING THE PRODUCTION CAPABILITIES IN THE AGRICULTURAL MACHINERY INDUSTRY IN AFRICA FROM LEVEL TO LEVEL

EXECUTIVE SUMMARY

1. BACKGROUND FOR THE STUDY

The first UNIDO Consultation on the Agriculture Machinery Industry held at Stresa, Italy in October 1979 considered issues relating to development of this industry on a worldwide basis.

In preparation for the first African Consultation on development of the agriculture machinery industry, the considerable progress achieved and the potential for development of this industry were examined. The opportunities for accelerating development by means of upgrading the production capabilities are real.

Patterns of success in developing manufacture of agricultural machinery have emerged in Africa. Manufacture of hand tools at all levels of technology has been initiated. Village artisans are being upgraded and a base for the important repair and maintenance of more complex machinery in rural African areas is being established in many countries. Sophisticated modern forging plants producing high quality hand tools are operating in several African economies. Yet the domestic production is not adequate and most countries are importing hand tools. There is an urgent need to be self sufficient in hand tools.

Manufacture of animal drawn implements are established in several countries, in large and medium scale of operations. The opportunity exists to extend this capability to more African countries, first to replace imports whose demand has been established and second to accelerate the process of upgrading farms and increase the demand.

Manufacture of tractors, tractor drawn implements and complex power operated machinery is at an early stage of development and economy of scale factors may restrict development of manufacturing of tractors in many countries, but the drawn implements and simple power operated machines can be produced with additional inputs.

Three profiles of upgrading choices and requirements are presented. They indicate ways and means on how a country from its existing level, would reach the next higher level of production capability. Profile 1 indicates conditions to reach production of hand tools for a country not producing any machinery. Profile 2 indicates how a country producing hand tools could go to the level of producing animal-drawn implements and manually operated machines and Profile 3 how to reach the next level of production of tractor-drawn implements and power operated machines. The levels of production capabilities are defined based on the categories of products and the scales of production.

These profiles are designed to help the decision makers in Africa to understand the issues involved in the selection of a production level and its upstream effect and to assist them in this development planning and interegional discussions.

The study also presents the techno-economic requirements for two composite units: a hand tools and animal drawn implements plant and an animal drawn implements and tractor drawn implements plant.

2. THE PRODUCTS

The range of product in the agriculture machinery sector is wide. Products range from simple hand tools that imply simple human powered agriculture technology but sophisticated manufacturing technology to complex product such as tractors that imply both complex agriculture technology and complex manufacturing technology. The development of animal traction with intermediate agricultural technology and intermediate manufacturing technology associated with animal drawn implements covers the spectrum of cultivation machinery required for agricultural mechanization.

In addition to cultivation and harvesting machinery, there is machinery used on the farm for irrigation, post harvest processing of the crop, crop storage and preservation, crop handling and transport. There is also an urgent need to develop and manufacture machinery of intermediate mechanization, appropriate to African agriculture.

A classification of this wide range of products into categories provides a framework for discussion.

o Simple Agriculture Implements and Hand Powered Equipment

Hand tools such as hoes, axes, machetes, sickles are in widespread use. These products are manufactured in: artisan workshops; intermediate scale and intermediate technology manufacturing facilities; and specialized modern forging facilities.

o Animal Drawn Implements and Simple Power Operated Machinery

The develcpment of animal traction requiring implements and machinery is of special importance as animal traction provides the means to extend the size of farm and to provide surplus crop over and above the farm family subsistence need. Such farms also require low cost harvesting and post harvesting machinery.

Fabrication of these products requires intermediate technology used in industrial workshops and medium scale industrial factories, particularly where the manufacturing facility combines animal drawn implements with hand tools, transport machinery and intermediate farmstead storage and post harvest processing machinery.

o Powered Agriculture Mechanization Machinery

The development of tractor mechanization provides opportunities to manufacture tractor drawn implements, specialized agriculture product, transportation machinery and more complex power operated post harvest crop processing machinery as well as water pumps and irrigation machinery.

Manufacture of such products requires medium scale light engineering facilities, of a higher degree of technical sophistication.

o Specialized Agriculture Machinery and Equipment

This category of manufacturing facility is capable of manufacturing tractors and self-propelled harvesting machinery together with related tractor drawn implements. The degree of product specification requires a facility concentrating and specializing in the manufacture of these products exclusively. A high degree of technical sophistication is required.

3. BASIC INPUTS REQUIRED FOR UPGRADING

3.1 Introduction

The essential inputs and/or constraints for development of agricultural equipment manufacturing capability are:

- Raw materials, parts, supplies and capital goods
- Research and Development
- Appropriate Scale
- Manpower
- Basic engineering support facilities

These are summarized in the following paragraphs.

3.2 Raw Material Parts

For all categories of agriculture machinery, steel is the primary input. Mild steel in the form of structural shapes and bar, sheet and plate is dominant. When a country is equipped with steel making capacity, the agriculture machinery industry is a major user of such product, second only to construction steel. When a country does not have domestic steel making capability commercially viable options are still possible.

Special steels for forgings, tool and die requirements require importing Agriculture machinery is an important market for ancillary industries such as for hardware and fasteners, as they develop within an economy.

There is a heavy dependance on import of capital goods and heavy initial foreign exchange is required for initial facility inputs.

African countries, even those with considerable industrial infrastructure, require large initial foreign currency allocation for start-up and for maintaining the continuous supply of materials.

3.3 Research and Development

In the case of hand tools little in the way of product Research and Development is required.

In the case of animal drawn implements and related agriculture machinery, Research and Development is a major requirement. Developed countries have little to offer. Developing countries in Asia and Africa have accomplished much in the way of indigenous research and development. Technology transfer is taking place between the developing countries but there is the requirement for every African country to make use of this process by:

- o Acquiring knowledge of development activities in other developing countries; and
- o Adaptation of such knowledge to their own particular agriculture environment.

Research and development on the agronomy aspects of animal traction is distinct from research and development of the agriculture machinery product. Different institutions have been developed for agronomy and machinery related R & D. Such R & D should be interlinked and coordinated. In turn, machinery related R & D requires interlinkage and coordination with industry and agriculture.

3.4 Appropriate Scale

Levels of production required to ensure a viable operation vary considerably with the type of products and the nature of the operation.

In the case of hand tools almost all African economies have market sizes large enough to support both artisan scale of manufacture, the small scale workshop and the modern sophisticated forging shops required for high quality hand tools. Economic scale of operation for such modern facilities is about 1 000 000 pieces per year. When such modern hand tool factories produce both hoes and cutting tools in combination, commercial viability is further assured and such facilities can compete with imports, even in less industrialized economies.

The competitive scale for a facility manufacturing animal drawn implements and related products is between 2 000 and 4 000 tons of product per year. Again, markets to support such facilities are developed in all of the African countries with climate conditions conducive to animal health and strength.

For tractor drawn implements, tractors and self-propelled harvesting machines and power operated agriculture machinery, economy of scale restrictions are a definite limitation. Volumes of 10 000 units a year are required to establish competitive tractor manufacturing plants. Tractor assembly plants require markets of 2 000 units a year. Very few African countries have developed markets of this scale although the rate of tractor mechanization is leading to this in a number of African countries.

For tractor drawn implements, production of 500-600 units/year of a specific implement could become viable provided it is combined with the manufacturing of non-agricultural products (e.g. transportation equipment, steel furniture) in light engineering facilities.

There are also opportunities for export trade between African countries. This pattern has evolved in Senegal where trade has developed between neighbouring countries and has encouraged the growth and development of the SISCOMA facility. Further development of this successful pattern would accelerate development of manufacturing of tractors, tractor drawn implements and the more complex power operated equipment.

3.5 Manpower

In the case of artisan and industrial workshop operations much of the required skills have been developed in some countries. Successful training programs, in Mali and Upper Volta for instance, have demonstrated what can be done to upgrade such skills in an organized and effective manner.

For the modern hand tool forging operation, successful projects have shown that technology can be transferred in a short period of time by the initiatives of both private and public sectors. While the work force skills may be readily transferred by on-the-job training, engineering and entrepreneurial skills usually require sustained external assistance.

In the case of the intermediate technology involved in animal drawn implement manufacture, much of the initiatives and development has come from indigenous sources. Apart from the entrepreneurial initiative (which can be deliberately fostered by African states seeking to accelerate this development) manpower and skills are also required. Such skills can be readily developed from within the economy.

In the case of tractor drawn implements, and related machinery, the technological skills required can be developed from the skills existing for the manufacture of animal-drawn implements.

Vocational training programs now underway in the more developed African industrial countries for skilled technicians and skilled tradesmen are a usefull supplement to their on-the-job training process.

Formal agriculture engineering, engineering and management training at university level is a necessary input to the industrial development process. This training has been sufficient for the successful operations reviewed. Development of these professionals in on-going operations is a necessary input to the industrialization process generally.

3.6 Basic engineering support facilities

The development of agricultural equipment manufacturing capability requires basic engineering support facilities such as foundries, forge shops, heat treatment shops, tool rooms and ancilliary industrial units/estates, for the supply of castings, forgings, tools and machine parts. When the industrial infrastructure of the country does not provide this support, the agricultral equipment manufacturing unit will have to consider some additional investment.

4. THE ROLE OF INSTITUTIONS IN UPGRADING

4.1 Introduction

The accelerated and cost effective upgrading of agricultural equipment manufacturing requires coordinated input from a number of national and international institutions and organizations in relation to the following functions which are discussed in more detail below:

- o industrial analysis and promotion
- o financing
- o additional services
- o technical assistance

4.2 Industrial Analysis and Promotion

Government as an active promoter of industrial development generally and specifically for the agricultural equipment industry can act to form and strengthen an agricultural equipment capability within the existing industrial development structure of the Ministry responsible for industry and trade.

The tasks to be undertaken would include:

- o market studies on present and future market demand for agriculture machines
- o assistance to the private sector in prefeasibility/feasibility studies for establishment of new facilities or expansion of existing facilities;
- o identification of potential African and/or foreign partners interested in licensing arrangements or joint-venture investment and promotion of this interest with national established manufacturers, investors, entrepreneurs;
- o coordination of policy related to incentives for industrial development such as tax incentives, tariff protection for infant industries, industrial park infrastructure concessionary finance and the communication of such incentives to potential investors and partners;

- o communication and liaison with other African countries to promote regional and sub-regional cooperation and rationalization of production and market sharing.

4.3 Financing

The role of financial institutions in relation with manufacturers and farmers should be as follows:

- o At the Manufacturer's Level

  In addition to ensuring access to adequate financial services it is essential that foreign exchange allocation be provided. This will enable the manufacturers to plan for foreign exchange requirements for capital goods, continuous supply of the necessary imported raw materials.

- o At the Farmers's Level

  In order to purchase tools, animal drawn equipment and tractors the initial investment usually requires credit support. Solvent demand can be promoted through such programs. Farm credit institution, government institutions, cooperative credit institutions and banks, all can perform this necessary role.

  Experience gained in the establishment of such programs points to the need to administer an appropriate mix of owner equity, interest rates (perhaps concessional), repayment period and discipline in collection procedure in order that these programs continue to be credit worthy and commercially viable.

4.4 Additional services

Additional services required from governments include:

- o Development of agricultural research to demonstrate effective mechanization technology;
- o Development of agriculture extension services to communicate and promote apropriate mechanization practice;
- o Development of distribution systems for agriculture machinery to rural areas;
- o Development of rural repair and maintenance and spare parts supply;
- o Development of training institutions;
- o Development of industrial extension services to provide effective engineering support to agricultural machinery production units;
- o Development of rural raw material supply.

4.5 Technical Assistance

The support of international, and particularly of multi-lateral organizations is required in the process of agricultural mechanization and agriculture machinery development.

This support can consist of the following typical activities:

- o Technical support for establishment of agriculture mechanization including R & D, prototype manufacturing facilities and support for the establishment and training of expert staff;
- o Support for prefeasibility/feasibility studies in this field;
- o Assistance in promotion of regional and sub-regional cooperation agreements;
- o Provision of advisory services to government project teams involved in negotiation of license agreements and joint-ventures, model contracts;
- o Support for establishment or development of Industrial Promotion Institutions (Industrial Extension Services);
- o Establishment of centers of expertise in agriculture machinery manufacturing technology.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Overview

Analysis of the requirements for upgrading of agricultural equipment manufacturing capability leads to the conclusions that there are four issues which are critical to the success of any program meeting the basic market and financial requirements.

These issues are:

- o Coordination of agricultural and industrial development
- o Linkages with the market
- o Development of technology
- o Economies of scale and regional cooperation

The issues are discussed and recommended actions are presented in the following paragraphs.

5.2 Coordination of Agricultural and Industrial Development

The establishment or upgrading of agricultural equipment manufacturing requires extensive coordination between the industrial and agricultural sectors. For instance, it is frequently found that there is an imbalance between production inputs and demand for the equipment. This raises the question of the coordination and planning process, as well as of analysis in support of decision making. The following are required to ensure an appropriate development.

- o A national level planning and analysis task force unit for agricultural machinery. This unit, separate from but incorporating expertise in the basic agricultural and industrial functions, would have responsibility for policies within the sub-sector, with particular emphasis on the coordination of equipment manufacture with agricultural development needs and industrial capabilities.

- o A national industrial promotion and project planning capability, to carry out the objective preparation of project proposals in order to obtain requisite financing and technical assistance.

- o Technical support from international and other multi-lateral or bi-lateral industrial cooperation agencies.

5.3 Linkages with the Market

It is necessary to ensure that the marketing and distribution functions are properly developed and carried out so as to provide steady sales of product and so facilitate production planning. A number of actions are required regardless of the specific marketing and distribution system established.

- o Grouping and control of orders at the level of local organization, for example with cooperatives.

- o Development of as wide a customer base as possible in order to ensure initial markets and to limit production fluctuations. Clients could include cooperatives, development projects, agro-industrial complexes and even export markets.

- o Development of flexible and appropriate credit systems.

5.4 Development of Technology

It is essential that research and development activities be undertaken in-country both for agronomy, for agricultural equipment and for manufacturing processes. This requires that product development capability be established at the manufacturing level, and that this capability be coordinated with the agricultural and machinery research efforts.

The options for acquisition of technology for the three levels of equipment are as follows:

- o Animal drawn equipment. Developed countries have little to offer, but some developing countries have accomplished much in the way of indigenous research and development. Therefore a knowledge of development activities in other developing countries, is important, and a capability for adaptation of such knowledge to a nation's own particular agricultural environment must be developed.

- o Tractor drawn equipment technology generally corresponds to that of animal-drawn implements but at a higher level. When the latter is existing it can be developed to manufacture tractor-drawn implements.

5.5 Economies of Scale and Regional Cooperation

Hand tools and animal drawn equipment manufacturing facilities can readily be sized to be viable in most national or local area markets. Tractor drawn equipment, however, frequently requires larger markets, unless such manufacturing is combined with other light engineering activities.

There are, however, clear advantages resulting from the higher volumes of production attainable with regional cooperation. Such cooperation could cover the following areas:

- o A range of accords, from commercial agreements to industrial integration;

- o Research and development programmes;

- o Standardization of input materials and complementarity of manufacturing activities.

1. SCOPE OF THE STUDY

The profiles examine the choices and requirements for upgrading the production capabilities of local capacities in the agricultural machinery industry in Africa from one level to the next higher.

The profiles are based on existing situations of the agricultural machinery industry in eight selected countries namely:

Cameroun
Mali
Senegal
Zaïre
Ethiopia
Uganda
Kenya
Zambia

Three profiles of upgrading choices and requirements are presented. They indicate ways and means by which a country or a production unit, from its existing level, would reach the next higher level of production capability. Profile 1 indicates conditions to reach production of hand tools for a country not producing any machinery. Profile 2 indicates how a country producing hand tools could go to the level of producing animal-drawn implements and manually operated machines. Profile 3 indicates how to reach the next level of production of tractor-drawn implements and power operated machines.

The study also presents the techno-economic requirements for two composite units: a hand tools and animal drawn implements plant and an animal drawn implements and tractor drawn implements plant.

2. METHODOLOGY

In order to draw the three profiles the following methodology has been developed:

- Definition of the terminology to be used
- Review of country studies and other documents of international fora.
- Research of supplementary information
- Analysis of existing situation
- Review of minimum requirements
- Establishment of upgrading choices and requirements
- Field survey
- Illustration of profile with cases

3. DEFINITIONS

It is necessary first to present some of the terminology used in the profiles.

- Levels: The levels of production capability are defined in the Rationale. Each level involves certain product categories and scales of production. The profiles indicate upgrading requirements for each category and in each level.

- Product categories: The profiles focus on three different product categories. Category 1 represents the hand tools, Category 2, the production of animal drawn implements and manually operated machines and Category 3, the tractor drawn implements and power operated machinery. The production technology is determined by the product and the scale or stage of production, which is given in detail in the profiles for each category of products and each scale/stage of production.

- Scales/Stages: For each product category the development of the industry can be at the village blacksmith stage, at the workshop stage or at the industrial plant stage. More than one stage can exists in a given country for a given category as, for example, in Zaire where there is a network of village blacksmiths and an industrial plant manufacturing hand tools.

  Generally in the study, stage 1, which is the village blacksmith, will be understood as an organized network of village shops. That is, before stage 1 is reached a number of village blacksmiths may exist in the country but are not part of any governmental programme or development plan and therefore do not meet significantly the hand tools demand.

- Case Illustration: Most of the observations and conditions discussed in the profiles are illustrated with real situation taken from selected countries. These cases are presented only for purposes of illustration and must not be taken as judgements or recommendations on a given country.

- Industrial Infrastructure: The upgrading conditions are established considering two types of industrial infrastructure. A limited industrial infrastructure means that the country has a limited industrial capability which could help the establishment of an agricultural machinery industry. A strong industrial infrastructure means that the country has some capabilities which can support, at least partially, the establishment of an agricultural machinery industry. The following chart (Chart I) summarizes the actual status of industrial infrastructure related to agricultural machinery in the eight selected countries.

FIGURE 5 [illegible]

[illegible] INFRASTRUCTURE [illegible] SELECTED COUNTRIES

INDICATORS		ZAIRE	SENEGAL	MALI	[illegible]	[illegible]
PRODUCTION CAPABILITY FOR AGRICULTURAL MACHINERY:						
LEVEL 1: HAND TOOLS	STAGE: 1	WORKSHOP DEVELOPMENT PROGRAM	TRAINING PROGRAMS; 2 HANDICRAFT MAKERS; 5 DEVELOPMENT ORGANIZATION	TRAINING PROGRAMS; 2 DEVELOPMENT ORGANIZATIONS		
	STAGE: 2	-	-	-		[illegible]
	STAGE: 3	3 [illegible] METAL [illegible]	-	-		
LEVEL 2: ANIMAL DRAWN	STAGE: 1	-	-	-		
	STAGE: 2	-	-	-		
	STAGE: 3	-	[illegible] (SISCOMA)	[illegible]	[illegible]	[illegible]
LEVEL 3: TRACTOR DRAWN	STAGE: 1	-	-	-	-	
	STAGE: 2	-	-	-	-	
	STAGE: 3	-	-	-	IN PROJECT	
LEVEL 4: TRACTORS		2 (FIAT, [illegible])	IN PROJECT	-	IN PROJECT	
- SUPPORT FACILITIES						
FORGING		1	1	1		[illegible]
CASTING		4 2535t	2	4		SEVERAL
STRUCTURAL SHAPES & TUBES		2 [illegible]	1	PARTLY		
BARS & RODS		1	-	-		[illegible]
SHEET STEEL		1	-	-		
ANCILLARY		1 225t	2	-		
FACTORY SUPPLIES		PARTLY	PARTLY	-		[illegible]
- PRODUCTION OF TOOLS & EQUIP'T (CAPITAL GOODS)						
FABRICATION:	(LIGHT)	NONE	NONE	NONE	NONE	LIMITED
FABRICATION:	(MEDIUM)	NONE	NONE	NONE	NONE	LIMITED
MACHINERY		NONE	NONE	NONE	NONE	LIMITED
- INSTITUTIONS (EDUC. & TRAIN.)				TRAINING CENTER OF [illegible]		
VOCATIONAL TRAINING		TECH. SCHOOLS & COMPANIES	[illegible] TECH. SCHOOLS & COMPANIES	3 TECH. SCHOOLS & COMPANIES	CENTRE [illegible] & COMPANIES	[illegible]
TECHNICAL ENGINEERING		2 FACULTIES	2 [illegible]	1 SCHOOL		UNIVERSITY
MANAGMENT TRAINING		3 FACULTIES: 1 TECH. INSTIT.	1	1 SCHOOL		UNIVERSITY
AGRICULTURAL ENGINEERING		2 FACULTIES: ENG. & TECHN.	1 TECHNOLOGICAL INSTITUTION	1 SCHOOL		UNIVERSITY
- FINANCIAL INSTITUTIONS						
PRIVATE DEVELOPMENT BANK		> 10	5	2		
INDUSTRIAL CREDIT		NONE	2	1 [illegible]	1 [illegible] WITH FOGAPE	
INTERN. & GOVERN'T FINANCE AGENCY		NONE	2	1 [illegible]	[illegible]	
FARM CREDIT		IN PROJECT	1	SCAER & BNDA	[illegible] WITH DEVELOPMENT [illegible]	
- RESEARCH & DEVELOPMENT CENTERS						
GENERAL INDUSTRIAL DESIGN		1 [illegible]	5 PUBLIC INSTITUTIONS	[illegible]	[illegible] INDUST. ENGIN. [illegible]	
AGRICULTURAL EQUIPMENT		OPEZ	2 PROJECTS (CNEFER & INOR)	DIV. MACH. AGRIC. HANDICRAFT	CENEEMA	UNIVERSITY
INDUSTRIAL EXTENSION SERVICE		NONE	SONEPI	CEPI	CAPME WITH 5 REG. OFFICES	
AGRICULTURAL EXT. SERVICE		6 PILOT CENTERS	6 REGIONAL DEVELOPMENT SERVICES; TRAINING CENTER OF SISCOMA	"ACTIONS AND OPERATIONS"	NATIONAL OFFICE OF DEVELOPMENT PARTICIPATION; DEVELOPMENT SOCIETIES; AGRIC. INDUSTRIAL COMPLEXE; COOPERATIVES	[illegible]

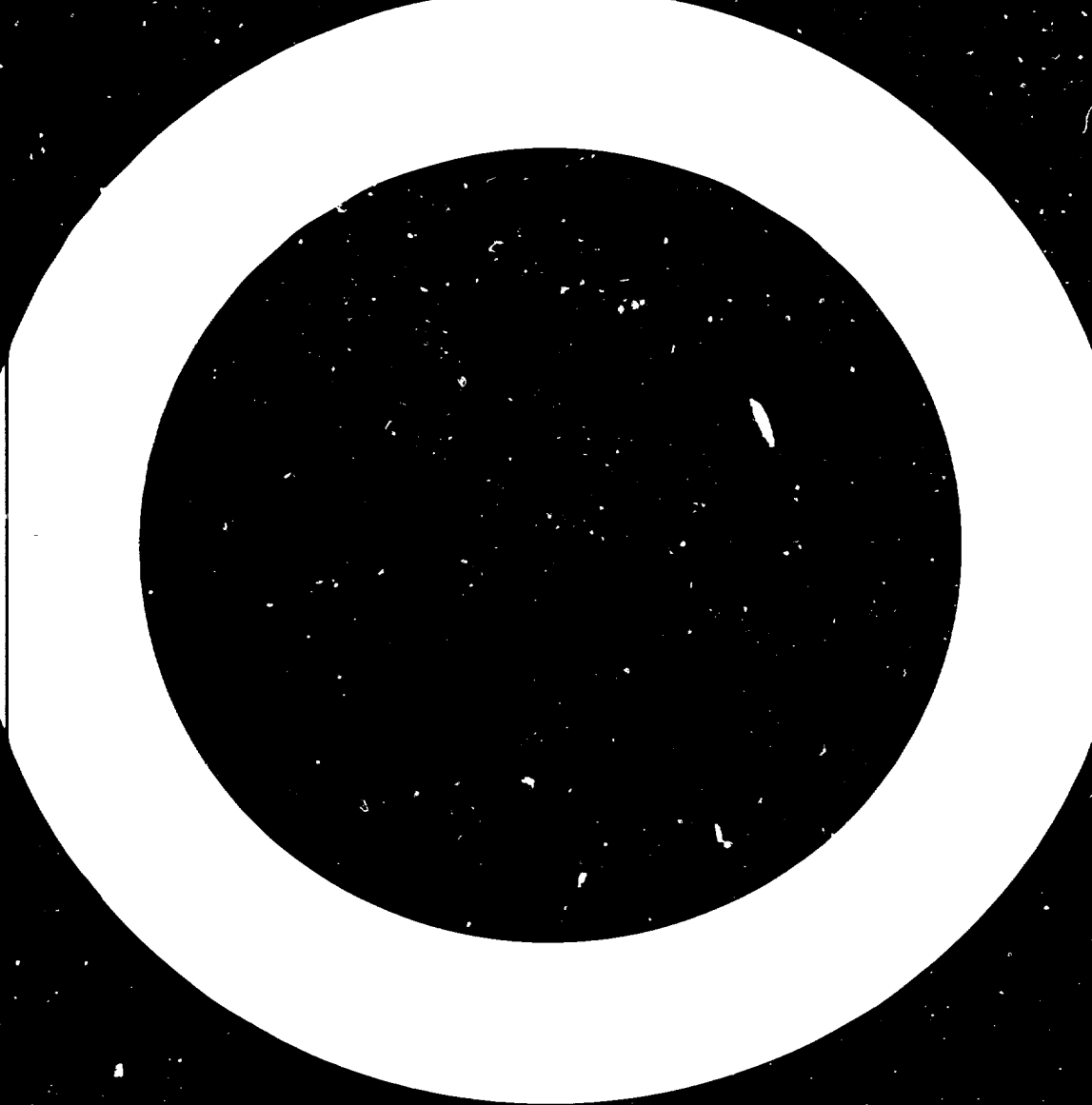
LEGEND:
1 FACILITY EXISTS

SECTION 1

SELECTED COUNTRIES

	GHANA	ETHIOPIA	KENYA	ZAMBIA
	GHOT LOW COST (STAGE 2)	ETHIOPIA METAL CORP. (STAGE 1)	SEAL CASEMENTS LTD (STAGE 3) AGRICULTURE IMPLEMENT MFGS LTD. (STAGE 2) KENYA-ENGINEERING LTD (STAGE 2)	SHONGA STEEL (STAGE 3)
	GHOT LOW COST (STAGE 3) IMPLEMENT PLANT.	BAKO PROTOTYPE SHOPS (STAGE 2) CADU PROTOTYPE SHOPS (STAGE 2)	SEAL CASEMENTS LTD. (STAGE 3) PLOUGHS AND ALLIED PRODUCTS (STAGE 2) AGR CULTURE IMPLEMENTS LTD (STAGE 2)	
			BURNS & BLAKE LTD (STAGE 3)	
				IN PROJECT
	✓	✓	✓	✓
	1 FORGE SHOP	1 FORGING MILL	1 FORGE SHOP	1 RAILWAY SHOP
	SEVERAL	6 SMALL	4 LARGE	AMPLE CAPACITY
	POTENTIAL AFTER REHABILITATION	VERY LIMITED	SMALLER STRUCTURAL BAR & SHAPES	LIMITED
	LIMITED	LIMITED	GOOD	GOOD
	LIMITED	NONE	LIMITED	LIMITED
	LIMITED	NONE	LIMITED	LIMITED
	LIMITED	NONE	LIMITED	LIMITED
KENYA & COMPANIES	POTENTIAL - REQUIRES REHABILITATION	LIMITED	DEVELOPED	DEVELOPED
	UNIVERSITY	LIMITED	DEVELOPED	DEVELOPED
	UNIVERSITY	LIMITED	DEVELOPED	DEVELOPED
	UNIVERSITY	UNIVERSITY	DEVELOPED	DEVELOPED
			GOOD PRIVATE BANKING SYSTEM	GOOD PRIVATE BANKING SYSTEM
APS		GOVERNMENT	PRIVATE & GOVERNMENT	PRIVATE & GOVERNMENT
[illegible]		UNDER DEVELOPMENT	PRIVATE & GOVERNMENT	PRIVATE & GOVERNMENT
[illegible]	UNIVERSITY	CADU BAKO	MINISTRY OF AGRICULTURE & PRIVATE SECTOR	MINISTRY OF AGRICULTURE
[illegible]		UNDERGOING DEVELOPMENT	DEVELOPED	UNDERGOING DEVELOPMENT
[illegible]	UNDERGOING REHABILITATION	UNDERGOING DEVELOPMENT		
[illegible]			WELL DEVELOPED & EXPANDING	WELL DEVELOPED

SECTION 2



4. THE UPGRADING PROFILES

The upgrading profiles discuss and present the ways and means to reach the next higher level. Various possibilities can be found depending on the solution of stages. They are presented in Figure 1, and are described below.

Profile 1: Upgrading Requirements for Production of Hand Tools

They represent the selection of a scale and establishment of units for production of hand tools. Existing units can expand into next higher scale. Table 2 summarizes the main characteristics of each stage.

Profile 2: Upgrading Requirements for Production of Animal drawn Implements and Manually Operated Machines

In this case upgrading can be attained by selected units producing hand tools, in each of the stages, and can extend this product category to diversify into animal-drawn implements and manually operated machinery within the same scale of operation or expand into scale scale. Table 3 summarizes the main characteristics of each stage.

Profile 3: Upgrading Requirements for Production of Tractor-drawn Implements and Power Operated Machines

In this case upgrading can be obtained by selected units producing animal-drawn implements and manually operation machines in the workshop and industrial plant scales and can extend this product category to diversify into tractor-drawn implements and power operated machinery within the same scale of operation or expand into next scale.

New units to be established where there is no manufacture of tractor-drawn implements and power operated machinery are studied.

At the village blacksmith scale, manufacture of tractor-drawn implements is not economically viable; but selected units can possibly be organized to supply parts to workshop units. Table 4 summarizes the main characterictics of each stage.

FIGURE 1

UPGRADING CHOICES

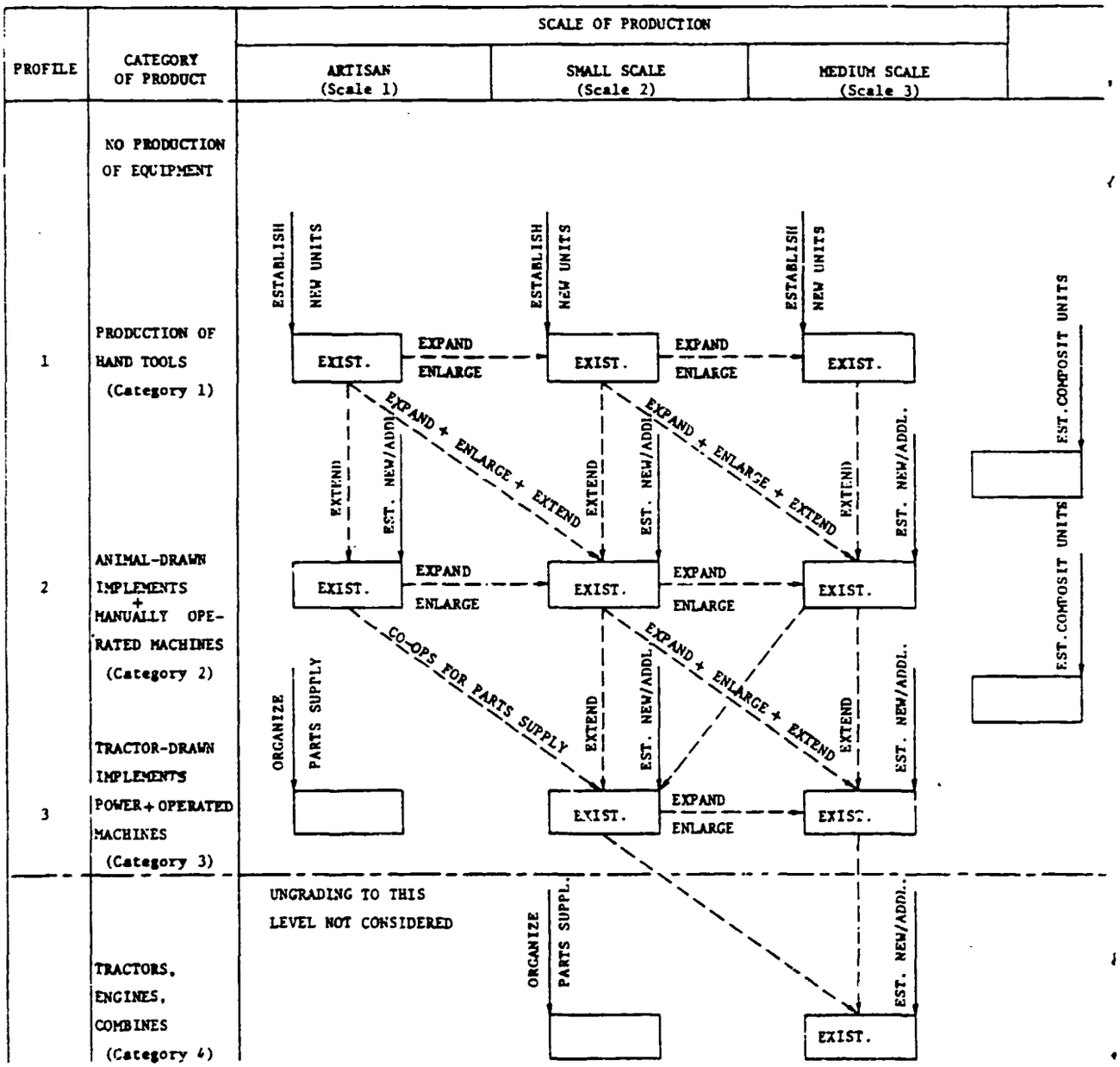


TABLE 2

CATEGORY 1

HAND TOOLS PRODUCTION
CHARACTERISTICS OF STAGES

Stage 1 Rural Blacksmith	Stage 2 Small Scale Workshop Units	Stage 3 Medium Scale Industrial Plants
PRODUCTS		
Hoes, slashers, spade forks, Sickles	All hand tools, Hoes, slashers, spade forks, Sickles - some animal-drawn implements	Hoes, slashers, spades, forks, Sickles - some animal-drawn implements
Some simple manually operated machinery	All simple manually operated machinery as hand planters, shellers, threshers.	High quality manually operated machinery
ANNUAL OUTPUT		
4-12000 units	50,000 - 100,000 units	1-2 million units
TECHNOLOGY		
Simple design Production according to demand	Simple design Production in large batches	Simple design and sophisticated mass production technology Large batch production for animal drawn implements.
INVESTMENT		
5-20,000 US$	US $500,000 to 1 million	US $ 2-3 million
EQUIPMENT		
Coal fired hand-blown forge	Forging facility Welding facility	Material preparation Forging unit Welding facility Heat treatment Machine Shop, including special lines. Paint shop Tool room, quality control, storing and shipping
MANPOWER		
5-9 skilled workers	Skilled labour 100	Skilled labour Production engineers Managers 200plus

TABLE 3

CATEGORY 2

ANIMAL-DRAWN IMPLEMENTS AND MANUALLY OPERATED MACHINES PRODUCTION

CHARACTERISTICS OF STAGES

Stage 1 Rural Blacksmith	Stage 2 Small Scale Workshop Units	Stage 3 Medium Scale Industrial Plants
PRODUCTS		
Simple tillage equipment (wood or steel) Simple manually operated machines	Tillage equipment sprayers, seeders manually operated machines as shellers, threshers	Tillage equipment sprayers, seeders manually operated machines, as shellers, threshers, mills and pumps
ANNUAL OUTPUT		
4 - 1200 units	20,000 units	More than 50,000 units
TECHNOLOGY		
Simple product design Small batch production according to demand	Product design production technology including production planning	Product design Production technology for large batch, Productin planning
INVESTMENT		
US $20-50,000	US $ 1-2 million	US $2-3 million
EQUIPMENT		
Similar to hand tools production equipment at stage 1	Similar to hand tools Production equipment at stage 2 but more complete Forging and foundry facility (external)	Similar to hand tools production equipment at stage 3 but more complete (but excepting special purpose lines) Forging and foundry facilities (external) or within plan depending on load
MANPOWER		
4-9 skilled workers	Skilled labour management 100	Skilled labour production engineers management 200 plus

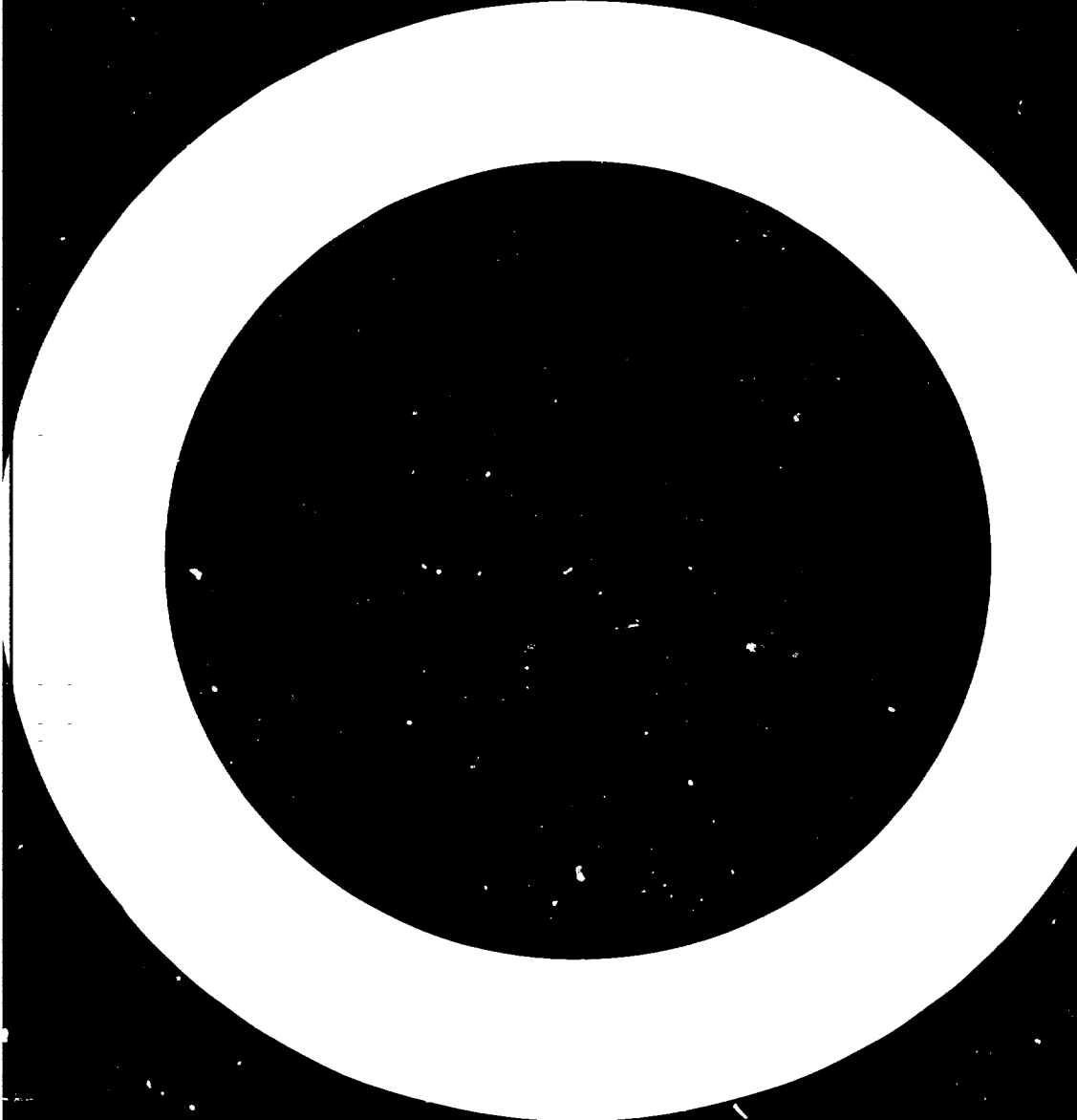
TABLE 4

CATEGORY 3

TRACTOR DRAWN IMPLEMENTS PRODUCTION

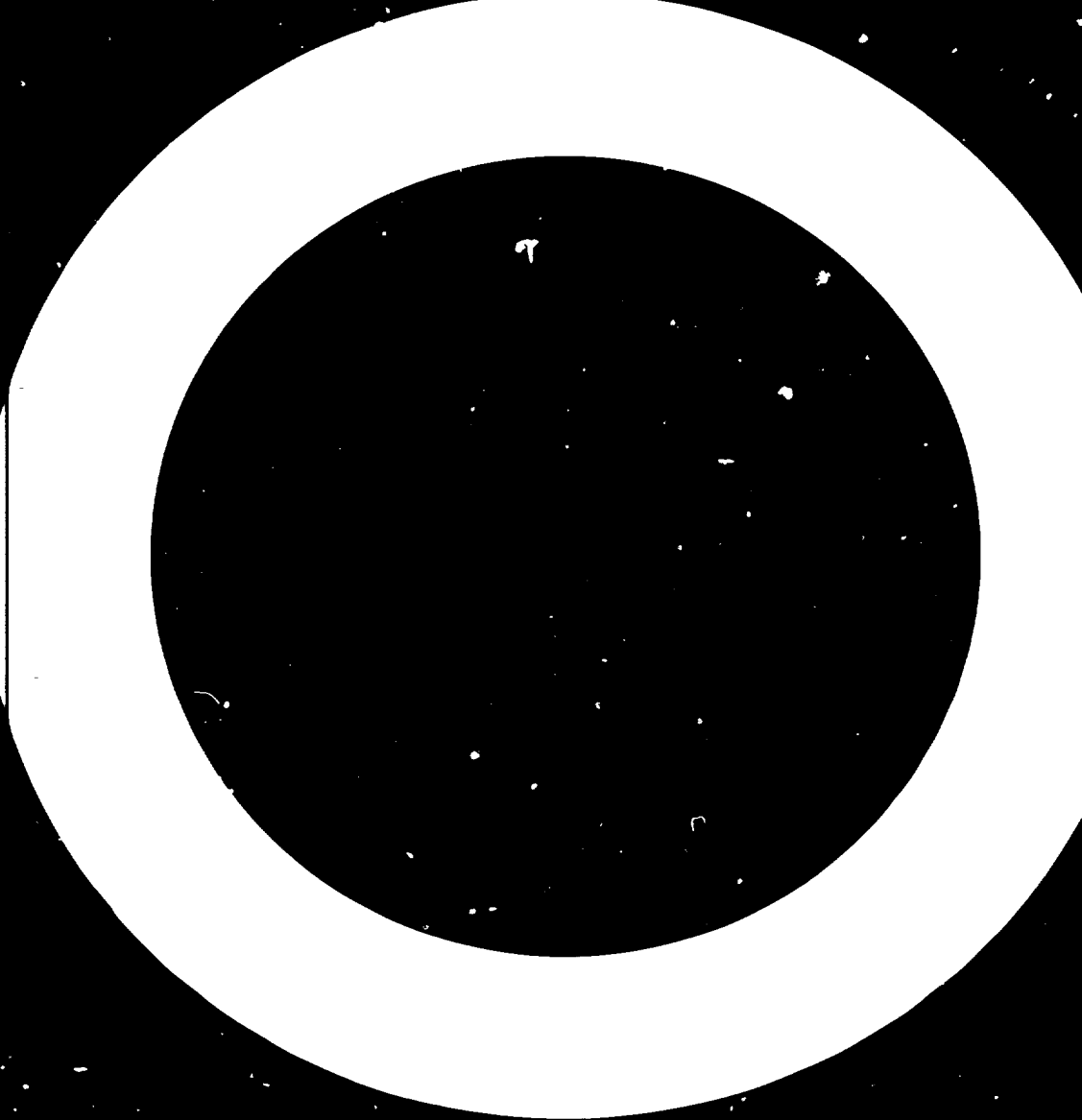
CHARACTERISTICS OF STAGES

Stage 1 Rural Blacksmith	Stage 2 Small Scale Workshop Units	Stage 3 Medium Scale Industrial Plants
PRODUCTS		
Tractor drawn implements are not produced at this stage	Ploughs, seed drills cultivators, harrows disc harrows, harvester and some powered machinery	Complete line of tractor drawn implements and powered machinery, pumps
ANNUAL OUTPUT		
-	3,500 units 500-1,000 tonnes/year	7,000 units 4,000 tonnes/year
TECHNOLOGY		
-	Product design Production in batches possible combination with animal-drawn implements	Product design production in large batches. Production planning
INVESTMENT	US $ 3-4 million	US $4-5 million
EQUIPMENT		
	Same as stage 2 (Level 2) plus structural welding and machining Forging and Foundry facility (external)	Material preparing machines, power saws machine tools welding machines sheet metal sheers, breaks, roll forming press shop, mechanized paint line tool room Quality control receiving and shipping Foundry facility (external) or within plant depending on load.



VOLUME II

PROFILE 1: UPGRADING REQUIREMENTS FOR PRODUCTION OF HAND TOOLS



1. DEFINITION

1.1 Introduction

The profiles focus on the requirements for upgrading production capabilities in a given country from one level to the next higher. Levels are defined based on category of product and scale of production: category 1 is the production of hand tools; category 2 animal-drawn implements and manually operated machines; category 3 tractor drawn implements and power operated machines and category 4 tractors and combines. This last category being found in only a very few countries, it is not studied in the profiles for upgrading. In each category the existing stage of development or scale of operation are considered: stage 1 is the organised village blacksmith operation, stage 2 is the small scale workshop and stage 3 the industrial plant. The production technology is determined by the product and the scale of production which is explained in detail at each product category in conjunction with its scale of production.

This report presents profiles which indicate ways and means by which a country could reach the next higher level of production capability, from its existing level.

Profile 1 discusses upgrading choices and requirements to reach hand tools production if a country is not producing any machinery.

Profile 2 discusses upgrading choices and requirements to produce manually operated and animal drawn implements when the country is already producing hand tools.

Profile 3 discusses upgrading requirements to produce power operated machinery and tractor drawn implements when the country is producing animal drawn implements and manually operated machinery.

Each profile focuses on the engineering part of the requirements and its directly related factors such as financing, training research and development and organization. However some other important factors to be considered in the formulation of an agricultural machinery industry program are not specifically discussed in these profiles, such as the need for machinery in Africa, an adequate marketing and distribution policy etc.

Each profile is structured in five chapters. Chapter I describes the different cases for upgrading, depending on the existing stage of production and the desired stage at the next level. Products considered are presented and illustrated. Chapter II reviews and summarizes the current status of agricultural machinery production in eight selected countries. These countries have been selected in order to provide case studies and examples on each profile. Chapter III details techno-economic conditions to operate a new plant independently of the existing infrastructure.

Chapter IV establishes the upgrading requirements by indicating in each case what part of the techno-economic conditions have to be acquired in order to upgrade the existing system. Chapter V indicates the role of the institutions in the development of agricultural machinery production in Africa.

The selection of a program for a given country depends upon the specific situation in that country, and its priorities. Therefore these profiles must not be construed as replacing the very necessary sectoral plans as well as prefeasibility and feasibility studies.

1.2 Upgrading choices

Profile 1 indicates ways and means by which a country can initiate production of hand tools when the country is not presently producing any agriculture equipment.

Three alternatives are studied:

- The country decides to create a network of good village blacksmiths to produce 10,000 tools per year; and in this case it is assumed that the country has already some traditional village blacksmiths but insufficiently equipped, trained and supplied.

- The country decides to create one or more workshop units, each producing 50,000 tools per year.

- The country decides to invest in an industrial plant for hand tools with a capacity of 1 million tools a year.

1.3 The context for hand tools

Hand tools are the predominant agriculture implements in use in Africa today and will continue to be important in the forseeable future.

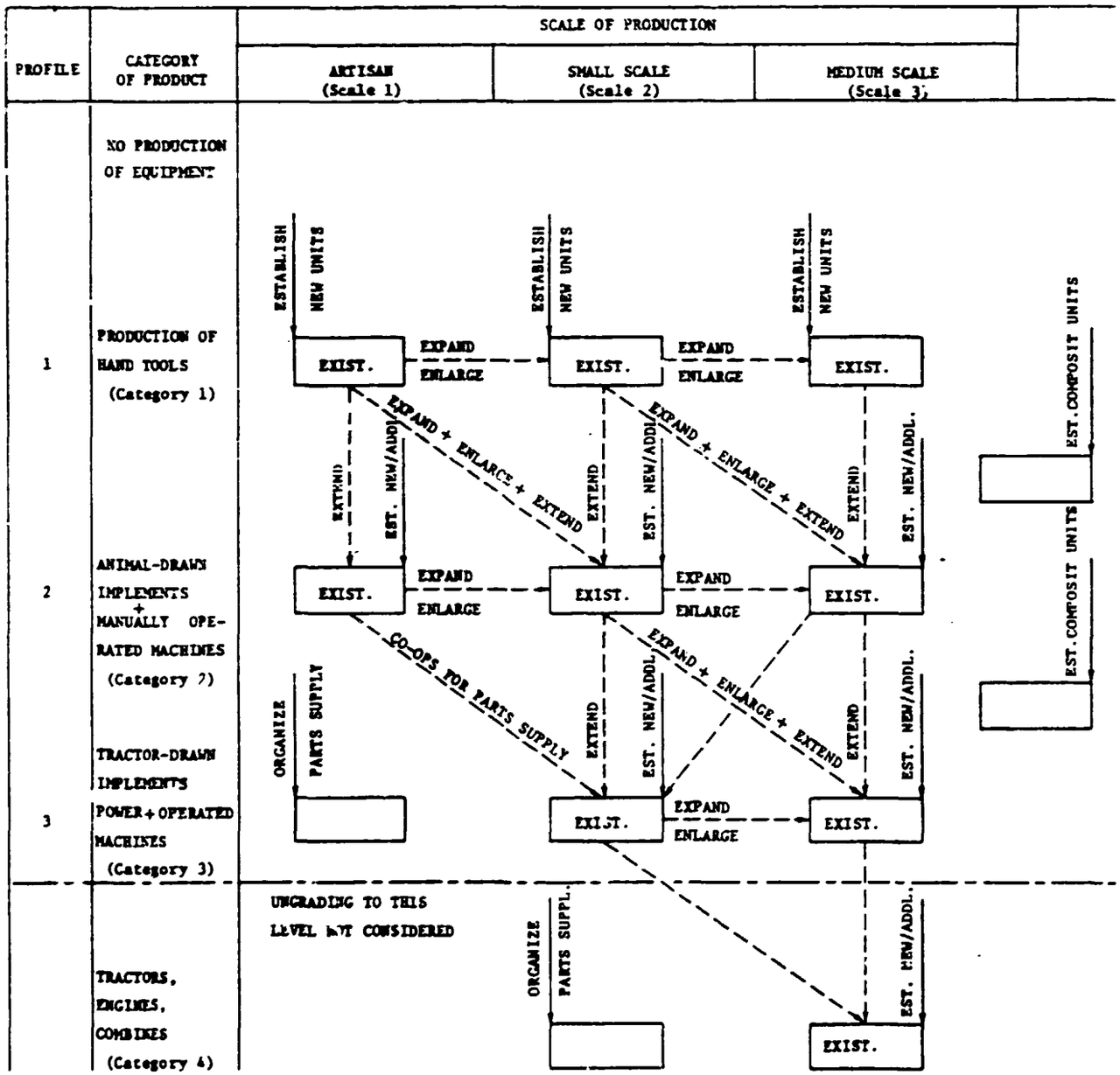
Over the centuries, Africa had developed an indigenous capacity to design and manufacture hand tools suited to local conditions which proved physically, ecologically, and economically appropriate. These tools varied widely in materials, shapes and configurations but were manufactured by small village smiths for very local consumption in limited quantities and to serve only the local area, and the quality was not adequate.

In the 20th century these locally produced hand tools began to be displaced by imported hand tools of European manufacture. These tools were superior in quality, designs were adapted to suit local practice and distribution and prices were such that in many parts of Africa the imported tools have replaced indigenous manufacture.

Today in Eastern and Central Africa indigenous manufacture by village blacksmiths had all but disappeared and technology has been virtually lost except in Ethiopia. Traditional design and manufacture survive however in West Africa.

FIGURE 1

UPGRADING CHOICES



Only in recent years have hand tools been made in Africa that are competitive in quality and price with imported hoes, forks and cutlasses. There remains a great opportunity to make African manufactured hand tools more widely available at quality standards and prices competitive with imported products.

Hand tools can be classified as to usage - cultivation tools and cutting tools. Tools used primarily for cultivation such as hoes, forks and shovels of various configurations, predominate in the small African farm of less than 2 hectares operating at subsistance level. These tools with entirely manual labour are used for soil preparation, planting and weed control operations.

Similarly, cutting tools such as axes, cutlasses, machettes, sickles scythes and sugar-cane knives are used on small farms for bush clearing and crop harvesting.

Emergent farmers using animal draught and tractor power continue to use all varieties of hand tools to supplement the powered tools. The use in Africa for hand tools, even after considering the evolution to more mechanized forms of agriculture, will continue to be important for years to come.

In parts of Africa, governments have supported programs to encourage and develop indigenous manufacture of hand tools by village blacksmiths with effective results. The programs act to improve the quality of the product by upgrading and improving the availability of steel raw materials, by upgrading blacksmith skills and by providing upgraded equipment for the smith.

Apart from local production of farm tools by the village smith, the smith is regarded as essential for repair and maintenance of farm machinery and in fact machinery in general, including repair and maintenance of automotive equipment, particularly in the rural areas.

Upgrading of village smiths by providing capability in welding technology as well as the traditional forging technology is important to the upgrading of village repair and maintenance services.

More recently a number of African countries have installed modern factory units based on sophisticated forging and metallurgical technology. These factories are fully capable of replacing imports from developed countries and can operate as commercially viable enterprises competing in terms of product design, quality and price with imported product. Such plants manufacture both cultivation and cutting hand tools and economies of scale are such that relatively heavy capital investment can be justified even in quite small countries such as Malawi because of the very high demand for hand tools. However adoption of modern hand tool manufacturing technology even in such small African countries does not preclude parallel development of upgraded village blacksmith networks.

1.4 The products

The products considered here are:

o Cultivating tools

Hoes
Forks
Shovels
spades

o Cutting and harvesting tools

Axes
Machettes
Cutlasses
Sickles
Sythes
Sugar-cane knives

o Other manually operated machines (cultivation and post-harvest processing)

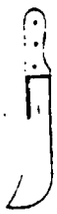
Planters and seed drills
Maize shellers
Ground nut shellers
Threshers
Grinding mills

HAND TOOLS

FORK HOE
Agricultural Implements
Kenya

HOE (JEMBE)
Ideal Casements Ltd
Kenya
(Welded construction)

HOE
Ubungo Farm Implements
Tanzanie
(Welded construction)



Curved Machete

Blade length

30 cm. Shg.
40 cm. Shg.
45 cm. Shg.

Straight Machete

Blade length

40 cm.
45 cm.

Garden Spade

Length: 106 cm.

Garden Rake

8 teeth
18 teeth
(Intermediate sizes available pro-rata)

Sugar-Cane Knife

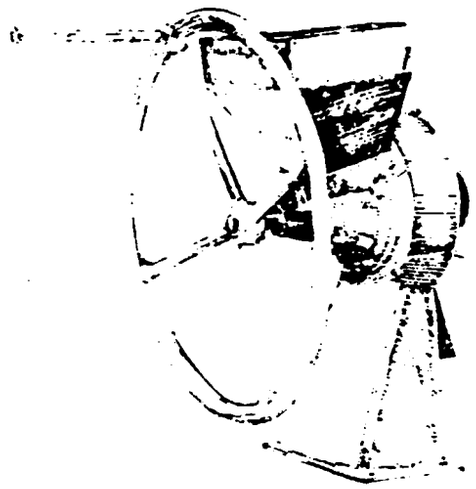
Blade-length: 53 cm.

Shovels

Round-mouth:

Square-mouth:

DUNIA HAND-OPERATED GRINDING MILL

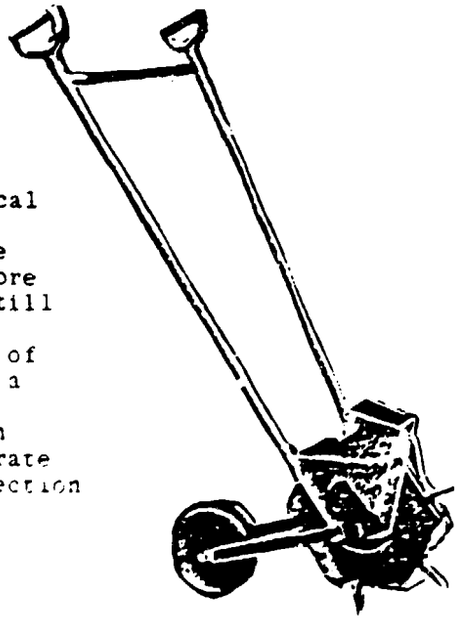


Description: The Dunia is a robust hand-operated mill that can be used for grinding many crops. Although principally designed for milling maize and wheat into flour, it can also be used to grind coffee.

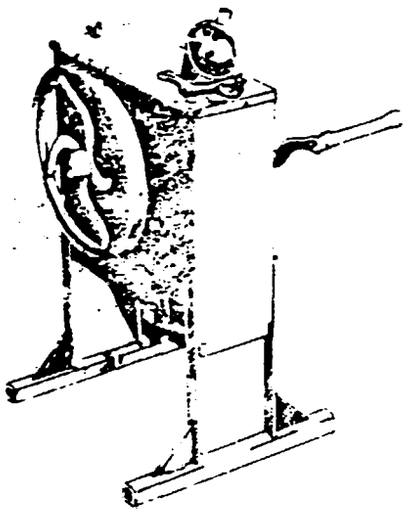
No castings are used in the manufacture: it is all made from welded steel for durability. Cleaning the machine is relatively easy. The front cover can be removed by unscrewing wing-nuts and no spanners or special tools are needed for maintenance.

Using the Dunia, one man can grind about 20kg. of maize in one hour

ROTARY INJECTION PLANTER



Description: Manufactured to a design by the International Institute of Tropical Agriculture at Ibadan in Nigeria, this planter is specifically designed for use in minimum tillage cultivation. Therefore it is best used in combination with no-till primary preparation by herbicide weed killing, followed by injection planting of seeds through the detritus (which forms a muich). Seeds are distributed from an axial hopper through seeding channels on the wheel rim, which themselves incorporate a slide to tamp down the soil after injection of a seed.



MAIZE SHELLER
Siscoma, Senegal

TAMTU HAND PLANTER

Description: The hand planter is a jab planter with wooden handles and a wooden slide seed metre. The jabbing action automatically meters seeds into the planting hole.

2. OVERVIEW OF HAND TOOL MANUFACTURING FACILITIES

The existing situation regarding hand tool manufacturing facilities in the countries visited is summarised in the following chart. Hand tool manufacture is widely distributed in Africa, and facilities are found at all stages from the artisan blacksmith shop, through organised network of blacksmiths, to industrial workshop and even, in one case, a fully fledged industrial plant of medium scale.

The countries surveyed are highly dependant on imports for provision of high quality hand tools and this situation is typical for Africa as a whole.

Imports of hand tools were estimated at 24,090 tonnes in 1980, an annual growth of 5.6% from 1976. Forecasts for the year 2000 point to a requirement of 59,500 tons with an annual growth rate of 3.5% for the period 1980 to 2000.

Local production by village blacksmiths is not well quantified and the exent of supply of traditional hand tools from this source of local production is not well understood or measured.

Estimate for the region indicate that approximately 20,000 village forge operations exist. No statistical information exists as to production. However assuming average production per forge shop at 3,000 pieces per year then 60 million units or 72,600 tonnes of product are produced by village forges.

African industrial production capacity is now estimated at 25 million pieces per year. However present industrial capacity is not well utilized. Existing operations operating at between 30 to 60% of capacity are producing an estimated 10 million piece per year or about 11 million tonnes of product.

Local capacity for hand tool manufacturing varies from 1/5 of local requirement to 4/5 of local requirements in the countries surveyed.

Industrial production capacity is concentrated in central African countries where present agriculture practice is largely limited to hand tool cultibvation practices.

Manufacturing is generally in vertically integrated factories producing forgings or weldments specialising in hand tool manufacture.

The present situation concerning hand tool manufacturing in the countries surveyed is as follows:

Ethiopia

A new high quality hand tool forge shop is in operation producing a variety of quality hand tools. The scale of operation is such that the requirements of the Ethiopia market will be adequately supplied and output of these high quality tools will gradually replace traditional hand tools made in village forge shops. In the interm period village forge shops are being supported by a program to upgrade

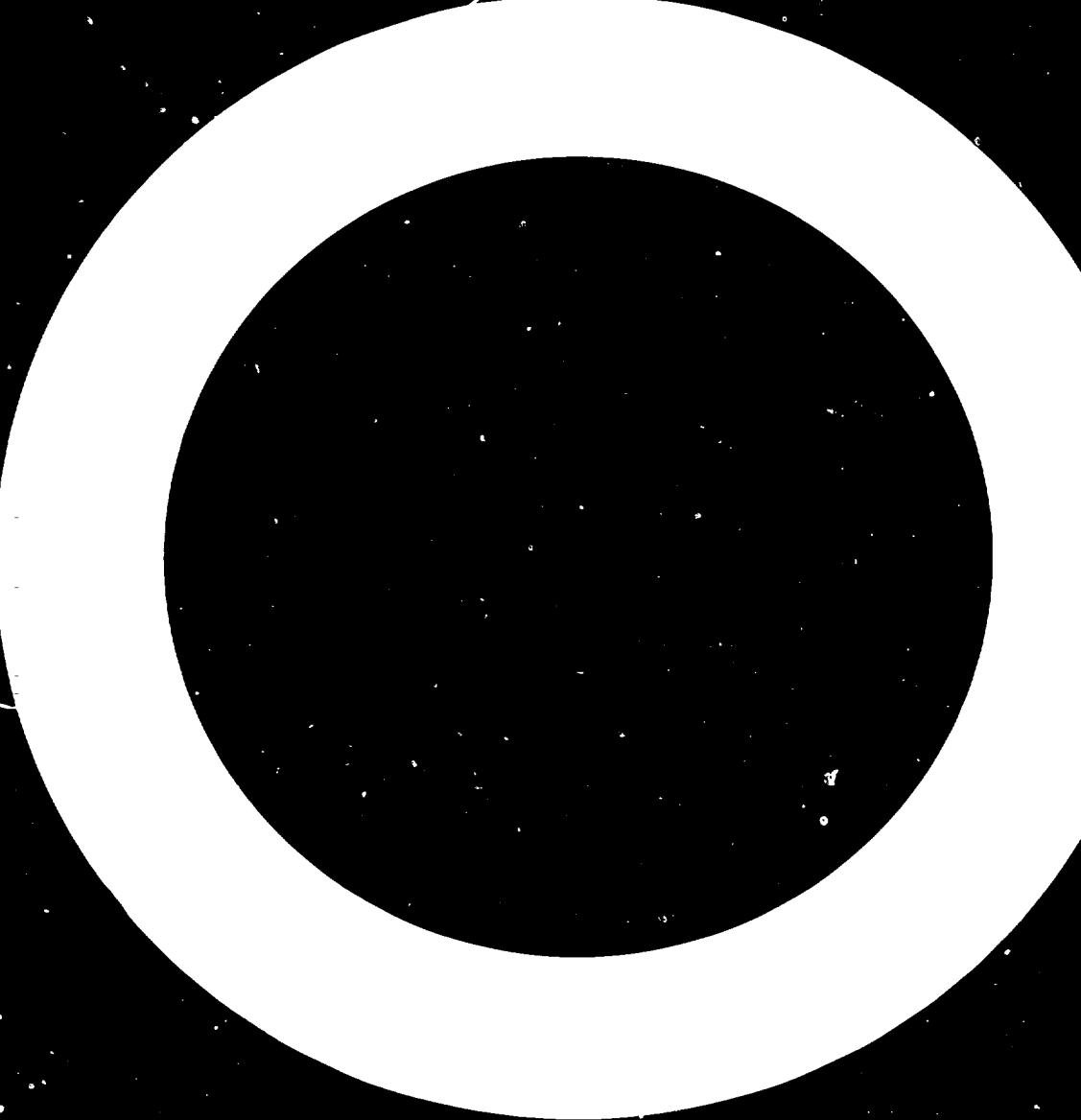


CHART II

HAND TOOLS MANUFACTURING FACILITIES IN SELECTED COUNTRIES

	COUNTRIES						
	ZAIRE				UGANDA		ETHIOPIA
NAME OF COMPANY	GMAZ SE AGRICULTURAL EQUIPMENT	CHAN METAL SARL DEV PRODUCT. DEPARTMENT	ACHEFOR METALIC CONSTRUCTION AND FOUNDRY	CERECR BLACKSMITH WORKSHOP	UGANDA HOES LTD JINJA	UGHA ENGINEERING CORP LUGAZI	NATIONAL METAL WORKS CORP ADDIS ABABA
OWNERSHIP	STATE	SIS CHARIC (BELGIUM) 15 PRIVATE BUILDERS 80% STATE	PRIVATE INTERESTS	WORKSHOP	STATE (WAS PREVIOUSLY OWNED BY CHILLINGTON UK)	JOINT OWNERSHIP, UGANDA GOVERNMENT AND INDIA MULTINATIONAL	STATE
HEAD TURNOVER - (3 LAST YEARS)							
* PRODUCTION CAPACITY 000/pa	822 PER YEAR	-	-		2 000.000 HOES PER YEAR	HOES - 500.000 PER YEAR	500 TONNES/YEAR
STATE CLASSIFICATION	MEDIUM	MEDIUM	SMALL	SMALL	MEDIUM	MEDIUM	MEDIUM
PRODUCTS	HOES. MACHETES. SHOVELS. AXES. SICKLES	HOES. MACHETS. SHOVELS. SPADES. FRUIT CUTTERS. GRASS CUTTERS. PICKS	SHOVELS AND SPADES	POST-HARVESTING MACHINES	HOES	CURRENT PRODUCTION 000.000 HOES/YR AXES. HOES AND MACHETTES 000 EA	
COVERED PLANT AREA	—	—	—	—	—		1.000 SQ. METERS
HAMMERS	343	2300 (GROUP) BIG (FACH. BRUXELLES)	05	20	200	300	100
SOURCE OF TECHNOLOGY	CHINA	THE GROUP	—	FOREIGN EXPERT	CHILLINGTON UK	INDIA	POLAND
EQUIPMENT USED AND SOURCE							
FABRICATION: LIGHT	X CHINA			X	TWO HOE FORGING LINES	FOUNDRY AND TWO FORGING LINES	METAL PREPARATION
: MEDIUM	X CHINA	(X)		-	1st ESTABLISHED IN 1964	ONE FOR HOES	FORGE SHOP
FORGING : LIGHT				-	2nd LINE IN 1980	ONE FOR AXES AND SHOVELS	TOOL & DIE SHOP
: MEDIUM	X CHINA	(X)		-			HEAT TREATMENT SHOP
HEAT TREATMENT	X CHINA	(X)		-			WELDING SHOP
MACHINERY (TOOL ROOM)	X CHINA	X		-			GRINDING SHOP
FOUNDRY	-	X		-			
MATERIALS					IMPORTED STEEL. HOT ROLLED FLAT FORGING BAR	IMPORTED STEEL.	IMPORTED FORGING STEEL.
SUPPLIES USED AND SOURCE							
FORGING	-	-		USED SCRAP METAL			
CASTING	-	-					
STRUCT. SHAPES AND TUBES	-	-					
BARS AND RODS	X CHINA	X IMPORTED FROM EUROPE		X			
SHEET STEEL	X CHINA	X IMPORTED FROM EUROPE					
ANCILLARY	X CHINA	X IMPORTED X ZAIRE		X			
FACTORY SUPPLIES	X CHINA X ZAIRE	X IMPORTED X ZAIRE					
STEEL CATEGORIES							
MANPOWER AND TRAINING							
SKILL LABOUR	IN THE PLANT	GROUP TRAINING CENTER		ON THE JOB	ON THE JOB	ON THE JOB	ON THE JOB
TECHNICAL / ENGINEERING	ZAIRE	ZAIRE AND OTHER COUNTRIES		FOREIGN EXPERT	REQUIRED FOR REHABILITATION	FROM INDIA	POLAND
TRAINING							ON THE JOB PLUS TRAINING OF KEY PERSONNEL IN POLAND ETHIOPIAN
MANAGEMENT	ZAIRE	ZAIRE AND OTHER COUNTRIES		NOT REQUIRED	UGANDA	UGANDA / EXPATRIATES	
INVESTMENT FINANCING							
PRIVATE DEVELOPMENT BANK	—	BPFIDC			ORIGINALLY CHILLINGTON UK		POLAND AID PROGRAM
INDUSTRIAL CRED *	—				PRIVATE FINANCING		
GOVERNMENT AGENCY	—						
OTHERS	CHINA	MAINLY SELF FINANCING		GOVERNMENT FINANCING IN PROJECT	PLANT NOW RATIONALIZED		
MARKETING ORGANIZATION	SALES TO PUBLIC AND INTERNATIONAL AGENCIES AND TO PROJECTS	WHOLESALERS		DIRECT SALES	COOPERATIVES	COOPERATIVES	COOPERATIVES
COMMENTS					REHABILITATION REQUIRED $200.000 FOR DIES, GRINDERS SPARE PARTS $120.000 FOR PRESS REPAIR FOREIGN EXCHANGE FOR MATERIALS	REHABILITATION REQUIRED PRESSES, DIES, ELECTRODES 2765 ODC FOREIGN EXCHANGE FOR MATERIALS	MODERN FACTORY MANUFACTURING HIGH QUALITY ALL-FORGED HOES, FORKS, TOO. THIS FACTORY PRODUCES PRO UPGRADED ARTHAL DRAWN WIR FOR R & D PURPOSES PLANT TO MODERN ARTHAL DRAWING

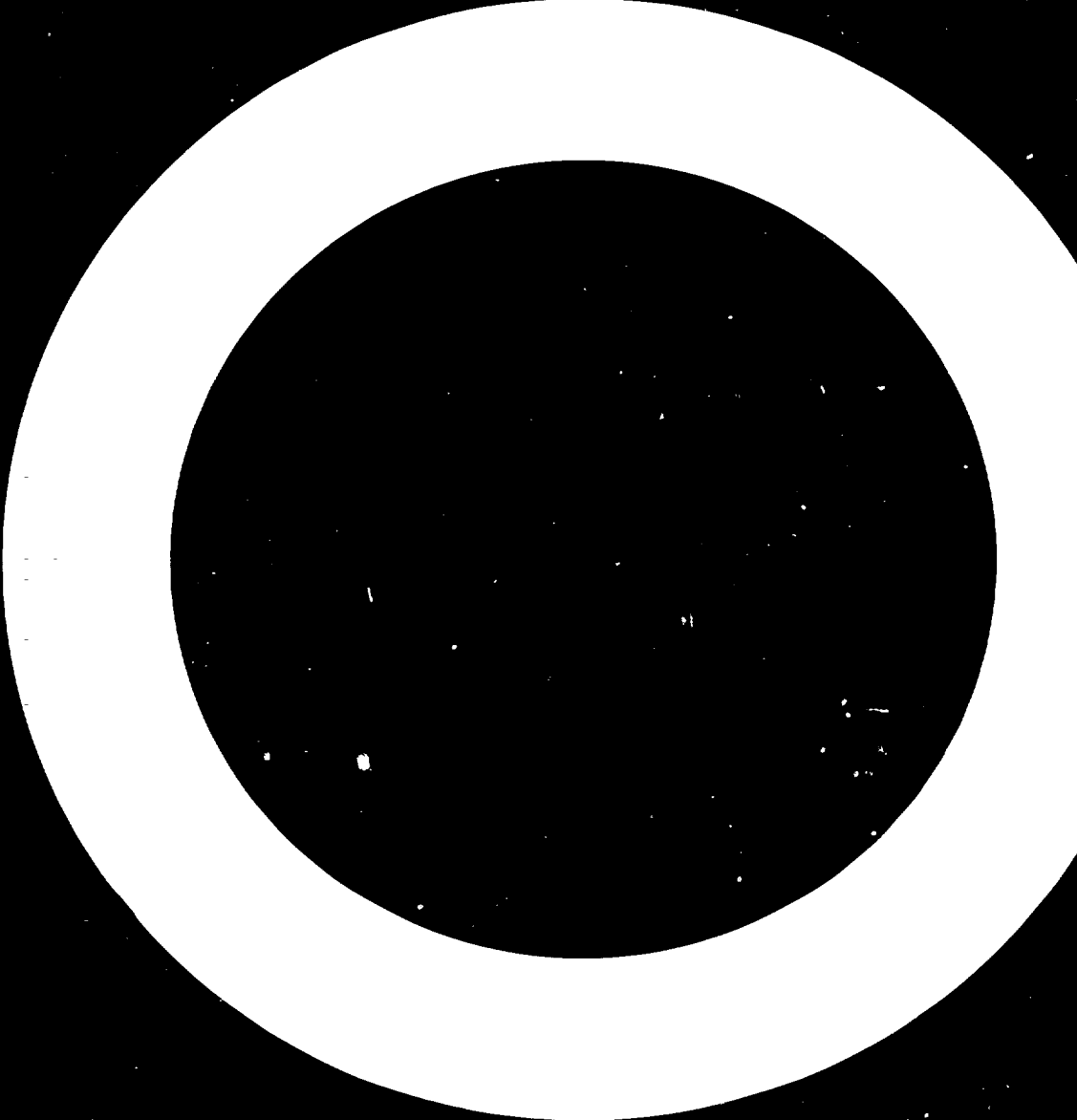
* / YEAR

SECTION 1

SELECTED COUNTRIES

ETHIOPIA		KENYA			ZAMBIA	MALAWI
NATIONAL METAL WORKS CORPORATION ADD 1 ADABA	BLACKSMITH COOPERATIVES ADDIS ABABA	IDEAL COMMODITY (E.A.) LTD NAIROBI	AGRICULTURAL IMPLEMENTS MANUFACTURERS - KAMPALA	KENYA ENGINEER. INDUSTRIES LTD NAIROBI	SHOBOSA STEEL CO. LTD LUSAKA	ADMARC (MALAWI) LTD BLANTYRE
STATE	STATE (BASIDA)	PRIVATE	PRIVATE	PRIVATE	PRIVATE	MALAWI GOVERNMENT 60% MASSEY-FERGUSON: 20%
500 TONNES/YEAR HOE-DO	600 UNITS/DAY	-	-	-	-	3000 TONES/YEAR
AXES, HOES AND MACHETES 1 000 000 PCS/YR	PLOW SHARES, SICKLES, GRUBBING	HOES (JEMBES) ROUND EYE AND RAISED HEAD HOES	HOES FORGED HOES AXES	MACHETTE (PANGA) SQUARE CASE KNIFE SHOVELS SPADES	GRUBBING HOES HOES (COMBINED WITH METAL OFFICE FURNITURE)	ROUND EYE AND FARGED HOES (COMBINED WITH ANIMAL DRAWN IMPLEMENTS
000 SQ. METERS	600 SQ. METER	-	-	-	4000 SQ. METERS	4000 SQ. METERS
100	100	-	-	-	100	100
POLAND	ETHIOPIA	UK	GERMANY	-	UK	MASSEY-FERGUSON UK
METAL PREPARATION FORGE SHOP TOOL & DIE SHOP HEAT TREATMENT SHOP WELDING SHOP GRINDING SHOP	HAND BLOWN FORGE, CHARCOAL FIRED GRINDERS ANVIL, HAMMERS	-	-	-	SHEET METAL SHOP PLATE SHOP PUNCHING SHOP WELDING SHOP HEAT TREATMENT SHOP	MACHINE SHOP FORGING SHOP TOOL & DIE SHOP WELDING SHOP ASSEMBLY SHOP
IMPORTED FORGING STEEL	SCRAP METAL AND IMPORTED	STEEL FROM KENYA AND IMPORTED	STEEL FROM KENYA AND IMPORTED	STEEL FROM KENYA	STEEL FROM ZIMBABWE	STEEL FROM ZIMBABWE
		FACTORY SUPPLIES FROM KENYA	FACTORY SUPPLIES FROM KENYA	FACTORY SUPPLIES FROM KENYA	FACTORY SUPPLIES FROM ZAMBIA	FACTORY SUPPLIES FROM MALAW LIMITED IMPORT FROM ZIMBABWE
ON THE JOB	ON THE JOB	ON THE JOB	ON THE JOB	ON THE JOB	ON THE JOB	ON THE JOB
POLAND	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	UK	FROM RHODESIA (NOW ZIMBABWE)
ON THE JOB PLUS TRAINING OF KEY PERSONNEL IN POLAND ETHIOPIAN	ETHIOPIAN	KENYA	KENYA	KENYA	ZAMBIA AND EXPATRIATES	MALAWI AND EXPATRIATES FOR START-UP
POLAND AID PROGRAM	ETHIOPIAN BASIDA INDUSTRIAL DEVELOPMENT ORGANIZATION	PRIVATE	PRIVATE	PRIVATE	PRIVATE	PRIVATE
COOPERATIVES	COOPERATIVES	RETAIL OUTLETS, DEALERS	RETAIL OUTLETS, DEALERS	RETAIL OUTLETS, DEALERS	DISTRIBUTION IS GOVERNMENT MONOPOLY	REPRESENTATIVES, DEALERS
MODERN FACTORY MANUFACTURING HIGH QUALITY PRODUCTS ALL-FORGED HOES, FORGES, CUTTING TOOL THIS FACTORY PRODUCES PROTOTYPE UPGRADED ANIMAL DRAWN IMPLEMENTS FOR R & D PURPOSES. PLANS TO EXPAND TO MODERN ANIMAL DRAFT EQUIPMENT	TYPICAL OF TRADITIONAL MANUFACTURE OF ARTISAN ARTICLES CENTRAL R&D INSTITUTE ARDU DEVELOPING NEW PRODUCT	KENYA IMPORTS ALL HAND TOOLS THROUGH A GOVERNMENT MONOPOLY THE NATIONAL TRADING CORPORATION QUALITY COMPARISON WITH IMPORTED ITEM. POINTS TO A NEED TO UPGRADE STEEL QUALITY, HEAT TREATING AND PRODUCTION OF ALL-FORGED HOES RATHER THAN WELDED PRODUCT DISTRIBUTION IN KENYA AND EXPORT IS BY PRIVATE DEALERS, RETAIL OUTLETS		THIS COMPANY IS A MANUFACTURER OF A WIDE RANGE OF SHEET METAL PRODUCTS. THE COMPANY MANUFACTURES A WELDED HOE FROM ZIMBABWE STEEL ON CONTRACT REQUIREMENT FROM LARGE GOVERNMENT ORDERS. THE COMPANY RECOGNIZED THE REQUIREMENT TO UPGRADE TO ALL FORGED HOES AND WOULD BE INTERESTED IN JOINT-VENTURE POSSIBILITY	THIS COMPANY HAS A WELDED PRODUCT IN PLANT CAPABLE OF MANUFACTURING A FORGED HOES OF SUPER OR DUAL TYPE IN ZIMBABWE STEEL. THE COMPANY IS INTERESTED IN EXPORT TO OTHER AFRICAN COUNTRIES AND INTERESTED IN PROVIDING TECHNICAL ASSISTANCE TO PROJECTS IN AFRICA

SECTION 2



capability to produce both hand tool manufacture and steel components for animal drawn implements widely in use in Ethiopia but of a simple largely wood constructed nature.

Uganda

Uganda had developed two modern high quality hand tool forge shops with sufficient capacity to serve Uganda market needs. Both these factories require rehabilitation and in the meantime imports under emergency relief programs supply the country's requirement.

Kenya

Kenya has suppliers of fully forged and of weldment type hand tools presently operating to supply government purchases of hand tools for regional agriculture development programs. Kenya imports sufficient high quality hand tools from Europe and Asia to warrant upgrading of existing Kenya facilities and this upgrading is now under serious consideration.

Tanzania

Tanzania has sufficient capacity now in place to supply the country's requirement. Production however is based on weldment designs and planning is to convert production facilities to the all forged product.

Zambia

Zambia recently developed capacity for weldment type hand tools in response to a government order. Higher quality all forged hand tools continue to be imported. Plans to convert to a fully forged product line are being considered.

Malawi

Malawai has an excellent facility now capable of supplying all of Malawi requirement for high quality hand tools. The operation is now able to consider export of both know-how and product to other African countries.

Zaire

UMAZ has recently established a modern plant to produce fully forged high quality hand tools. This facility is in addition to the long established Chanimetal operation producing high quality product so that Zaire is now largely self sufficient in requirement for high quality hand tools.

Cameroun

Tropic is a long established facility producing high quality hand tools and has developed an export capacity of some 20% of its production in addition to serving the Cameroun market.

Mali

Mali has developed a successful pattern of upgrading village forges to produce improved hand tools in small volume local operations as well as establishning a basis for local repair and maintenance capability for farm machinery in general.

Constraints to Development

Examination of present development of manufacture of hand tools indicates that those countries establishing high quality fully forged hand tools succesfully compete with imports from Europe and Asia. Raw materials and machinery are imported requiring foreign exchange allocation. Lack of foreign exchange accounts for some under utilization of capacity but value added is such that the small number of such operations established are viable operations even when operating under capacity (usually during the early stage of development).

A number of operations, based on weldments have been established at relatively low investment cost. Quality competition with imported product that the farmer prefers is leading to upgrading of such facilities.

A number of succesful programs to upgrade village forge operations (Mali, Upper Volta) provide a pattern of development that should be considered for other countries either as a first step in development or development in parallel with establishment of industrial facilities (Ethiopia).

Contraints to development would appear to be mainly investment and promotional efforts to establish modern hand tool high quality facilities. Marketing, distribution and farmer credit programs do not constitute the type of problems and restraints encountered in development of animal drawn or power drawn implements.

3. MANUFACTURING TECHNOLOGY

3.1 General

Manufacture of hand tools is organized in three stages of technological development namely:

Stage 1 The artisan Village Blacksmith organized as individual units or organized in a network of village blacksmith shops.

Stage 2 The Industrial Workshop Stage. Here the manufacture of other equipment is also undertaken. Tools are manufactured in an industrial forging and heat treating shop using light forging presses or pneumatic forging hammers without use of closed dies. Annual volume is about 50,000 pieces per year.

Stage 3 Medium-scale Industrial Plant

Here hand tools are manufactured on heavy custom designed forging presses either mechanical or hydraulic. Heat treating is by continuous special processing. Annual production volume is 1,000,000 pieces per year or greater to justify the heavy capital investment in forging plant.

Tables 3.1 and 3.2 present a summary of requirements by stage.

3.2 The Village Blacksmith

A typical profile for a village artisan smith operation manufacturing hand tools would be:

Shop Area - 30 - 120 sq m
Employees 4 - 9

Equipment:	Shear	
	Charcoal fired forge furnace	
	Anvil	
	Quenching tank	
	Grinding machine	
	Black smith hand tools	
	Arc welder	
Cost:	Estimated cost:	$12,500

Production: 4,000 - 12,000 units per year
$ 10,000 - 30,000 annual sales

Raw Materials: Purchased steel $3,000 - $10,000 per year

TABLE 3.1

HAND TOOL MANUFACTURING

Stage	Artisan Village Blacksmith Stage 1	Industrial Workshop Stage 2	Medium Scale Industrial Plant Stage 3
Requirement			
Output	4,000-12,000 pc/yr	50,000 pieces/year	1,000,000 pc/y. 3,000 ton./year
Equipment (1)			
Wood Shop	X		
Machine Shop		X	X
Welding Shop	X	X	X
Forging Shop	X	X	X
Tool and Die Shop			X
Heat Treat Shop		X	X
Materials			
Forging Steel	X	X	X
Scrap steel	X		
Manpower			
Metallurgists			X
Skilled labour	X	X	X
Management		X	X
Investment			
Forging Machines and Equipment	$20,000	$200,000	$2,000,000

(1) For more detail on equipment requirements, see Table 3.2.

TABLE 3.2

EQUIPMENT

Village Blacksmith	Industrial Workshop	Medium Scale - Industrial Plant
50 kg. anvil	Cutting shop	Production Plant
Mechanical hand operated forge blower	Press (160 t.)	Billet shear capacity 200 t.
	Cutting machine	Oil fired forging furnace
Vice		Custom design squeezing M/C
Files	Forge shop	600 tonne 10" stroke press
Bolt die set for Thread forming	Oil fired furnace	Custom Design duplex rolling mill comprising lengthening and spreading mill
Hand drills and drill bits	Friction press	
	Forging press	
Hand grinder	Friction press	1x100 Tonne Crank press
Metal saw and blades	Pneumatic hammer	120 hydraulic press
	Press (315 t)	4x3 cwt open space forging hammers
Square and tape rule	Press	
	Vertical Press	3 Lead pot/salt pot hardening U.
Wood saw		3 Slot type furnaces
Brace and bit	Heat treatment shop	3 Double ended grinding machines
Oxyacetylene welder		2 varnish tanks
	Salt bath oven	2 Labelling machines
	Tempering pneumatic press	Auxiliary Equipment
	Nitrate bath	2x120 C.F.M. Air compressors
	Cold water bath	Hardness testing machine
	Hot water bath	Portable heavy duty hand grinder
	Electric oven	Work tables & trucks
	Tempering bath	Sundry Hand Tools
		Toolroom Plant
	Control	
		No 8 combination turret lathe
	Grinding machines	Centre lathe to accomodate jig for segment boring and grinding
	Hardness tester	
	Sharpening machines	Tool post grinding unit
	Elasticity testers	Vertical milling machine table size 1000mm x 500mm
	Equipment for handles manufacture	Pillar drilling machine 1¼ cap.
		Surface grinder table size 600mm x 300mm
	Painting equipment	Shaping machine 20"
	Set of tools	Bench grinding machine
		Bench vices cutting and hand tools
		Segment boring jig
		Segment grinding jig

3.2 The Village Blacksmith (cont'd)

The material specifications for agricultural hand tools generally conforms to SAE 1078 (American) or BS2094 Part 6: 1954 - forging and drop forging Gr.4 (British) or equivalent DIN or ISO standards where carbon content 0.72% - 0.85%, manganese 0.30% - 0.60%. The material should be suitable for forging and heat treatment.

This shop would be linked with neighboring woodworkers/carpenters.

Skills are passed down from master to apprentice. In addition to production of hand tools the smith would provide up to 50% of his work for the repair and maintenance of village, household and farm mechanical equipment.

Appendix A is a survey of typical configuration of hoes manufactured by village smith's in Nigeria. This data was prepared as input to a market survey of Nigeria for factory produced hand tools to determine the specifics of size, weight, configuration of designs deemed most appropriate for the Nigeria market.

3.3 The Organized Village Blacksmith Network

A number of African countries have adopted programs to upgrade rural blacksmiths and to establish new rural centers by means of development projects. Successful programs of this nature are now maturing after 10 years of development, for example, in Upper Volta, Mali and Cameroun.

In appendix D, a full case description of the Mali program is given in "Organization of Forging Equipment in the Cotton zone CMDT Mali".

The case describes a program initiated in 1970 that has resulted in equipment and training for 155 forge operators of which 96 have been equipped with heavy equipment for more universal work. The case describes organization, training equipment and results of the program.

A less elaborate but important program to organize and upgrade village forge shops is apparent in many other African countries. Of particular importance is the supply of forging steel. A strong case can be made for central purchase of good quality forging steel and distribution by cooperatives to improve what is the greatest constraint to quality of product and continuity of operation of otherwise "unorganized" village forges.

3.4 The Small Scale Industrial Workshop

Hand tools can be manufactured in medium size quantities by those industrial workshops equipped with forging capability (blacksmith shop).

Such workshops have a blacksmith type forging department primarily to form parts for animal drawn implements. Typical of this type of operation is a power operated forging furnace to heat metal to

forging temperatures. The forge shop is equipped with a light spring hammer forge. This equipment does not require forging dies. The forge acts to deliver hammer blows to the metal being forged but under power rather than manual. Similarly pneumatic 50 ton forge hammers can be selected for the same purpose. Parts are manipulated manually by a skilled smith and parts are reheated as required during the forging operation. After forging, water quench and salt bath heat treatment is used to harden and temper the forged parts. Such small scale workshops can produce 50,000 to 100,000 pieces per year. The particular advantage of this type of facility is that it can produce short run small volume product at good quality standards. Costs for standard products requiring longer runs such as hoes and machetes of course do not compare to those of high volume forging using forging dies in heavy duty mechanical or hydraulic forging presses (100 to 500 tons). An example of this type of operation is the Soroti plant in Uganda.

3.5 Medium to Large Scale Hand Tool Manufacturing

A large portion of the African market for hand tools is provided by specialized hand tools factories located outside of Africa exporting to developing countries. One such company is the Chillington Tool Company of Wolverhampton England.

Recognizing the needs of developing countries to have their own local manufacturing facilities Chillington established large operating plants in Uganda and Brazil. A new such plant is presently being planned for Nigeria.

The Peoples' Republic of China exports considerable product to Africa under the COCK brand. This product is fully-forged to high quality standards and offers a wide selection of configurations. The Chinese company has demonstrated willingness to cooperate with the Ubungo Farm Implement Company in Tanzania to produce welded hoes in Tanzania with considerable Chinese technical assistance including supply of specialized machinery. This factory in Tanzania is undergoing conversion to upgrade the quality of welded hoes to fully forged hoes.

The Peoples' Republic of Poland has in recent years supplied technical assistance to the National Metal Works in Addis Ababa to equip a modern high volume high quality factory to produce hoes and cutting tools.

Among particularly good suppliers of cutting tools, hoes sickles and scythes to Africa is SENSENWORK KRENHOF of Austria.

The European manufacturers tend to specialize in either hoes or cutting tools. Volumes would appear to be sufficiently large for European producers to specialize. The technology is common however both as to forging metals and forging manufacturing processes.

The new African plants sometimes combine manufacturing of both hoes and cutting tools in the one facility as for instance: National Metal Tools in Ethiopia, UMAZ in Zaire and SISCOMA in Senegal.

Other African plants such as Agrimal, Malawi, and Uganda Hoes specialize in hoes only, while Kenya Engineering Industries, Nairobi, specializes in cutting tools only.

In a typical African market cutting tools comprise about 25% of market volume expressed in tons relative to hoes and cultivation tools.

The scale at which an African plant becomes competitive with foreign manufactures for the production of cultivation tools or cutting tools is in the order of 1,000,000 pieces per year. There is a market for this volume of production in most African countries even in the smaller ones such as Malawi. Given a smaller African market then it makes sense to combine manufacture of cultivation tools and cutting tools in one facility since the manufacturing technologies are quite similar.

3.6 Large Scale Hand Tool Manufacturing Technology

The essential knowledge for the manufacture of hand tools in large volume (1,000,000 plus pieces per year) is metallurgy and forging.

While use of hand tools is simple farming technology, manufacture of these tools is not simple. Manufacturing technology must ensure that tools:

- o Have a long life (by hardened wear surfaces)
- o Do not shatter on impact
- o Withstand bending loads at the blade or at the weld
- o Are uniform in dimensions and weight.

Appendix B shows a specification now established in Kenya for such tools together with a sample test report of a product qualifying to this specification.

What are the manufacturing steps required to achieve such a typical specification for high quality hand tools such as the specified fully forged hoe?

- o Metals

  The material specifications for forging steel are critical. Such steels are not yet manufactured in Africa and must be imported in large billet form or alternately in small billets of a shape, size and weight ready for forging.

  Purchase of this material from various sources in the world requires an intimate knowledge of world steel suppliers in order to obtain continuous deliveries and to control prices of the steel and its subsequent transportation to the factory. The steel is purchased to a specification and the factory must be capable of testing the steel upon delivery to ensure that the steel conforms to specification.

o Material Preparation

The steel must then be prepared for the forging process by cutting to size to conform to the usage requirement of metal in the finished products. This raw steel is called forgirg blank.

o Preheating

The forging blank must be brought to forging temperature in a furnace and kept at this temperature through the forming operations.

o Forging

The forging blank then proceeds through four sequential forging operations each on different forging machines which pierce the "eye" and roughly shape the part.

At Chillington, National Metal Works, Ethiopia and at Agrimal, Malawi these high pressure forging machines are custom built by forge press capital goods manufactures to specifications drawn up by the manufacturer to fit his particular process. Such forging machines cannot be selected from catalogues of general purpose equipment. The machines can be mechanical forging presses or hydraulic forging presses fitted with complex dies. The dies are produced and maintained in the factory's own tool and die shop.

The tool and die shop manufactures these forging dies from very special (and expensive) tool steels for each configuration and shape of hand tool produced.

o Rolling Operations

The partially formed blank (after reheating if required) is introduced into rolling mills. Again these are special purpose machines equipped with dies special to the tools being manufactured.

o Blanking Operations

After rolling, excess metal and flash is trimmed and the hole size is finished. Again special custom designed machinery is used.

o Shaping

The forged hand tools are then dished to final shape.

o Welding

In order to cut down on the cost of special forging presses, hoes can be manufactured by welding the blades forged as above but on standard forging presses. The "eye" (formed from steel tubing) is then welded to the forged blade.

This is the process used at Ubungo Farm Implement Ltd, Tanzania, Shonga Steel, Zambia.

There is a trade off between capital equipment investment and quality. It is generally believed in the trade (and by farmers) that the all-forged hoes are superior in quality.

o Grinding

The cutting edges are ground on custom designed grinding machines.

o Hardening and Tempering

The final product is heat treated to bring the wear surfaces to proper hardness and tempering. This operation may be automated and performed by various methods (at Chillington UK by a continuous heat treating furnace including timed cooling, at Ethiopia Metal Tools with electric induction furnaces, at Agrimal Malawi by air cooling and hardening only because of the choice of forging raw material).

o Marking, Labelling, Varnishing and Painting, Wrapping and Packing

The finished product is prepared for shipping. No great investment in equipment is required for these operations.

o Cutting Tools (Finishing Operations)

For cutting tools, following the forging of the cutting blades in a process much like the process described for manufacture of hoes, the cutting edge must be sharpened.

The forged blade is now then treated to provide a hard yet tempered surface by heating in a nitrate salt bath and then rinsing with hot and cold water.

The blade is then ground (or whetted) to a sharp cutting edge by special grinding machines.

Wooden handles are added and labelling, varnishing wrapping and packing operations complete the process.

4. UPGRADING REQUIREMENTS

4.1 General

The upgrading requirements are studied for each of the possible choices that a country can consider. For each case, the conditions are then established first to set up a new production capability and then to operate the plant. The upgrading conditions are derived from the techno-economic factors required, and from the existing industrial infrastructure of the country. Two levels of development of the industrial infrastructure are considered a limited one and an extensive, or strong, one.

A limited industrial infrastructure indicates that the country does not have a significant industrial capability to support the establishment of an agricultural machinery industry. This covers not only the current fabricating industry but also research and development capacity in the country, the training system and the marketing system.

A strong industrial infrastructure indicates that the country, even in the case where no agricultural machinery industry exists, has some industries and related activities which can be used to set up and operate a new agricultural machinery industry. As an example, if a given country has some shipbuilding facilities, this indicates the existence of forging facilities and possibly that casting supply for steel products is organized and various categories of trained personnel are employed in the country. Therefore the creation of an agricultural machinery industry can be planned with the objective of maximizing the existing infrastructure which can lead to a better value added in the country.

4.2 Establishing the facilities

When the country wants to go to the next higher level, it is first necessary to evaluate the requirements for the investment. This aspect covers four major fields: the equipment or capital goods required to establish the new plant, the technology, the training to get competent manpower and the financing for the project. A summary of requirements appears in Table 4.1.

- Capital goods

  Basically all the equipment required (as presented in table 3.2) to set up a production capability for hand tools has to be imported. In general, even in the case of a strong industrial infrastructure, a country does not produce the machinery required for hand tools production.

  At stage 1 (rural blacksmith) or stage 2 (small scale industry) fabrication equipment, forging and heat treatment are required, Fabrication and forging equipment must be imported. Adequate heat treatment equipment can often be acquired locally. At stage 3 (medium scale industry) machining and tool room will have to be added and all equipment items must be imported.

o Technology

Two different aspects are considered for technology: the design of the product and the organization of the production. Product design for hand tools is required at each stage. When the industrial infrastructure is limited the country will have to import it. However, when the industrial infrastructure is strong, the country should use its own research and development centers to produce their own design and to develop a line of products suitable for the different agricultural conditions of the country.

Production technology is not required at the rural blacksmith stage. For the small scale industry, production technology will be imported with the equipment in the case of a limited industrial infrastructure and can be developed in the country in the other case. The same pattern applies for the medium scale industry but at a new sophisticated level.

o Manpower

At all stages skilled labour is required and appropriate training can be done in the country. However some external expertise will be required in all cases, except for that of small scale industry in a strong industrial infrastructure where local expertise should be adequate. In particular, a program to develop heat treatment and welding capabilities of blacksmiths should be developed. Technical engineering is required for stages 2 and 3 and will have to be imported when the local capability is limited. The same applies for management. Agricultural engineering capability for design purposes is not essential to produce hand tools.

o Financing

The relative importance of external financing tends to increase with the size of the project, its foreign content and the sophistication of the technology. For blacksmiths and workshops, expected sources of financing are international assistance programs or government agencies. For medium scale industry, participants in the financing could also include a foreign partner, the production unit and commercial banks.

o Conclusions

In the profile for upgrading to hand tools production, it is assumed that no agricultural machinery industry exists in the country and therefore almost every investment item has to be imported. The use of the existing industrial infrastructure is generally rather limited. The case of UMAZ in Zaire described in Appendix C illustrates these general considerations.

TABLE 4.1

HAND TOOLS PRODUCTION INVESTMENT

	RURAL BLACKSMITH		SMALL SCALE INDUSTRY		MEDIUM SCALE INDUSTRY	
	LIMITED	STRONG	LIMITED	STRONG	LIMITED	STRONG
Capital goods (*)						
Fabrication equipment	●	●	●	●	●	●
Forge	●	●	●	●	●	●
Heat treatment	θ	θ	θ	θ	●	●
Machining	-	-	-	-	●	●
Tool room	-	-	-	-	●	●
Technology						
Product design	●	θ	●	θ	●	θ
Production	-	-	●	θ	●	θ
Manpower						
Skilled labour	θ	θ	θ	0	θ	θ
Technical engineering	-	-	●	θ	●	θ
Management	-	-	●	θ	●	θ
Agricultural engineering	-	-	-	-	-	-
Financing	-international assistance -government agency		-international assistance -government agency		-international assistance -government agency -production unit -foreign partner -commercial bank	

● to be imported
θ partly imported; can be found or developed in the country
0 available locally

(*) see table 3.2 for detailed list of equipment

4.3 Operating the facilities

Details of the upgrading conditions related to the operations of a new hand tools production center are presented in Table 4.2.

Three sets of factors are studied: the source of supplies, research and development facilities at the plant and the marketing constraints.

o Source of supplies

Hand tools production requires mainly sheet steel and some bars and plates. When the industrial infrastructure is limited these items will be imported. However in a strong industrial infrastructure some can be produced in the country. This can lead to opportunities for new related industries. Factory supplies are also required, for the small and medium scale industry. These can reasonably be provided locally even where industrial infrastructure is limited. Forgings required by a small scale industry could also be made available where industrial infrastructrure is strong.

o Research and development

Research and development at the plant is not required at stage 1 and 2. The rural blacksmith is mainly concentrating on reproduction of simple designs. It is only at the medium scale industry stage that some research will be required to develop more adequate hand tools according to regional needs.

o Marketing

The market for hand tools at stage 1 is local. The rural blacksmith sells directly at a very competitive price compared to the two other stages. Sales for a small scale industry are done over a larger area, to farmers and cooperatives. Selling to cooperatives or major development projects often requires a credit system in order to help the small-scale industry to operate continuously. At the medium scale industry stage, sales of hand tools have to be made through a more sophisticated marketing system which includes credit and distribution system. At this stage the organization of the production requires also a good information system to evaluate in advance the requirements from the major clients like regional development programs and national cooperative network. This production programming is essential to insure a balanced marketing mix of products.

TABLE 4.2

HAND TOOLS PRODUCTION OPERATIONS

	RURAL BLACKSMITH		SMALL SCALE INDUSTRY		MEDIUM SCALE INDUSTRY	
	LIMITED	STRONG	LIMITED	STRONG	LIMITED	STRONG
Supplies						
Forgings	-	-	-	⊖	-	-
Castings	-	-	-	-	-	-
Structural shapes and tubes	-	-	-	-	-	-
Bars and rods	●	⊖	●	⊖	●	⊖
Sheet steel	●	⊖	●	⊖	●	⊖
Ancillary	-	-	-	-	-	-
Factory supplies	-	-	⊖	⊖	⊖	⊖
Research and development	-	-	-	-	O	O
Marketing						
Credit system	-	-	X	X	X	X
Distribution network	-	-	-	-	X	X
Production programming	-	-	-	-	X	X

● to be imported
⊖ partly imported; can be found or developped in the country
O available locally
X required but generally handled by other agencies

5. RESEARCH AND DEVELOPMENT AND OTHER ASPECTS

From the production process description, it can be seen that manufacture of hand tools (at quality and price levels competitive with imported products) is rather simple at the village blacksmith stage and workshop stage but becomes complex at the medium scale industry where economy of scale is required to compete with developed country manufactured products.

Research and Development to define the product line is not a significant requirement. However, because of the large investment in the custom made forging capital equipment and in tools and dies, decision on the exact specification and shape of product and number of different terms to produce for the national and/or export market requires very careful market studies. There is much local tradition and preference by local farmers as to what quality, what shapes and weights of tools they prefer.

The next step is to lay out the factory and to select the production machinery. This operation is complex and an experienced foreign partner willing to license technology, may take a joint venture investment position or provide turn key engineering and supply an equipped factory ready to run together with considerable training during plant start-up. At this stage, a number of successful African manufacturers such as Agrimal or SISCOMA could be considered as partners.

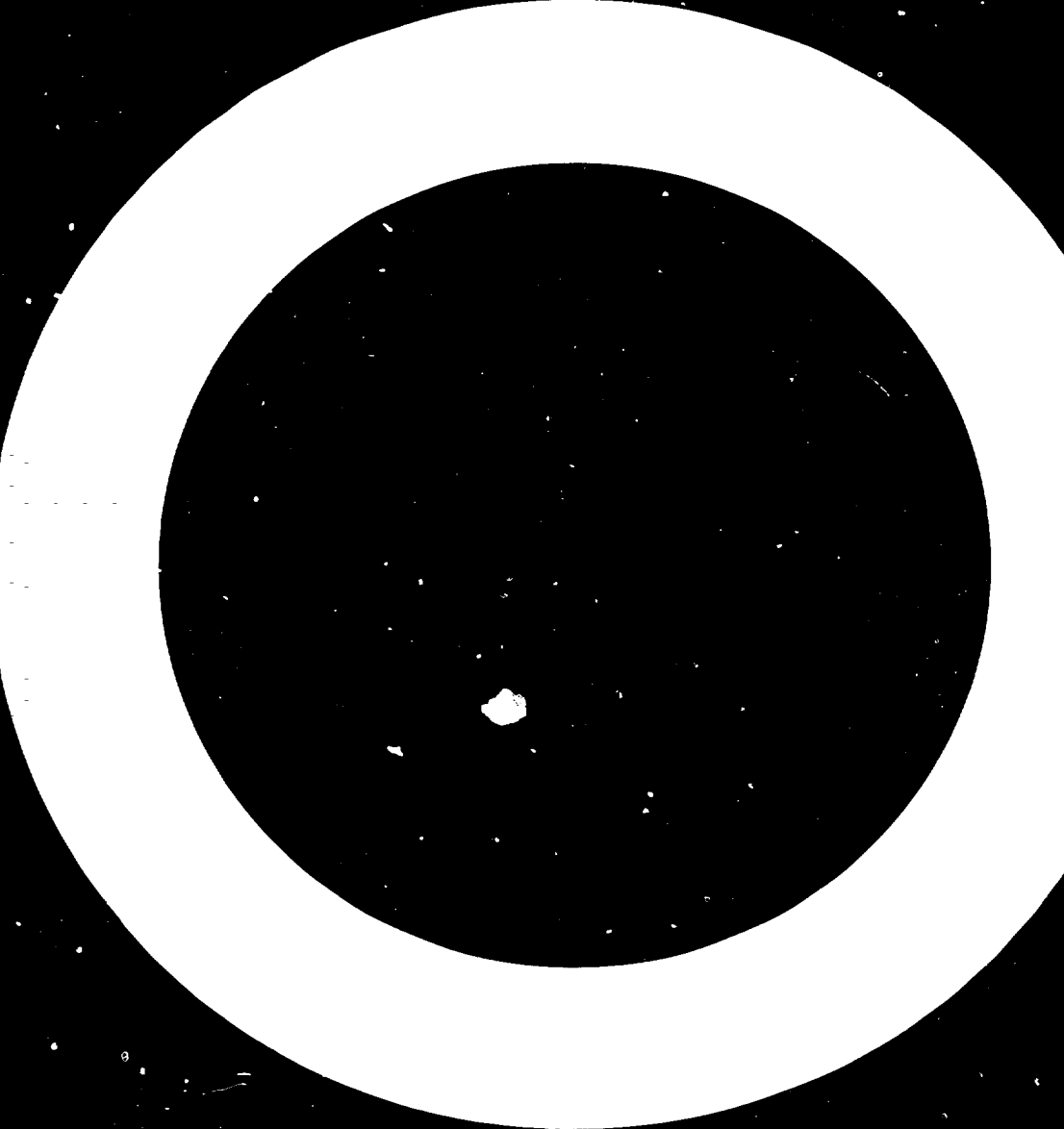
These factories employ a work force up to 200 people from very skilled engineering metallurgical oriented management to very skilled tool and die makers, forging technicians and heat treatment technicians supported by semi-skilled work force for the less demanding tasks. A considerable investment in the recruiting and training of personnel is mandatory.

Because of the heavy investment in capital equipment for forging operations, consideration should be given to combined operations making use of the expensive forging equipment to produce forged parts for other agriculture implements (animal draft equipment in the case of Agrimal Malawi and SISCOMA Senegal). Note also that since the forging process is such an integral and major component of hand tool manufacture, it is not practical to purchase forgings and to provide finishing operations only.

It should also be noted that, due to the high investment in capital equipment and skilled labour, value added is high in such a facility (50%-70%) although tool and forging steels must often be imported.

VOLUME III

PROFILE 2: UPGRADING REQUIREMENTS FOR PRODUCTION OF ANIMAL DRAWN IMPLEMENTS AND MANUALLY OPERATED MACHINES



1. DEFINITION

1.1 Introduction

The profiles focus on the requirements for upgrading production capabilities in a given country from one level to the next higher. Levels are defined based on category of product and scale of production: category 1 is the production of hand tools; category 2 animal-drawn implements and manually operated machines; category 3 tractor drawn implements and power operated machines and category 4 tractors and combines. This last category being found in only a very few countries, it is not studied in the profiles for upgrading. In each category the existing stage of development or scale of operation are considered: stage 1 is the organised village blacksmith operation, stage 2 is the small scale workshop and stage 3 the industrial plant. The production technology is determined by the product and the scale of production which is explained in detail at each product category in conjunction with its scale of production.

This report presents profiles which indicate ways and means by which a country could reach the next higher level of production capability, from its existing level.

Profile 1 discusses upgrading choices and requirements to reach hand tools production if a country is not producing any machinery.

Profile 2 discusses upgrading choices and requirements to produce manually operated and animal drawn implements when the country is already producing hand tools.

Profile 3 discusses upgrading requirements to produce power operated machinery and tractor drawn implements when the country is producing animal drawn implements and manually operated machinery.

Each profile focuses on the engineering part of the requirements and its directly related factors such as financing, training research and development and organization. However some other important factors to be considered in the formulation of an agricultural machinery industry program are not specifically discussed in these profiles, such as the need for machinery in Africa, an adequate marketing and distribution policy etc.

Each profile is structured in five chapters. Chapter I describes the different cases for upgrading, depending on the existing stage of production and the desired stage at the next level. Products considered are presented and illustrated. Chapter II reviews and summarizes the current status of agricultural machinery production in eight selected countries. These countries have been selected in order to provide case studies and examples on each profile. Chapter III details techno-economic conditions to operate a new plant independently of the existing infrastructure.

Chapter IV establishes the upgrading requirements by indicating in each case what part of the techno-economic conditions have to be acquired in order to upgrade the existing system. Chapter V indicates the role of the institutions in the development of agricultural machinery production in Africa.

The selection of a program for a given country depends upon the specific situation in that country, and its priorities. Therefore these profiles must not be construed as replacing the very necessary sectoral plans as well as prefeasibility and feasibility studies.

1.2 Upgrading choices

The profile for upgrading the production of Animal Drawn Equipment incidates the ways and means by which a country, can significantly meet its requirements for such equipment when that country is currently only producing hand tools. The current production of hand tools can be at either the blacksmith, workshop or industrial plant stage. Likewise, the upgrading possibilities presented consider attainment of production capability at each of these three stages.

The alternatives cases studied are:

- the country is producing hand tools through a network of village blacksmiths and wishes to upgrade to produce animal drawn equipment and manually operation machines:

  Either through this village blacksmith network or in industrial workshops. Or establish new village blacksmith units.

- the country is producing hand tools in industrial workshops and wishes to upgrade to produce animal drawn equipment and manually operated machines in either:

  Industrial work shops or in an industrial plant or establish new workshops.

- the country is producing hand tools at the industrial plant scale and wishes to upgrade to also produce animal drawn equipment and manually operated machines in an industrial plant or establish new industrial plant.

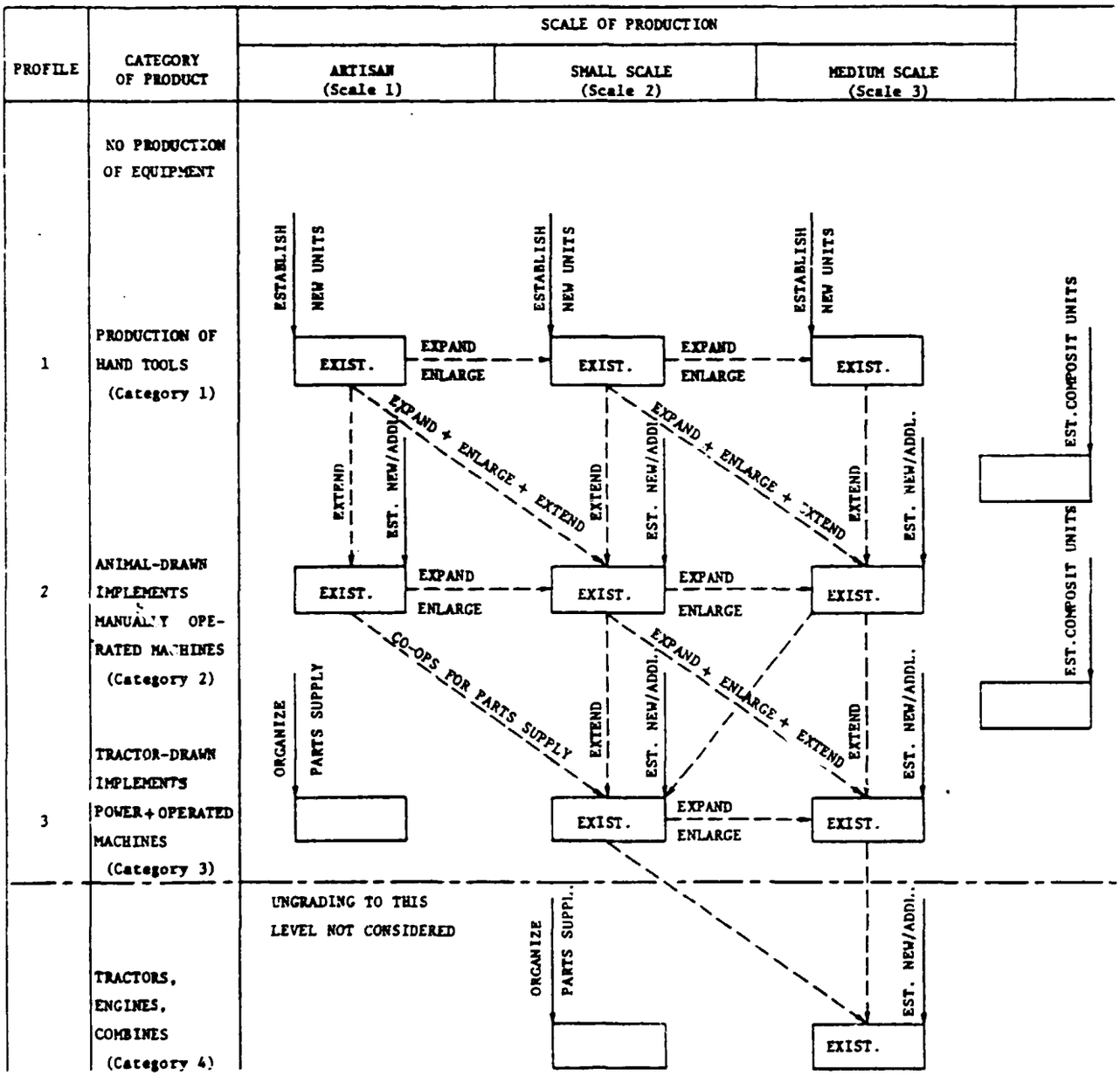
For all cases the requirements are assessed for countries with a limited industrial infrastructure, and for countries with an extensive (or strong) industrial infrastructure.

1.3 The context of animal drawn equipment

Animal powered farming, usually using oxen, is of particular importance to the emergent farmer. The use of animal power equivalent to (.5 to .8 Horse Powers) enables the smallhold farmer to increase land under cultivation from less than 2 hectare par farm family using hand tools to up to 10 hectare. This use of animal power for

FIGURE 1

UPGRADING CHOICES



ploughing, seeding and weeding overcomes the major labour bottlenecks that restrict the area that can be managed by hand cultivation. This additional area under cultivation permits the farmers to market surplus over and above the family subsistence food needs. The farm can produce food for local consumption as well as cash crops such as grains, coffee, tea, sugar and rice for an extended market.

The animal power is used to draw implements - ploughs, ridgers, harrows, cultivators and planters. The implements vary from simple wooden constructed traditional implements to modern steel constructed general purpose or special purpose implements such as groundnut harvesters as discussed in more detail in the following section.

These implements are now manufactured at two levels of manufacturing development - the artisan level or the industrial workshop level.

The advantages:

- o Larger area of cultivation (and yield) per unit of labour input as compared to hand tools.
- o Relatively low capital investment for oxen and machinery within the manufacturing capability of locally available resources and skills and involves minimal use of foreign exchange.
- o Oxen and related equipment are within the reach of small farmers' ability to buy.
- o Ox drawn equipment is simple to maintain and repair by the farmer or by the village artisan.
- o Oxen can be used economically on small and scattered fields.
- o Improved yields per hectare result from uniform and optimum plant spacing.
- o Alleviation of drudgery.

Some of the contraints to more widespread use are:

- o The need to change traditional farmers practice and the requirement for demonstration and training.
- o The limited availability of animal drawn implements of appropriate design manufactured locally.
- o Difficulties in obtaining credit for the initial investment.
- o Animal health due to tsetse fly in humid zones.

1.4 The Products

o Main Products

The main animal draft agricultural implements and their principal field uses are described and illustrated in the figures.

The Traditional Wooden Ox-Plough

The traditional wood construction ox plough, used extensively in Ethiopia, is made up of a wooden ox yoke and a wooden beam holding a single forged metal share which plows a narrow furrow turning up big clods. This implement is produced in local artisan workshops.

The Single-Furrow Mould Board Plough

This is the most common implement in use. The mould-board acts to turn-over the earth to bury stubble and weeds preparing fresh mixed soil for planting. These ploughs weigh 30-35 kg and cut a furrow width of 13-21 cm and a furrow depth of 7-18 cm. They are capable of plowing 3-4 hectares in an 8 hour period.

Construction is of mild steel with carbon steel for wear parts and a forged beam as the main structural member.

The Ridger

This implement is similar to the mould board plow but it is fitted with adjustable ridging blades to form a ridge suitable for planting with subseqent advantage for weed control.

The Harrow

The harrow acts to break up clods formed from plowing to prepare a smooth seed bed situable for row crops. It can be found in various configuration triangular, diamond, ziz-zag or fitted with rotory spiked toothed wheels

The cultivator

The cultivator is a mild steel structure designed to carry sweeps and tines to weed between rows of varying widths from 60 @ 100 cm.

The Single-Row Planter

The planter cuts a furrow for seed application by means of a mechanism to regulate seed spacing. A hopper for fertilizer or herbicides enables metered application of fertitizer and herbicids in combination with the seeding operation.

The Seed Drill

This configuration of planter is used for multi-row sowing of grains, rice and legumes.

Other Implements

There are number of specialized implements available such as the Ground-nut lifter designed to harvest ground nuts.

Tool Bar

This more modern implement consists of a wheel mounted frame (the tool bar) to which can be attached a variety of attachements including a plough share, a ridging plough, seed drills, chisel tines, ground nut lifting blades, weeding sweeps, etc. The wheel frame is made light and strong and the attachments provide a wide variety of cultivation functions from the common frame unit.

The tool bar was developed specifically in Africa for African conditions. Much research and development activity centers on development of this implement.

o Related Products

There are many related agriculture machines that bear consideration. These machines are related to such activities as post-harvest crop processing, irrigation, farm processing and storage, transport (ox-carts and trailers).

Analysis of the present status of manufacture of such products in Africa indicates two patterns of manufacture. One pattern is that most of the animal drawn implement companies manufacture these related products (both hand operated and powered equipment). SISCOMA, (Senegal) for example, produces shellers, grinders and mills. The Sorati (Uganda) plant produces hammer mills, ox carts and wheel barrows. The Agrimal (Malawi) plant produces threshers and ground-nut shellers.

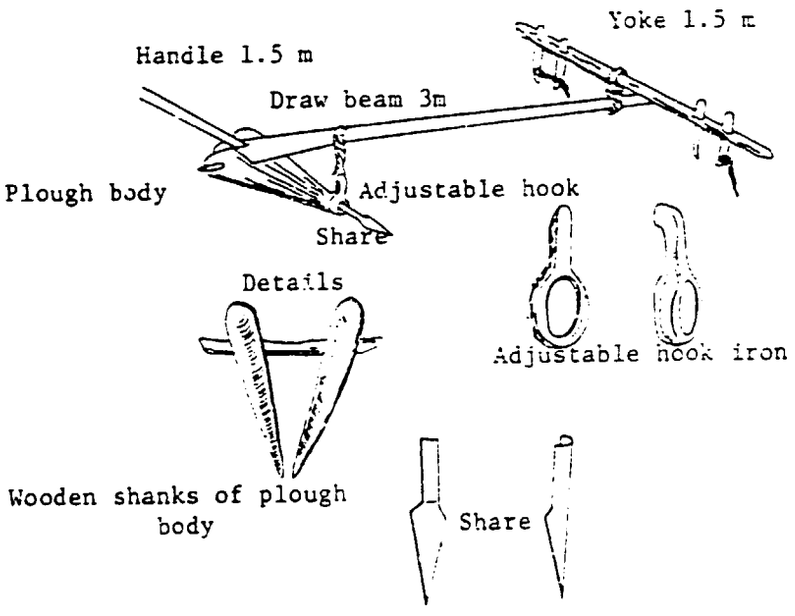
The products are particularily compatible with the animal drawn implement plant equipment, materials and processes and the technology required to manufacture such equipment in industrial workshops or medium scale industrial factories. There is an opportunity to extend the line of products produced in the existing factories by technology transfer from one African country to another. Again these products are generally not proprietary and such transfer depends to a large degree on the identification and communication process between African countries.

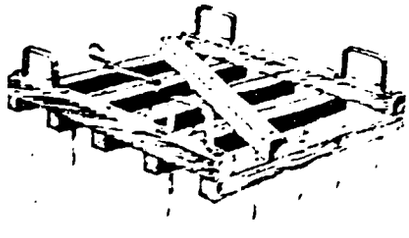
The other pattern is manufacture of equipment such as pumps, storage equipment, wheel barrows and hammer mills in light general engineering shops manufacturing product not necessarily related to the agriculture industry. Kenya, Senegal and Tanzania are particular sources of such equipment. Markets for such related agriculture products are generally so small that a specialized manufacturing plant for such product is not appropriate. The products are therefore manufactured in combination either with agriculture implement product or other light engineering industry product

WOODEN OX PLOUGH

(ARTISAN MANUFACTURE)

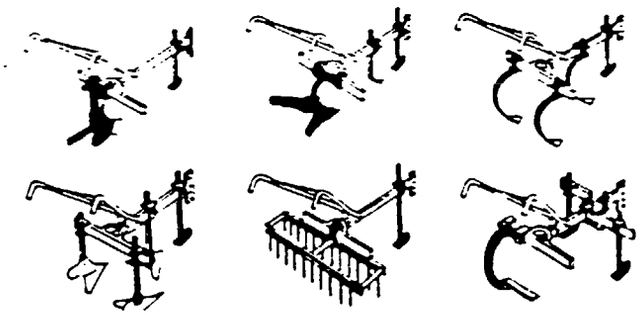
ETHIOPIA



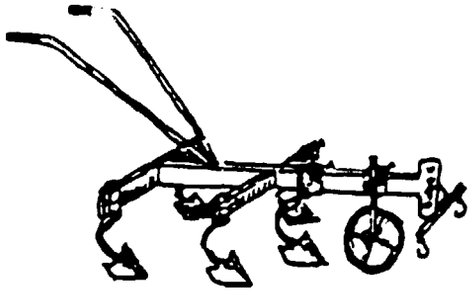


WOODEN HARROW
Tantu, Tanzania

ANIMAL DRAWN IMPLEMENTS

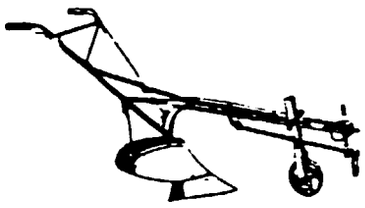


SINE-HOUE TOOL FRAMES
Ploughs and Allied Products Ltd
Kisumu, Kenya

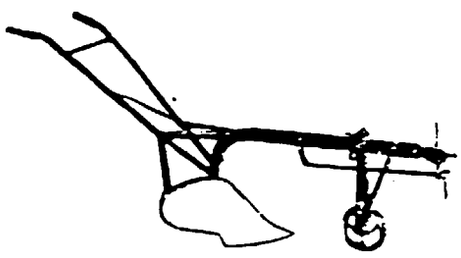


SINE TOOL BAR
Siscoma, Senegal

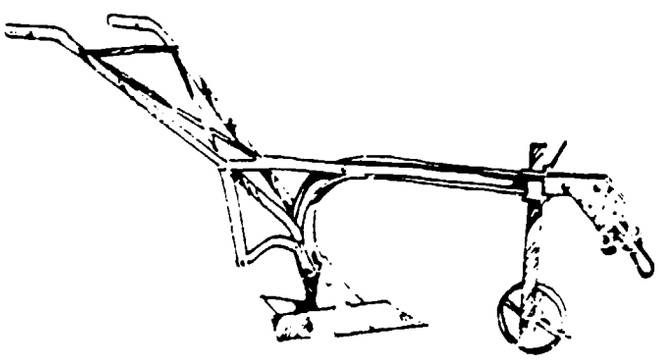
ANIMAL DRAWN IMPLEMENTS
OX PLOUGHS



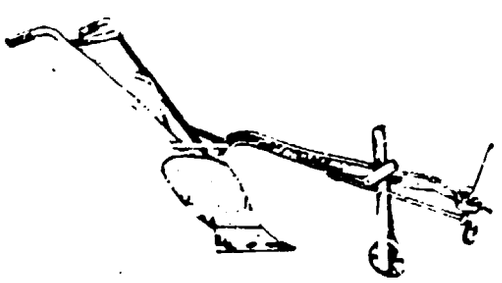
OX PLOUGH
Ideal Casements Ltd
Kenya



OX PLOUGH
Ploughs and Allied Products Ltd.



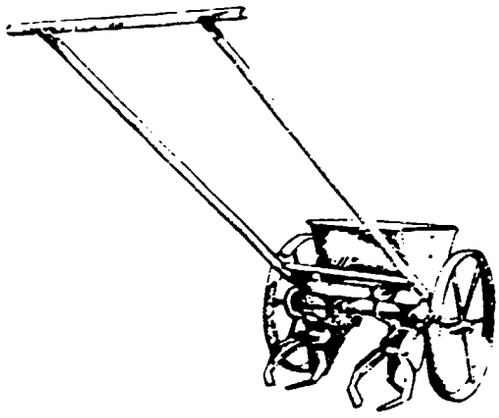
OX PLOUGH
Bulawayo Steel Products
Zimbabwe



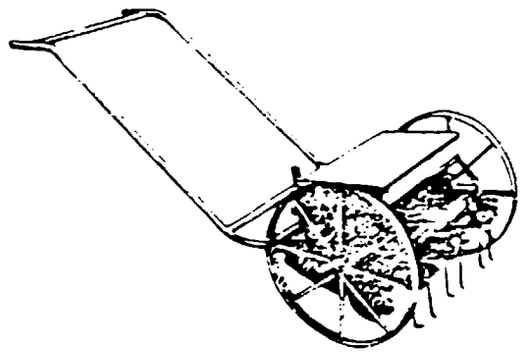
OX PLOUGH
Agricultural Implements Manufactures
Kenya

ANIMAL DRAWN IMPLEMENTS

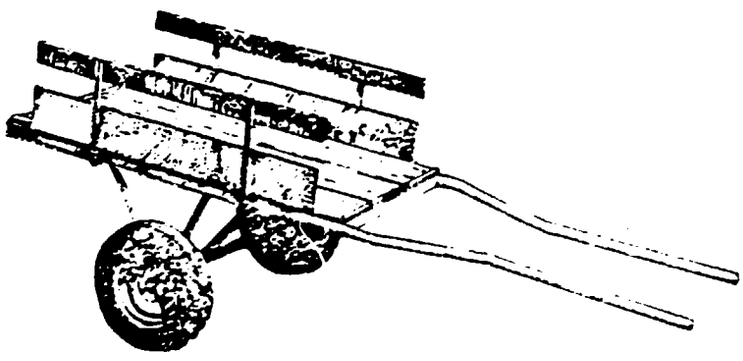
ZIG-ZAG HARROW
Agrimal, Malawi



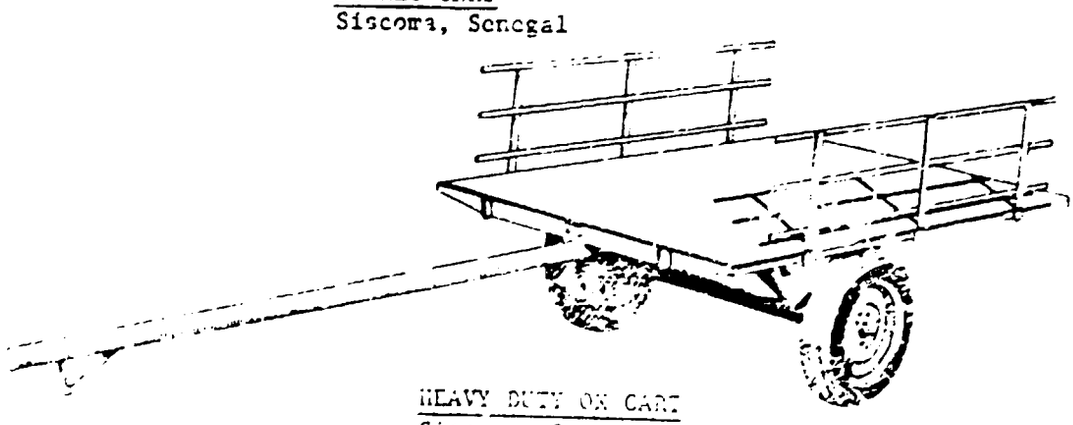
MANUAL RICE SEED DRILL
Siscoma, Senegal



ANIMAL DRAWN RICE SEED DRILL
Siscoma, Senegal

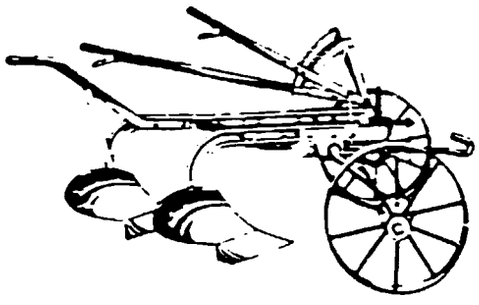


DONKEY CART
Siscoma, Senegal



HEAVY DUTY OX CART
Siscoma, Senegal

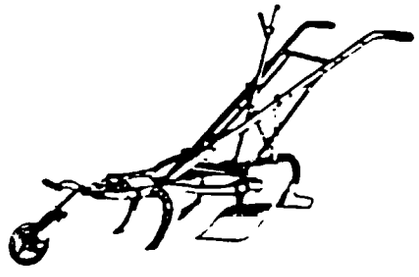
ANIMAL DRAWN IMPLEMENTS



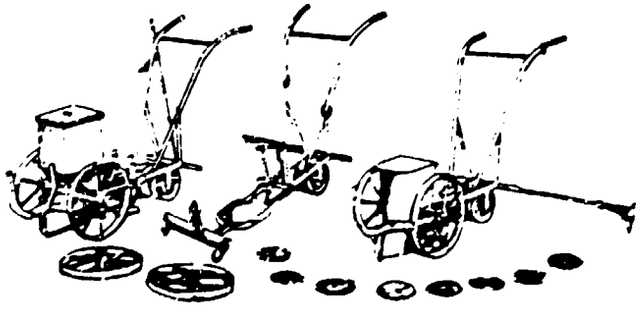
TWO-FURROW PLOUGH
Rhoplow Ltd., Zimbabwe

OCCIDENTALE TOOL BAR
Siscoma, Senegal

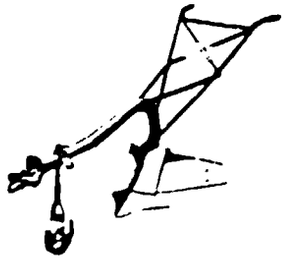
5 TINE CULTIVATOR
Agrimal, Malawi



5 TINE CULTIVATOR
Rhoplow Ltd., Zimbabwe



SUPER ECO SEED-DRILL



HIGH-WING RIDGER
Rhoplow Ltd., Zimbabwe

2. OVERVIEW OF ANIMAL DRAWN IMPLEMENT MANUFACTURING FACILITIES

The summary chart (Chart III), presents an overview of exiting animal drawn implement facilities in Africa. These facilities represent both industrial workshop scale and medium-industrial scale plants. The chart sets out the companies together with a description of the facility, data on products manufactured and data on manufacturing technology. These examples of manufacturing facilities will be referred to from time to time in the profile.

The examples include all significant animal drawn implement manufacturing facilities in the eight countries studied. In addition, facilities in Tanzania and Malawi have been included because of their particular significance. Note that all these facilities although primarily manufacturers of animal drawn implements produce other agriculture product. The combination of animal drawn implements and hand tools produced in the same facility is significant.

Contrary to agriculture hand tools, animal drawn implements are mostly manufactured in Africa rather than imported. Imports consist principally of manufacturing machinery and raw materials and certain parts. Imports represent 60% to 80% of cost of product.

Manufacture is concentrated in West Africa where 9 of the 15 companies manufacture animal drawn implements are located. The remaining plants are located in East Africa. This corresponds with savannah lands appropriate to animal drawn mechanization where land conditions favour the use of animal power.

Established facilities face problems of undercapacity operations due to structural and marketing problems.

A summary of status of existing operations in the countries under study follows:

Senegal and Mali

Faced with the problem of the need to import raw materials and the present shortage of foreign exchange SISCOMA (Senegal) has expanded operations by vertical integration and has increased value added.

SMECMA (Mali) however manufactures as essentially an assembly operation depending on materials and parts sourced from outside Mali (including some integration with SISCOMA (Senegal).

SISCOMA now is faced with problems of providing repair and maintenance service for machines previously manufactured. SISCOMA has experimented with mobile repair units. The CMDT operation in Mali developing local village capability for repair and maintenance has demonstrated a longer term solution to this important aspect.

Companies generally are not strong in Research and Development capability. SISCOMA Senegal is the exception and SISCOMA has developed a strong capability in this important aspect of the business. The Mali case is more typical in that R & D is a government institution responsability.

	SENEGAL	MALI	CAMEROUN	ETHIOPIA			
- NAME OF COMPANY	SISCOMA	SMECMA	TROPIC	CARL	BARE	BLACKSMITH COOPERATIVE ADDIS ABABA	PLOUGHS
- OWNERSHIP	90% STATE (BNDS: 60% FOREIGN PARTNERS (F)	83% STATE (BDM NAT. SOCIETIES) 17% CDMAM (F)	40% SONAC (F 35% SOFICAL (F) 10% SBI (C.	MINISTRY OF AGRICULTURE	MINISTRY OF AGRICULTURE	MINISTRY OF INDUSTRY	PRIVA
- MEAN TURN OVER (3 LAST FIN. YEARS) US $ MILLION	8.2	6.3	6..	LIMITED	LIMITED	NOT AVAILABLE	E' 300
- PRODUCTION CAPACITY	200.000 (1) PCES (FULL TEAM AND PART-TIME LABOUR)	90.000 (2) PCES (PRODUCTION OF TWO SHIFTS)	4000 t (1652 t EN 79.80)	LIMITED	LIMITED	1996 TONNES/YEAR	
- STAGE CLASSIFICATION	3	3	3	3	3	:	3
- PRODUCTS	ANIMAL DRAWN EQUIPMENT FOR TILLAGE, SEEDING AND SPREADING -POST HARVESTING MACHINE	ANIMAL DRAWN EQUIPMENT FOR TILLAGE AND SEEDING EQUIPMENT	HAND TOOLS AND ANIMAL DRAWN EQUIPMENT	PROTOTYPES HOWLO-DRAWN PLOWS, OX CRAFTS HARROWS, THRESHERS	PROTOTYPES	WORKED 03 PLOUGHS YOKES	02 PLOU CULTIVAT TOOL & E WEED PU
- COVERED PLANT AREA	10756 m^2	NOT AVAILABLE	6000 m^2	NOT AVAILABLE	NOT AVAILABLE		
- EMPLOYEE	360 FULLTIME + 100 TO 000 TEMP.	160 FULL TIME + PART TIME	250 FULL TIME	NOT AVAILABLE	NOT AVAILABLE	05	
- SOURCE OF TECHNOLOGY	FRANCE AND SENEGAL	CDMAM		D & D ETHIOPIA	D & D ETHIOPIA		TOOL DA
- EQUIPMENT USED & SOURCE FABRICATION LIGHT	I	I		LIMITED	LIMITED	WOOD WORKING EQUIPMENT	
MEDIUM	I	-	I				
FORGING LIGHT	A	-					
MEDIUM	A	-	I				
HEAT TREATMENT	I	-	I				
TOOL ROOM	I	-	I				
FOUNDRY	PARTLY OWNED	-	IN CONSTRUCTION				
- SUPPLIES USED (SOURCE)	I EUROPA	I CDMAM	I EUROPA				
SPARE PARTS	I EUROPA	I CDMAM	I EUROPA	FORGINGS, CASTINGS ETHIOPIA	FORGINGS, CASTINGS: ETHIOPIA	FORGINGS FROM ARTISAN	BEARI
FORGING		-	-	OTHER MATERIALS IMPORTED	OTHER MATERIALS: IMPORTED	WORKSHOPS	CAST
CASTING	I EUROPA	-	I EUROPA				WHEEL
STRUCT. SHAPES & TUBES	I EUROPA	I CDMAM	I EUROPA				HIGH CAR
BARS AND RODS	I EUROPA	I CDMAM	I EUROPA				
SHEET STEEL	I EUROPA	I CDMAM	I EUROPA				
ANCILLARY	I EUROPA	I CDMAM	I EUROPA				
FACTORY SUPPLIES	I PARTLY IN SENEGAL	I PARTLY IN MALI	I EUROPA				
STEEL CATEGORIES	MILD PARTLY IN SENEGAL						
	1/2 HARD PARTLY IN SENEGAL						
	HARD PARTLY IN SENEGAL						
- MANPOWER & TRAINING SKILL LABOUR	TECHNICAL SCHOOL AND IN PLANT TRAINING	TECHNICAL SCHOOL AND IN THE PLANT		ON THE JOB	ON THE JOB	ON THE JOB	
TECHNICAL / ENGINEERING	BASICALLY IN SENEGAL	MALI					
MANAGEMENT	BASICALLY IN SENEGAL	MALI		RESEARCH ORIENTED MANAGEMENT	RESEARCH ORIENTED MANAGEMENT	ETHIOPIAN	
- INVESTMENT FINANCING PRIVATE DEVELOPMENT BANK INDUSTRIAL CRED.				GOVERNMENT OF ETHIOPIA	GOVERNMENT OF ETHIOPIA	GOVERNMENT OF ETHIOPIA	
GOVERNMENT AGENCY	MAINLY (BNDS)	100% BDM					
OTHERS							
- MARKETING ORGANIZATION	COOP - BNDS - SONIVA (PROCUREMENT) IN THE FRAME WORK OF THE AGRICULTURAL PROGRAM (AGRIC. CREDIT) FOR 80% OF THE PRODUCTION 20% ARE EXPORTED	DEVELOPMENT "OPERATIONS" WHOLESALERS INDIVIDUALS	WHOLESALERS DEVELOPMENT SOCIETIES	SUPPLY OF PROTOTYPES FOR FIELD TESTING		COOPERATIVES	
- COMMENTS				ETHIOPIA HAS EXTENSIVE DEVELOPMENT OF ANIMAL DRAFT AGRICULTURE USING TRADITIONAL EQUIPMENT. ETHIOPIA RECOGNIZES NEED FOR A PRODUCTION FACILITY TO UPGRADE EQUIPMENT. PLANS ARE UNDER WAY TO STRENGTHEN D & D UNITS TO PROVIDE BASIS FOR THIS EXPANSION. PLANS ARE FOR ETHIOPIAN METAL WORKS TO MANUFACTURE HARROWS, OX CARTS, STATIONARY THRESHERS, SEED TREATERS AND DESICATORS. INDIGENOUS PEARLING FURTHER R/D FOR OTHER PRODUCTS			EFFORTS A EFFORTS A FACTOR R & D A PRODUC

SECTION 1

...ENT MANUFACTURING FACILITIES

...NTD BY

	KENYA		ZAMBIA	TANZANIA		UGANDA	MALAWI
...D AND ALLIED PRODUCTS	IDEAL CASEMENTS E.A. LTD.	AGRICULTURAL IMPLEMENTS MANUFACTURES	...OOSTBLAAS ENGINEERING LTD	...GRAND FARM IMPLEMENTS	TANYA	LOW COST IMPLEMENT FACTORY	...NATIONAL MALAWI LTD
	PRIVATE	PRIVATE	PRIVATE	STATE OWNED	STATE OWNED	MINISTRY OF AGRICULTURE	60% MALAWI GOVERNMENT 20% MASSEY-FERGUSON LTD
	NAIROBI	NAIROBI	NDOLA	DAR ES SALAAM	ARUSHA	SOROTI	BLANTYRE
						1000 TONNES/YEAR	3000 TONNES/YEAR
	3	2	3	3	(PROTOTYPES)	2	3
...MES 5000/YEAR ...TERS 100/YEAR ...KS 100/YEAR ...MP, OX CART WHEELS	8X PLOUGHS HAND TOOLS 7000 UNITS/YEAR (WELDED)	6X PLOUGHS PLANTERS	6X PLOUGHS 5,000/YEAR	PLOUGHS 10,000/YEAR HAND HOES 1,000,000/YEAR GRAIN MAT. SHELLERS	PLOUGHS 200 PLANTERS 120 6X CARTS 5000 CULTIVATORS 120 HARROWS 60	MOULD BOARD PLOWS 6000/YEAR HARROWS PLANTERS 6X CARTS 500/YEAR HAND TOOLS 30,000/YEAR HAMMER MILLS 70/YEAR	MOULD BOARD PLOW 10000/YEAR CULTIVATORS RIDGERS HOES 1½ MILLION/YEAR CAPACITY PLANTERS GRAIN MAT LIFTER 500/YEAR
						10000 SQ. METERS	1000 SQ. METERS
						120 (AT CAPACITY)	120
...M FROM SIDCOWA (SENEGAL)				China		INDIA	ZIMBABWE
			LARGE GENERAL MACHINE SHOP			MACHINE SHOP WELDING SHOP SHEET METAL SHOP FORGE AND HEAT TREATMENT ASSEMBLY	MACHINE SHOP FORGE SHOP TOOL AND DIE SHOP WELDING SHOP PLANT SHOP ASSEMBLY SHOP
...IMPORTED ...TON JOHEELS IMPORTED STEEL KENYA SUPPLY CARBON SHARES IMPORTED	3 - COMPONENTS INCLUDING HEAT TREATED PLOUGH SHARES 30 JIG IN KENYA		LARGELY IMPORTED RAW MATERIALS	LARGELY IMPORTED (STEEL) CASTING AND FORGINGS, HARDWARE, TANZANIA, SOURCES		UGANDA (POTENTIAL MILD STEEL SHAPES FORGINGS CASTINGS NUTS AND BOLTS BUT PRESENTLY ALL MATERIALS AND SUPPLIES IMPORTED	STEEL (ZIMBABWE SHEET METAL (MALAWI NUTS & BOLTS ZIMBABWE 65% OF VALUE IMPORTED WATER ETC 15% VALUE - ADDED IN MALAWI
						ON THE JOB	ON THE JOB
						EXPERIENCED UGANDA ADMINISTRATION	LARGELY MALAWI 2 EXPATRIATES ONLY
						.7 MILLION INPUT REQUIRED TO REHABILITATE FACILITY AND PURCHASE MATERIALS	1978 PRICES BUILDING $235 000 TOOLING 80 000 MACHINERY 2 000 000 TOTAL $2 375 000
...HAS INDUSTRIAL INFRASTUCTURE TO PERMIT ...VALUE ADDED TO 50-60% IN ADDITION TO ABOVE ...SPHERE ARE SEVERAL OTHERS MANUFACTURING IMPLEMENTS ...OR WITH OTHER MANUFACTURING, GOVERNMENT SPONSORED ...AND INDUSTRIAL DEVELOPMENT PROGRAMMES WILL ACT TO UPGRADE ...AND INCREASE MANUFACTURING CAPABILITY			TO ENCOURAGE ZAMBIA MANUFACTURING, IMPORTS OF HAND TOOLS AND MACHINERY ARE RESTRICTED ZAMBIA MANUFACTURES HAVE OPPORTUNITY TO UPGRADE AND EXTEND PRODUCT LINE	ESTABLISHED IN 1969 WITH ASSISTANCE FROM PEOPLE REPUBLIC OF CHINA THE UGANDA FACTORY HAS NOW EXPANDED TO 6 000 TONS/YEAR TWO NEW PLANTS ARE PLANNED AT KENYA 6500 TONNES/YR WITH ... MILLION INVESTMENT AND AT KHARTOUM 6 700 TONNES/YEAR	FUTURE PLANS ARE FOR TWO AND THREE REGIONAL FACILITIES TO MEET UGANDA REQUIREMENTS THIS FACTORY CAN BENEFIT FROM SENEGAL AND KENYA R & D PROGRAMS	THIS ORGANIZATION IS INTERESTED IN JOINT VENTURE OR TECHNICAL ASSISTANCE AGREEMENT OR WITH INTERESTED AND CAN SUBMIT E

SECTION 2

Marketing problems at SISCOMA require solutions. SISCOMA is currently working well below capacity and is presently not able to fully meet market demand because of difficulty in sustained production runs due to difficulty in planning manufacturing operations to coordinate with distribution. The Senegal farm credit system has had collection difficulties and as a result lack of credit facilities to farmers restrains the present developed manufacturing capability of SISCOMA. A further difficulty is the accelerating price increased in raw materials and equipment due to inflation and inability to pass on these costs to farmers whose crop revenues have not increased at the same rate.

Kenya

Animal drawn equipment is a healthy growing industry in Kenya. Existing plants are able to keep pace with the increase in demand for animal drawn equipment. Research and Development is successful and new improved implements are being offered. The companies are profitable and expanding.

Zambia

Zambia has developed a strong capability to produce animal drawn equipment at Northland Engineering. The market for animal drawn equipment is growing but Zambia is facing foreign currency restrictions limiting supply of raw materials. Distribution and marketing problems are similar to Senegal and Mali so that inherent demand for animal drawn implements is restrained by lack of credit and inflation of machinery costs relative to crop prices.

Malawi

The Agrimal plant in Malawi is a very successful model of an operation in a smaller country operating profitably in a market rapidly adopting animal drawn cultivation practice. The combination of animal drawn equipment and hand tool manufacturing is particularly a success. The Agrimal operation is now capable of exporting both know-how and product to other Africa countries.

Tanzania

Tanzania experience in providing manufacturing capability for animal drawn equipment has resulted in accelerating adoption of animal drawn cultivation. As a result of this success a three fold expansion of activities is planned even considering the same restraints to development as experienced in Senegal. Research and Development activities are well coordinated and have been important in developing the growth pattern experienced.

Ethiopia

Animal drawn implement cultivation practice is extensive in Ethiopia. Implements however tend to be very simple artisan produced wooden ploughs and harrows. There is a great opportunity to upgrade to improved steel ploughs and other steel fabricated implements. Planning for this upgrading process is under active development.

3. MANUFACTURING TECHNOLOGY

3.1 Artisan Level (Traditional Implements)

Manufacture of simple tillage implements such as the wooden plough, wooden harrow, is carried out in many small artisan enterprises. The manufacturing unit consists of a wood shop equipped with hand tools to manufacture the ox yoke, the draw beam and the plough body.

Two metal parts, the hook iron and the plough share, are produced by hand forge operations The forge is fired by charcoal and blown with hand operated bellows. The parts are formed by hand with hammer and anvil from scrap steel.

This method of manufacture of animal drawn implements is not well developed, but is found in many parts of Africa. Technology, skills, investment and organization are similar to Artisan level technology described in the hand tool profile.

3.2 Industrial Work Shop Manufacture

3.2.1 Technology

Based up on an examination of the existing plants as presented in the preceeding section a general description of the manufacturing process can be made in terms of a typical plant. The requirements by stage are summarized in Table 3 and discussed in more detail in the following paragraphs.

- o Process

  The implements are fabricated from mild steel structural shapes, fabricated parts produced in the factory and bought out parts.

  Process flow begins with parts fabrication in the machine shop, sheet metal shop and forge shop. Parts are produced in small batches according to the weekly assembly schedule requirement. Parts are then processed to sub-assembly stage by welding. Jigs, templates and simple fixtures are employed. Final assembly, painting and packaging operations are continuous operations. The factory operates on two eight-hour shifts. Materials handling in the factory is entirely manual. There is no use made of fork lift trucks or overhead cranes.

  Quality control is important for welding, machining and heat treating operations. Production control is a formal process controlling purchasing of steel and hardware items, scheduling of parts and sub-assembly operations. Work measurement and control of work force productivity is dependent on direct supervision. There is no formal work study, or piece rate incentives.

o Machine Shop

The lathes, milling machines, drilling machines, shapers and grinding machines are basic machine tools capable of producing machine parts to the required quality standards. The machine tools are not equipped with automatic features but rather depend on the machinists to manually load, unload and control the machines. The machinist skills required are of a high order since little tooling is used and each machine and machinist produces a wide variety of parts. Machinists are responsible for their own set-ups and for their own quality control.

Training of machinists requires years of experience under the learning-on-the-job basis. A nucleus of experienced machinists are in a position to train and develop new staff. This program is typical of all factory shops.

As production volume increases, more automatic equipment would be appropriate; for example engine lathes equipped with capstans combine drilling operations with turning operations.

o Sheet Metal Shop

The sheet metal shop is equipped with a power shear, power and manually operated roll form machines. Sheet metal shapes are formed by means of nibbling machines. Blanking machines could be considered.

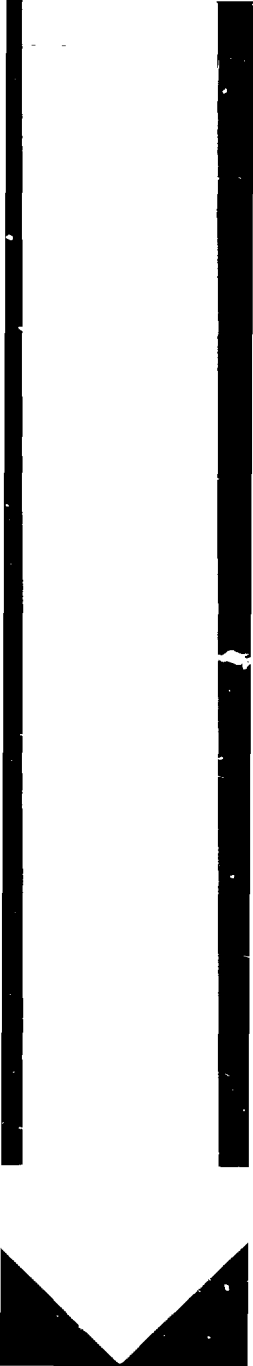
The sheet metal shop is optional depending on whether sheet metal parts can be purchased locally and depending on the amount of sheet metal used in the product line. When product other than animal drawn cultivating equipment is manufactured the sheet metal shop can be important.

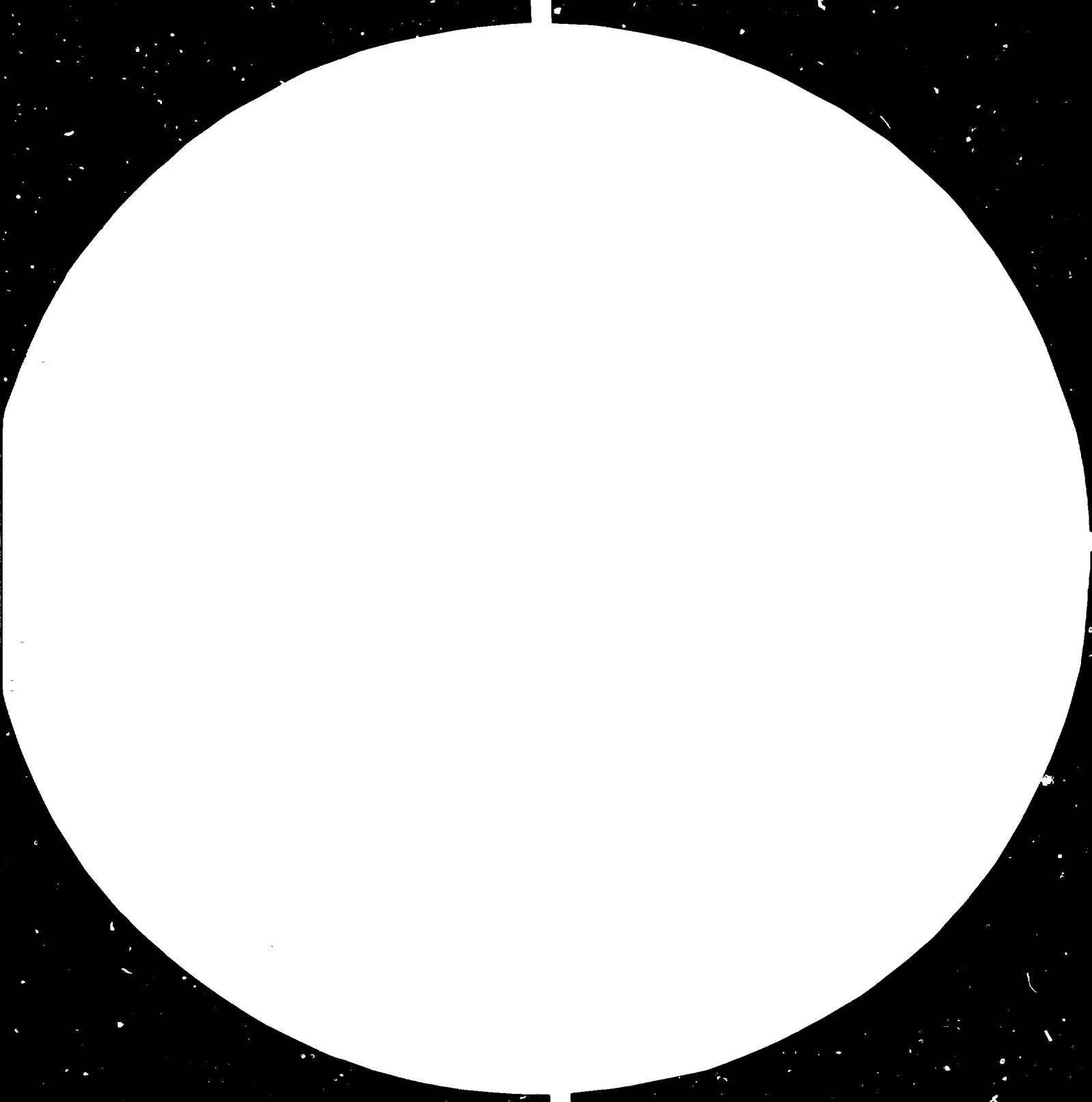
o Forging and Heat Treating Shop

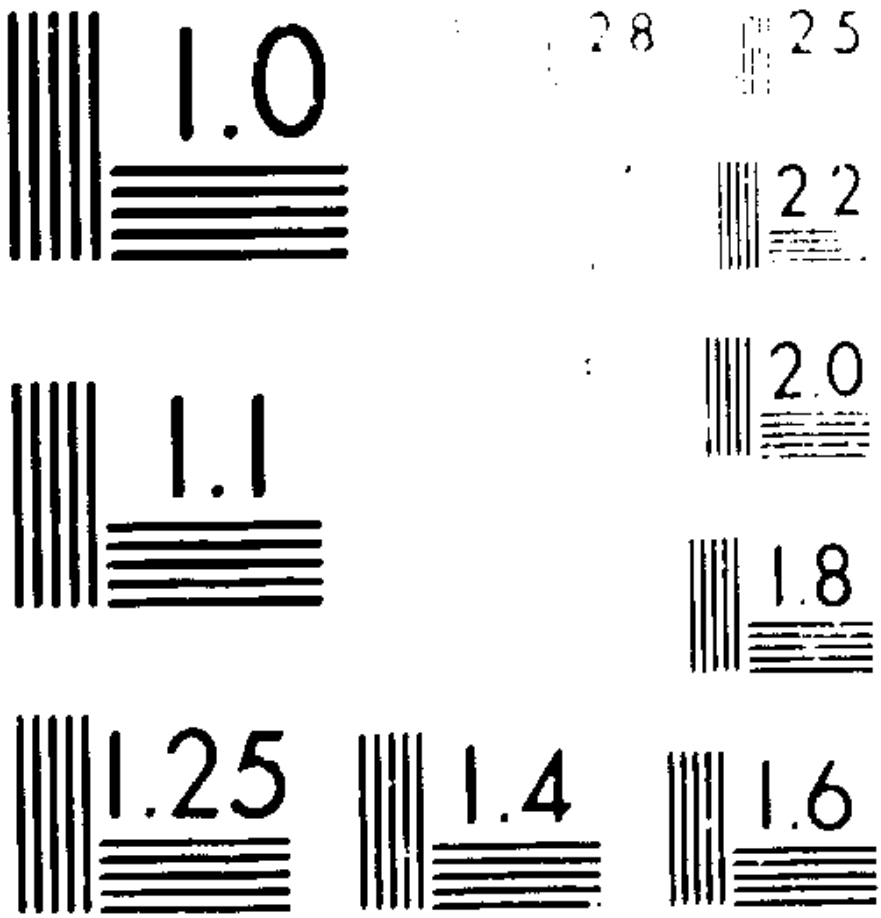
The factory has the option of producing production forgings with sophisticated forging technology or of providing only a minimum forging investment in order to provide the simpler hand forged parts, to have local capability for repair and maintenance and to provide a manufacturing capability for local manufacture of specialized hand tools.

The pros and cons of the decision on forge shop capability will be dealt with at length in the section on vertical and horizontal integration.

A minimum scale forge shop requires an oil fired forging hearth, a tilting furnace, pneumatic forging hammer and or spring forge operating without the use of fixed dies. A tool and die shop is therefore not required. A simple salt bath serves for heat treatment.






1.0
2.8
2.5
2.2
1.1
2.0
1.8
1.25
1.4
1.6

o Welding Shop

The welding shop can be equipped with arc welders using electrodes but a high degree of welding skill is required and this skill is critical to the quality of the product. More modern shielded arc welding equipment may be selected in those countries providing industrial gas. In this process, welding wire is used rather than electrodes. Productivity is improved over arc welding as is quality. There is a material saving in using wire rather than electrodes. Capital equipment cost is about the same but high plant maintenance skills are required to keep the machines in good working order.

3.2.2 Raw Materials, Purchased Parts and Factory Consumable Supplies

o Steel Product

Analysis of material inputs to implement manufacturing show that supply of steel product - structural shapes, bar and tubing, wire products, etc. is of particular importance. The steel specifications required vary from mild steel structural shapes readily produced by the mini steel mills in Kenya and Uganda to special tool steels and forging steels not produced in any African country studied.

Steel product comprises the largest single basic material requirement for agriculture implements often 70% or more. The volume required from an industrial workshop producing animal drawn implements, say 4,000 tons per year is significant when related to the total output of a typical 25,000 ton per year electric mini steel mill. Development of steel making capacity is of great importance for light engineering industrial development such as agricultural implements. The cases profiled show the impact on "value-added" with and without indigenous steel supply 13% as against 70% in the Uganda, Soroti, example.

Material specifications for major implement components are as follows:

Major implement components	SAE No.	Carbon (%)	Manganese (%)
Implement frame (MS)	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 shares, (plate)	1074	0.70-0.80	0.50-0.80
Rake teeth	1078	0.72-0.85	0.30-0.60
Scraper, blades, discs, spring tooth harrow	1085	0.80-0.93	0.70-1.00
Mower and binder section	1086	0.82-0.95	0.30-0.50
Tine holders,knotter discs	1090	0.85-0.98	0.60-0.90

TABLE 3.1

ANIMAL DRAUGHT IMPLEMENTS

Stage	Artisan Stage 1	Industrial Workshop Stage 2	Medium Scale Industrial Plant Stage 3
Requirement:			
Output	5,000 units/year	2,000 tons/year	5,000 tons/year
Equipment:			
Wood Shop	X		
Machine Shop		X	X
Welding Shop		X	X
Forging Shop			X
Sheet Metal Shop			X
Assembly Shop		X	
Tool & Die Shop			X
Maintenance Shop		X	X
Material:			
Forgings	X	X	X
Castings		X	X
Mild Steel Shops, Bar, Rod		X	X
High Carbon Steel			X
Forging Steel			X
Industrial Fastners, Springs, Tines, etc.		X	X
Factory Supplies		X	X
Man Power:			
Skilled labor	X	X	X
Unskilled labor	X	X	X
Production Engineering:			
Agricultural Engineering Management		X	X
Approximate investment	$20,000	$2 million	$3 million plus

TABLE 3.2

EQUIPMENT
VILLAGE BLACKSMITH

- o 50 kg. anvil
- o mechanical hand operated forge blower
- o vice
- o files
- o bolt die set for thread forming
- o hand drills and drill bits
- o hand grinder
- o metal saw and blades
- o square and tape rule
- o wood saw
- o brace and bit
- o oxyacetylene welder

TABLE 3.3

EQUIPMENT

WORKSHOP

Cutting shop

Hack saw
Hand shear

Forge & heat treatment shop

Mechanical drop
Press forge 150 tons
Oil fired furnace
Water quenching tanks
Blacksmiths tools
Shearing machine
Abrasive grinders
Dies & tools

Fabricating & press shop

Ecentric press
150 tons
Press brake 200 tons
Manual bending machine
Arc welding
machine 300 amps.
Nibbling machines
to cut 6 mm MS
Welding fixtures etc.
Pedestal grinding machine
Oxy-actelene & brazing
equipment
Upright drilling machine
12 mm dia in MS
Dies and press tools

Machine shop

Pedestal grinder double ended

Upright drilling machine 25mm dia in MS.

Lathe, maximum bore 75mm, swing 46cm, length 92cm
Capstan lathe with accessories maximum collect size 4cm, swing 30cm, maximum work piece length 16cm

Figs, tools and fixtures

Hydraulic press 1 ton capacity

Gauges, inspection tools & equipment

Portable drill 12mm in MS

Portable grinder 15cm diameter

Assembly Shop

Assembly fixtures

Upright drilling machine 12cm in MS

Portable drilling machine 12mm in MS

Portable grinder 15cm diameter

Paint Shop

Degreasing vat

Dipping plant & conveyors etc.

Tool Room & Maintenance

Universal milling machine, 5HP

Universal cutter grinder 1½ HP

Double ended grinding machine

Surface table

Gauges and tools

Precision Lathe 2HP

Maintenance tools & equipment

Arc welding set 250 Amps.

Mechanical Handling

Fork lift truck 1 ton

Hydraulic pallet truck (hand operated)

Racks, stillages & bins

Conveyors, etc.

TABLE 3.4

EQUIPMENT
MEDIUM SCALE INDUSTRY

Material Preparation

4 Cut-off saws
3 Band saws
2 Shears
3 Presses 15-60 tons
1 Shear press

Machine Shop

12 Lathes
11 Drill press
3 Broaching machine
1 Turret Lathe
2 Milling machines
1 Shaper
9 Vertical drills
4 Grinders
3 Welding machines

Press Room

8 Mechanical presses 15-140 tons
2 Presses 100 and 120 tons
1 Brake press 80 tons
3 Grinders
3 Blanking presses
5 Hand shears
1 Hand punch
2 Special punch presses 8 stations

Welding Shop

29 Welding-machines- arc welders
13 MIG welding machines

Plate Shop

1 Hydraulic shear
1 Hydraulic brake - 140 tons
1 Roll machine
1 Vibromatic machine
1 Oxyacetylene profile cutter
2 Spot welding machines
9 Arc welding machines
1 Shear
1 Band saw
1 Punch press
1 Hand roll machine
1 Profile roller

Forge Shop

1 Mechanical press vertical 400 tons
1 Mechanical press horizontal 250 tons
2 Hammer Forge 140-200 tons
2 Hammer Forge 120 tons
1 Hydraulic press 15 tons
1 Muffle furnace 1000x600x400
1 Butane fired forge furnace
2 Chain conveyors
1 Belt grinder
2 Grinding Mills
2 Steam hammers 75 kg.
1 Punch press

Assembly Shop

2 Punch presses
2 Special presses
1 Weighing machine

Prototype Shop

1 Power saw
2 Universal milling machine
1 Hand brake press
1 Break press powered
1 Roll former
2 Punch presses
1 Grinding mill
1 Arc welding set
1 Oxyacetylene welding set

Tool Room

1 Lathe
1 Milling machine
1 Saw
3 Grinding machines
1 Universal grinder
1 Punch press
2 Arc welders
1 Oxyacetylene welder
1 Muffle furnace 6000x300x300
1 Oil bath (Heat treatment)

o Forging

Forgings typically comprise up to 20% of the value of material inputs. The factory has the option to make or buy the forgings. Generally, the quantity of forgings required for animal drawn implements would not justify the heavy capital investment required for in plant manufacture of production forgings except in the case of combined hand tool production with animal drawn implement production or other product, an example is Agrimal (Malawi).

Generally forging capability is found within a country's railway repair shops. There is usually an opportunity to purchase forgings from local suppliers. There is also the opportunity to purchase only special larger forgings, such as the critical plough beam forging outside the local economy rather than to justify the capital investment required to manufacture relatively low volume requirement locally.

o Castings

Iron and steel castings, such as the mould board plow cast iron wheel make up a percentage of material input. Most African economies have iron and steel casting capability.

However in many cases the existing foundry capacity will need to be expanded in order to supply adequately a new agricultural machinery plant. Therefore, the establishment of an animal-drawn implement production unit will require an evaluation of the existing foundry facilities either to maximize their utilization or to find other potential suppliers in order to support viable expansion project.

o Industrial Fasteners, Springs, Tines, Hardware, Wheels, Tires

These parts typically comprise about 5% of product material inputs. Supplies of such parts were found in many of the African countrie studied. However, quality standards for such parts and ready availability of such parts for repair and maintenance are critical.

Development of such ancilliary industries where they are not found in a country can be greatly stimulated by development of agriculture machinery manufacture.

o Intermediate Parts - Auxiliary Engineering Industries

The requirement for puchased parts from auxiliary manufacturing industries is of great importance to produce low cost agricultural implements. The investment required to manufacture such auxiliary parts and components is such that demand levels often preclude economic manufacture. Annual economic production volume for selected items are as follows:

- Cast iron wheels	1,000,000 units
- Standard bearings	1,500,000 units
- Tines	2,000,000 units
- Discs	1,000,000 units
- Bolts, nuts, washers	1,000 tons
- Chain	500 tons

Such items however, may be practical for development projects on a sub-regional basis. Development of auxiliary industries to produce implement parts at inter-country level will allow existing and new implement industries to procure the essential parts which otherwise cannot be manufactured economically at national levels.

o Subcontracting

There is an opportunity to subcontract parts that could be manufactured in-house with the machinery and equipment and work force established in the implement industrial work-shop.

From time to time, because of manufacturing schedules, these facilities may become overloaded and subcontracting to general engineering shops or artisan level local operations will be required. A subcontract plan to diversify industry can be made a part of the implement factory business plan. Often price advantage may be obtained by subcontracting.

The opportunity to subcontract should be a part of the decision on choosing machinery and equipment for the implement shop, reducing fixed investment and adding to commercial viability.

o Factory Supplies

The supply of items consumed in the factory in the course of implement manufacturing is significant in terms of value-added and foreign exchange requirements. A good number of items such as cutting tools, measuring equipment, instruments and gauges are not produced in any of the African countries surveyed. A good number of factory supply items such as industrial gases, paints, electrical fittings are manufactured and the requirements for the implement industry is important to development of these manufacturing opportunities either at national levels or at sub-regional, regional levels in Africa.

3.2.3 Value-added

Value added in the manufacture of animal drawn implements varies widely in the African countries and factories surveyed in the study.

o Examples

In the case of Agrimal (Malawi), a factory producing both animal drawn implements at Blantyre Malawi, approximately 15% value was added in the manufacturing operation. Malawi is not highly industrialized and depends on foreign input for virtually all

materials and supplies. This factory, which operates on a private sector basis, must compete with imports in terms of product design, product quality and product cost. Agrimal is profitable and contributes significently to the Malawi economy at this presently, low level of value-added.

SMECMA (Mali) is another competitive animal drawn implement manufacturer operating successfully in a country with limited industrial infrastructure. Value-added in Mali has increased from 8.7% in 1976-77 to 28.4% in 1979-80.

At the other extreme SISCOMA (Senegal) competes by exporting to other African countries against foreign competitors. This plant competes very well as to quality and price. Value-added is between 40% to 50% depending on specific product. All steel is imported but forgings, castings and ancillary parts are largely locally produced as is a high portion of factory supplies.

Analysis of the animal drawn implement plant at Soroti (Uganda) shows that the operation once rehabilitated after heavy damage during the Uganda liberation war can be viable with 13% Uganda value added. Given the rehabilitation of other Uganda industry including the steel industries Uganda value added would be 70% and African value added would be 75%. These value added figures are also typical of light industrial operations today in Kenya.

o Implication

From this evidence it would appear that animal drawn implement industrial workshops can be viable in smaller, less developed industrial economies such a Mali and Malawi with value added at the 15% level and contribute significantly to industrial development process. The improvement in SISCOMA value-added from 9% to 28% over a five year period shows development potential once a new operation is established.

In the more industrially developed economies such as Kenya, Nigeria, Senegal, Zimbabwe, value added in the range of 50% - 70% can be achieved and such plants will be significant contributors to the industrial economy and will provide an important market for steel product development (up to 25% in Kenya and Uganda of the total domestic market for steel).

3.2.4 Management, Production, Engineering and Work Force Skills

The typical animal drawn implement plant requires a high degree of manufacturing administrative skills. The management group requires expertise in manufacturing, marketing, personnel administration, purchasing and accounting.

In the factories examined in depth in the study some expatriate contribution to management particularily in the start-up phase was required in all cases.

Today however in th successfull plants, management is largely African. Management personnel generally require university background with training either in other African manufacturing facilities or within the organization.

The factory workforce in the plants visited were entirely African including supervisors, foremen and skilled tradesmen. These plants were started up with a small core group of experienced personnel supported by key personnel. Development of the factory work force was by means of on-the-job training. Intake from vocational schools is important today but was not a factor in initial start up of the factories surveyed.

Mastery of the technology and management of animal drawn workshops is well within the capability and resources available to developing countries. Technical assistance is required from foreign as from African operations for start-up but no sustained foreign technological and managerial input is required for these operations.

4. UPGRADING REQUIREMENTS

4.1 General

The upgrading requirements are studied for each of the possible choices that a country can consider. For each case, the conditions are then established first to set up a new production capability and then to operate the plant. The upgrading conditions are derived from the techno-economic factors required, and from the existing industrial infrastructure of the country. Two levels of development of the industrial infrastructure are considered a limited one and an extensive, or strong, one.

A limited industrial infrastructure indicates that the country does not have a significant industrial capability to support the establishment of an agricultural machinery industry. This covers not only the current fabricating industry but also research and development capacity in the country, the training system and the marketing system.

A strong industrial infrastructure indicates that the country, even in the case where no agricultural machinery industry exists, has some industries and related activities which can be used to set up and operate a new agricultural machinery industry. As an example, if a given country has some shipbuilding facilities, this indicates the existence of forging facilities and possibly that casting supply for steel products is organized and various categories of trained personnel are employed in the country. Therefore the creation of an agricultural machinery industry can be planned with the objective of maximizing the existing infrastructure which can lead to a better value added in the country.

4.2 Establishing the Facilities

For this profile on animal-drawn implements, it is assumed that the country has production capabilities in hand tools at one of the three stages. Therefore, upgrading conditions are established considering the existing capability and trying to take the maximum advantages from it (as illustrated in Table 4.1).

o Equipment

Additional fabrication equipment will be required at all stages and has to be imported. Light forging facilities will be also be imported in all cases except one - the expansion of a small scale industry where that equipment already exists and can be shared for production of animal drawn equipment. A larger forging unit will also be required at the small and medium scale stages. However, when the industrial infrastructure is strong this activity can probably be subcontracted in the country. Heat treatment facilities are required and, except for stage 1, will be imported. Machining and tool room are to be considered at the medium scale stage as well as welding facilities.

TABLE 4

ANIMAL DRAWN IMPLEMENTS INVESTMENT

	RURAL BLACKSMITH				SMALL SCALE INDUSTRY				MEDIUM SCALE INDUSTRY EXPANSION	
	RURAL BLACKSMITH		SMALL SCALE INDUSTRY		SMALL SCALE INDUSTRY		MEDIUM SCALE INDUSTRY			
	LIMITED	STRONG	LIMITED	STRONG	LIMITED	STRONG	LIMITED	STRONG	LIMITED	STRONG
Capital goods *										
Fabrication	●	●	●	●	●	●	●	●	●	●
Forge (light)	●	●	●	●	○	○	●	●	●	●
Forge (medium)	—	—	●	●	●	○	●	○	○	○
Heat Treatment	⊖	⊖	●	●	●	●	●	●	●	●
Machinery	—	—	—	—	—	—	●	●	●	●
Tool Room	—	—	—	—	—	—	●	●	●	●
Welding Shop	●	●	●	●	●	●	●	●	●	●
Technology Initial										
Product Design	●	●	●	⊖	●	⊖	●	●	⊖	⊖
Production	—	—	⊖	⊖	●	○	●	⊖	○	○
Manpower										
Skilled Labour	○	○	●	○	○	○	●	○	○	○
Technical Engineering	—	—	●	⊖	●	○	⊖	○	⊖	○
Management	—	—	●	⊖	○	○	●	⊖	⊖	⊖
Agricultural Engineering	—	—	-	—	—	—	●	●	○	○

● to be imported
⊖ partly imported; can be found or developed in the country
○ available
* detailed lists of equipment are in tables 3.2, 3.3 and 3.4

o Technology

Product design is needed at all stages but depending upon the existing structure it can either be developed within the country through existing research and development centers or has to be imported. The same pattern applies for the production technology.

o Manpower

Generally skilled labour is available in the country through the existing hand tools production units. Technical personnel are required for the small and medium-scale stages that is for industrial workshop and industrial plant respectively; however, it may not be directly available in the country but adequate training can be set up in the country. Management expertise will be imported or training can be done in the country for these stages. However, in the case of expansion of a small scale plant, the existing management staff will be able to directly handle the projet. Agricultural engineering will be required at the medium-scale stage only.

4.3 Operating the Facilities

Details on the upgrading conditions for production of animal drawn implements are given in Table 5. Three major aspects are covered: the source of supplies, the research and development capability of the production unit and the marketing environment.

o Supplies

For the production of animal drawn implements a forging facility has been included in the investment. However, in some cases, some special forging can be subcontracted in the country when such an installation already exists. At small and medium scale stage casting will be needed and when adequate facilities are not available in the country. The capacities may be upgraded or facilities utilized on sub-regional basis. Structural shapes and tubes, bars and rods are mainly imported, but in the case of a strong industrial infrastructure opportunities of local supply can be found. Sheet steel is almost exclusively imported, no country surveyed being equipped for such production. For ancillary and factory supplies the degree of local availability varies greatly from one country to another.

o Research and Development

Internal research and development is only required at the medium scale (industrial plant) stage. In the case of an expansion of the existing plant producing hand tools such a department already exists.

o Marketing

When animal drawn implements are produced by a network of rural blacksmiths, sales, like production, is integrated to the line of hand tools. At the small scale stage, a credit system has to be developed for a new plant but if a hand tools small scale industry is expanding into animal drawn implements the credit system already exists and only requires expansion. At the medium scale stage, as for hand tools, a distribution network and production programming have to be developed.

4.4 Economy of Scale

Upgrading can be accomplished by producing more product, by increasing the range of implements offered or by adding more investment in manufacturing to increase floor space, workforce and machinery complement but with the same basic processes involved. In this process some economy of scale is gained.

Examination of the economy of scale of the industrial workshop represented by the animal draught implement plants studied and the case study with subcontracting lead to the conclusion that, say a doubling of volume from approximately 2,000 tons per year of product to 4,000 tons a year will not have significant impact on the cost of materials or parts. At 4,000 tons per year some improvements in manufacturing technology in the machine shop is to be expected. More labour-saving is possible by economic justification of say capstan equipped lathes to combine turning and drilling operations. In the sheet metal shop use of blanking presses to cut parts rather than the more labour intensive nibbling machines can be justified. The technology upgrading, however, is minimal. Generally in African conditions machinery selected for labour savings only, is not appropriate. Rather, machinery selection should be based on product quality considerations.

The upper limit to the size of the industrial workshop is about 4,000 tons per year. When a country requires more production volume than the output of a 4,000 ton plant, then more plants located in different agricultural zones of the country become appropriate. This is the pattern being followed in Tanzania where two new plants are being planned, each operating at the scale of the existing Ubungo Farm Implement Plant (4,000 tons per year). This too is the planning in Uganda once the Soroti plant is up to planned capacity.

The advantage of this plan of upgrading is that plants are located in agricultural regions close to the particular implement needs of the region (depending on what different crops are produced). Better rapport with the regional farmers results in better market feed-back to the manufacturing unit as to suitability of product, quality and repair services.

Under this plan of vertical upgrading, rationalization of product manufactured in each plant should also be considered. In the case of the Tanzanian plan some plants will manufacture product for the total Tanzanian market when product requirement is small, and all

TABLE 4.2

ANIMAL DRAWN IMPLEMENTS PRODUCTION

EXISTING LEVEL: / NEXT LEVEL INDUSTRIAL INFRASTRUCTURE	RURAL BLACKSMITH				SMALL SCALE INDUSTRY				MEDIUM SCALE INDUSTRY EXPANSION	
	RURAL BLACKSMITH		SMALL SCALE INDUSTRY		SMALL SCALE INDUSTRY		MEDIUM SCALE INDUSTRY			
	LIMITED	STRONG	LIMITED	STRONG	LIMITED	STRONG	LIMITED	STRONG	LIMITED	STRONG
Supplies										
Forging	—	—	—	—	—	—	—	—	—	—
Casting	—	—	●	⊖	●	⊖	●	⊖	●	⊖
Structural Shapes & Tubes	●	⊖	●	⊖	●	⊖	●	⊖	●	⊖
Bars and Rods	●	⊖	●	⊖	●	⊖	●	⊖	●	⊖
Sheet Steel	●	●	●	●	●	●	●	●	●	●
Ancillary	●	⊖	●	⊖	●	⊖	●	⊖	●	⊖
Factory Supplies	●	⊖	●	⊖	●	⊖	●	⊖	●	⊖
Research & Development	—	—	—	—	—	—	⊖	⊖	○	○
Marketing										
Credit System	—	—	●	⊖	○	○	○	○	○	○
Distribution Network	—	—	—	—	—	—	⊖	⊖	○	○
Production Programming	—	—	—	—	—	—	⊖	⊖	○	○

● to be imported
⊖ partly imported; can be found or developed in the country
○ available

plants will manufacture the same product, for example mould-board plows, when requirements are great.

At this point, upgrading to a large-scale industrial type of operation characteristized by fixed investment of $10 million dollars plant area of 50,000 square feet, manpower of 500 people can be examined.

Economy of scale consideration allows for adding capability to manufacture more components in-house. In the case of animal drawn implements this could mean establishment of a production forging department and a foundry. It would appear that volumes of over 1,000,000 pieces per year are required to justify production forging capacity and approximately 1 ton per hour of casting requirement is necessary to justify a small foundry operation. Animal drawn implements presently are not likely to generate such volumes.

5. RESEARCH AND DEVELOPMENT

5.1 The Options

The starting point in the process of upgrading animal drawn implements centers on the product line to be manufactured on a commercial basis.

A Research and Development Service is an essential requirement. The research & development responsibility can be managed in number of ways. The function can be the direct responsibility of the manufacturing unit or units in a country. The function can be the responsibility of a government Ministry such as the Ministry of Agriculture, or the Ministry of Industry can be designated to serve all the agriculture machinery needs of the country and even other light engineering industries. A third option could be to have the center associated with a university agriculture engineering department.

The mission of the center is to develop a complete range of animal drawn implements and manually operated machines in order to cover all the agricultural operations. More specifically the center would be responsible for the following:

- o Adaptation of imported animal drawn implements to local agriculture field conditions and local manufacturing capability with attention directed to use of indigenous parts and materials.
- o Development of improved implements to better suit local conditions.
- o Development of a consistent line of equipment in order to provide the farmers with all the necessary tools. The line of products has to be developped according to farm sizes, type of crops and regional agricultural practices.
- o Production or purchase of prototype machines.
- o Field testing and demonstration of prototypes.
- o Promotion of animal drawn implement usage by linkage with manufacturers, Ministry of Industry, university agricultural establishments, Ministry of Agriculture extension services.
- o Liaison with state and regional authorities within the country when federal type government structures apply.
- o Liaison with other African centers for farm machinery development and with international institutions.

5.2 The R & D Center as the Responsibility of a Commercial Manufacturing Unit

The concept

Probably the most effective way to manage the R & D function is, as the scale is sufficiently large, to have the function be the direct responsibility of the manufacturing unit. This manufacturing unit has direct responsibility for commercial results. The product must be produced in quantities and to quality standard while retaining the practical ability to control quality of raw materials, purchased parts and manufacturing process within the manufacturing unit. The implements must be accepted by the farmers and they must understand how the use of the implements in the field will improve yields and otherwise benefit the farmer. The investment on the part of the farmer is considerable and the farmer must be pursuaded that the product will be effective and reliable and that repair and maintenance is under the farmer's control.

The manufacturer is in the best position to ensure that product design is fully compatible with manufacturing and that manufacturing process capability within the factory is appropriate or can be upgraded. The manufacturer ensures control of quality of input of raw materials and purchased components from the industrial infrastructure of the domestic economy. The manufacturer has the incentive to ensure his product is commercially viable and that the produce is priced competitively so that cost of materials, purchased parts and manufacturer parts are economically controlled.

The manufacturer of animal drawn implements is usually a medium scale industrial workshop. The investment for research and development and subsequent product engineering will be high relative to its ability to finance the operation and recover the cost of the investment in product pricing. Particularly if government policy is directed to promoting use of animal drawn equipment, an element of subsidy for the significant initial costs is indicated.

If a number of small manufacturing units are already engaged in production of animal drawn implements duplicating the R & D function at each manufacturing unit is not economic. This is the case in Kenya where implements are now manufactured in five smaller manufacturing units. Under these circumstances a central R & D responsibility is indicated.

- Examples

  If only one manufacturer is engaged in manufacture of advanced animal drawn implements as is the case in Uganda, then a strong case is made for the R & D center to be attached to the manufacturing organization subsidized in order to develop improved product within the single manufacturing establishment and to provide the R & D inputs to establish additional manufacturing units.

The Agrimal (Malawi) factory is a private sector company responsible for its own R & D operation and funding. The company developed and marketed a new ground-nut lifter with its own design and prototype development. The Malawi Department of Agriculture funded field testing during the course of product development and acted to assist in promotion and market introduction in close cooperation with the Agrimal company.

The Agrimal ground-nut lifter has subsequently been adopted by a number of other African manufacturer. The product, as with most animal draught implements, is not subject to patent protection and developed designs are readily transferable. For example, Agrimal is aware of the tool bar development in Senegal and Kenya. Agrimal can readily introduce these new products in the Malawi market and manufacture the product when satisfied with application of this new technology in Malawi.

The SISCOMA company in Senegal has developed a line of tool bar product and attachments new to Africa. SISCOMA has a New Product Engineering Department and a prototype shop. The company funds the complete R & D process with its own resources with no direct participation from Senegal Government institutions. There is interlink between SISCOMA and the Senegal Unversity Agriculture Engineering Departments.

The Ploughs at Allied Products Ltd Company (KISUMU Kenya) is developing a set of tool bar implements that represents advanced R & D indigenous to Africa. The designs are made of lighter weight steel alloys and much work has gone into details and configuration of accessory equipment particularily suited to Kenya conditions This work is undertaken on a private sector basis but has benefited from technology transfer from SISCOMA, Senegal.

The Kenya Government Department of Agriculture is well aware of this development and is anxious to support this initiative.

5.3 The R & D Center as a Central Government Responsibility

The establishment of a national center for development of agriculture machinery and implements under government jurisdiction is an effective method of promotion of industrial development.

Precedent for this type of institution is found in Zambia when in 1977 the Agricultural Machines Research & Development Unit was established under jurisdiction of the Ministry of Agriculture. The unit works hand in hand with some six private companies and acts to study the needs of Zambia with respect to hand, animal and powered equipment on a continuous basis. The unit collects information available from countries working on similar problems and acts to coordinate introduction and construction of prototypes, to adapt of existing designs development of designs peculiar to Zambia conditions, to undertake operational and qualitative testing of machines and to advise of provision on spare parts and servicing.

Ethiopia has established the ARSI Rural Development Unit as a control body charged with much the same responsibility as the Zambia institute.

Tanzania established a similar unit, the Tanzanian Agriculture machinery Testing Unit (TAMTU) responsible for R & D. The Tanzanian R & D unit is substantially equipped to produce prototypes and as a result manufactures in significant volume animal drawn implements for the market. Another government unit TISCO (Tanzania Industrial Studies Consulting Organization) is a consulting unit organized to carry out market studies and feasibility studies in conjunction with SIDO (Small Industrial Development Organization) and the unit offers technical assistance to artisan groups.

Kenya is now involved in planning for a similar R & D institution. In a circumstance similar to Zambia many smaller private companies are involved in the manufacture of agricultural equipment but development is fragmented and uncoordinated. The establishment of a central facility under government jurisdiction is an appropriate response given the Kenya policy of acceleration of agriculture mechanization. An investment of $300,000 is proposed for this facility.

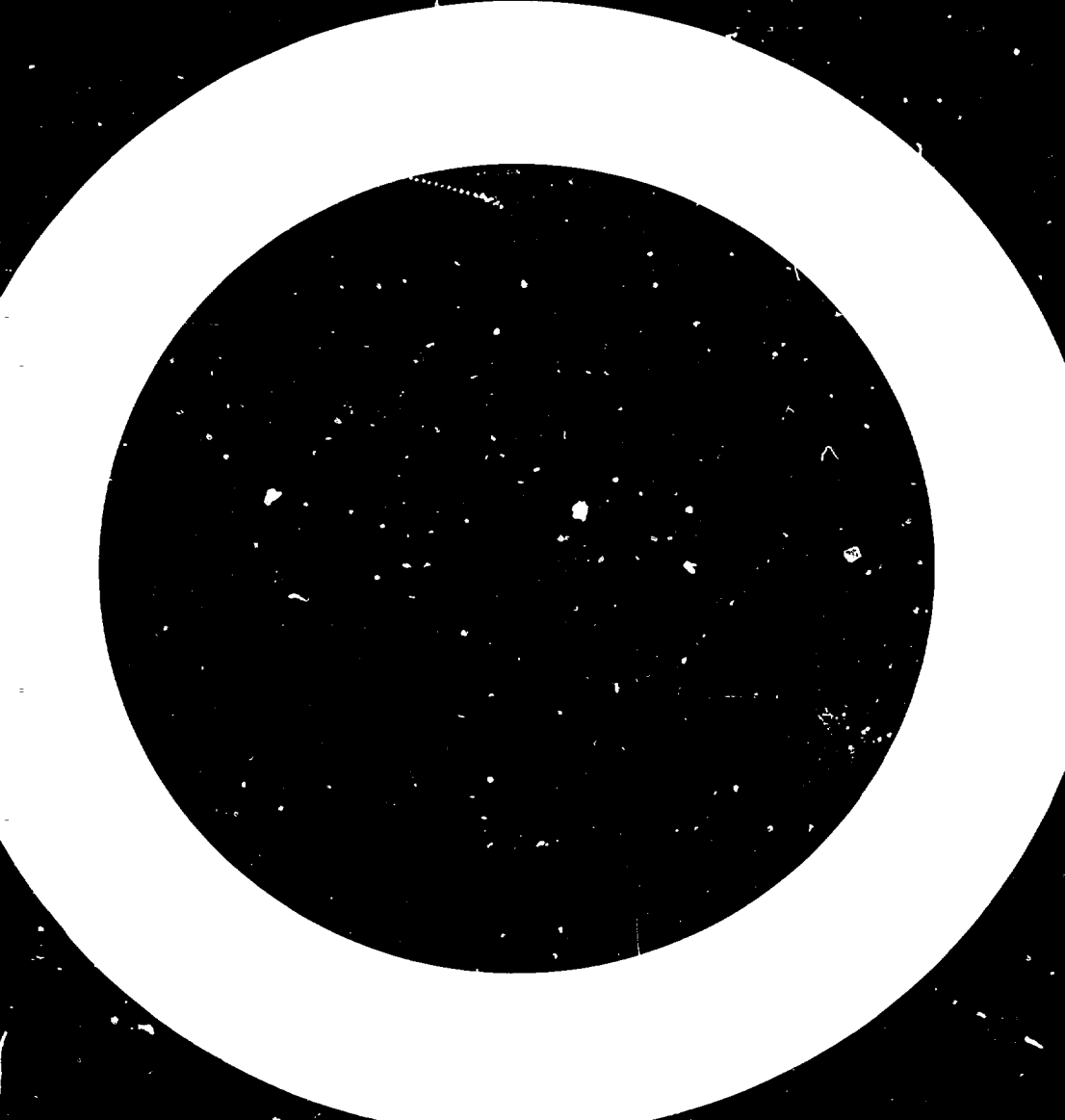
5.4 The R & D center as a University Responsibility

Many agricultural education institutes have farm machinery research establishments. These establishments however, are usually interested in highly developed powered machinery as a means of acquiring advanced knowledge. The research establishments are primarily intended for academic purposes and are not therefore usually commercially oriented. It would appear that even when considerable investment is in place in facilities, workshops and technical personnel that this option is not the most favorable.

However, the institution established for R & D, either private sector or government, is well advised to maintain close links with the University centers now established.

VOLUME IV

PROFILE 3: UPGRADING REQUIREMENTS FOR PRODUCTION OF TRACTOR-DRAWN IMPLEMENTS AND POWER OPERATED MACHINES



1. DEFINITION

1.1 Introduction

The profiles focus on the requirements for upgrading production capabilities in a given country from one level to the next higher. Levels are defined based on category of product and scale of production: category 1 is the production of hand tools; category 2 animal-drawn implements and manually operated machines; category 3 tractor drawn implements and power operated machines and category 4 tractors and combines. This last category being found in only a very few countries, it is not studied in the profiles for upgrading. In each category the existing stage of development or scale of operation are considered: stage 1 is the organised village blacksmith operation, stage 2 is the small scale workshop and stage 3 the industrial plant. The production technology is determined by the product and the scale of production which is explained in detail at each product category in conjunction with its scale of production.

This report presents profiles which indicate ways and means by which a country could reach the next higher level of production capability, from its existing level.

Profile 1 discusses upgrading choices and requirements to reach hand tools production if a country is not producing any machinery.

Profile 2 discusses upgrading choices and requirements to produce manually operated and animal drawn implements when the country is already producing hand tools.

Profile 3 discusses upgrading requirements to produce power operated machinery and tractor drawn implements when the country is producing animal drawn implements and manually operated machinery.

Each profile focuses on the engineering part of the requirements and its directly related factors such as financing, training research and development and organization. However some other important factors to be considered in the formulation of an agricultural machinery industry program are not specifically discussed in these profiles, such as the need for machinery in Africa, an adequate marketing and distribution policy etc.

Each profile is structured in five chapters. Chapter I describes the different cases for upgrading, depending on the existing stage of production and the desired stage at the next level. Products considered are presented and illustrated. Chapter II reviews and summarizes the current status of agricultural machinery production in eight selected countries. These countries have been selected in order to provide case studies and examples on each profile.

Chapter IV establishes the upgrading requirements by indicating in each case what part of the techno-economic conditions have to be acquired in order to upgrade the existing system. Chapter V indicates the role of the institutions in the development of agricul-

tural machinery production in Africa.

The selection of a program for a given country depends upon the specific situation in that country, and its priorities. Therefore these profiles must not be construed as replacing the very necessary sectoral plans as well as prefeasibility and feasibility studies.

1.2 Upgrading Choices

The profile for upgrading production of tractor drawn implements indicates the ways and means by which a country can significantly meet its requirements for such equipment when the country is producing animal drawn implements and has developed a relativity strong infrastructure. The upgrading profiles presented consider attainment of production capability at two levels - that of animal drawn manufacturing capability demonstrated at either the workshop or the factory stage.

Thus the alternatives studied are:

- The country wishes to assemble tractors at the industrial plant stage and wishes to manufacture related tractor drawn implements at the same time.
- The country has an industrial plant to produce animal drawn implements and wishes to expand production to include tractor drawn implements.
- The country wishes to manufacture tractor drawn implements (but not tractors) and wishes to combine manufacture of animal drawn implements in this same plant).
- The country is producing animal drawn equipment at the workshop level and wishes to expands it into production of tractor drawn implements or to create a medium scale industrial plant.

1.3 The Context for Tractor Drawn Equipment

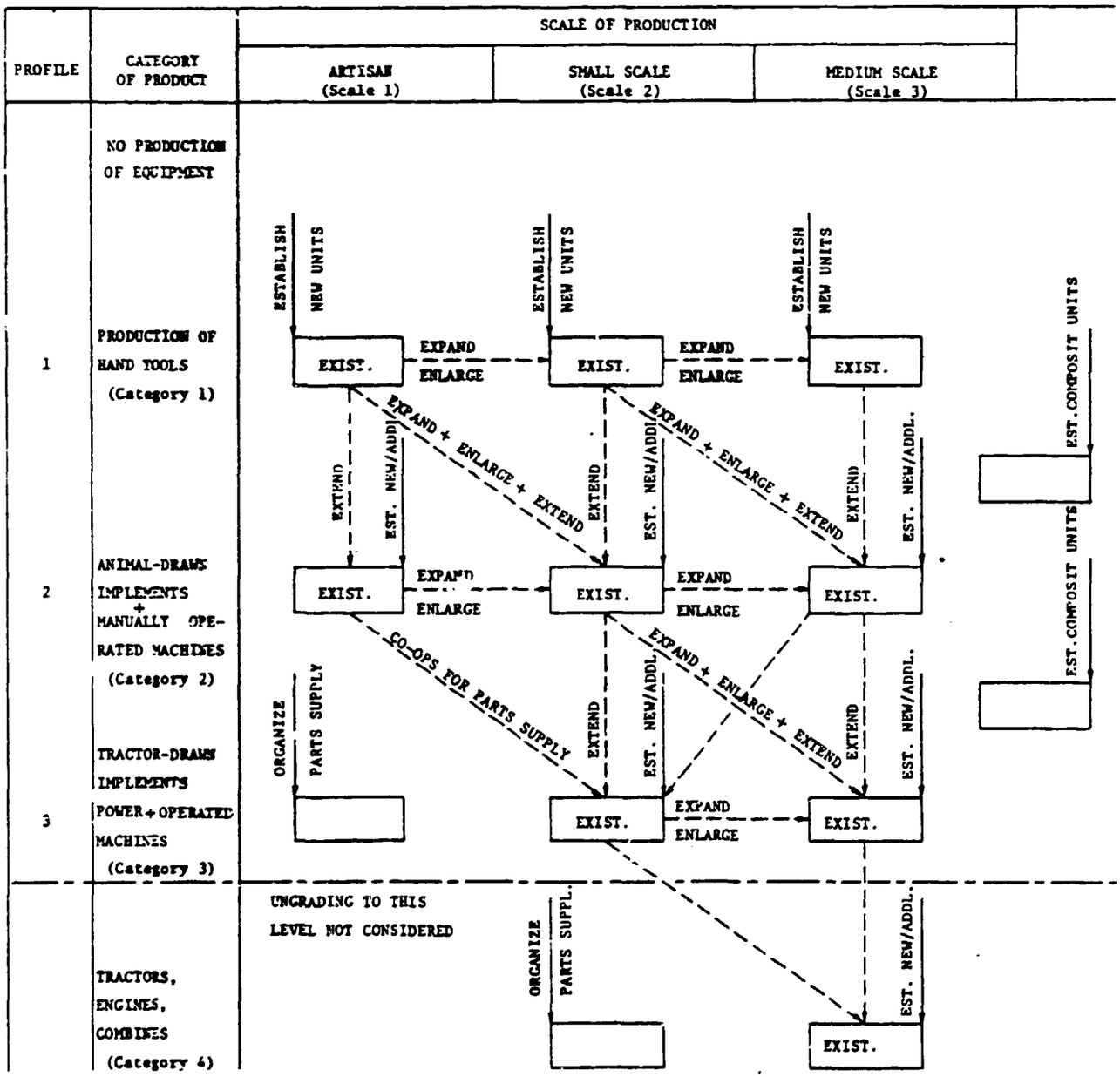
The question of development of tractor drawn implement manufacturing is closely linked to the manufacture or assembly of tractors in a given country.

It is generally considered that an annual volume of 10,000 to 20,000 tractors is required in order to justify complete manufacture. On the other hand, an assembly operation of components, a complete knockdown (CKD) operation can be justified at a level of 1,000 to 2,000 units per year. The number of implements required is related to the number of tractors. One source estimates that for every ten tractors, requirements are generated for 4.6 ploughs and 5.1 seeders.

Consideration of the question of how to develop manufacturing capability to produce tractor drawn implements begins with a review of the studies of tractor mechanization in African countries and the status of manufacture or assembly of tractors themselves.

FIGURE 1

UPGRADING CHOICES



A survey of opinion from tractor manufacturers stated that successful operations demanded at least a market of 10,000 units annually and to really justify the costs and irregulatities of production in developing country markets, over 20,000 units would be a more realistic minimum. Therefore, full tractor manufacturing is only a practical consideration over development of regional trade cooperation. Total inventory for tractors in all African countries today is in the order of 800,000 tractors resulting in a replacement market of about 100,000 per year but fregmented into many small markets.

There is however the classical patten of tractor manufacture in developing countries to consider. Countries such as Brazil and India have developed full manufacturing capability by evolving manufacturing plants beginning with assembly operation only from components shipped "knocked-down" (CKD) from the developed country plant. The value added in the assembly plant is of the order of 15%.

The output to warrant starting this process is 1,000-2,000 tractors per year. As the market of the developing country grows it becomes economic to manufacture more and more parts and components both in-house and purchased items such as tires and engines until full manufacturing capability is developed over time. A number of African countries are undergoing such development and Ethiopia, Sudan, Tanzania, Senegal are at the planning stage to begin the process.

In the developing world today some 14 countries assemble tractors on a CKD basis, further 15 countries have added parts manufacturing and have integrated production to the 30% level of value added, 11 countries have developed integration above the 50% level.

While tractor-drawn implements are less complex to manufacture than tractors the same economics of scale apply. There is a wide variety of implements and there is a relationship between the number of tractors used and the numbers implements required. Where is there is an opportunity to begin CKD tractor assembly at about 2,000 tractors per year there is also and opportunity to assemble on a CKD basis the related implements.

This relationship was recently estimated as follows:

Number	Item	Unit value 1975 US $
1	45 HP tractor	$ 5,460
1	3-bottom moldboard plough	2, 100
1	Tandem disc harrow	940
1	Seed-box	940
1	Trailer	1,560
		$11,000

A study on the Agriculture machinery industry states that investment costs increase with the rate of integration, rising from the order of US $20,000 to $30,000 per job created for CKD assembly with 20%

value added to US $50,000 to $60,000 in the case of 60% to 80% integration. It is increasingly more expensive to move up from one level of integration to the next.

A phase 1 CKD assembly plant investment is of the order of $30 million for the creation of 700 new jobs and investment of US $110 million (60% integration for the creation of 1,700 jobs).

Tractors can be classified into small tractors 30HP and under, medium sized tractor 40-80 HP ands large tractors (100 HP plus).

There are a number of programs under way to search for a small economic tractor of about 25 HP that would be particularily suited to developing countries. Kenya, Senegal and Zambia have significant research programs in Ministries of Agriculture to specify such a product and to search for a developed tractor that could be modified to suit African conditions. Such a tractor would represent an upgrading for animal powered emergent farms.

The Tinkabi tractor was developed in Africa by means of a project in Swaziland. This tractor is powered by a 15 HP diesel engine. It has a hydro-static transmission which controls speed, backward and forward motor and braking with as single movement of a hand lever. Operations are extremely simple. The simple design permits long engine life. The tractor has a relatively low capital cost.

Another school of thinking believes that adoption of standard and proven designs from developed countries, particularly larger tractors, with the additional power required for dry land farming is the better way to accelerate mechanization and to establish more and better large commercial cash crop and grain farms.

Recognizing the high capital cost of the heavy tractors there have been a number of experimental projects undertaken to purchase large fleets of tractors and then to hire out the tractors and drivers to farmers.

There are successful examples of private contractors and collective farms using smaller fleets of tractors and implements on a contract basis to spread the investment over a larger number of farms, and to achieve the 1000-2000 hours of tractor utilization necessary to amortize the investment.

The actual market in Africa for imported tractors has moved from small 30 HP tractors to 60-80 HP tractors in recent years for the commercial and state farms. This market is very small in the Africa countries but this larger tractor powered farming for cash export and grain crops is well established and will continue to grow.

Tractors and related implements are highly proprietary. Designs of tractors and implements incorporate large R & D investment. The product and manufacturing complexity is such that joint-venture or license agreement with a foreign partner is mandatory for technology transfer for both the product and the manufacturing know-how.

1.4 The Products

Products considered are tractor drawn implements as well as powered equipment related to agriculture such as water pumps, irrigation system pumps, water tanks, post harvest machinery such as threshers and grinding mills to process, maize, wheat, cassava, millet into meal at village scale operations.

There is a well established international standard for tractor hitches. The tractor hydraulic lift-hitch mechanism uses tractor hydraulic power to manipulate the tractor hitch mechanism. There are three standardized attachment points to join the mounted implement with the tractor. For ground engaging implements such as ploughs and harrows the tractor hydraulic system lifts the implement and produces a reactive force on the tractor tires which increases traction. In addition, tractors are equipped with draw bars for those implements and trailers not requiring lift.

The international standard categories hitches by size. Category 1: hitches fit tractors 40 HP and below, Category 2: hitches fit tractors 40 HP - 80 HP: Category 3: for larger tractors. Implements of all manufactures therefore interchange freely with tractors of all manufactures. This interchangeability means that economy of scale achievement is simplified. Once local manufacture of implements is established the market for new and replacement implements can be based on all tractors operating in an economy rather than a market limited to one brand of tractor.

For an African tractor implement manufacturer, we will consider only those implements fitting Category 1 and Category 2 hitches. The size weight and complexity of Category 1 and Category 2 implements are near enough alike that the manufacturing plant and equipment would readily handle both sizes of implements. Implements larger than Category 2 however require such heavier plant equipment.

This strategy would account for 90% of the market for implements in Africa and maximize production volumes - the implements would fit all the tractors in the country and provide the opportunity to achieve market penetration and economy of scale.

The main tractor drawn implements are described and illustrated below.

o Mould Board Ploughs (Ridgers)

These ploughs are equipped with wear resistant mould boards acting to cut a furrow up to 400 mm in depth and to turn the soil as the first step in soil preparation for cultivation. The ploughs range from two furrow ploughs to up to five furrows.

These ploughs weigh between 200 Kg to 500 Kgs.

o Disc Ploughs (offset disc harrow)

These ploughs use special heat treated steel discs to cut the furrow up to 400 mm in depth and by offseting the discs to the direction of tractor travel the discs act to turn over the furrows. This means of ploughing is growing, particularily for grain crops and sugar cane. These ploughs weigh between 300 Kg and 900 Kg.

o Chisel Plows (Subsoilers)

This type of plow is equipped with tines that act to penetrate into sub soil down to 610 mm. Subsoiling encourages drainage, brakes up and aerates the soil killing weeds and brush and encouraging root growth but without turning over the top soil. This means of soil preparation is particularily important for dry areas in order to conserve soil moisture. These ploughs are fitted with 6 to 12 tines and weighs 400 Kg to 1500 Kg.

o Cultivators (Tillers)

This implement is equipped with rows of tines acting to break up clods produced by ploughing, to loosen the soil and for weed control. Weight ranges from 500 to 1200 Kg.

o Disc Harrows

These harrows are equipped with 12 to 20 heat treated steel discs that act to break up clods after ploughing to prepare a smooth level seed bed and to complete the process of killing grau, weeds and brush Weights are from 400 Kg to 800 Kg.

Disc harrows can be equipped with hoppers to carry seed and fertilizer and so combine soil preparation operations with seeding and fertilizing.

o Planters (Seed Drills)

This implement acts to plant seed 2 to 4 rows at a time. The machine is equipped with soil openers and press wheels to press moist soil in close contact with seed dropped by the seeding mechanism designed for uniform spacing. Fertilizer is metered uniformily in conjuction with seeding. The equipment weighs 250 Kg.

o Transport equipment

The tractor is used to draw a wide variety of general purpose and special purpose transport equipment. Special purpose trailers for coffee, tea and sugar crops, are of particular interest.

o Other power operated machinery

Among the products that offer manufacturing opportunities are the following power operated machines:

Sprayers
Power tillers
Rotary cultivators
Power brush cutters
Crop dryers
Maize shellers (hand operated and powered)
Groundnut shellers
Ground nut crackers
Ground nut threshers
Grain winnowers
Paddy threshers
Palm nut cracker
Hammer mills
Grinding mills
Maize mills
Sorghum-dehuller and mill
Storage bins
Hand pumps lever type and rotat
Bore-hole pumps
Wind mills water pumps
Water tanks

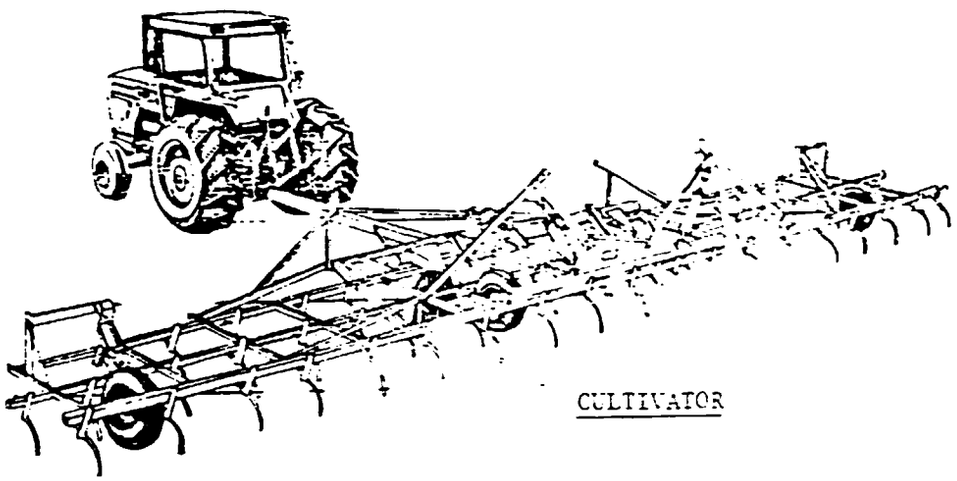
Markets for such related agriculture products are generally so small that specialized manufacturing plant for such product is not generally appropriate. These products can be manufactured in combination with agriculture implement product (both tractor drawn and animal drawn) or manufactured in general purpose light engineering manufacturing facilities.

The pattern seen in Kenya is that separate business have involved for manufacture of grinding mills and post harvest machines and separate business have evolved for pump manufacturers.

A case can therefore be made for manufacture of a line of pumps and irrigation equipment as a distinct business. Foundry and machine shop technology would be the basis of the manufacturing operations.

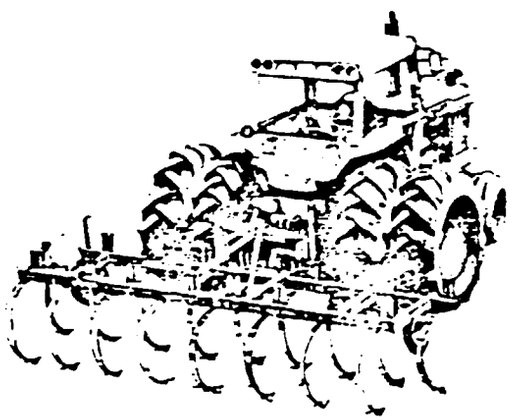
In the case of grinding mills and post harvest equipment the foundry, forge shop and sheet metal shop technologies are much the same as technology required for implement manufacture. The pattern evolved at the Soroti Uganda factory is consistent with this concept. Here grinding mills are manufactured in combination with implements.

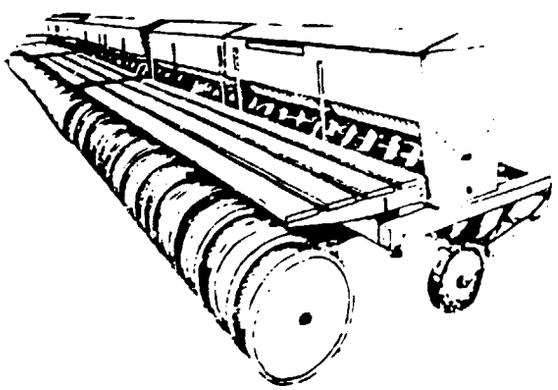
TRACTOR DRAWN IMPLEMENTS



CULTIVATOR

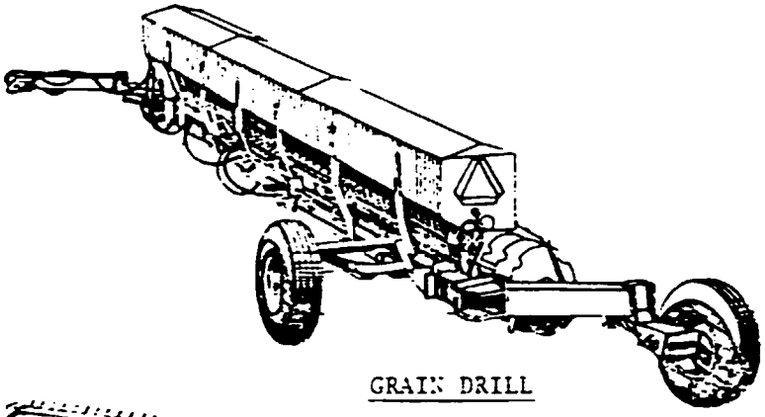
CHISEL PLOUGH



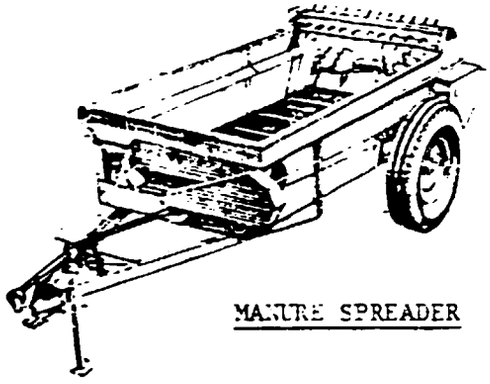


PRESS DRILL

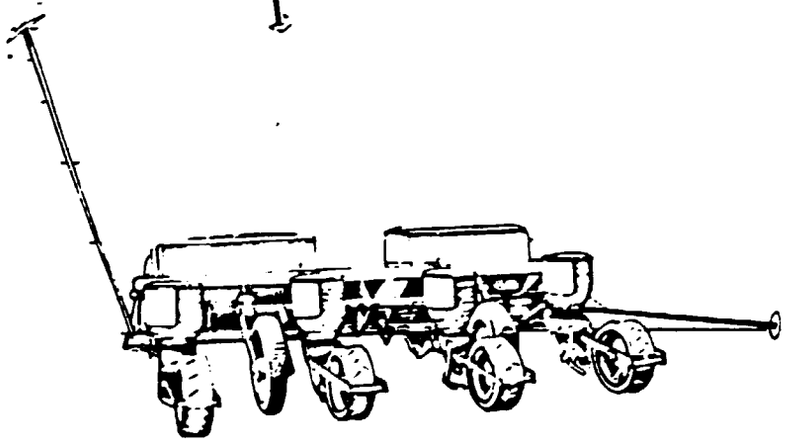
TRACTOR DRAWN IMPLEMENTS



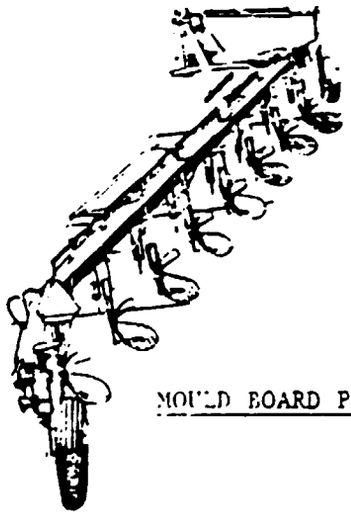
GRAIN DRILL



MANURE SPREADER

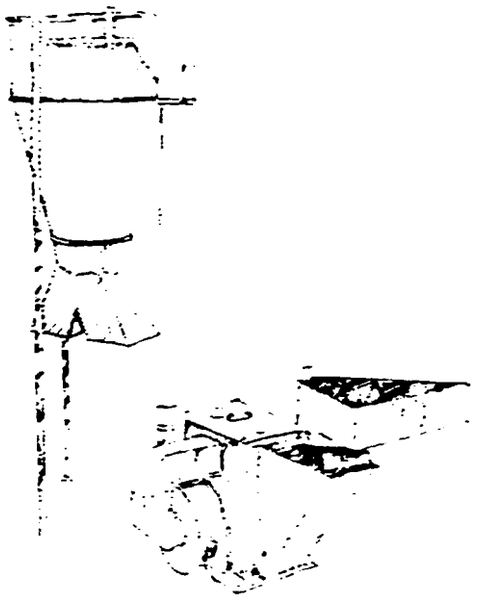


4--ROW SEEDER



MOULD BOARD PLOUGH

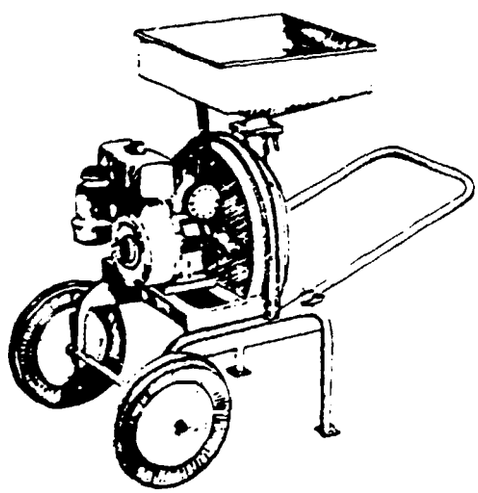
NDUME POWER DRIVEN HAMMER-MILLS



Description: The Ndume hammer-mills are designed to mill a variety of crops: maize, wheat, oats, barley, millet, hay and straw but are especially suitable for grinding maize into meal. There are 3 models: the ND20, ND30 and GM40, of differing sizes but all of a similar basic design. From the loading hopper, grain is fed into the central mill housing in which heavy duty hammers grind the grain. The hammers are reversible, and replaceable. From the mill-housing, a fan blows the meal up into an overhead screened hopper.

The ND20 is the smallest model, the cheapest and with the lowest capacity and can be driven from small power sources of 12-25 HP. The ND30 is the next in size It has double the capacity of the ND20, and it is fitted with a special overhead screen which allows oversize meal particles to fall back into the mill for regrinding. The meal it produces is therefore finer. The ND30 can be driven from small power sources of 16Hp but also from larger sources up to 100HP. It is, of course, nearly twice the price of the ND20.

The GM40 is specially designed for power take-off from tractors, costing about the same and having about the same capacity as the ND30, but designed to operate at the lower r.p.m. given by tractor pulley-drive.



PALM-NUT CRACKER

Description: The palm-nut cracker operates centrifugally, by means of a disc driven inside a drum by direct drive from a 3h.p. petrol engine. The hourly capacity of the cracker is 300-400kg/hr. (The motor is a Bernand W19A)

2. OVERVIEW OF TRACTOR DRAWN IMPLEMENT MANUFACTURING FACILITIES

The manufacture of tractor drawn equipment in Africa is currently very limited. Particularly in the eight or so countries reviewed in this study only one plant, Burns and Blayne in Kenya was found which concentrates on such equipment. They manufacture tractor drawn implement and agricultural trailors and the operation is discussed in more detail in Appendix A.

A considerable number of companies do manufacture post harvesting and other ancillary equipment, such as pumps, powered threshers and grinding mills. These companies usually have a general light engineering capability and are engaged in manufacture of a variety of non-agricultural product.

Such companies include

Ndume Ltd, Kenya - powered and hand operated grinding mills.

Ploughs and Allied Products Ltd, Kenya - Wind mill, water pumps combined with animal drawn implements

Brown and Clapperton Ltd, Malawi - Pumps

SISCOMA, Senegal - Post harvesting equipment

CEDECO, Zaire - Post harvesting particularly wooden items

Once a manufacturing infrastructure has been established (including steel making, foundry, forgings, plastics, rubber industry, tool making etc.), the main problem to develop manufacturing capability in the long list of "other power operated agriculture machinery" is to accumulate sufficient market to warrant economic scale of operations.

Constraints inhibiting development are:

- o Limits imposed by national markets only and lack of sub-regional trade patterns
- o Insolvency of farmers in general and need for agriculture credit and economic pricing for agriculture products.
- o Support and promotion systems adequate to help small and medium sized firms, identify opportunity and develop the necessary commercial and technical capability.

3.0 MANUFACTURING TECHNOLOGY

Manufacturing technology for tractor drawn implements is closely related to animal draught implements as discussed in detail in Profile 2. The major difference is that the units are larger, heavier and subject to greater loading and stress. For example a typical ox-drawn (0.5HP) mould board plow able to cut a single furrow weights 30 Kg. A Category 2 hitch 5 bottom mould board plow (pulled by a 65 HP tractor) weights 500 Kg.

For manufacturing, this means that while the industrial processes remain common, (use of mild steel, use of castings and forgings, machined parts welding and assembly) the materials are larger and heavier. Steel sections are heavier than normally rolled in mini-steel mills. Parts and sub-assemblies are too heavy to lift by hand so that the factory now needs lift trucks, hoists and overhead cranes. The machine tools and forging machines need to be larger to take the larger pieces and the larger dies, required for instance for chisel plough tines. The welding operations become more critical from a quality control point-of-view. The welds are subject to much greater stress. Paint systems and assembly operations require conveyors.

As to purchased parts from within the country, or imported castings and forgings should not be a problem even when they are larger in size. Again, industrial fastners, nuts and bolts, springs sprokets and chain are needed with tractor drawn seeders, grain drills and disc harrows. Sheet metal components are required for the hoppers.

There is usually no need to set-up a sheet metal operation when purchase of these components from outside is possible.

Another major difference is that for assembly of the structural components rather complex welding jigs are required.

There is however no great difference in management, engineering and skilled tradesmen and technician training requirement from that previously discussed in manufactury technology for animal draft implements.

The implication of this significant difference in weight, size and strength of tractor drawn implements as compared to the animal drawn implements on manufacturing technology is significant as to capital investment.

To upgrade to the heavier tractor drawn implements on a large scale requires new plant equipped with overhead cranes, conveyors and larger capacity machine tools. On the other hand a plant set up for tractor implements can easily accomodate animal drawn implements.

4. UPGRADING REQUIREMENTS

4.1 General

The upgrading requirements are studied for each of the possible choices that a country can consider. For each case, the conditions are then established first to set up a new production capability and then to operate the plant. The upgrading conditions are derived from the techno-economic factors required, and from the existing infrastructure of the country.

We have seen that to consider manufacture of tractor drawn equipment, a volume of at least 2,000 new tractors a year entering the economy is probably a necessity. Those African countries now having this market for tractors or approaching this market size tend to be the countries with more developed industrial infrastructure such as Nigeria, Kenya, Senegal.

Egypt, Sudan and Algeria, where planning for manufacture of tractors and implements is now proceeding, have the prerequiste infrastructure.

A strong industrial infrastructure indicates that the country, even in the case where no agriculture machinery exists, has some industries and related activities which can be used to set up and operate a new agricultural machinery industry. As an example, if a country has some shipbuilding facilities or railroad workshops, this indicates the existance of testing and forgings facilities and various categories of industrial trained personnel are employed.

Detail of the upgrading requirements are given in Table 4.3 and 4.4 showing the conditions at stage 2 and stage 3 only to reach the derived stage of production capability and to operate the new production unit.

4.2 Establishing the Facilities

- Equipment

  The equipment required to establish manufacturing is listed in Table 4.1. The equipment list assumes a forging capability but not a foundry. Forgings are important components of tractor drawn implements and should be integrated with the production process. A heavy fabricating and press shop is required as well as a general machine shop a welding shop and assembly shop. The plant is supported by a sophisticated tool room capable of manufacturing assembly and welding jigs and fixtures and of repairing and maintaining plant equipment.

- The investment required (see composite unit Tractor Drawn Implement and animal Drawn Implements Volume I) is in the order of US $4 million of which $1 million is for land and the 7,000 sq.meter building, $1,5 million for equipment and machinery and $1,5 million for working capital. Employment is about the 200 level. This compares to approximately US $1,2 million for capital investment for a 1620 square meter facility for animal drawn equipment.

This illustrated the upgrading investment required in the options either to upgrade an existing animal drawn implement plant (virtually a new factory is required) or to establish a new facility for tractor draw equipment and animal drawn implements in combination.

In the case of adding tractor drawn equipment to a plant primarily designed for tractor assembly, incremental investment for related implement assembly should be somewhat less than the $4 million required for a new facility.

In the case of adding limited capacity to manufacture tractor drawn equipment to a light engineering facility such as the Burns and Blane Ltd Nairobi, Kenya, operation engaged in manufacture of special farm trailers the incremental investment is much lower. The only incremental capital expediture required was for welding jigs and fixtures in that all the exiting facilities, plate shop, machine shop welding shop, paint shop etc. were compatible to fabrication of tractor drawn implement components.

o Technology

Product design for the manufacture of tractor drawn implements probably requires licence agreement from a multinational farm equipment manufacture with sales of about 500 to 600 implements of each configuration per year, not enough revenue could be generated to amortize R and D and design development. Significant design engineering and product development is inherent in tractor drawn implements to ensure rugged construction and trouble free service life. Existing designs are somewhat proprietary. The license agreement would also ensure technology transfer and required technical support.

There would appear to be little in the way of peculiar African requirements for tractors drawn implements to require indignous R & D (contary to indigenous R & D requirements for animal-drawn equipment).

o Manpower

Manufacturing technology in the matter of production control, manufacturing management and work force skills relates closely with that required for animal-drawn manufacturing. Upgrading from animal-drawn implements to tractor drawn implement manufacture would be relatively straight forward.

In the case of a combined tractor-drawn implement project in combination with animal drawn implements when no prior experience exists, then extensive technical support is required from the multinational license agreement. Such know-how transfer in the case of the relatively developed industrial infrastructure (a perequisite) should be practical when related skills and experience from other light engineering industry can be attracted to the new enterprise.

o Financing

The investment required in the upgrading options indicate the financing structure required joint venture with an international farm machinery manufacturer is a distinct possibility and private sector financing sources would apply. A joint venture with an African public sector partner is yet another option.

In the case of adding tractor drawn equipment (or other power operated equipment) to an existing operation, financing of the smaller incremental capital requirement is much reduced and in such cases private sector financing is probably indicated.

4.3 Operating the Facilities

o Supplies

Material and factory supply for the upgrading alternatives studies should be relatively straight forward given the perequisite of a relatively developed industrial infrastructure consistent with the 2,000 tractors per year developed agriculture economy. A target of 50% value-added is indicated. Steel imports would be the major foreign supply problem. Steel specifications are given in Table 4.2

o Manufacturing and engineering operations

In the case of tractor drawn equipment and relatively complex power operated equipment such as pumps, grinding mills and post harvest equipment on-going technical support in both manufacturing technology particularily for quality control and metallurgy is probably a requirement for some longer time period.

In the case of product technology (R & D and product adaptation) some on-going technical support from the source of the license is required. There would be some scope however for local product engineering to ensure proper field applications, customer satisfaction, repair service, etc.

o Marketing

Tractor drawn implements are designed for a very specific market: large farms (private or cooperative) producing industrial products and export crops. These large farms are rather limited in number in most of the African countries and therefore the first consideration to take into account in the upgrading decision is to see if a sufficient market can be developped. This aspect may appear to be of critical importance in the choice of a medium scale industry.

Well developed farm credit programs are a necessity. The cost of tractor drawn implements and power operated equipment is such that farmers require credit support to afford the high initial capital costs to be repaid from farm revenue.

TABLE 4.1

EQUIPMENT

Cutting shop

Power hack saw
Hand shear

Forge and heat treatment shop

Mechanical drop forge 3-4 tons.
Press forge 150 tons
Oil fired furnace
Water quenching tanks
Blacksmiths tools
Shearing machine
Abrasive grinders
Dies and tools

Fabricating & press shop

Eccentric press 150 tons
Press brake 200 tons
Hydraulic bending press (horizontal) 10 tons
Manual bending machine

Arc welding machine 500 Amps
Nibbling machine to cut 6 mm MS.
Welding fixtures etc.
Pedestal grinding machine
Gas welding and brazing equipment

Upright drilling and tapping machine 12 mm in MS.
Dies and press tools

Machine shop

Double ended pedesel grinder
Upright drilling and tapping machine 12 mm in MS.
Lathe, maximum bore 80 mm swing 50 cm; length 100 cm

Capstan lathe with accessories maximum collet size 4 cm, swing 30 cm, maximum work piece length 16 cm.

Jigs, tools & fixtures
Hydraulic press 1 ton
Gauges, inspection tools and equipment
Portable drill 12 mm in MS.
Portable grinder 15 cm wheel
Hand nibbler 3 mm MS
Tools, tool holders,etc.

Assembly shop

Assembly fixturers
Upright drilling machine 3 cm in MS.
Portable drilling machine 12 mm in MS.
Portable grinder 15 cm wheel
Arc welding machine 250 Amps.

TABLE 4.1

EQUIPMENT

Paint Shop

Degreasing vat
Dipping plant with conveyor
Spray painting booth and sprayers, etc.

Toolroom & Maintenance

Universal milling machine 5 HP
Universal cutter grinder 1½ HP
Double ended grinding machine
Surface table
Gauges and tools
Precision lathe 2 HP
Maintenance tools and equipment
Arc welding set 250 Amps.

Mechanical handling

Fork lift truck 1 ton

Hydraulic pallet truck (hand operated)

Rocks, stillages and bins

TABLE 4.2

STEEL SPECIFICATIONS

Major implement components	SAE No.	Carbon (%)	Manganese (%)
Implement frame (MS)	1006-1008 1010-1015	0.08 - 0.18	0.25 - 0.60
Sprirgs	1065	0.60 - 0.70	0.60 - 0.90
Plough beam or tool bar	1070	0.65 - 0.75	0.60 - 0.90
Plough shares	1074	0.70 - 0.80	0.50 - 0.80
Rake teeth, beater	1078	0.72 - 0.85	0.30 - 0.60
Scraper, blades, shovel	1085	0.80 - 0.93	0.70 - 1.00
Discs	1085	0.80 - 0.93	0.70 - 1.00
Brackets and binder sections	1086	0.82 - 0.95	0.30 - 0.50
Shafts	1090	0.85 - 0.98	0.60 - 0.90
Casting parts, wheels, hubs etc.	BS 1452 Gr4 1961	-	-

TABLE 4.3

OR DRAWN IMPLEMENTS

INVESTMENT

Existing Stage / Next Stage Industrial Infrastructure	SMALL SCALE INDUSTRY				MEDIUM SCALE INDUSTRY	
	Small Scale Industry Limited - Strong		Medium Scale Industry Limited - Strong		Limited - Strong	
Equipment *						
Casting	-	-	●	θ	●	θ
Fabrication	0	0	●	●	0	0
Forging	0	0	●	θ	0	0
Heat treatment	0	0	●	●	0	0
Machining	0	0	●	●	●	●
Tool Room	0	0	●	●	0	0
Welding Shop	0	0	●	●	0	0
Technology						
Product Design	●	●	●	●	●	θ
Production System	0	0	●	θ	0	0
Manpower						
Skilled Labour	0	0	θ	0	0	0
Technical Engineering	θ	θ	θ	θ	0	0
Management	0	0	●	θ	0	0
Agriculture Engineering	-	-	●	θ	0	0
Financing:	production unit governt agency commercial bank		production unit interm. assistance governt agency foreign partner		production unit commercial bank foreign partner	

● to be imported; θ partly imported - can be found or developed in the country;
0 available
* See table 4.1 for detailed list of equipment

TABLE 4.4

TRACTOR DRAWN IMPLEMENTS

PRODUCTION

Existing Stage / Next Stage Industrial Infrastructure	SMALL SCALE INDUSTRY				MEDIUM SCALE INDUSTRY	
	Small Scale Industry Limited - Strong		Medium Scale Industry Limited - Strong		Limited - Strong	
Supplies						
Casting	●	θ	-	-	-	-
Forging	-	-	-	-	-	-
Structural sharpes tubes	●	θ	●	θ	●	θ
Bars and rocks	●	θ	●	θ	●	θ
Sheet metal	●	●	●	●	●	●
Ancillary	●	θ	●	θ	●	θ
Factory supplies	θ	θ	θ	θ	θ	θ
Research and Development	-	-	●	θ	0	0
Marketing						
Credit system	θ	θ	θ	θ	0	0
Distribution network	-	-	θ	θ	0	0
Production programming	-	-	θ	θ	0	0

● to be imported
θ partly imported - can be found or developed in the country
0 available

5. RESEARCH & DEVELOPMENT

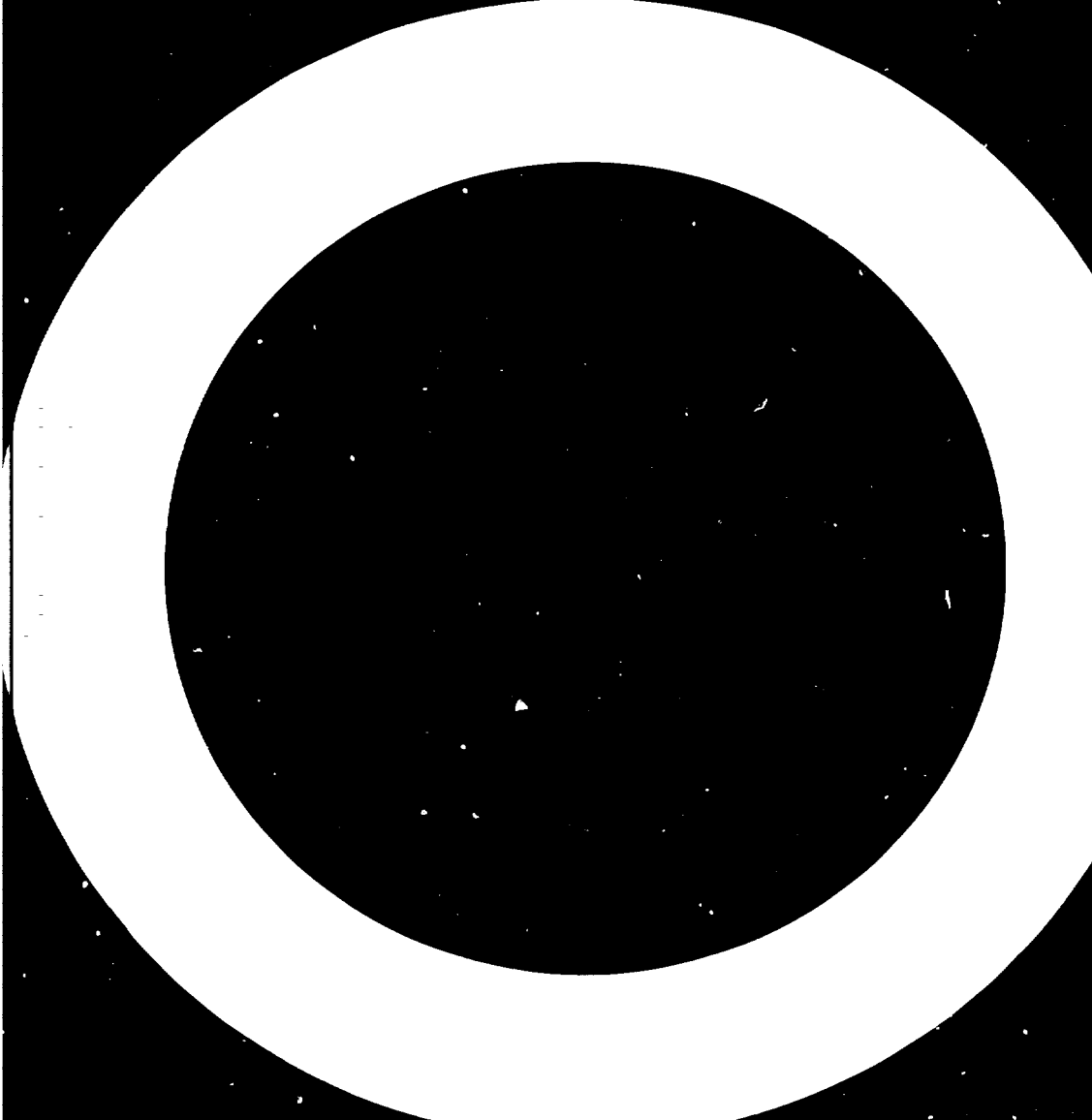
Since most of the product technology for tractors and tractor drawn implements results from R & D undertaken by the large integrated multinational tractor and implement maufacturers, there is not the need or the requirement for indigenous R & D, (as there is for Animal - drawn implements).

There is a need however to understand this equipment and to be able to select the most appropriate equipment from the wide supply available for specific African conditions, to understand tractor mechanization application and economics to foster development of trained tractor operators, repair and maintenance support and distribution of spare parts and service items. The African Ministries of Agriculture farm mechanization establishments and the Agriculture Universities have devoted considerable resources to this process.

R & D devoted to development of the small tractor (and its related implements) is of interest to a number of Africa countries and considerable resources are being applied to both indigenous R & D and to influence the multinational manufacturers to greater efforts in this regard.

Although R & D is interesting and important for tractor mechanization technology, the need and opportunity offered by directing resources to the more prosaic hand tools, animal draught equipment and related other agriculture products for post harvest storage and processing should not be neglected in the process.

APPENDICES TO PROFILES



PROFILE 1

APPENDIX A

DOSSIER ON HOE TYPES USED IN THE NORTHERN STATES OF NIGERIA

In the process of market analysis of the potential in Nigeria for a modern hand tool factory producing all forged hand tools, the Chillington company made a survey of implements found in selected regions of Nigeria manufactured by village blacksmiths.

The report here summarized serves to illustrate the wide variety of indigenous tools that have developed over the years.

This variety of shapes, weights, materials prices etc. creates a number of problems. What configurations of all-forged high quality hand tools are best suited to a particular country? Since high volume production requires a standardized product, a survey of traditional implements now in use helps to make this very important standardization decision.

Once the decision is made, on a standard configuration, then the problem of convincing farmers to change and adopt the new product can be recognized as a major problem given this mode of variety of traditional designs.

DOSSIER ON HOE TYPES USED IN THE NORTHERN STATES OF NIGERIA

WEEDING TOOLS

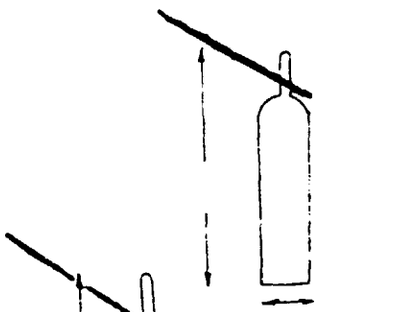
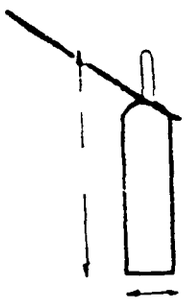


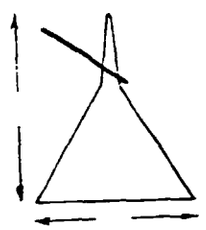
Fig. (i)

This hoe which has a thin blade and weighs approximately 1 kg, is used primarily for planting out crops.



(ii)

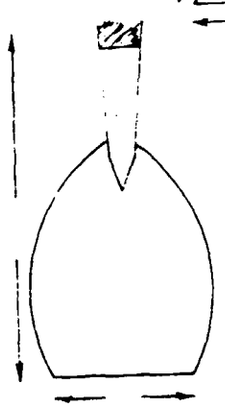
Virtually the same hoe, but it has a much thicker blade and weighs approximately 1-1,5 kg. Used mainly for clearing bushland.



(iii)

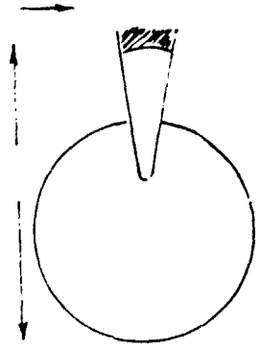
A thin bladed hoe used exclusively for weeding or scratching round plants.

Approximate weight: 0,2 - 0,4 kg



(iv)

This blade, socket type used in North Eastern State for weeding.
Approximate weight: 0,2 - 0,4 kg



(v)

Thin blade socket type used for weeding.
Approximate weight: 0,2 - 0,4 kg

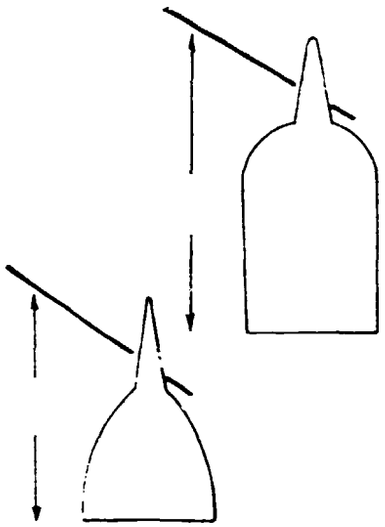
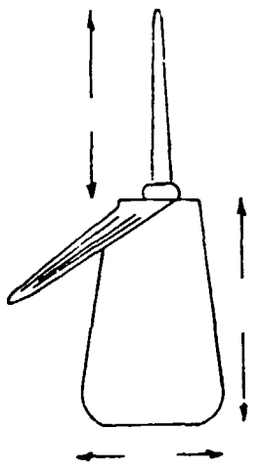


Fig.

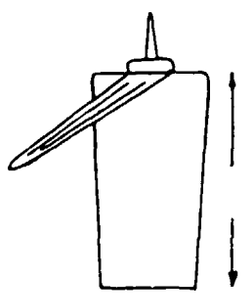
Thin blade, heavily dished hoe used for weeding in North Eastern Province.
Approximate weight: 0,2 - 0,4 kg.

Thicker blade weeding hoe used in North West State.
Approximate weight: 0,75 - 1,0 kg.

DIGGING/FURROWING TOOLS



(viii) The tang on this furrowing tool is 65 cm long and the weight inclusive of handle (see diagram) is approximately 3,0 - 3,5 kg. The blade is thick and the tool is used principally in Benue Plateau State.
Expected life-time: 4 - 7 years.



(ix) Basically the same tool with a shorter tang, weighing approximately 2,5 kg. Made of steel or sometimes wood - life expantancy 5 years.

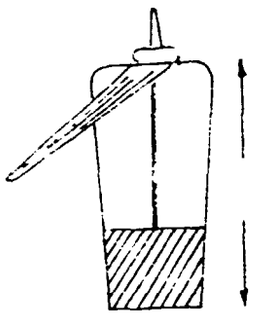
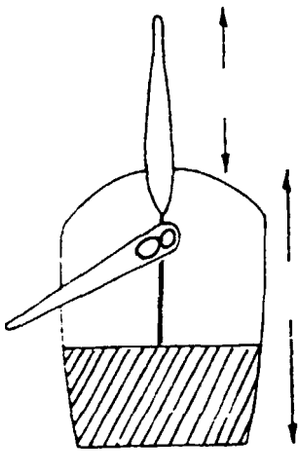


Fig.

Digging/furrowing tool used widely throughout the Northern States. Short tang only, and the blade is shown as shaded in diagram.

(x) Approximate weight: 2 kg.
Life expectancy: 4 - 5 years.



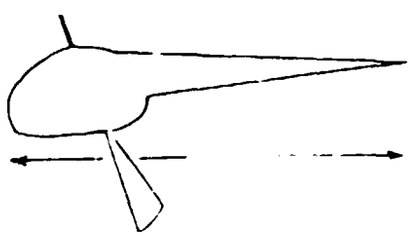
A longtanged hoe (150 cm) weighing about 4 kg. used principally in Zaria and Benue Plateau.

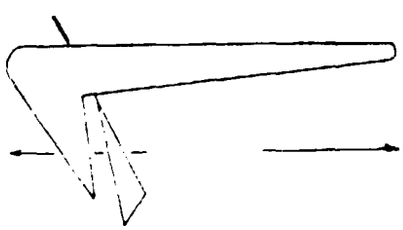
(xi)

Life expectancy probably 4 - 5 years.

HANDLES

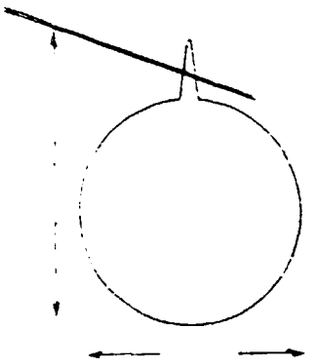
Direction of handles is shown on each diagram. One constant feature of the handles was that except for the socket hoes, they were basically the same and in contrast to many other countries they were all short.



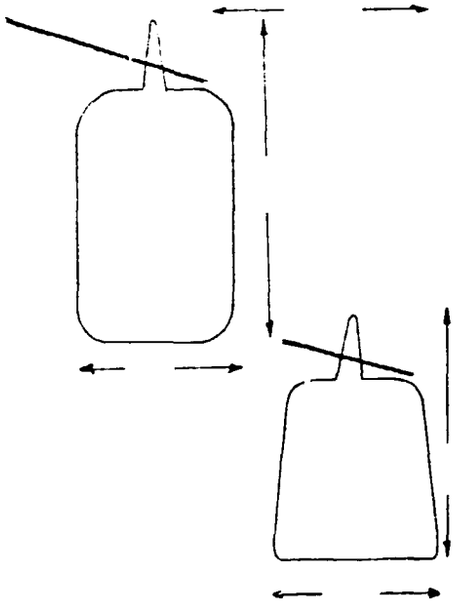


DOSSIER ON HOES USED IN EASTERN STATES, MID-WESTERN AND WESTERN STATES

Fig.



(i) Weights approximately 2,5 kg and is used particularly for yam mounds and furrowing in waterlogged areas.

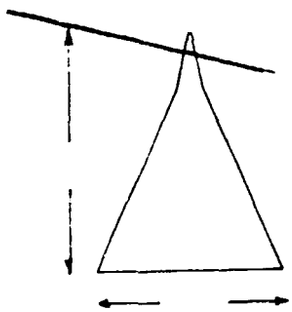


(ii) Weights approximately 1,5 kg and is used principally for furrowing.

Very slightly dished.

(iii) Weights approximately 0,5 kg and is used for general weeding.

Not dished.



(iv) Used for light weeding work mainly in Western State.
Approximate weight: 0,2 - 0,4 kg.

Note:

(v) Exactly the same pattern of hoe is used in 1½ weight in the Mid-West and Western States for ridging and mounding.

(vi) These were not seem and therefore no positive information is available.

APPENDIX B

KENYA MOW/BAR TECHNOLOGY UNIT

SPECIFICATION NO. 6 - JEMBE (PLAIN)

1. Dimensions are shown on Figure No. 1.

2. Weight to be 1.5 kg (+ 10%, - 5%).

3. Material Specification (Steel)

Carbon Percent	Manganese Percent	Phospherus Percent	Sulphur Percent
0.40/0.50	0.050/0.10	0.05 max.	0.05 max.

4. Heat Treatment and Hardness

After the forging has been normalized the lower part of the blade shall be hardened and tempered to give hardness within 50 mm of the cutting edge of 40/46 Rockwell C. The hardened zone shall not extend nearer than half way to the Eye.

5. Construction

The forging must be symmetrical and free from flaws. All fins and flashes must be dressed off. The Eye must be smooth internally, uniformly tapered, and must lie centrally in the forging. The cutting edge must be ground sharp.

6. Strength Test

With a standard hardwood handle fitted and the tool clamped as shown on Figure 2 a load of 45 kg. shall be gradually applied by suspension at the handle end, and maintained for two minutes. On removal of the load the tool shall show no signs of damage to the head or loosening of the handle, nor shall there be any permanent set in excess of 25 mm measured at the end of the handle.

7. Marking

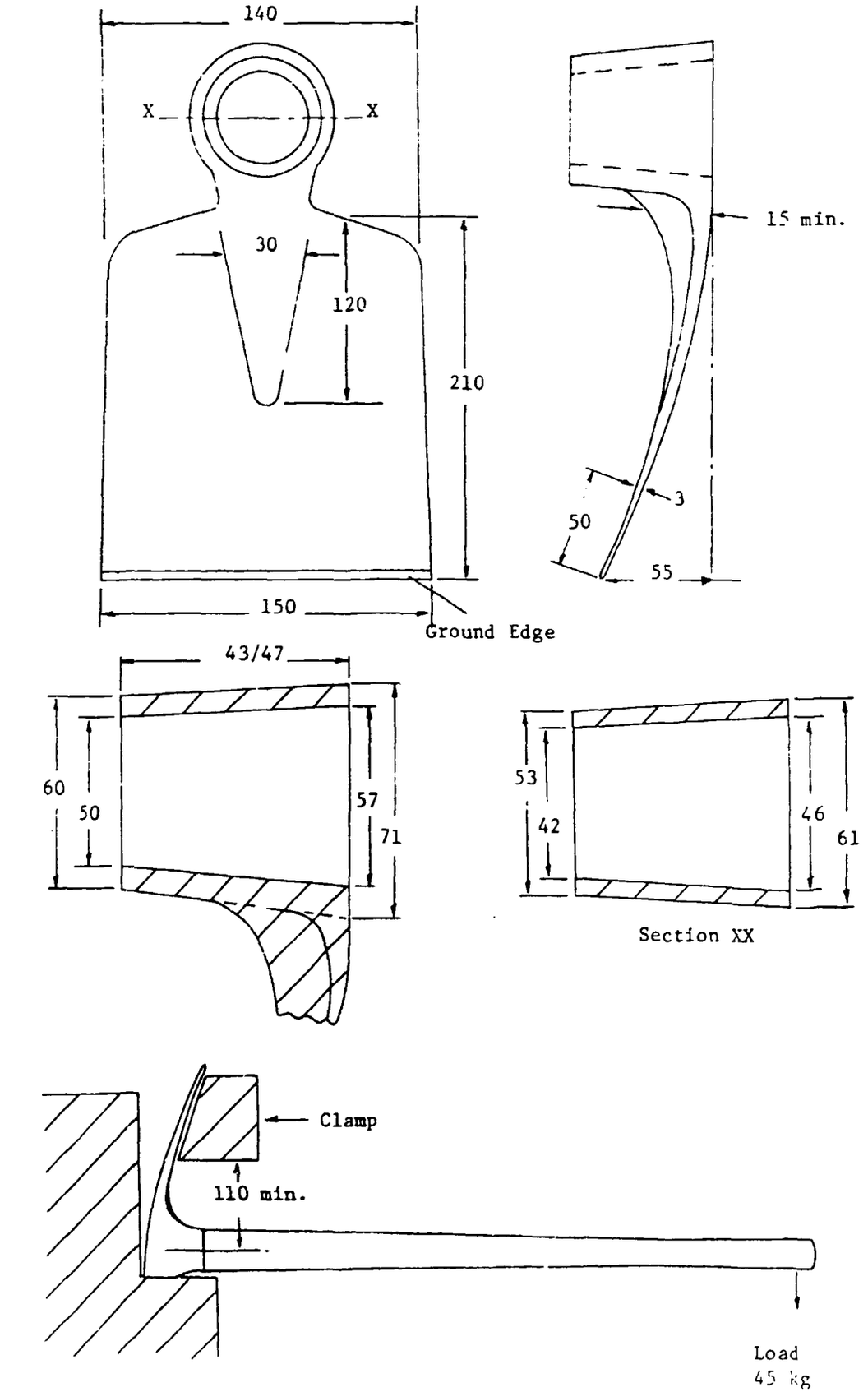
The forging shall be clearly and indelibly marked with the following:

a) Manufacturers name and/or trademark
b) The letters MOW/BAR
c) The nominal weight.

FIGURE 1

Specification n° 106

Dimensions in mm.



8. Preservative Treatment

The head to be varnished all over.

Note:

The Jembe may be made of two piece welded construction provided prior written approval of the design and material specifications is obtained from the MOW/BAR Technology Unit. Such welded Jembes must conform with all the requirements of Specification No. 6.

SEPTEMBER 1977

TEST REPORT

JEMBE (PLAIN)

CROCODILE BRAND PATTERN 3672C/3-LB

WEIGHT 1,6 kg.

MATERIAL

C	MN	PH	SU
0.41	0.72	0.037	0.040

HARDNESS 41 Rockwell "C" Hardness Zone 90mm from blade edge.

STRENGTH TEST

Hoe sited as per spec. Sheet No. 6
Pressure point = 150mm from center line of shaft.

Shaft length = 1025mm

Applied load = 45 Kg (2 minute duration)

Shaft deflection under load = 62mm

Shaft permanent set = 9mm

APPENDIX C

USINE DE MATÉRIEL AGRICOLE DU ZAÏRE (U.M.A.Z.)

1. INTRODUCTION

The project for the establishment of UMAZ resulted from an agreement of technical and economic cooperation concluded between the Republic of Zaire and the Peoples Republic of China in 1973. The agreement of the UMAZ Hand Tool Factory was signed on 10 April 1974 in Kinshasa. The factory was turned over to Zaire management in July 1979. The factory operates under the jurisdiction of the Ministry of Agriculture and Rural Development.

Zaire has heavily forested areas, savanah land more or less forested and steppe mainly on plateau. As well all regions are dominated by tropical forest and tree crops, agriculture relies very heavily on hand tool cultivation except for limited but large agro-industrial commercial mechanized farms.

UMAZ specializes in the manufacture of hand tools for the small farmer dominating Zaire agriculture. The UMAZ objective is to sell at significantly cheaper prices than imported hand tools or private manufacturers of hand tools and to reduce imports by 50%.

2. PRODUCTION

UMAZ produces five types of tools (along with the handles):

Hoes	2,0 kg (net weight of hoe body 1,36 kg)
Machettes	0,7 kg (net weight of machette body 0,48 kg)
Axes	1,7 kg (net weight of axe body 1,135 kg)
Shovels and Spades	

Production capacity for an 8-hr shift on an annual basis is:

Hoes	360,000 units
Machettes	360,000 units
Shovels	102,000 units
Axes	105,600 units
Spades	360,000 units

Since the hoe and the axe are not manufactured concurrently nor spades and machettes, the maximum total annual capacity is 822,000 pieces. Production has developed since start-up as follows:

	1979	1980	Plan 1981
Hoes	53,138	188,405	360,000
Machettes	71,687	180,298	360,000
Shovels	28,863	61,449	102,000
Axes	4,000	-	-
Spades	-	-	-
TOTAL	157,708	430,152	822,000

50% of the 1981 program was accomplished by July. Production capacity can be doubled by adding a second shift.

3. TECHNOLOGY AND EQUIPMENT

All the equipment has been imported from China. The plant is organized in 8 departments and flows are designed to route different products through the departments. The list of equipment installed by department is presented in Table C.1. The following tables (C.2, C.3 and C.4) indicate the production process for hoes, axes and machettes with the equipment used, the manpower employed by operation and productivity. Note that much equipment is used in common to manufacture the three products.

4. RAW MATERIALS

All raw materials are imported from China with the exception of wood, oil and paint. Raw material is detailed in Table C.5.

5. ORGANIZATION AND PERSONNEL

The factory was operated at the start up period by a mission from China, who trained production operators in the factory and trained specialists technicians and engineer.

Today the factory is entirely controlled by Zaire nationals. The factory is under the direction of a factory manager, who also assumes marketing, assisted by a chief of production, a chief of finance and a chief of administration, supported by three superintendants and eight foremen. Factory employment is 243 people.

6. MARKETING

Marketing is direct. The principle clients of UMAZ are government departments, large agro-industrial operations, religious communities, private distributors.

Difficulty in distribution to the interior is a recognized problem. In addition the end of the UN World Food Program resulted in the loss of the most important client. Consequently a new distribution network is required.

7. RESEARCH AND DEVELOPMENT

UMAZ does not have its own R & D facility but reproduced Chinese models. These initial models appear to be appropriate. However UMAZ is working with CRIAC at Lumumba, the central Zaire institute for R & D for industrial, agriculture and commerial research in order to plan for diversification of product line in the future.

TABLE C.1

EQUIPMENT

UMAZ

Cutting Shop	press (160 t.) cutting machine
Forge Shop	Oil fired furnace Friction press Forging press Friction press Pneumatic hammer Press (315 t) Press Vertical press
Heat Treatment Shop	Salt bath oven Tempering pneumatic press Nitrate bath Cold water bath Hot water bath Electric oven Tempering bath Nitrate bath
Control, Polish and Sharpening	Grinding machines Hardness tester Sharpening machines Elasticity testers
Woodwork	Equipment for handles manufacture
Painting	Painting equipment
Assembly	
Maintenance	Set of tools

TABLE C.2

PROCESS FOR HOE FABRICATION

UMAZ

Steel used: steel plate 45 dimension 16 x 110 x 6000 mm
Weight: 1,70 kg 16 x 120 x 6000 mm
Net weight of hoe body: 1,135 kg 16 x 110 x 145

Operation	Equipment	Number of workers	Productivity pieces/hour
FABRICATION			
- Material cutting	Press	2	400
- Heating 1200 - 1250° C	Oil fired furnace semi continuous	2	200-350
- Piercing	Friction press	3	225
- Forging	Forging press	4	225
- Hoe finishing and stamping	Friction press	2	225
- Deburring	Press	2	225
- Piercing and forming	Friction press	2	225
- Hole finishing	Vertical drill	1	250
- Quality control			
HEAT TREATMENT			
- Heat treat	Salt bath	2	200
- Cooling	Pneumatic press	1	200
- Tempering	Nitrate bath	1	
- Cold water wash	Cold water bath	1	200
- Hot water wash	Hot water bath		
- Quality control (shape and hardness)	Hardness tester		
SHARPENING			
- Deburring	Grinding machine	1	150
- Sharpening	Special grinding machine	1	60

TABLE C.3

PROCESS FOR AXE FABRICATION

UMAZ

Steel used: steel plate 45 dimension 25 x 75 x 6000 mm
Weight: 1,70 kg 25 x 75 x 117
Net weight of axe body: 1,135 kg

Operation	Equipment	Number of workers	Productivity pieces/hour
FABRICATION			
- Material cutting	Press	2	400
- Heating (900 - 1000° C)	Oil fired furnace		60
- Rough forming	Pneumatic hammer	2	60
- Reheating (1200-1250°C)	Oil fired furnace	2	60
- Piercing, polishing	Press (315 T)	3	60
- Forging	Hydraulic press	4	60
- Deburring	Press (160 T)	2	60
- Finishing and stamping	Friction press	2	60
- Hole finishing	Friction press	2	60
- Quality control			
HEAT TREATMENT			
- Drying	Electric oven		
- Heat treating	Salt bath		
- Cooling	Water bath		
- Tempering	Nitrate bath	2	75
- Cold water wash	Water bath		
- Hot water wash	Water bath		
- Quality control (shape and hardness)	Grinder and hardness tester	1	
- Grinding and sharpening	Grinder	1	15

TABLE C.4

PROCESS FOR MACHETTE FABRICATION

UMAZ

Steel used: sheet steel 65 mn — dimension 2.5 x 850 x 1200 mm
Weight: 0,71 kg — 2.5 x 850 x 1400 mm
Net weight of machette body 0,48 kg — 2.5 x 850 x 1800 mm

Operation	Equipment	Number of workers	Productivity pieces/hour
FABRICATION			
- Shearing	Shear	3	120
- Blanking and punching	Press	2	350
- Straightening (if necessary)	Friction press		250
- Quality control			
HEAT TREATMENT			
- Drying	Electric oven	1	
- Heat treating	Salt bath	3	250
- Cooling	Nitrate bath		
- Cold water wash	Water bath	1	
- Quality control (shape and harness)			
- Tempering	Nitrate bath	1	250
- Cold water wash	Water bath	1	
- Hot water wash	Water bath	1	
- Finishing (if necessary)	Water bath	1	
- Quality control	Temper tester		
Elasticity 5%	Grinding machine Hardness tester		
Hardness 3%			
- Polishing	Grinding mill	3	75
- Cutting edge	Grinding mill	2	75
- Quality control			

TABLE C.5

RAW MATERIALS AND SUPPLIES

UMAZ

For Hoes

Steel Plate 45	16 x 110 x 6000 mm
	16 x 120 x 6000 mm
	16 x 110 x 145 mm

For Axes

Steel Plate 45	25 x 75 x 6000 mm
	25 x 75 x 117 mm

For Machettes

Sheet Steel 65 mm	2.5 x 850 x 1200 mm
	2.5 x 850 x 1400 mm
	2.5 x 850 x 1800 mm

For Handles

Wood from Zaire
Aluminium rivets

SUPPLIES

Oil (from Zaire)
Grinding Wheels
Nitrate of sodium
Carbonate of sodium
Nitrate of potassium
Paint

APPENDIX D

Development and Equipment of Village Blacksmiths in the Cotton Zone

CMDT - MALI
(From the annual report 80-81 Rural Artisans CMDT)

Introduction

The program concerns small artisans who manufacture articles from iron and steel, leather and wood in a region of Mali. These artisans are often small farmers who work on a part time basis in the artisan workshop.

Their equipment and level of technology does not allow for repair and maintenance of farm equipment and animal drawn implements. However, since they are closely related to the farming population they are well placed to develop capability to undertake this necessary work.

The program is directed to developing and equipping artisans in the CMDT zone. The program has been active for 11 years. The initial objective was to create a network of 150 upgraded forge shops. Today 155 such forge shops are established, the program is a success which can serve as a model for rural development.

History of the Development

The program was developed as a result of a study concerning rural forge capability in 1969-70 and started in 1970. The study objectives were:

- In the short term, development of a network of 150 village forge workshops, then development, their initial equipment, construction of workshops by the village smiths themselves.
- In the medium term, further development leading to more sophisticated technology such as oxy acetylene and arc welding, repair of motors, distribution of grinding mills to provide a source of finance for equipment purchasing.
- In the long term, development leading to capability for repair and maintenance of motors and engines of all types, automobiles and trucks, pumps and other heavy mechanical equipment.

The objectives are realized through a training program in three phases: construction and equipment of the shop, manufacture of tools and training for welding.

At this time 155 forge workshops have been equipped and developed with 96 now capable of heavy equipment repair and maintenance.

Organization

. Personnel

The program was planned and carried out through the formation center of CMDT at Bamako. This Mali government organization is responsible for development of cotton production in a region of Mali producing cotton as a cash crop.

The zone was divided into 6 regions. For each region there is a manager responsible for management of the training program and 14 smith training agents are operating at the village level. They were recruited at a smith and mechanic C.A.P. level (certificate of professional skill). Recruits were required to demonstrate language and communication skills as well as aptitude for the work.

. Equipment

Upon completion of training each training agent was equipped with a motor bike, basic forging equipment, an oxyacetylene welding machine and a tool box.

The equipment includes:

. 50 kg anvil
. mechanical hand operated forge blower
. vice
. files
. bolt die set for thread forming
. hand drills and drill bits
. hand grinder
. metal saw and blades
. square and tape rule
. wood saw
. brace and bit
. oxyacetylene welder

The training agent, his bike and equipment were transported by trucks from one village blacksmith to another after completion of the training.

Financing for the equipment was guaranteed by CMDT for the first phase. In the second phase, heavy equipment was financed by a grant of US $133,000 from the Fonds d'Aide à la Coopération and by a loan of US $222,000 from the Caisse Centrale de Coopération Économique.

Phase 3

. Practice in welding on pieces brought for repair by local farmers

. Commercial training, mainly estimating of production cost.

The three phases require 45 to 50 days of training.

Results

. Smiths in operation 155

. Equipped for oxyacetylene welding 43

. Equipped for arc welding 40

Annual production from these shops, fabrication, welding, repair work, etc. amount to US $254,000 per year or an average of US $4,700 per smith.

The smith have demonstrated their ability to manufacture ploughs, hoes, cultivators of good quality, cheaper than prevailing market prices.

After sales service, repair and maintenance of agriculture equipment in the CMDT zone is now assured.

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APPENDIX "E"

PROPOSAL FOR THE MANUFACTURE OF HOES AND PICK AXES IN AN AFRICAN COUNTRY

BY PERMISSION OF CHILLINGTON TOOL COMPANY LTD., WOLVERHAMPTON, UK

1. INTRODUCTION

The following document summarizes data from a proposal prepared by the Chillington Tool Company Limited, Wolverhampton U.K., for the establishment of a manufacturing facility to produce hoes and pick axes in an African country.

All figures are in 1981 values and are of a preliminary nature.

2. THE MARKET

o Hoes

The total consumption of all types of hoe in the country is estimated to be of the order of 2.5 million pieces per year. However, 95% of the market is supplied by a cottage industry that manufactures a cheap and very low quality tool.

o Pick Axes

There is a very large market indeed throughout the country for picks, particularly in the Southern States.

The market is currently supplied by Chillington with the Acotupy product from Brazil, and from Poland, Hungary, Czechoslovakia and Taiwan. The quality of the Acotupy pick is considered to be superior to the other imports and commands some premium in price.

The market potential for picks is considerd to be around 500,000 pieces per year but could be much greater in view of the programmes now being considered.

3. HISTORY

In 1977 Chillington was visited by a member of MOW/RAR Technology unit-Kenya who were engaged in a project to establish a specification for a hand hoe that was of universal use. The subsequent specification developed was almost identical to Chillington pattern manufactured in volume.

There is no doubt that a substantial market for forged hoes would exist especially bearing in mind that about 90% of the population is involved in farming.

In order to achieve volume of the forged tool a large scale marketing operation would have to be launched. However it should be possible to prove that the uses of a robust cultivating tool would be of advantage.

4. BASIS OF PROJECT

This project is based on the annual production and sale of 750,000 3-lb hoes, and 250,000 7-lb picks. It is possible that other weights or patterns may ultimately be required but for the purposes of the project only these two products have been considered.

The annual turnover based on current CIF Prices would therefore be. ($US 3.5 million).

5. LAND, BUILDINGS AND SERVICES

The factory working area will be 2700 m^2 (30m x 90m) which will allow adequate production and storage space, accomodate toolroom facilities and will allow for some further expansion.

The load bearing capacity of the ground should be about 5500 kg/m 2, the height of the building should be 4m to the eaves 7.6 m to the apex, and the floor in reinforced concrete should be of minimum thickness 150mm.

Foundations will be required under the various items of machinery involving a total of 75 m^3 of concrete.

The area of land required will be about 1 Hectare which will allow ample provision for outside steel storage, car parking and some expansion.

An office of total area 180m^2 will be required and this could be attached to the factory building.

The maximum electrical demand is likely to be 350 KVA thus a transformer of capacity 500 KVA should be installed to adequately cope with an increased future demand. The cost of the necessary electrical installation including full distribution is estimated at US $30,000..

Storage capacity of 15,000 litres of Heavy Fuel Oil, and 10,000 litres of Gas Oil, should be made available together with the necessary pipework and circulating pumps.

A water supply of about 3,000 gallons per day will have to be provided.

A total cost estimate for the building and land has been made at US $200,000. This is very much subject to local confirmation.

The total cost of factory site including all services is US $230,000.

6. FACTORY CAPACITY AND METHOD OF PRODUCTION

The factory will initially have a production capacity of 750,000 hoes and 250,000 picks working on a 2 shift basis for 47 weeks, giving an average production rate for both products of 266 pieces per hour.

The production of hoes by means of the well proven Chillington methods will be of the order of 320 pieces per hour, and the production of eyed pick blanks will be at the same rate but the drawing out of the picks under 4 free space forging hammers will be of the order of 130 pieces per hour.

The method of production will be as folows:

Hoes	Operation	Machine
1	Shear steel bars into moulds	Billet Shearing M/C
2	Heat to forging temperature 1150°C	Forging Furnace
3	Pre-Form Mould	Squeezing Machine
4/5/6	Form eye and rib	Forging Press
7	Side spread mould	Duplex Rolling Mill
8	Roll spread mould to length	Duplex Rolling Mill
9	Blank hoe to shape	100 Tonne Press
10	Punch and shape eye	75 Tonne Press
11	Apply Trade Mark	120 Tonne Hydraulic Press
12	Dish blade	75 Tonne Press
13	Grind cutting edge	Double Ended Grinding Machine
14	Harden and temper	Lead & Salt Bath Unit
15	Varnish all over	Varnish Tank
16	Label, wrap and pack in wooden cases of 25 pieces.	

Picks	Operation	Machine	
1	Shear steel bars into blanks	Billet Shear	X
2	Heat to forging temperature 1150°C	Forging Furnace	X
3	Form eye in mould	Forging Press	X
4	Clip eye	100 Tonne Press	X
5	Punch and shape eye	75 Tonne Press	X
6	Mark on side of eye	120 Tonne Hydraulic Press	X
7	Re-heat one end of mould	Slot Furnace	
8	Draw out one end of pick	Forging Hammer	
9	Re-heat other end of mould	Slot Furnace	
10	Draw out other end of pick	Forging Hammer	
11	Harden & Temper	Slot Furnace and Oil Bath	
12	Varnish all over	Varnish Tank	
13	Pack in wire bundles		

Machines marked (X) are those also used in the manufacture of hoes.

7. PLANT REQUIRED

All plant supplied would have an expected life of about 25 years but the equipment associated with heating and hardening would require regular re-furnishment in the areas of heat application.

7.1 Production Plant

Billet Shear Capacity 200 Tonne

Oil Fired Forging Furnace

Chillington Design Squeezing M/C

600 tonne
10" Stroke Press

Duplex Rolling
Mill comprising Lengthening
and Spreading Mill

1 x 100 Tonne Open Fronted Crank Press

2 x 75 Tonne Open Fronted Cranks Press

120 Hydraulic Press

4 x 3 Cwt Open Space
Forging Hammers

3 Lead Pot/Salt Pot Hardening Units

3 Slot Type Furnaces

3 Double Ended Grinding Machines

2 Varnish Tanks

2 Labelling Machines

7.2 Auxiliary Equipment

2 x 120 C.F.M. Air compressors

Hardness Testing Machine

Portable Heavy Duty Hand Grinder

Work Tables & Trucks

Sundry Hand Tools

7.3 Toolroom Plant

Number 8 Combination Turret Lathe

Centre Lathe to accomodate jig
for segment boring and grinding

Tool Post Grinding Unit

Vertical Milling Machine Table
size 1000mm x 500mm

Pillar Drilling Machine 1¼ capacity

Surface Grinder Table Size
600mm x 300mm

Shaping Machine 20"

Bench Grinding Machine

Bench Vices Cutting and Hand Tools

Segment Boring Jig

Segment Grinding Jig

8. TOOLING COSTS

A complete set of tooling sufficient to cover the first years production of hoes would be US $50,000. Many of these tools could be completely re-furnished and would last several years.

It would be realistic to assume that an initial import of tools would be sufficient to get hoe production underway and further imports could be made when necessary. A realistic estimate of the cost of tooling per 100 produced would be US /3.50.

An initial import of pick making tools would be required with an average cost of tooling per 100 produced at US $.57

Total initial cost of tools US $100,000.

9. CARRIAGE AND FREIGHT

The total weight of machinery, equipment and tooling is approximately 250 tonnes.

Shipment would be by means of container, of which about 15 would be required.

Special packing and handling would be necessary for the 600 tonne forging press.

Total cost estimate US $160,000.

It is envisaged that all shipping would be arranged through a an African shipping line.

10. OTHER CAPITAL COSTS

These would comprise, office equipment, motor vehicles and miscellaneous minor items, and are estimated at US $100,000.

11. PRE-PRODUCTION EXPENSES AND TRAINING

Chillington would supervise all the installation of the plant and equipment, provide all the know-how and would ensure the training of all the operators.

12. WORKING CAPITAL

It would be necessary to finance about 200 tonnes of steel and probably 2 months debtors, and capital in this category would be about US $750,000. It is assumed this can be locally borrowed at 15% interest per annum.

13. SUMMARY OF TOTAL CAPITAL COST

	$US
Land and Buildings & Installation	101,754
Production, Ancilliary and Toolroom Plant	1,166,666
tools	100,263
Carriage and Freight	166,666
Other Capital Costs	96,500
Pre-Production Expenses	222,807
	$ 2,455,000

14. ESTIMATE OF COST OF PRODUCTION

1. Steel

1500 Tonnes of EN9 95 x 18mm flat bar 850 Tonnes of EN9 40mm square To the precise specification of Chillington.	$ 1,385,000

2. Production Materials

Cases, Varnish, Labels etc.	$ 50,000

3. Variable Overheads

Fuel, Power, Consumable Tools and Miscellaneous Materials	$ 219,500

ESTIMATE OF COST OF PRODUCTION (cont'd)

4. Wages

Fifty productin operators will be required, and 10 engineering personnel, therefore, the total wages per annum are estimated at $ 315,789

5. Staff

A total of 18 will be required including General Manager, Sales Manager, Accountant, Works Manager, 2 Production Foremen, Engineering Foreman, Personnel Officer, 5 Clerks and 1 Driver. The total salary cost is estimated at $ 175,000

6. Fixed Overheads

Advertising, Insurance, Travelling Vehicle Expenses, Repairs, Maintenance and Directors Fees. The total cost assumed to cover the aforementioned is $ 132,000

7. Technical and Management Agreement

(to be reported)

8. Depreciation

This is estimated on the basis of 5% on buildings and 10% on plant and machinery. $ 140,000

15. TOTAL COST OF PRODUCTION SUMMARY

	US$
Steel	$ 1,385,000
Production Materials	50,000
Variable Overheads	220,000
Wages	316,000
Staff	175,000
Fixed overhead	132,000

TOTAL COST SUMMARY (cont'd)

Depreciation	140,000
Interest on Working Capital	112,500
TOTAL PRODUCTION COST	$ 2,700,000 approx.
Turnover	$ 3,500,000 approx.

PROFILE 2

APPENDIX A

A Case Study for manufacture with sub-contracting Animal Drawn Implement Manufacture in Two Modes

The following is a case study developed in synthesised models of factories to produce animal drawn implements in two distinct modes of operation.

One mode of operation is a factory vertically integrated to produce much of the required parts in-house, particularly forgings.

The second mode of operation is a factory horizontally integrated with the national industrial infrastructure and more parts (including forgings) are purchased rather than manufactured in-house.

The two modes of operation have equal investment and have equal employment.

Analysis shows that higher in-house value added is achieved at the expense of lower production output and lower commercial viability. In this trade-off, the choice of simpler technology leads to a bigger output available to the farmer at better prices and a higher return an investment. A lower value added results in a higher need for foreign exchange.

TABLE A.1

ANIMAL DRAWN IMPLEMENTS

Product Specifications

(Three Selected Products)

and Ex-factory Selling Price

Product	Specification	Mode 1	Mode 2
Single hand wheel hoe	Weight 12 kg (optimal: 3 hoe blades or 3 cultivator tines or 3 ploughs)	$ 30.	$ 25.
Animal drawn disc harrow	Weight 50 kg; discs 6-12; working width 92 cm; output 0.25 ha/hour	$ 300.	$ 250.
Animal drawn mould-board plough	Weight 35 kg; furrow width 13 cm - 21 cm; furrow depth 7 cm - 18 cm	$ 100.	$ 80.

TABLE A.2

ANIMAL DRAWN IMPLEMENTS

Material Specifications

Major Implement Components	SAE No.	Carbon (%)	Manganese (%)
Implement frame (MS)	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 shares (plate)	1074	0.70-0.80	0.50-0.80
Rake teeth	1078	0.72-0.85	0.30-0.60
Scraper, blades, discs, spring tooth harrow	1085	0.80-0.93	0.70-1.00
Mower and binder section	1086	0.82-0.95	0.30-0.50
Tin holders, knotter discs	1090	0.85-0.98	0.60-0.90

TABLE A.3

ANIMAL DRAWN IMPLEMENTS

Product Volume (1)

Product Description	Mode 1 (Manufacturing majority parts). Annual production (units)	Mode 2 (Manufacturing with greater subcontracted parts). Annual production (units)
Single-hand wheel hoe	10,000	30,000
Animal drawn discs harrow	2,000	3,000
Animal drawn ploughs	10,000	20,000
Tons per year	570	1,210

(1) Based on 250 working days and an 8 hr. shift.

TABLE A.4

ANIMAL DRAWN IMPLEMENTS

Manufacturing Technology

Estimate Cost $ U.S. - Machinery & Equipment

	Mode 1	Mode 2
1. Cutting shop	$ 15,000	$ 5,250
2. Forge & heat treatment shop	362,000	-
3. Fabricating & press shop	136,000	96,000
4. Machine shop	121,000	37,000
5. Assembly shop	15,000	25,000
6. Paint shop	15,000	23,750
7. Tool room	48,500	36,000
8. Compressor set	10,000	10,000
9. Mechanical handling	28,000	56,000
10. Stores	10,000	20,000
TOTAL:	$756,000	$310,000

TABLE A.5

MACHINERY AND EQUIPMENT

Mode 1 Manufacturing majority parts of the products.
Mode 2 Manufacturing with greater subcontracted parts of the products.

Mode 1			Mode 2		
Description	No.	Estimated cost(US$)	Description	No.	Estimated cost(US$)
Cutting shop			Cutting shop		
1. Hack saw	2	10,000	1. Hack saw	1	5,0000
2. Hand shear	2	500	2. Hand shear	1	250
Forge & heat treatment shop			Forge & heat treatment shop		
1. Mechanical drop	2	80,000	Not required because parts to be subcontracted e.g. tines, discs, bar, blades, shovels, etc.		
2. Press forge 150 tons	2	160,000			
3. Oil fired furnace	2	26,000			
4. Water quenching tanks	4	2,0000			
5. Blacksmiths tools	2	1,000			
6. Shearing machine	1	5,000			
7. Abrasive grinders	4	8,000			
8. Dies & tools	Sets	80,000			

TABLE A.5 (Cont'd)

Mode 1			Mode 2		
Description	No.	Estimated cost(US$)	Description	No.	Estimated cost(US$)
Fabricating & press shop			Fabricating & press shop		
1. Ecentric press 150 tons	2	60,000	1. Ecentric press 150 tons	1	30,000
2. Press brake 200 tons	1	30,000	2. Press brake 200 tons	1	30,000
3. Manual bending machine	2	2,000	3. Hydraulic bending machine	1	10,000
4. Arc welding machine 300 Amps	2	4,000	4. Arc welding machine 300 Amps	1	2,000
5. Nibbling machines to cut 6 mm MS	2	8,000	5. Nibbling machines tc cut 6mm MS	1	4,000
6. Welding fixtures etc.	Sets	5,000	6. Welding fixtures etc.	Sets	3,000
7. Pedestal grinding machine	4	2,000	7. Pedestal grinding machine	2	1,000
8. Oxy-actelene & brazing equipment	Sets	1,000	8. Oxy-actelene & brazing equipment	Sets	1,000
9. Upright drilling machine 12 mm dia in MS	2	4,000	9. Upright drilling machine	2	4,000
10. Dies and press tools	Sets	20,000	10. Dies and press tools	Sets	11,000

TABLE A.5 (Cont'd)

Mode 1			Mode 2		
Description	No.	Estimated cost(US$)	Description	No.	Estimated cost(US$)
Machine shop			Machine shop		
1. Pedestal grinder double ended	2	2,000	1. Pedestal grinder	1	1,000
2. Upright drilling machine 25mm dia in MS.	3	6,000	2. Upright drilling machine 25mm dia in MS.	1	2,000
3. Lathe, maximum bore 75mm, swing 46cm, length 92cm	2	30,000	3. Lathe, maximum bore 75mm, swing 46cm, length 92cm	1	15,000
4. Capstan lathe with accessories maximum collect size 4cm, swing 30cm, maximum work piece length 16cm		60,000			
5. Figs, tools and fixtures	lot	10,000	5. Gauges and tools	lot	5,000
6. Hydraulic press 1 ton capacity	1	2,000	6. Portable drill	2	1,000
7. Gauges, inspection tools & equipment	lot	8,0000	7. Portable grinder	2	1,000
8. Portable drill 12mm in MS	3	1,500	8. Jigs, tools fixtures	lot	10,000
9. Portable grinder 15cm diameter	3	1,500			

TABLE A.5 (Cont'd)

Mode 1			Mode 2		
Description	No.	Estimated cost(US$)	Description	No.	Estimated cost(US$)
Assembly Shop			Assembly Shop		
1. Assembly fixtures	lot	10,000	1. Assembly fixtures	lot	5,000
2. Upright drilling machine 12cm in MS	2	4,000	2. Assembly conveyors	lot	15,000
3. Portable drilling machine 12mm in MS	2	1,000	3. Upright drilling machine	2	4,000
4. Portable grinder 15cm diameter	2	1,000	4. Portable drill	2	1,000
			5. Portable grinder	2	1,000
Paint Shop			Paint Shop		
1. Degreasing vat	1	5,000	1. Degreasing vat	2	6,000
2. Dipping plant & conveyors etc.	1	10,000	2. Dipping plant with conveyor	1	15,000
			3. Spray unit	1set	2,750
Tool Room & Maintenance			Tool Room & Maintenance		
1. Universal milling machine, 5HP	1	20,000	1. Universal milling machine	1	20,000
2. Universal cutter grinder 1½ HP	1	10,000	2. Universal cutter grinder	1	10,000
3. Double ended grinding machine	1	500	3. Double ended grinding machine	1	500

TABLE A.5 (Cont'd)

Mode 1			Mode 2		
Description	No.	Estimated cost(US$)	Description	No.	Estimated cost(US$)
4. Surface table	1	500	4. Surface table	1	500
5. Gauges and tools	set	3,000	5. Maintenance tools & equipment	1	3,000
6. Precision Lathe 2HP	1	10,000	6. Arc welding set 300 Amps.	1	2,000
7. Maintenance tools & equipment	set	3,000			
8. Arc welding set 250 Amps.	1	1,500			
Compressor Set			Compressor Set		
Complete motor compressor unit 300ft^3/min, 80 psi.	set	10,000	Complete motor compressor unit 300ft^3/min, 80 psi.	1	10,000
Mechanical Handling			Mechanical Handling		
1. Fork lift truck 1 ton	1	15,000	1. Fork lift truck 1 ton	2	30,000
2. Hydraulic pallet truck (hand operated)	4	5,000	2. Hydraulic pallet truck (hand operated)	8	10,000
3. Racks, stillages & bins	lot	5,000	3. Racks, stillages & bins	lot	8,000
4. Conveyors, etc.	lot	3,000	4. Conveyors, etc.	lot	8,000
Stores			Stores		
Rack, stillages, pallets, etc.	lot	10,000	Rack, stillages, pallets, etc.	lot	20,000
TOTAL		756,000			310,000

Table A.6

COST OF BUILDINGS

Description	Mode 1	Mode 2
Administration bldgs. at $ 200./sq. m.	100 sq.m./$ 20,000	100 sq.m./$ 20,000
Factory bldg at $ 150./sq. m.	6,000 sq.m./$ 900,000	3,000 sq.m./$ 3,000
Storage area at $ 100./sq. m.	500 sq.m./$ 50,000	1,500 sq.r./ $ 150,000
TOTAL BUILDINGS	$ 970,000	$ 173,000

Table A.7

MATERIAL REQUIREMENTS

Product	Mode 1	Mode 2
	10,000 UNITS	30,000 UNITS
Single wheel hoes		
- Manufactured parts	$ 120,000	$ 75,000
- Bought out parts	60,000	360,000
TOTAL:	$ 180,000	$ 435,000
Cost per unit	18.00	14.50
	2,000 UNITS	3,000 UNITS
Animal drawn disc harrows		
- Manufactured parts	130,000	90,000
- Bought out parts	130,000	279,000
TOTAL:	260,000	369,000
Cost per unit	130.00	123.00
	10,000 UNITS	20,000 UNITS
Animal drawn mould board plough		
- Manufactured parts	380,000	360,000
- Brought out parts	190,000	680,000
TOTAL:	$ 570,000	$ 1,040,000
Cost per unit	57.00	52.00
Materials cost	$1,010,000	$ 1,844,000
Scrap allowance	10,000	6,000
TOTAL DIRECT MATERIAL COST	$ 1,020,000	$ 1,850,000

Table A.8 (cont'd)

Annual Direct Material Requirement and Costs

Description	Parts group	Mode I						Mode II					
		MOW	BOF	Cost of Group (US$)	Total unit cost (US$)	Annual production (Units)	Total material costs (US$)	MOW	BOF	Cost of group (US$)	Total unit costs (US$)	Annual production (Units)	Total material costs (US$)
Animal drawn Mould board Plough	MS handle	x		3.00	57.00	10,000	570,000		x	2.00	52.00	20,000	1,040,000
	Steel beam	x		8.00				x		8.00			
	Steel mould board & shares	x		15.00					x	12.00			
	Bracket	x		4.00				x		4.00			
	Land side	x		1.00				x		1.00			
	Chain ring & shackle	x		2.00					x	2.00			
	Ridging body	x		5.00				x		5.00			
	CI gauge wheel	x	x	6.00					x	5.00			
	Bearing		x	10.00						10.00			
	Bolts/nuts/ washers		x	3.00					x	3.00			
	TOTAL						1,010,000						1,844,000
	Scrap allowance						10,000						6,000
	Total direct material cost					22,000	1,020,000					53,000	1,850,000

The prices of commercial steel sections and profiles; and bought out ancillary parts/companents vary widely in African countries due to different import duties, agency commissions, distribution costs etc. The unit prices of materials indicated below are CIF prices in selected African countries. Retail prices of steel vary from US $500 to US $1,000 per metric ton of mild and carbon alloy steels.

MOW - manufactured in own shop; BOF - bought out finished (subcontracted or import).

Table A.9

Annual Overhead Costs

Item	Mode 1	Mode 2
1. Electricity	$ 40,000	$ 20,000
2. Fuel, coal and water	18,000	8,000
3. Lubricants, coolants, etc...	2,000	1,500
4. Maintenance & spare parts	40,000	25,000
5. Tools, dies & consumables	20,000	15,000
6. Paints	10,000	25,000
7. Office supplies	10,000	15,000
8. Transport	15,000	25,000
TOTAL	$155,000	$135,000

Table A.10

Manpower Requirements and Costs

Category	Mode 1			Mode 2		
	No. of persons	Annual wage rate ($US)	Total labour cost ($US)	No. of persons	Annual wage rate ($US)	Total labour cost ($US)
A) DIRECT LABOUR						
- Skilled	20	$ 2,500	$ 50,000	10	$ 2,500	$ 25,000
- Semi-skilled	35	2,000	70,000	45	2,000	90,000
- Unskilled	25	1,200	30,000	25	1,200	30,000
B) INDIRECT LABOUR						
- Manager	1	10,000	10,000	1	10,000	10,000
- Management staff	12	4,000	48,000	10	4,000	40,000
- Designer & Draughtsman	3	8,000	24,000	3	8,000	24,000
- Supervisors	6	3,500	21,000	4	3,500	14,000
- Inspectors	4	3,500	14,000	3	3,500	10,500
- Foreman	4	3,000	12,000	3	3,000	9,000
- Charge hand	6	2,800	16,800	4	2,800	11,200
- Maintenance	5	3,000	15,000	4	3,000	12,000
- Unskilled	15	1,200	18,000	20	1,200	24,000
TOTAL	136		$328,800	132		$299,700

Table A.8

Annual Direct Material Requirement and Costs

Description	Parts group	Mode 1						Mode 11					
		MOW	BOF	Cost of Group (US$)	Total unit cost (US$)	Annual production (Units)	Total material costs (US$)	MOW	BOF	Cost of group (US$)	Total unit costs (US$)	Annual production (Units)	Total material costs (US$)
Single wheel hand hoe	MS handle	x		2.00	18.00	10,000	180,000		x	1.50	14.50	30,000	435,000
	MS fork	x		1.50					x	1.00			
	Hoe frame	x		1.50				x		1.50			
	Shovel	x		3.00					x	2.00			
	Toeing hook	x		1.00				x		1.00			
	Y-bracket	x		1.00					x	1.00			
	Axle shaft	x		2.00					x	1.50			
	CI wheel		x	5.00					x	4.00			
	Wooden grip		x	0.50					x	0.50			
	Bolts, nuts & washer		x	0.50					x	0.50			
Animal drawn disc harrow	Beam frame	x		12.00	130.00	2,000	260,000	x		12.00	123.00	3,000	369,000
	Disc axle shaft	x		8.00				x		8.00			
	Middle tine shovel	x		10.00					x	8.00			
	Gang angle Mechanism	x		10.00				x		10.00			
	Seat	x		6.00					x	5.00			
	Disc hub	x		5.00					x	4.00			
	Hub bracket	x		5.00					x	4.00			
	CI wheel & backrest	x		9.00					x	7.00			
	Discs		x	40.00					x	40.00			
	Bearings		x	20.00					x	20.00			
	Bolts, nuts, washers		x	5.00					x	5.00			

Table A.11

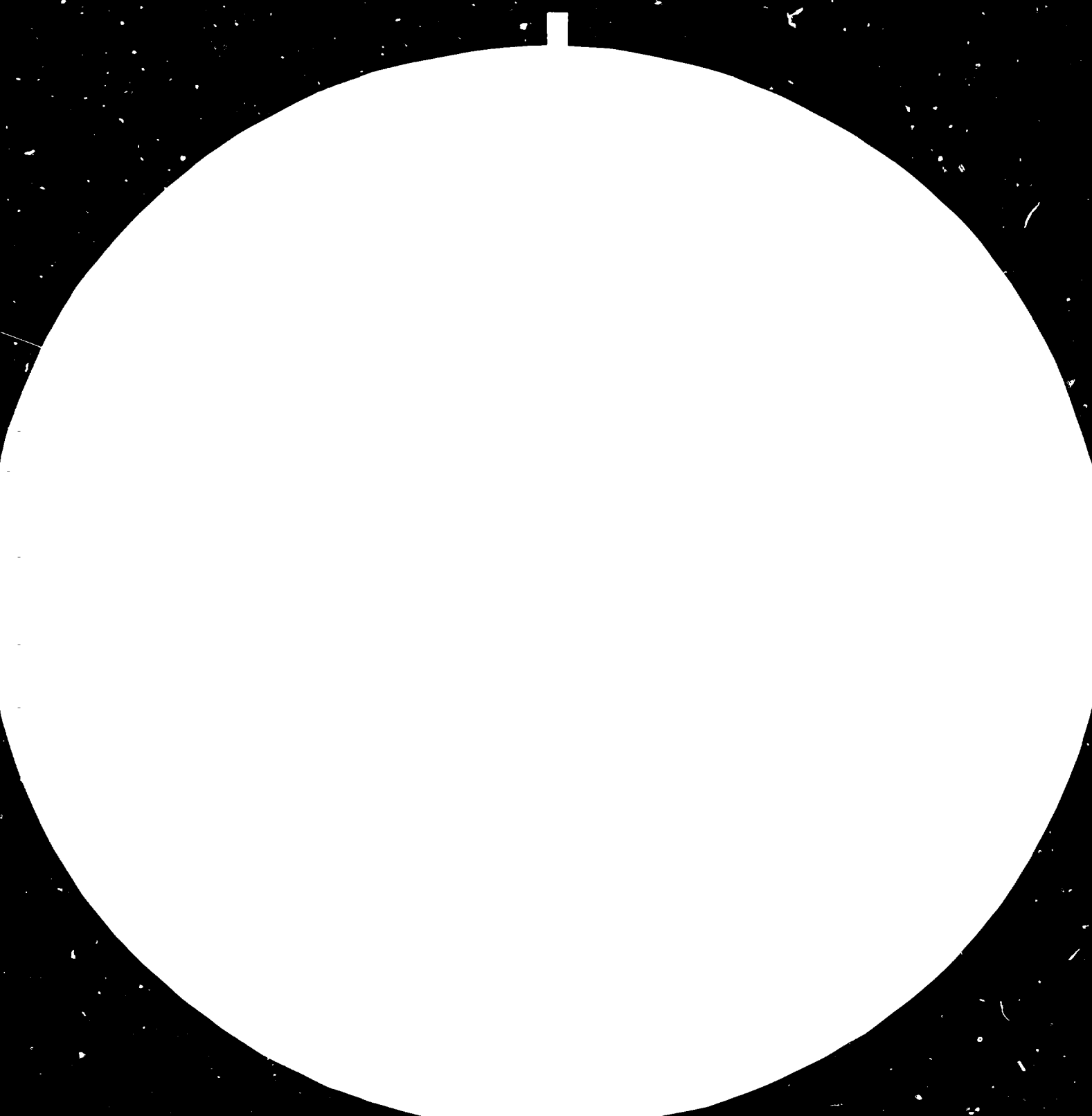
Investment Required

	Mode 1	Mode 2
FIXED CAPITAL		
1. Land	-	-
2. Buildings	970,000	173,000
3. Furniture, fittings racks, etc.	50,000	50,000
4. Machinery & equipment	756,000	310,000
5. Electrical installations	75,000	50,000
6. Transport Equipment	25,000	40,000
7. Contingencies	143,000	140,000
TOTAL FIXED CAPITAL COST	$2,019,000	$1,210,000
WORKING CAPITAL		
1. Direct material costs (4 months)	$ 340,000	$ 616,000
2. Labour costs (7 months)	110,000	110,000
3. Overhead costs (4 months)	52,000	45,000
4. Transport costs (1st year)	100,000	100,000
5. Contingencies	1,000	3,000
TOTAL WORKING CAPITAL COST	$ 603,000	$ 864,000
TOTAL BASIC INVESTMENT	$2,622,000	$2,074,000

Table A.12

Annual Operating Statement

	Mode 1	Mode 2
Annual Sales (Ex factory)	$1,900,000	$3,100,000
Total bank investment	2,622,000	2,074,000
Investment per employee	19,280	15,712
COST OF SALES		
1. Direct material costs	$1,020,000	$1,850,000
2. Overhead costs	155,000	135,000
3. Labour costs	328,800 (136 men)	299,700 (132 men)
Manufacturing Cost	$1,503,800	$2,284,700
4. Sale costs	$ 49,000	$ 90,000
5. Depreciation of fixed capital	201,000	121,000
Total Cost of Sales	$1,754,700	$2,495,700
Profit before tax	$ 145,300	$ 604,300
Return on Investment	5.5%	29%
Value added	29%	18.6%




1.25
1.4
1.6

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2.0
1.8

APPENDIX B
A Low Cost Farm Implement Factory in Uganda

1. INTRODUCTION

The following example illustrates the operations of a typical animal drawn implements manufacturing unit. The terminology "low cost" refers to the low cost of the implements manufactured. Located in the savannah agriculture region where cotton and coffee an the major crops, the factory provides a wide range of animal drawn implements adapted to local needs. Originally imported the implements have been adapted by the Research and Development Department of the plant in cooperation with national agricultural development organizations.

2. PRODUCT LINE

The factory is presently equipped for and capable of manufacturing of drawn implements.

o Ox-Plough

The plough is designed to be drawn by a pair of oxen and can plough 3 to 4 hectares in 8 hours. The plough weighs 55 kg and produces a furrow width of 5"-8" and a furrow depth of 2½-7". The plough frame is of the long beam type with a forging making up the main structural member. A second forging, the "frog", serves to support the moldboard plough share. Handles are a welded structure made up of mild steel section. Depth control is by means of an adjustable land wheel assembly. The plough share, moldboard and landside units are formed from plate and subsequently heat treated.

o Cultivator-Seeder

This ox drawn unit is a multi purpose machine. The frame serves as a cultivator to be used to break clods left after plowing for seed bed preparation. The implement is fitted with seeding and fertilizer funnel attachments and with hoppers to provide two-row seeding. The unit can subsequently be used as a cultivator for weed control with the seeding mechanism and hoppers removed.

o Harrow

A light ox drawn implement for shallow soil cultivation for seed bed preparation or weed removal.

- o Ox cart

  All stel construction ox carts. Two wheel units with steel tires. These units are now in great demand because of increasing cost of motor vehicles and fuel.

- o Wheelbarrow

  All steel construction with pressed steel body.

- o Hammer Mills

  These units powerred with 10 to 30 HP motors either electric or diesel are manufactured for village millers. The machines are designed to grind or shell maize, millet, cassava.

- o Hand tools

  The factory has the capability of forging sickles and hoes at a rate of 10,000 units per year.

3. PRODUCTION CAPACITY

In keeping with existing facilities and market demand the annual factory manufacturing program at full two-shift capacity produces approximately 1600 tons of product per year of the following machines:

		Number of units per year
1.	OX DRAWN IMPLEMENTS	
	a) Ploughs complete	6,000
	b) Plough spares	2,000 sets
	c) Seeders/weeders	500
2.	PROCESSING MACHINERY	
	a) Hammer mills	70
	b) Maize shellers/Rice hullers	20
3.	TRANSPORT EQUIPMENT	
	a) Ox carts	500
	b) Wheelbarrows	50
4.	HAND TOOLS	
	a) Hoes	10,000
	b) Slashers	500
	c) Reconditioned hoes	1,000

5. REPAIR SERVICES (for cotton gins)

a) Spares — 10% of production capacity
b) Repairs

4. MANUFACTURING TECHNOLOGY

The implements are fabricated from mild steel structural shapes, fabricated parts produced in the factory and bought out parts.

Process flow begins with parts fabrication in the machine shop, sheet metal shop and forge shop details of the equipment is given in Table B.1. Parts are produced in small batches according to the weekly assembly shedule requirement. Parts are then processed to sub-assembly stage by welding. Jigs, templates and simple fixtures are employed. Final assembly, painting and packaging operations are continuous operations. The factory operates on two eight-hour shifts. Materials handling in the factory is entirely manual. There is no use made of lift trucks or overhead cranes.

Quality control is important for welding, machining and heat treating operations. Production control is a formal process controlling purchasing of steel and hardware items, scheduling of parts and sub-assembly operations. Work measurement and control of work force productivity is dependent on direct supervision. There is no formal work study or piece rate incentives.

o Machine Shop

The lathes, milling machines, drilling machines, shapers and grinding machines are basic machine tools capable of producing machined parts to be required quality standards. The machine tools are not equipped with automatic features but rather depend on the machinists to manually load, unload and control the machines. The machinist skills required are of a high order since little tooling is used and each machine and machinist produces a wide variety of parts. Machinists are responsible for their own set-ups and for their own quality control.

Training of machinists requries years of experience under learning-on-the-job basis. A nucleus of experience machinists is available from the earlier operations and are in a postion to train and develop new staff. This program is typical of all factory shops.

As production volume increases, more automatic equipment would be appropriate for example engine lathes equipped with capstans to combine drilling operations with turning operations.

- o Sheet Metal Shop

  The sheet metal shop is equipped with a power shear, power and manually operated roll form machines. Sheet metal shapes are formed by means of nibbling machines rather than by blanking presses. As production volume increases, blanking machines could be considered.

- o Forging and Heat Treating Shop

  A forging hearth 4' x 5'; and oil fired tilting furnace - capacity parts up to 9 kg in weight; a salt bath; a pneumatic forging hammer, a spring hammer provide capability to form plough shares and to produce small hand tool forgings and to enable heat treatment of implement and hammer mill parts. High quality forgings such as the plough frog and beam will be purchased either from local production forging facilities or purchased from outside.

- o Welding Shop

  Welding machines are for arc-welding process with 50-300 AMP DC 3 HP power supply. beacause of the difficulty of obtaining welding gas and because of the quality standard required this technology is appropriate. A high degree of welding skills, however, is required. given a reliable and economic supply of welding gas and electrodes the process can be upgraded in future years to higher productivity and quality standards resulting from modern gas-shielded arc welding machines.

5. RAW MATERIAL AND PURCHASED COMPONENTS

Raw materials and purchased parts required to manufacture a typical implement - ox plough is listed in Tables B.2 and B.3.

At the present time all raw materials purchased, parts such as fasteners, bearings, castings and forgings and consumable factory supplies such as welding rods, cutting tools, industrial gases must be purchased outside.

Comments on selected supply items follows:

- o Steel

  Steel is provided by a local mill. The mill operates from scrap but iron-ore deposits in Uganda can be developed to supplement scrap input. This plant, once rehabilitated, is capable of supplying much of the mild steel bars and shapes, nuts and bolts.

- o Forgings

  The implement plant bill of material requires medium sized high quality forgins such as the 9.5 kg plough beam and the 2.5 kg plough frog. Consideration was given to adding this forging capability to the implement plant. However, in view of the fact that the Sugar Corporation of Uganda Ltd. at Lugazi has a general engineering work shop previously equipped to manufacture hand tool forgings of the size and quality required for the implement factory, a decision was made to purchase these forgings from India until such time as the Lugazi facility is rehabilitated.

  A second source of implement forgings is Uganda Hoes Ltd., Jinga, a hand tool forging facility. This facility also has the capability of supplying implement forgings once rehabilitated.

- o Castings

  The implements presently developed do not utilize any significant volume of castings. Casting facilities are available in Uganda. However, these operations all require rehabilitation.

6. VALUE ADDED

On this basis the material and supplies amount to an annual cost of $969,000. This represents 76% of the factory annual operating costs. Under these conditions of restricted supply of Uganda sources materials value added by the Soroti factory is approximately 13% of factory total costs.

Uganda, however, has the inherent capability of supplying up to 57% of materials input given rehabilitation of existing industrial infrastructure - steel, hardware forgings, castings, industrial gas, etc. -.

In addition, it is estimated that a further 23% of materials and supplies can be sources from East Africa - Kenya and Tanzania.

The full usage of Uganda and East Africa sources for materials and supply would have the effect of:

- o Reducing need for allocation of foreign currency from $969,000. per year to $416,670. per year.
- o Improving Uganda value added from 13% to 70%.
- o Improving African value added from 13% to 75%.

7. MANAGEMENT, ENGINEERING AND WORKFORCE SKILLS

The Soroti industrial workshop is managed by skilled and competent administrators. The General Manager is a graduate of a Uganda university followed by post graduate education in USSR. Administration experience includes management of an agriculture educational institute. Experienced accounting and purchasing skills result from continuity of these managers trained in the earlier operations.

Three younger professional engineers each with post graduate and foreign followship training form the core of technology management.

A core of skilled and experienced foremen and journeymen trained on-the-job in the earlier operations provide the critical machinery, welding and forging workforce skills. Technical assistance will supplement this small core of experienced personnel to train a new workforce of 90 men on an on-the-job basis. Detailed list of manpower is presented in Table B.4.

8. RESEARCH & DEVELOPMENT

The Soroti factory inherited a viable product line from the India owned company. This product line was developed by means of direct technology transfer from India. Very limited adaptation of designs was required for Uganda conditions. Existing product line selected was appropriate for Uganda conditions. In a similar manner manufacturing technology was transfered including a number of special machines (e.g. plough share forming, tooling and sub-assembly fixtures).

Upon transfer of responsibility to the Uganda Ministry of Agriculture a local research and development project was instituted in cooperation with the nearby Busitama National College for Agriculture.

The Soroti implement factory maintained direct responsibility to develop new product for its operation. In order to fulfil this mandate the factory management arranged to purchase implements from India, for example, various configurations of ploughs, harrows, cultivators, seed drills, hand and power operated maize shellers, sprayers, dusters, lawn mowers, and grinding mills.

The R/D program was to conduct market studies and field trials in Uganda conditions under factory R & D staff supervision in cooperation with the Soroti agriculture research station. The plan was to then produce locally manufactured prototypes and to adapt the designs to the factory equipment and process capability before introducing the new machinery to the market.

9. FINANCIAL ASPECTS

A 1981 study provides data to construct a proforma statement of investment in fixed capital and working capital, at present day replacement costs. For the 1,600 tons per year production program annual operating costs for labour and materials are accurately estimated and revenues required for a commercially viable operations are calculated.

The tables of data presented in Table B.5, B.6 and B.7 provide a profile in some detail of what can be regarded as a typical industrial workshop manufacturing animal drawn implements of an appropriate technology for the market served by the operation.

TABLE B.1

Machinery and Equipment

Machine Shop	
Planer	1
Shoper	2
Engine lathe	4
Drill press	3
Milling machine	2
Power saw	2
Pedestal grinder	1
Precision toolroom lathe	1
Tool and cutter grinder	1
Sheet Metal Shop	
Power break	1
Power shear	1
Hydraulic press	1
Punch press	1
Nibbler	2
Roll forming machine	1
Tube bending machine	1
Welding Shop	
Welding machines	8
Oxy-acetylene profile cutter	1
Forge and Smith Shop	
Pneumatic hammer	1
Spring hammer	1
Heavy duty grinder	1
Swage block	1
Oil fried muffle furnace	1
Tempering furnace	1
Salt bath	1
Forging hearth	1
Paint Shop	
Spray paint booth	1
Air compressor	1
Design Office	
Drafting machines	3
Ammonia printing machine	1
Photostat machine	1
Vehicles	
Automobile	1
Land Rover	1
Lorry	1

TOTAL INVESTMENT: $ 470,000.

TABLE B.2

Quantity of Material for 500 Ox-Ploughs

Material	Quantity	$U.S. Price
1. M/S flat bar 1¼ x 3/8"	4,915'	$ 1,485.30
2. M/S flat bar 1" x ¼"	4,565'	756.62
3. M/S flat bar 2" x ½"	625'	414.00
4. M/S angle bar 1½" x 1½" x ¼"	170'	84.00
5. M/S flat bar 4" x 3/8"	500'	487.00
6. M/S rod 5/8" o	1,340'	272.50
7. M/S rod ½" o	1,805'	235.12
8. M/S rod 3/8" o	1,005'	98.21
9. M/S square bar 5/8"	500'	129.50
10. M/S flat bar 1½" x 3/8"	985'	384.14
11. M/S flat bar 2" x 3/8"	875'	435.10
12. M/S round bar 1" o	105'	55.00
13. M/S round bar 2" o	4,000'	8,331.00
14. M/S pipe ½ o (galvanised)	500'	28.50
15. M/S plate 8' x 4' x 3/16"	21 sheets	11,793.00
16. Beam 9.5 kg (forging)	500 units	6,000.00
17. Frogs 2.5 kg (forging)	500 units	1,275.00
18. Bolts & nuts 5/16" o x 1¼"	2,500 units	325.00
19. Bolts & nuts 3/8" o x 1½"	500 units	68.00
20. Bolts & nuts ½" o x 2¼"	1,000 units	326.00
21. Bolts & nuts 7/16" o x 1" (counter-sunk)	3,500 units	565.00
22. Bolts & nuts ½" o x 2"	3,000 units	$ 578.00
23. Bolts & nuts 7/16" x 4"	500 units	110.00
24. M/S welding rods gauge 10	500 kg	850.00
		$35,082.00
Plus freight at 35%		12,179.00
TOTAL:		$47,362.00

TABLE B.3

Analysis of Material Sourcing

	Material Costs local	Material Costs Foreign	Freight Cost	%
Items 1-13/STEEL	$13,165.00			33%
Items 14-15/STEEL		$11,321.00	4,137.00	40%
Items 16-17/FORGINGS	7,275.00			19
Items 18-23/BOLTS & NUTS	1,972.00			5
Item 24/WELDING ROD		850.00	297.00	3
	$22,412.00	$12,671.00	$4,432.00	100
TOTAL MATERIAL COSTS:		$39,515		

"VALUE ADDED": 57%

TABLE B.4

Workshop Organization & Manning Schedule

(Two Shift-Capacity Operation)

General Manager

Finance Officer

Administration Officer

Controller

Works Manager

Design and Development

	Machine Shop Tool Room	Heat Treatment Forging	Sheet Metal Shop	Assembly Fitting	Plant Maintenance
SKILLED	8	2	2	5	3
SEMI-SKILLED	20	6	6	8	2
UNSKILLED	4	2	2	18	2

Professionals: 10

Office Staff: 20

Production Staff: 90 - of which 20 skilled journey men

Total manpower: 120

Total annual cost: $150,750.00 (U.S.)

TABLE B.5

Capital Cost Estimate

(1981 $ U.S.)

Land:	-
Buildings: (1) 1,625 sq. meters @ $150.	$244,000.
Machinery & Equipment:	
- Replacement cost (1981) Existing machinery	204,000.
- Cost of new machinery & vehicles	266,000.
- Electrical & machinery repair parts	76,000.
	$548,000.
Office Equipment	82,000.
Furniture, fitting, ...racks	20,000.
FIXED CAPITAL	$894,000.
Working Capital	
- Direct material costs (4 months)	$323,000.
- Labour costs (4 months)	38,000.
- Overhead costs (4 months)	20,000.
TOTAL INVESTMENT	$381,000.

(1) Cost of buildings at replacement cost 1981.

TABLE B.6

Operating Cost and Revenue Estimate

(1981 U.S. dollars)

Sales revenue (1):		$1,358,000
Cost of Sales:		
- Material costs	$ 969,000	
- Manpower costs	151,000	
- Supplies, indirect material	34,000	
- Power, fuel, water	25,000	
	$1,179,000	
- Depreciation (2)	89,000	
TOTAL AMOUNT COST OF OPERATION		1,268,000
GROSS PROFIT		$ 90,000

(1) Product sale price approximately equivalent of CIF cost of imported implements.

(2) Calculated at 10% of fixed capital.

TABLE B.7

Value Added

1. Assuming all materials purchased outside of Uganda

a) Cost of sales	$1,179,000
b) Uganda Input	
. Manpower costs	151,000
. Power, fuel and water	25,000
. Supplies	15,000
. Depreciation	89,000

Value added = 13%

2. Assuming 57% of Cost of Materials purchased in Uganda

a) Cost of sales	$1,179,000
b) Uganda Input	
. 57% of material costs	$ 552,330
. Manpower costs	151,000
. Power, fuel, water	25,000
. Supplies	15,000
. Depreciation	89,000
	$ 832,330

Value added = 70%

APPENDIX C

An animal drawn implements factory in Senegal

SISCOMA

1. INTRODUCTION

Senegal has an animal drawn implements factory (Société Industrielle Sénégalaise de Construction Mécanique et de Matériel Agricole) partly state owned and partly foreign owned. The SISCOMA company operates under a governmental controlled pricing and development planning system.

2. PRODUCTION

SISCOMA produces a wide range of animal draught implements, post harvesting machines both hand powered and engine powered. Among these machines are:

- soil preparation implements
- seeders and fertilizer spreader
- cultivators
- Harvesting and post harvesting machines
- transport and storage equipment

As well the company is planning assembly of a 20 HP tractor together with tractor drawn implements and forecast to produce hand tools mainly for export.

Capacity is difficult to measure in that it is basically operating on one shift. Two or three shift operation given growth in demand is possible.

Development of production to meet the agricultural program requirements during the last years, illustrates partly the growths capability.

74-75	88,967 units
76-77	178,802 units
77-78	157,655 units
78-79	123,291 units

In addition some 30% of production was for export in 76-77, 232,400 units.

3. TECHNOLOGY AND EQUIPMENT

Production is organized in classical manner and includes:

- planning
- start-up
- process methods
- production control
- quality control (raw materials, purchased parts work-in-process, finished products)

A list of manufacturing equipment representing an investment of $3,100,000 (U.S.) in shown in Table 1. Buildings for factory 10,755 sq. meters, offices 2,108 sq. meters.

4. RAW MATERIALS AND SUPPLIES

Provisioning is made up of:

- mild steel, half hard and hard in various shapes
- sheet metal
- wood
- purchased parts
- nut and bolts, screws, springs, bearings, chains
- chemicals

The annual volume of purchases is highly variable. Material stocking is difficult due to long lead times for imported materials. Delivery is normally in the order of 4 months from order point. Materials inventories are accordingly high.

Raw materials are imported from Europe except wood and paint and castings from a local supplier. Purchase record is as follows:

74-75	4146 tonnes	$1,040,000
75-76	4731 "	1,250,000
76-77	7571 "	2,393,000
77-78	9584 "	3,445,000
78-79	5496 "	2,188,000

The cost of imported materials due to inflation and inflated transport cost has reduced value added from 50% to 45%.

TABLE I

MACHINERY

Material Preparation

4 Cut-off saws
3 Band saws
2 Shears
3 Presses 15-60 tons
1 Shear press

Machine Shop

12 Lathes
11 Drill press
3 Broaching machine
1 Turret lathe
2 Milling machines
1 Shaper
9 Vertical drills
4 Grinders
3 Welding machines

Press Room

8 Mechanical presses 15-140 tons
2 Presses 100 and 120 tons
1 Brake press 80 tons
3 Grinders
3 Blanking presses
5 Hand shears
1 Hand punch
2 Special punch presses 8 stations

Welding Shop

29 Welding-machines-arc welders
13 MIG welding machines

Plate Shop

1 Hydraulic shear
1 Hydraulic brake - 140 tons
1 Roll machine
1 Vibromatic machine
1 Oxyacetylene profile cutter

TABLE 1 (Cont'd)

2 Spot welding machines
9 Arc welding machines
1 Shear
1 Band saw
1 Punch press
1 Hand roll machine
1 Profile roller

Forge Shop

1 Mechanical press vertical 400 tons
1 Mechanical press horizontal 250 tons
2 Hammer Forge 140-200 tons
2 Hammer forge 120 tons
1 Hydraulic press 15 tons
1 Muffle furnace 1000 x 600 x 400
2 Coal fired forging furnaces
1 Butane fired forge furnace
2 Chain conveyors
1 Belt grinder
2 Grinding Mills
2 Steam hammers 75 kg.
1 Punch press

Assembly Shop

2 Punch presses
2 Special presses
1 Weighing machine

Prototype Shop

1 Power saw
2 Universal milling machine
1 Hand brake press
1 Break press powered
1 Roll former
2 Punch presses
1 Grinding mill
1 Arc welding set
1 Oxyacetylene welding set

TABLE 1 (Cont'd)

Tool Room

1 Lathe
1 Milling machine
1 Saw
3 Grinding machines
1 Universal grinder
1 Punch press
2 Arc welders
1 Oxyacetylene welder
1 Muffle furnace 6000 x 300 x 300
1 Oil bath (Heat treatment)

Personnel and Organization

Work force in 1979 was composed of:

158 permanent workers
147 seasonal workers
168 daily workers
12 foremen
4 superintendants
2 factory managers
175 administrative staff

Design engineers were mainly educated in Europe. From now on they will be coming from Thies Polytechnical Institute. The other technical employees are coming from "Institut universitaire de Technologie de Dakar" and from "École des cadres ruraux de Bambey". Training may be completed in the training center of the plant and on the job.

Research and Development

The success of SISCOMA in developing new product particularily animal draught implements is becoming well known as a successful example of indigenous African R & D. SISCOMA is sustaining this effort with enthusiasm by:

- improvement to existing implements
- development of new machines
- development of auxiliary tools and attachments
- improvement and rationalization of standards

New initiatives are being directed to:

- intermediate technology applied to devlopment of small power tractor mechanization and post harvest processing.

- large power tractors for commercial farms and regional development projects

- harvesting and threshing machinery

The company has its own Research and Development department with its own prototype shop. In addition, the company cooperates with two Senegal government institutions. The national committee on agriculture mechanization and the National Research and Development Center.

Marketing

Marketing for agricultural inputs and outputs in Senegal, is organized around an agricultural program which is elaborated as follows:

- Cooperatives record needs for equipment (as well as for fertilizers) from their members.

- The national society for procurement of farmers (SONAR) accumulate the needs by administrative regions.

- The Senegal National Development Bank (BNDS) leader for agricultural financing, assesses the borrowing capability of each cooperative and informs its regional representatives.

- Orders are adjusted in accordance with capabilities and are centralized at national level by SONAR then orders are placed on SISCOMA.

- Reimbursement of BNDS's loans is done via SONAR by retaining a part of the crops stored in cooperatives before sales.

PROFILE 3

APPENDIX A

The Case of Burns and Blane Ltd. Nairobi Kenya

Burns and Blane Ltd. Nairobi Kenya is a subsidiary of the Motor Mart and Exchange Ltd. a private Kenya company engaged in a number of operations. Another subsidiary company is the Massey Ferguson franchised dealer for Kenya.

Burns and Blane had developed a business in manufacturing special steel tractor drawn trailers for commercial scale coffee and tea plantations. These trailers were used to gather coffee and tea in the field operations and to provide transport to the processing centers. The Burns and Blane factory was equipped to cut and size the steel shapes and plate used to fabricate trailers and to weld the components. The factory also made boilers and other industrial equipment from plate and steel.

Motor Mart and Exchange Ltd. saw an opportunity some years ago to assemble (CKD fashion) tractor drawn implements being distributed by the subsidiary company when a particularly large order for a tractors and implements resulted from a Kenya regional agriculture development project. The company worked out an agreement with Massey-Ferguson that Massey-Ferguson would ship only those parts that Burns and Blane could not fabricate in their factory or that Burns and Blane could not purchase in Kenya. Massey-Ferguson would license the design and ensure that quality standards were met and provide what technical assistance Burn and Blane required.

Burns and Blane manufactured welding jigs and proceeded to fabricate plate parts in the plant and to purchase disc separator castings, sheet metal wheels and tires, nuts and bolts etc from other Kenya manufacturers and to assemble paint and label the finished product. As a result Burns and Blane were able to achieve about 50% value added in Kenya, to reduce the price of the product and to build a viable commercial addition to the main product line - agriculture trailers.

Much of the content added by Burns and Blane from Kenya sources are the wear and replacement parts needed for spares. Much of the Massey-Ferguson content was the main large structural parts that do not wear out or need replacement. Typically spare parts servicing represents 10% of tractor and implement business volume and so there is a base of steady revenue resulting from the spare parts business.

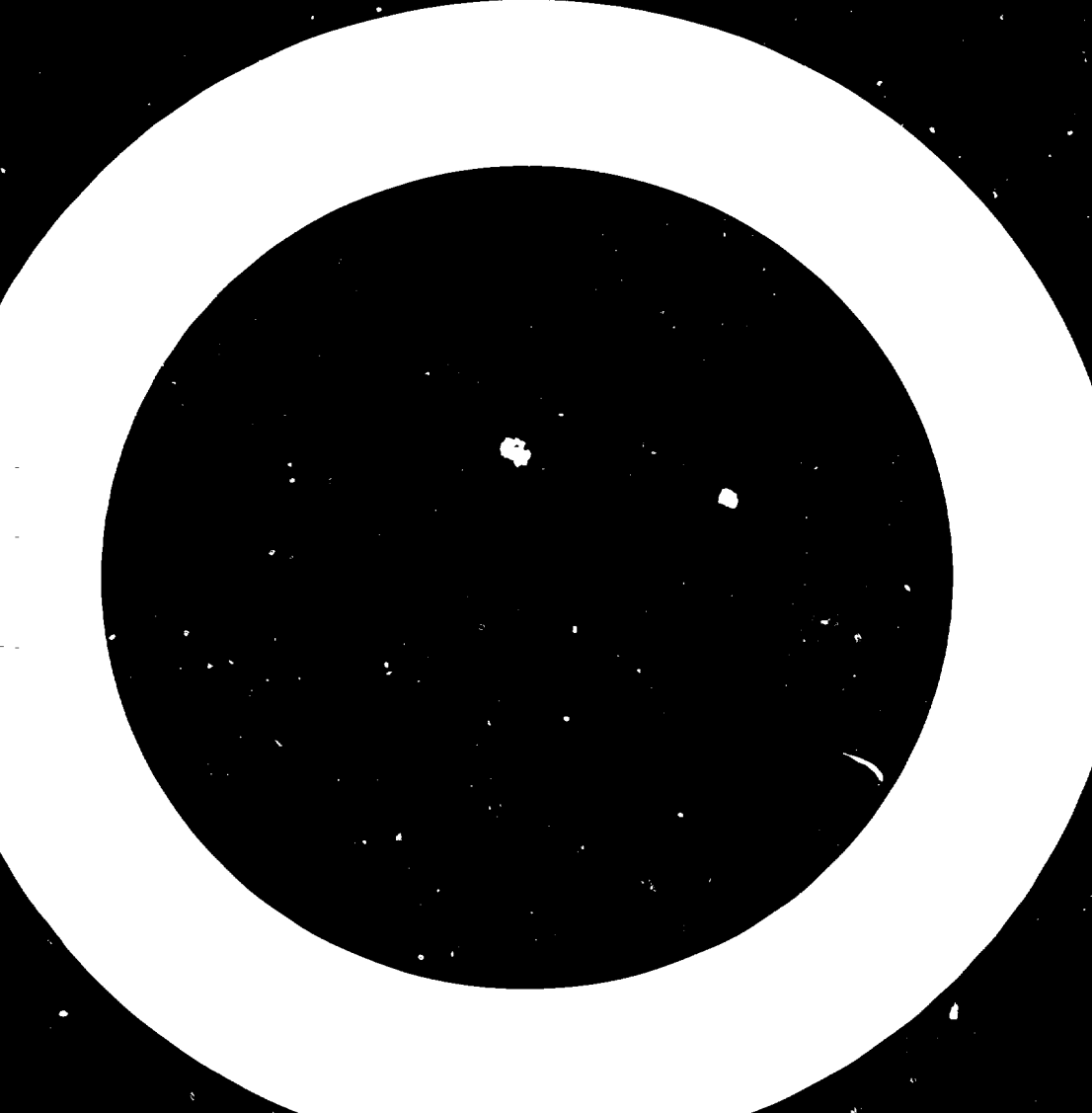
In a similar manner these are three manufacting establishments in Zimbabwe manufacturing tractor implements.

The economy of scale typical of tractor drawn implements according to Burns and Blane Ltd. experience is an initial requirement for a production run of 600 units. This is required to justify the investment in jigs and fixtures, additional shop equipment (in this case MIG welding machines) and the overhead required for administration for transfer the technology, import and foreign exchange permits, etc. and to provide the necessary quality control assurances (both from Massey-Ferguson and Kenya government).

Once the initial investment is made for a specific implement then much shorter runs in an intermittant seasonal basis are practical using the job shop production operations used to manufacture agriculture trailers, boil -s and other light engineering products.

COMPOSITE UNITS:

- HAND TOOL AND ANIMAL-DRAWN IMPLEMENT PLANT
- ANIMAL-DRAWN AND TRACTOR-DRAWN IMPLEMENT PLANT



1. INTRODUCTION

There is a potential to combine manufacture of two categories of equipment, thus yielding economies of scale that might facilitate the establishment of viable manufacturing units. Profiles of two such composite units are presented here.

The first is for the combination of animal drawn equipment and hand tools, and is based upon cases existing today in Africa. The second, on the combination of animal drawn and tractor drawn implements, is based upon technical data since no facility currently exists in the countries surveyed.

o Animal drawn implements and hand tools

A survey of commercially viable factories now producing agricultural implements in Africa points to two alternative models for what can be accomplished in the process of developing industry in smaller African countries.

One is on a smaller operation supplying only the domestic market. The other on a larger operation to supply markets in the sub-region with cooperative trade arrangements.

Manufacture of hand tools is now mostly associated with artisanal production and to a limited extent with large scale production that is not always a success. Is there a case for development of manufacture of hand tools together with animal-drawn implements? Considering the technology, forging is the major process for the manufacture of hand tools and is also an important one for animal-drawn implements. Could this be a way to find an economic scale fo operation to meet the potential market?

o Animal Drawn and Tractor Drawn Implements

The composite manufacturing unit composed of animal drawn implements and tractor drawn implements did not appear in the African countries included in the study. Manufacture of tractor-drawn implements in African countries is today rare.

Manufacture of tractor drawn implements is now associated with light engineering industry as in Kenya and Zimbabwe. Is there a case for development of manufacture of tractor drawn implements in combination with animal drawn implements? The technology is similar. Is this a way to find the economic scale of operation to fit the present small domestic African markets? Would greater sub-regional trade cooperation provide this opportunity?

2. PROFILE OF A HAND-TOOL AND ANIMAL DRAUGHT IMPLEMENT PLANT

2.1 General Description

A model, a plant with a total area of about 1500 sq meters employing around 200 people, is of the industrial workshop scale of activity, is presented.

Since forgings represent the major input to hand tool manufacturing and is an important input to animal drawn implements a modern forge shop is provided. The model represents a two-shift manufacturing operation.

2.2 Product Line

o Hand Tools

Forged hoes	1.3 kg - 1,000,000/year	1300	tonnes/year
Picks	3.18 kg - 250,000/year	795	"
Machettes	.48 kg - 250,000/year (less handle)	120	"
		2215	tonnes/year

o Animal - Draught Implements

Mould board plough	38 kg - 10,000/year	380	tonnes/year
Harrow	50 kg - 10,000/year	500	"
Ridgers	37 kg - 5,000/year	185	"
Other implements		145	"
		1210	tonnes/year

2.3 Factory

The plant layout - including location of major machines, office and storage is illustrated in Chart 1.

Factory - 1400 sq meters
Office - 150 sq. meters
1550 sq. meters @ $205/sq. meter = 320,000

2.4 Manufacturing Process

The factory layout shows a continuous flow forging operation. The flow is from raw material stores to forging operations to roll form finishing then to flash removal painting and packaging.

Hand tools manufacturing process includes the following steps:

1. Blanking by press or cutting to size by shearing machine (dies and press tools are used).
2. Pre-heating to 900°C by oilfired furnace.
3. Drop-forging to obtain primary shape by $\frac{1}{2}$ tons strikers. (Open die tools are used).
4. Press forging to final shape - by 150 tons hydraulic press. (Closed die tools are used).
5. Trimming by press or shearing machine.
6. Heat treatment to 750°C by oil fired furnace.
7. Quenching in oil or water to obtain required hardness.
8. Removing of scale by grinding wheels.
9. Assembly of handles etc. (parts are generally bought out)
10. Inspection.
11. Painting.
12. Finished Product.

Forging equipment is multi-purpose in that implement forgings and cutting tools can be formed over the same equipment with die changes for each particular forging. The most modern forging technology is used. (Hydraulic forging presses). Conveyors are used between operations.

Cutting tools are finished after forging by hardening and sharpening processes.

The forging operations are supported by a tool room capable of manufacturing and maintaining the forging dies. The tool room also provided a base for plant maintenance operations.

Implement assembly is based on a shielded arc weire electrode welding department. Considerable storage space is provided to store implement forgings and parts produced in batches are drawn down as assembly of implements is scheduled.

Raw materials and finished implements are stored outside the plant. Finished hand tools are stored inside the plant.

The plant purchases sheet metal from local suppliers. Similarily there is only limited in-house manufacturing of machinery parts.

2.5 Equipment

o Forging shop

1- 500 ton hydraulic forging press

2- Oil fired muffle furnace

2- 300 ton hydraulic forging press

2- Forming mills

1- Blanking Press

1- Friction Press

4- Grinding Machines

o Hardening & Whetting Shop

1- Salt bath

2- Rinse tanks

4- Grinding/whetting machines

o Machine shop & cutting shop

1- Screw machine

5- Drill presses

4- Lathes

2- Shapers

2- Milling-machines

2- Power metal saws

2- Shears

2- Grinding machines

1- Hydraulic Press - 1 ton

Gauges & Tools

o Tool Room

1- Grinding lathe

1- Surface grinder

1- Shaper

1- Pedestal grinder

1- Lathe

1- Universal milling machine 5 hp

1- Band saw

1- Jig boring machine

1- Hardening furnace

o Welding Shop

4- Mig welders

2- Arc welders 300 amps.

o Assembly Shop

2- Paint dip tanks & conveyors

Racks, pallets, bins, etc.

o Inspection

1- Hardness Tester

1- Tensile Tester

o Mechanical Handling

2- Fork lift trucks

8- Hydraulic pallet trucks

2.6 Manpower

General Manager	1
Sales Manager	1
Personnel Manager	1
Puchasing Manager	1
Accounting Manager	1
Engineering Manager	1
Draftsman/technicans	8
Office Staff	10
Foremen	14
Toolmakers	3
Smiths	8
Machinists	16
Welders	12
Maintenance mechanics	4
Maintenance electrician	3
Inspectors	10
Production Operators	60
Unskilled Helpers	50
Total	195

2.7 Materials

Steel forging stock and mild steel sections are purchased from outside the economy.

The material specification for major implement components are the following:

Major implement components	SAE No.	Carbon(%)	Manganese(%)
Implement frame (MS)	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 shares, (plates)	1074	0.70-0.80	0.50-0.80
Rake teeth	1078	0.72-0.85	0.30-0.60
Scraper, blades, discs, spring tooth harrow	1085	0.80-0.93	0.79-1.00
Mower and binder section	1086	0.82-0.95	0.30-0.50
Tine holders, knotter discs	1090	0.85-0.98	0.60-0.90

Castings can be purchased localy. Wood parts (handles) are usually purchased locally.

Purchased parts - fastners, springs, tines, sprockets, chains gears, bushings are purchased from local source. Sheet metal parts are usually purchased locally.

As to factory supplies - oil and lubricants, industrial gases are imported, when not available from local sources.

2.8 Summary of Estimated Costs (US -$)

o Capital Cost

Land & Buildings	320,000
Machinery Production and Tool Room	2,200,000
Toolage	100,000
Transport Equipment	80,000
Pre-Production Expense	350,000
Total Capital	$3,050,000
Working Capital	1,200,000

o Production Cost

Materials	$3,285,000
Factory Supplies	300,000
*Wages & Salaries	582,000
Depreciation @ 10%	305,000
Interest on working capital	180,000
Total Costs	$4,652,000
Gross revenue	$5,200,000
Net Revenue	US $ 548,000

* Note: Wages & Salaries vary widely in African Countries. An average of $3,000/man/year was used.

3. PROFILE OF A ANIMAL-DRAWN IMPLEMENT AND TRACTOR DRAWN IMPLEMENT PLANT

3.1 General Description

A composite operation involving animal draught implements and tractor drawn implements did not appear in the Africa countries studied. Tractor-drawn implement manufacturing associated with light engineering industry is just beginning to develop as the tractor market in African countries begins to reach economic scale of production.

The plant is assumed to be located in an economy with a good industrial infracture and in an economy well developed in tractor mechanization. Such an economy would likely have forging and casting operations. It is assumed therefore that investment in forging equipment would not be required rather forgings and castings would be purchased. The factory would be equipped to manufacture sheet metal and machined parts. Taking into account the heavy parts involved in tractor drawn implements,, the plant will be equipped with conveyors, fork lift trucks, hoists. The conveyor system is linked to an electrostatic spray system linking welding and sub assembly departments.

The volumes of traction drawn implements are such that they support sales of approximately 4,000 tractors per year. This is a volume of tractor sales found only in more developed African economies.

3.2 Product Line

- Animal Draught Implements - 1200 tonnes/year

Mould board plough	38 kg.	10,000 units/year
Cultivator	45 kg.	5,000 units/year
Planter	50 kg.	500 units/year
Harrow	63 kg.	5,000 units/year
Ridger	40 kg.	6,000 units/year

- Tractor Drawn Implements - 2500 tonnes/year

Mounted 2 furrow disc plough	318 kg.	2,000 units/year
Mounted 12 tines cultivator	500 kg.	3,000 units/year
Mounted offset disc harrow	300 kg.	2,000 units/year
Power operated thresher	500 kg.	100 units/year

3.3 Factory

Office 300 sq meters $200/sq. m.	$ 60,000
Factory 5,000 sq meters @ $150/sq. m.	750,000
Storage area 2,000 sq. meters @ $100/sq. m.	200,000
	$1,010,000

3.4 Manufacturing Process

o Fabricated Parts (from mild steel profiles)

a) Products implement frames, bar, link, level, spacer, bumpers, etc.

b) Manufacturing technology: marking, cutting, trimming, bending, drilling, threading, welding, cleaning, inspection.

o Hot and Cold formed Parts (from plate, bar and sheet)

Products: discs, tines, shovels, shares, blades, beam, hoppers. The manufacturing Technology for Cold Forming includes:- blanking, bending, press forming, punching, trimming, welding, spot welding, cleaning, inspection. The manufacturing technology for hot forming includes: preheating, forging, trimming, heat treatment, scale removing, inspection.

o Machining (steel-round, square, hexagonal sections)

Products: shafts, axles, pins, special bolts and nuts, washers. The manufacturing technology includes: part-off, turning boring, milling, drilling, heat treatment, cleaning, inspection.

o Sub-Assembly and Assembly

a) In batch production assembly carried out normally by operators.

b) In higher volume production assembly carried out by fixtures, power tools on conveyors.

o Painting & Conveyor System

a) For implements by dipping process

b) For machinery and sheet metal by spray painting with degreasing and rinse system and conveyor. The continuous conveyor runs from welding department to the spray booth to shipping department.

3.5 Equipment

	Number of units
o Cutting shop	
Power hack saw	2
Hand shear	2
Forge and heat treatment shop not required as the parts will be bought out finished	
o Fabricating & press shop	
Eccentric press 150 tons	2
Press brake 200 tons	1
Manual bending machine	2
Hyraulic bending machine	1
Arc welding machine 500 amps.	4
Nibbling machine to cut 6 mm MS	2
Shearing machine	2
Welding fixtures	sets
Pedestal grinding machine	4
Gas welding set	set
Upright drilling and tapping machine 12 mm dia.	4
Dies and press tools	sets
o Machine shop	
Double ended pedestal grinder	2
Upright drilling and tapping machine 25 mm dia.	2
Lathe maximum bore 80 mm; swing 50 cm length 100 cm	3
Capstan lathe with accessories	6
Jigs, tools & fixtures	lot
Hydraulic press 1 ton	1
Gauges, inspection tools and equipment	lot
Portable drill 12 mm in MS	4
Portable grinder 15 cm wheel	4
Hand nibbler 3 mm MS	3
Tools, tool holders, etc.	lot
o Assembly shop	
Assembly fixtures	lot
Upright drilling machine 3 cm in MS	3
Portable drilling machine 12 mm in MS	3
Portable grinder 15 cm wheel	3
Arc welding machine 250 Amps.	2

	Number of units
o Paint shop	
Degreasing vat	2
Dipping plant with conveyor	1
Spray painting booth with sprayers and powered conveyor system	1
o Toolroom & Maintenance	
Universal milling machine 5 HP	1
Universal cutter grinder 1½ HP	1
Double ended grinding machine	1
Surface table	2
Gauges and tools	sets
Precision lathe 2 HP	1
Maintenance tools and equipment	set
Arc welding set 250 Amps.	1
o Compressor set	
Complete motor compressor unit 400 cuft/min, 80 psi.	set
o Mechanical handling	
Fork lift truck 1 ton	2
Hydraulic pallet truck (hand operated)	8
Racks, stillages and bins	lot
Conveyors, etc.	lot
o Stores	
Rack, stillages, pallets, etc.	lot

3.6 Manpower

General Manager	1
Office Staff	20
Design Engineer	1
Draftsmen & Technicians	8
Supervisors and Foreman	16
Inspectors	12
Maintenance Mechanics	4
Maintenance Electricians	4
Skilled Tradesmen	40
Semi Skilled Operators	50
Unskilled Helpers	70
TOTAL:	226

3.7 Materials

For the major implement components the material specifications are:

Major implement components	SAE No.	Carbon(%)	Manganese(%)
Implement frame (MS)	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 shares	1074	0.70-0.80	0.50-0.80
Rake teeth, beater	1078	0.72-0.85	0.30-0.60
Scraper, blades, shovel	1085	0.80-0.93	0.70-1.00
Discs	1085	0.80-0.93	0.70-1.00
Brackets and binder sections	1086	0.82-0.95	0.30-0.50
Shafts	1090	0.85-0.98	0.60-0.90
Casting parts, wheels, hubs, etc.	1961	-	-

3.8 Summary of Estimated Costs (U.S. Dollars)

o Capital Cost

Land & Buildings	$1,016,000
Machinery, Tool Room	985,000
Furniture, Fittings, Racks	100,000
Transport Equipment	80,000
Pre-Production Expense	350,000
Total Capital	$2,531,000
Working Capital	$1,500,000

o Production Cost

Materials		$4,000,000
Factory Supplies		500,000
*Wages & Salaries		678,000
Depreciation @ 10%		252,000
Interest on Working Capital		225,000
Total Cost		$5,655,000
Gross Revenue		$6,100,000
Net Revenue	US	$ 445,000

*Note: Wages & Salaries vary widely in Africa. An average of $3,000/man/year was used.

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Addis Ababa, Ethiopia, 5-9 April 1982

PROFILES FOR UPGRADING THE PRODUCTION CAPABILITIES IN THE AGRICULTURAL MACHINERY INDUSTRY IN AFRICA

Addendum

V.82-[illegible]

CHART 1 : LAYOUT HAND TOOL / ANIMAL DRAWN IMPLEMENT PLANT

OUTPUT - 5 000 TONS / YEAR

PLANCHE 1 :

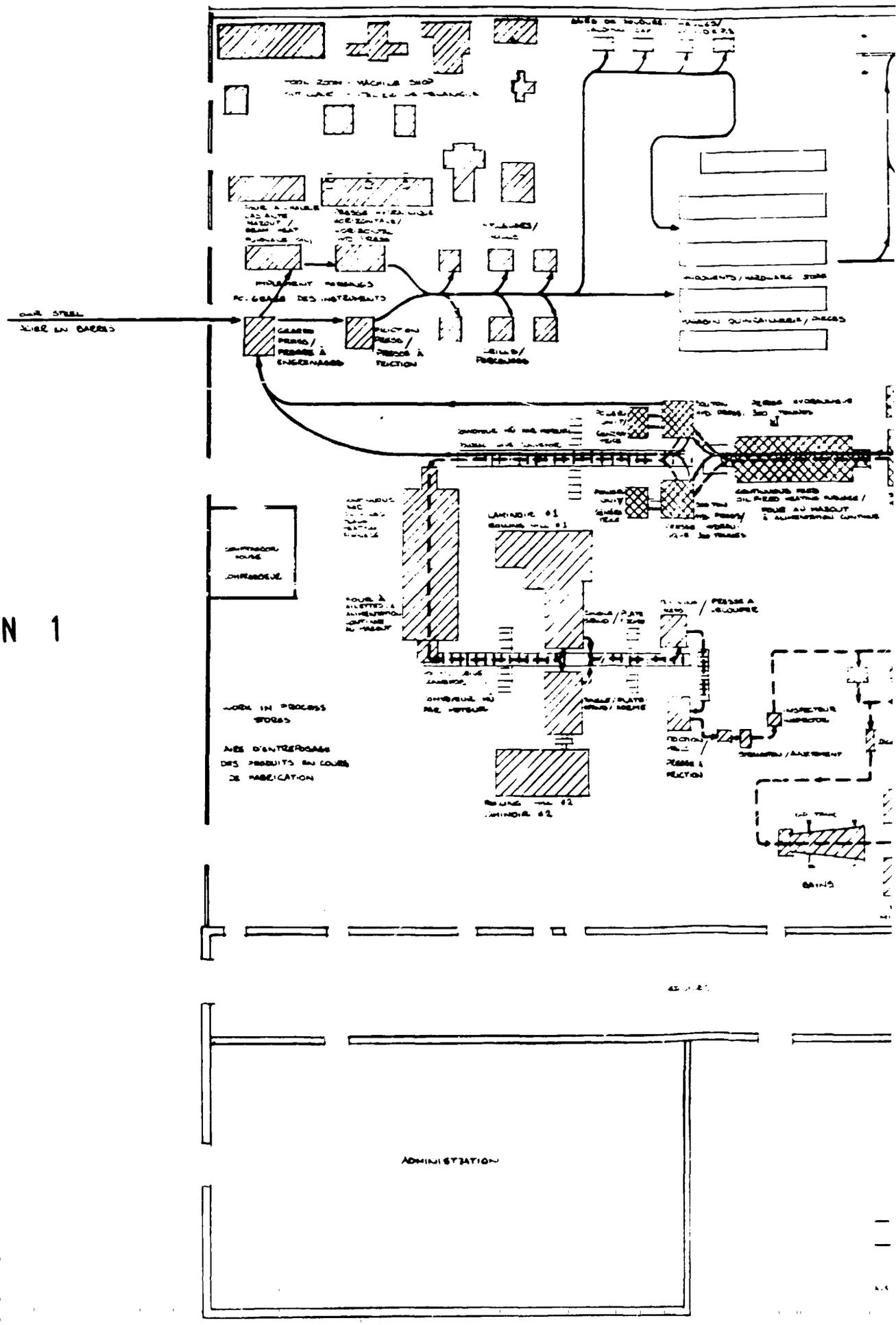
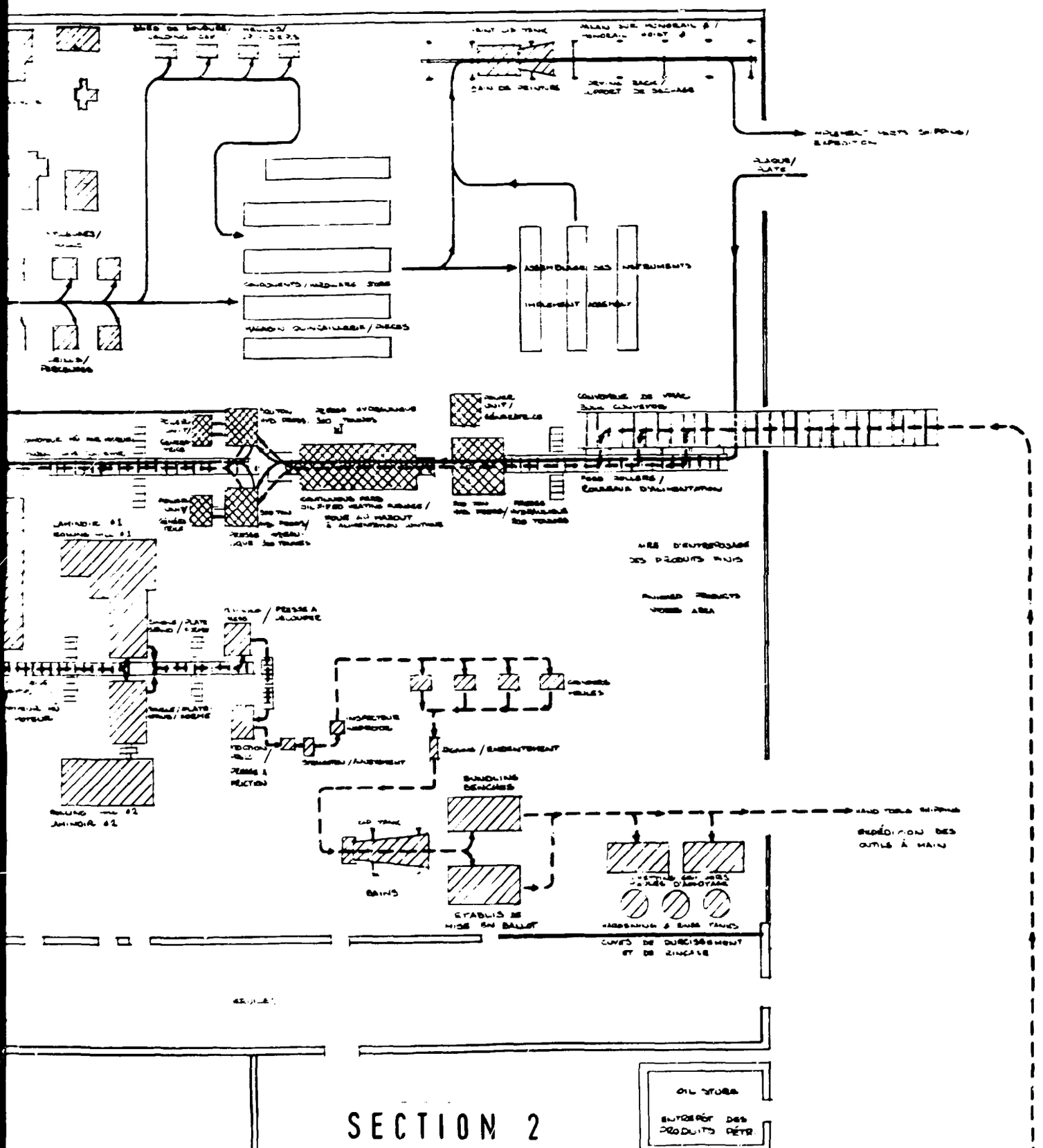


PLANCHE 2 : PLAN MASSE - USINE DE FABRICATION D'OUTILS MANUELS ET D'INSTRUMENTS A TRACTION ANIMALE

CAPACITE - 5 000 TONNES AN

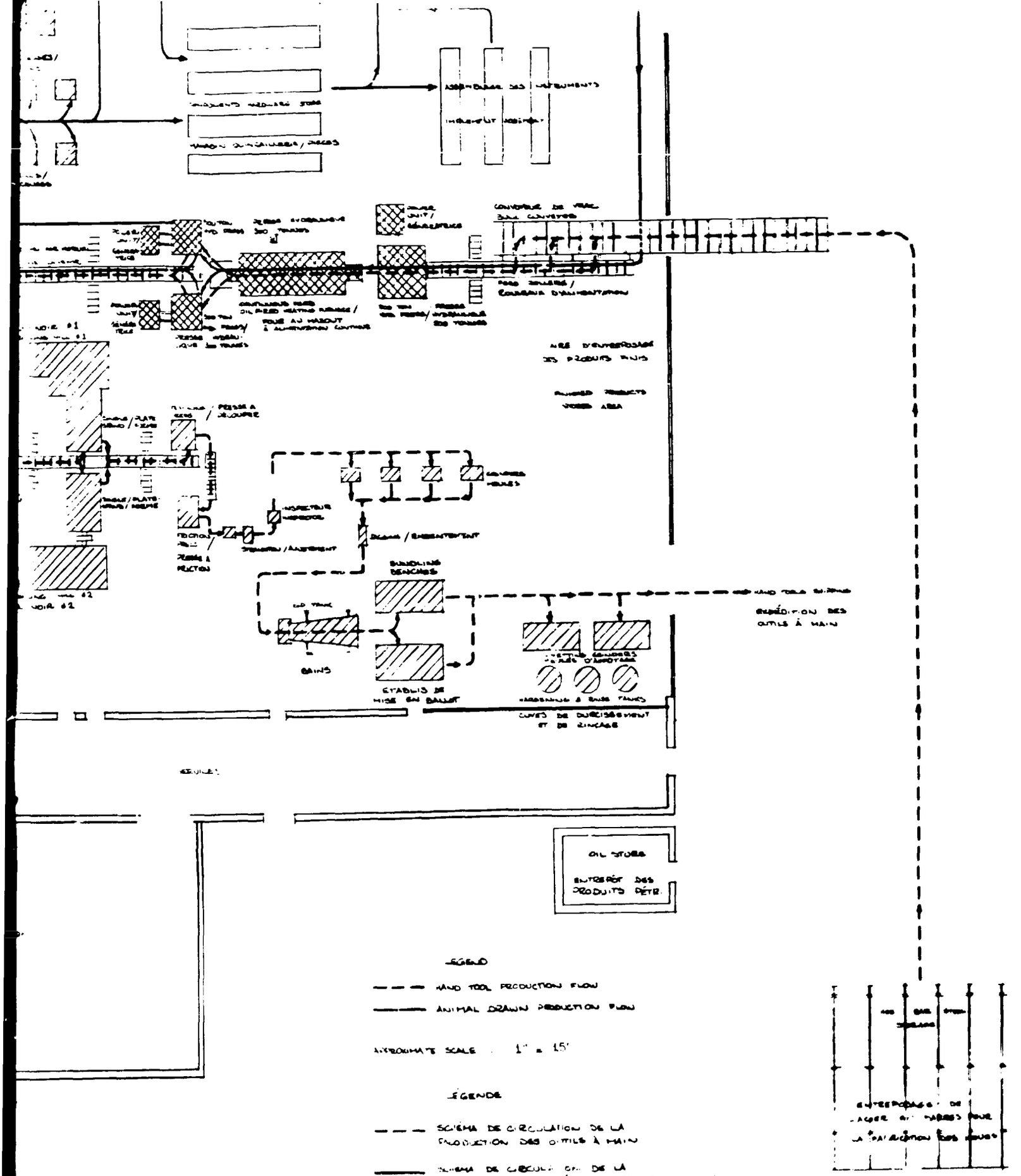


SECTION 2

LEGEND

— — — HAND TOOL PRODUCTION FLOW

——— ANIMAL DRAWN PRODUCTION FLOW



LÉGENDE

— — — HAND TOOL PRODUCTION FLOW

——— ANIMAL DRAWN PRODUCTION FLOW

APPROXIMATE SCALE : 1" = 15'

LÉGENDE

— — — SCHÉMA DE CIRCULATION DE LA PRODUCTION DES OUTILS À MAIN

——— SCHÉMA DE CIRCULATION DE LA PRODUCTION DU MATÉRIEL À TRACTION ANIMALE

ÉCHELLE APPROXIMATIVE : 1" = 15'

SECTION 3

CHART I - LAYOUT

TRACTOR TRAILER AND ANIMAL DRAWN IMPLEMENT PLANT

OUTPUT 5300 TONNES / YEAR

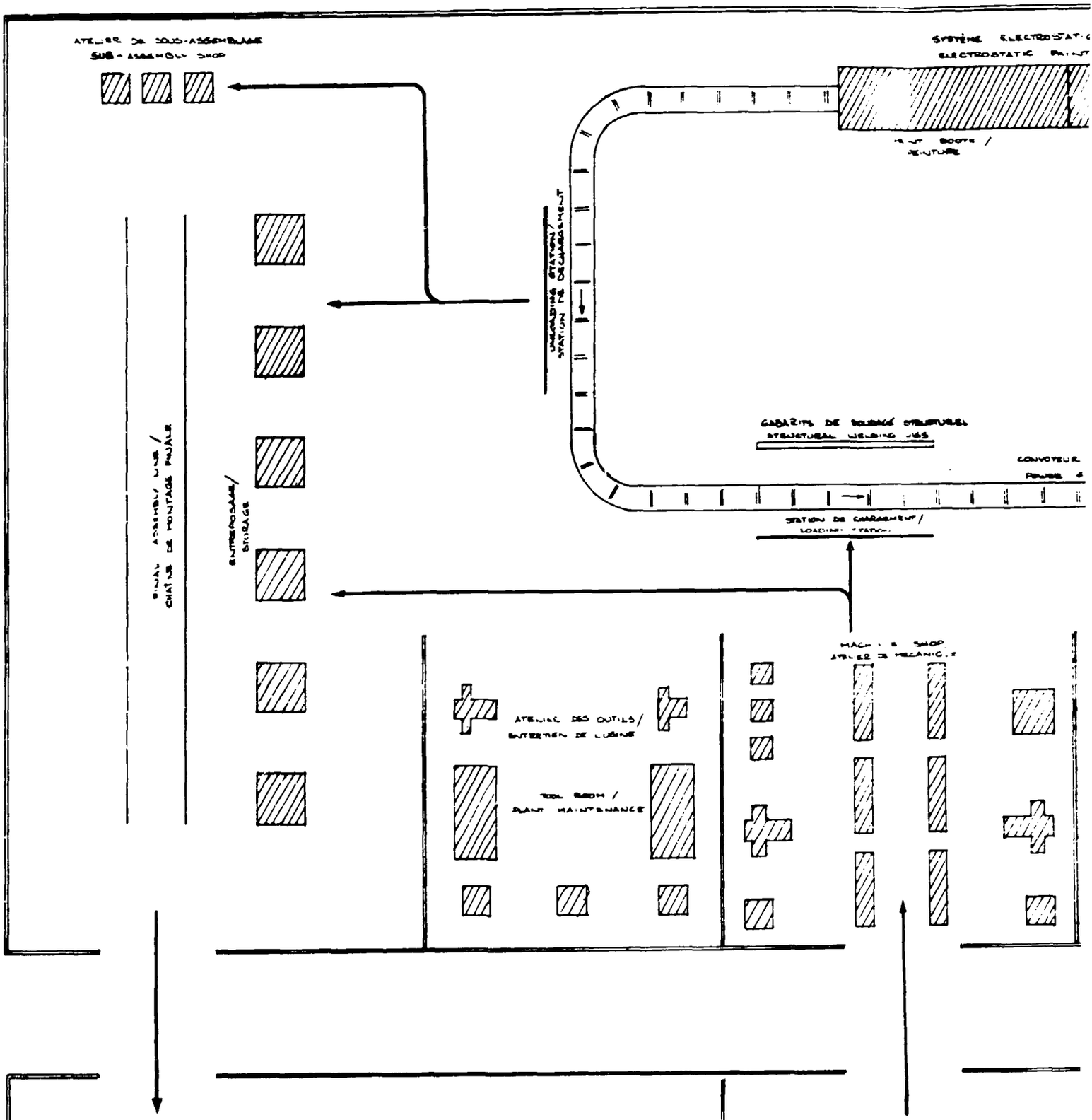
ECHELLE APPROXIMATIVE
1 : 20'

PLANCHE I

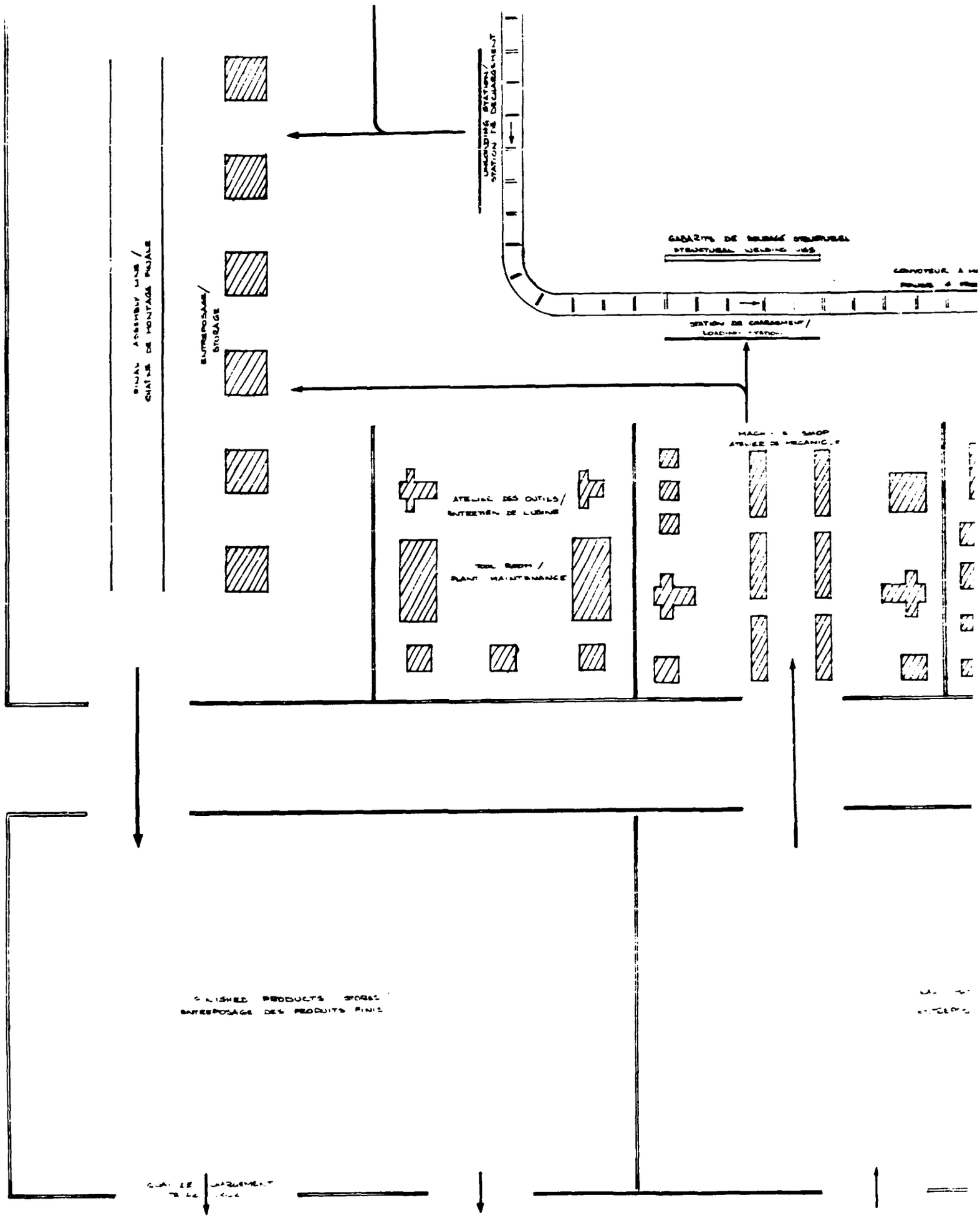
USINE D'INSTRUMENTS A
ET MECANIQ

CAPACITE

ECHELLE APP
1" 20



SECTION 1


FINAL ASSEMBLY LINE / CHAÎNE DE MONTAGE FINALE
ENTREPOSAGE / STORAGE
ATELIER DES OUTILS / ENTRETIEN DE L'USINE
TOOL SHOP / PLANT MAINTENANCE
STATION DE CHARGEMENT / LOADING STATION
FINISHED PRODUCTS STORAGE
ENTREPOSAGE DES PRODUITS FINIS

SECTION 2

PLANCHE I - PLAN MASSE

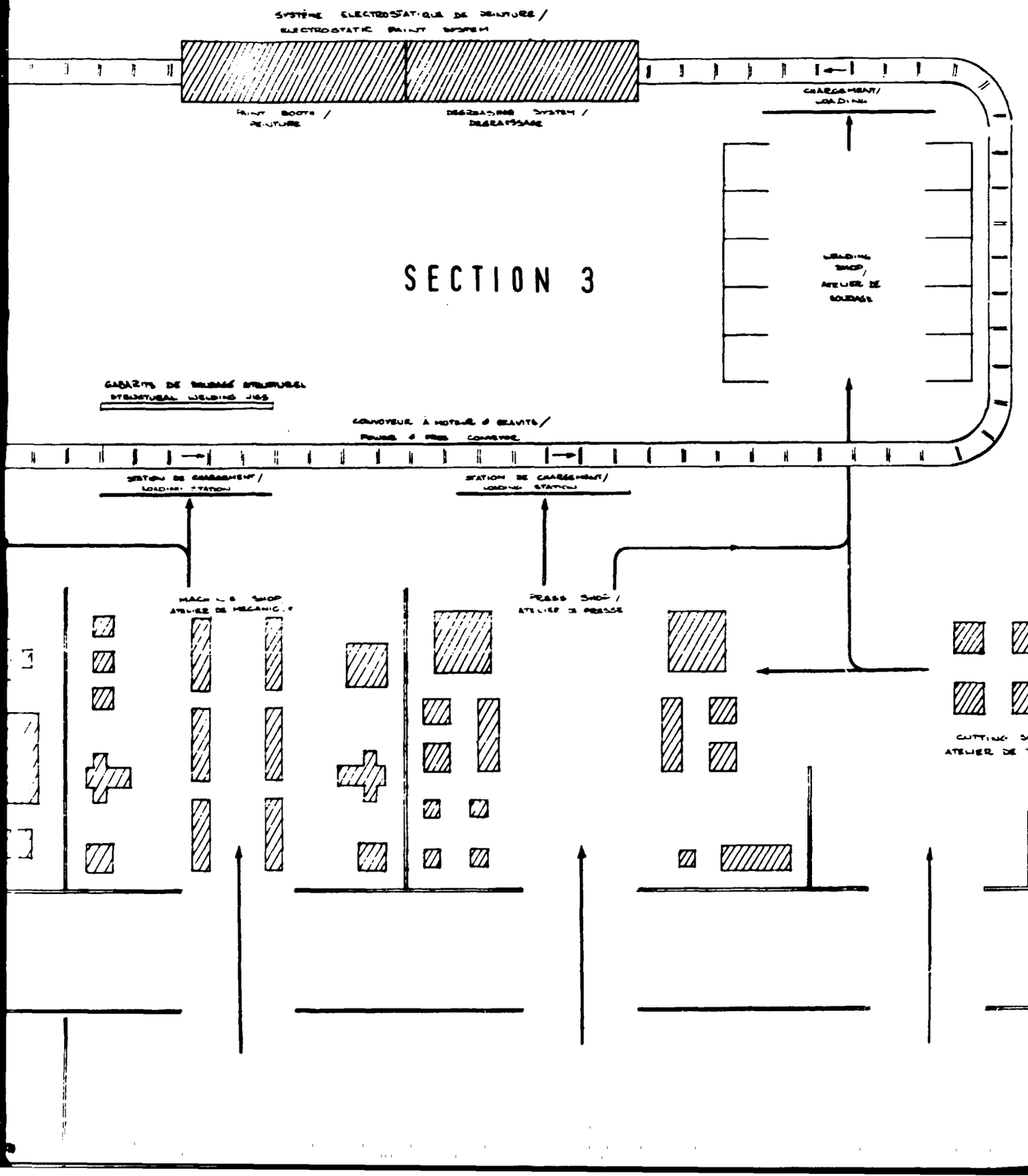
USINE D'INSTRUMENTS À TRACTION ANIMALE ET MÉCANIQUE

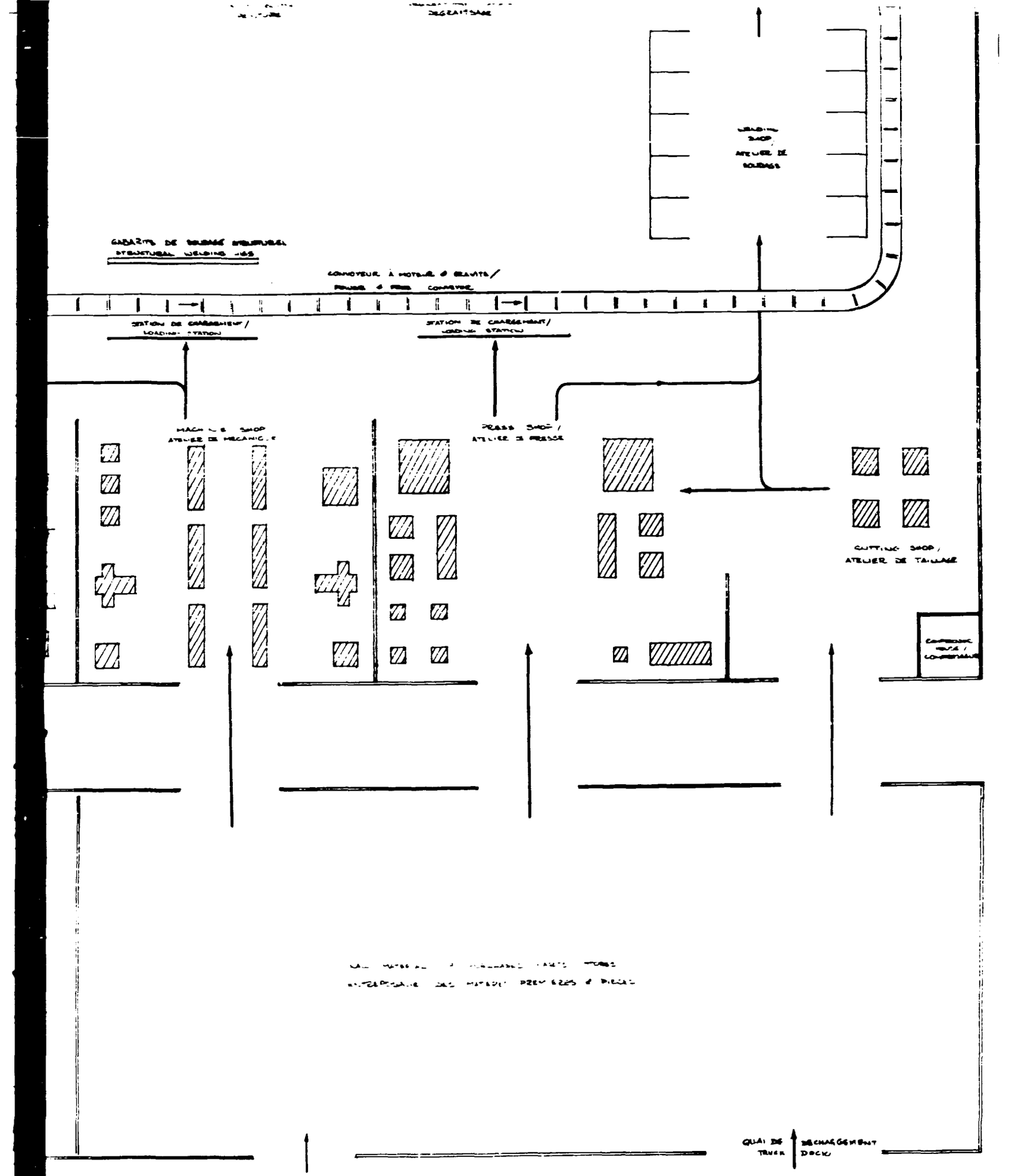
CAPACITÉ 5 000 TONNES / AN

ÉCHELLE APPROXIMATIVE
1' 20

PLANT

FENCE
ADMINISTRATION




GABARITS DE SOUDAGE STRUCTURAL
STRUCTURAL WELDING JIGS
CONVOYEUR À MOTEUR À GRAVITÉ/
POWER & FREE CONVEYOR
STATION DE CHARGEMENT/
LOADING STATION
STATION DE CHARGEMENT/
LOADING STATION
MACHINE SHOP
ATELIER DE MÉCANIQUE
PRESS SHOP/
ATELIER DE PRESSE
CUTTING SHOP/
ATELIER DE TAILLAGE
QUAI DE TRANSBORDEMENT
DOCK

SECTION 4