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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna

Monographs on Appropriate Industrial Technology
No. 11

APPROPRIATE INDUSTRIAL TECHNOLOGY FOR LIGHT INDUSTRIES AND RURAL WORKSHOPS

UNITED NATIONS
New York, 1980

EXPLANATORY NOTES

A full stop (.) is used to indicate decimals.

A comma (,) is used to distinguish thousands and millions.

A slash (/) is used to indicate "per", for example t/a = tonnes per annum.

A slash between dates (for example, 1979/80) indicates an academic, crop or fiscal year.

A dash between dates (for example, 1970–1979) indicates the full period, including the beginning and end years.

References to dollars ($) are to United States dollars.

References to rupees (Rs) are to Indian rupees. In October 1978 the value of the rupee in relation to the dollar was $1 = Rs 7.90.

The word billion means 1,000 million.

The word lakh means 100,000.

The following notes apply to tables:

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

A dash (–) indicates that the amount is nil or negligible.

A blank indicates that the item is not applicable.

Totals may not add precisely because of rounding.

In addition to the common abbreviations, symbols and terms and those accepted by the International System of Units (SI), the following have been used.

Economic and commercial terms

The monetary unit in the Philippines is the peso (P).

EUDP	Egypt Urban Development Programme
GDP	gross domestic product
hp	horsepower
ISIC	International Standard Industrial Classification
R and D	research and development
SK	Swedish kronor
t	tonnes
W	watt

Organizations

GEOCPSSI	General Egyptian Organization for Co-operative Production of Small-Scale Industries (Egypt)
EIDDC	Engineering and Industrial Design Development Centre (Egypt)

EXPLANATORY NOTES *(continued)*

HIPCO	Handicraft Industries and Productive Co-operative Organization (Egypt)
ILO	International Labour Organisation
ISSI	Institute of Small-scale Industries (Egypt)
ITDG	Intermediate Technology Development Group Ltd. (United Kingdom)
ITI	Industrial Training Institute (India)
RTC	Regional Trading Corporations (United Republic of Tanzania)
SIDO	Small Industries Development Organization (United Republic of Tanzania)
UFI	Ubango Farm Implements (United Republic of Tanzania)

The concept of appropriate technology was viewed as being the technology mix contributing most to economic, social and environmental objectives, in relation to resource endowments and conditions of application in each country. Appropriate technology was stressed as being a dynamic and flexible concept, which must be responsive to varying conditions and changing situations in different countries.

It was considered that, with widely divergent conditions in developing countries, no single pattern of technology or technologies could be considered as being appropriate, and that a broad spectrum of technologies should be examined and applied. An important overall objective of appropriate technological choice would be the achievement of greater technological self-reliance and increased domestic technological capability, together with fulfilment of other developmental goals. It was noted that, in most developing countries, a major development objective was to provide adequate employment opportunities and fulfilment of basic socio-economic needs of the poorer communities, mostly resident in rural areas. At the same time, some developing countries were faced with considerable shortage of manpower resources; in some other cases, greater emphasis was essential in areas of urban concentration. The appropriate pattern of technological choice and application would need to be determined in the context of socio-economic objectives and a given set of circumstances. The selection and application of appropriate technology would, therefore, imply the use of both large-scale technologies and low-cost small-scale technologies dependent on objectives in a given set of circumstances.

Report of the Ministerial-level Meeting, International Forum on Appropriate Industrial Technology

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Foreword

As part of its effort to foster the rapid industrialization of developing countries, the United Nations Industrial Development Organization (UNIDO), since its inception in 1967, has been concerned with the general problem of developing and transferring industrial technology. The Second General Conference of UNIDO, held at Lima, Peru, in March 1975, gave UNIDO the specific mandate to deal in depth with the subject of appropriate industrial technology. Accordingly, UNIDO has initiated a concerted effort to develop a set of measures to promote the choice and application of appropriate technology in developing countries.

Appropriate industrial technology should not be isolated from the general development objective of rapid and broad-based industrial growth. It is necessary to focus attention on basic industrial development strategies and derive from them the appropriate technology path that has to be taken.

The Lima target which, expressed in quantitative terms, is a 25 per cent share of world industrial production for the developing countries by the year 2000, has qualitative implications as well. These comprise three essential elements: fulfilling basic socio-economic needs, ensuring maximum development of human resources, and achieving greater social justice through more equitable income distribution. Rapid industrialization does not conflict with these aspirations; on the contrary, it is a prerequisite to realizing them. But, in questioning the basic aims of development, we also question the basic structure of industrial growth and the technology patterns it implies.

Furthermore, it is easy to see that the structure of industrial growth that should be envisaged and the corresponding structure of technology flows should be different from what they are today; a fresh approach is called for. This does not mean that the flow of technology to the modern sector and the application of advanced technologies are unnecessary. On the contrary, it is essential to upgrade the technology base in general, and it is obvious that to provide basic goods and services, there are sectors of industry where advanced or improved technology is clearly necessary. It would be difficult to envisage a situation where the dynamic influence of modern technology is no longer available for industrial growth and development in general. However, an examination of the basic aims of industrial development leads to the conclusion that there must be greater decentralization of industry and reorientation of the design and structure of production.

Such decentralized industry in the developing countries calls for technologies and policy measures that often have to be different from those designed for the production of items for a different environment, that of the developed countries. As a result, there is a two-fold, or dualistic, approach to

an industrial strategy. Morever, the two elements in such an industrial strategy need to be not only interrelated but also integrated.

In approaching the question of appropriate industrial technology from an examination of basic development needs, a mechanism is necessary to link and integrate appropriate industrial technology to the overall development process. Through such a process the concept of appropriate industrial technology could be placed in the mainstream of the industrial development effort.

It is hoped that these monographs will provide a basis for a better understanding of the concept and use of appropriate industrial technology and thereby contribute to increased co-operation between developing and developed countries and among the developing countries themselves.

It is also hoped that the various programmes of action contained in the monographs will be considered not only by the forthcoming meetings of the United Nations Conference of Science and Technology for Development and UNIDO III but also by interested persons working at the interface over the coming years.

Abd-El Rahman Khane
Executive Director

Preface

To focus attention on issues involved in choosing and applying appropriate technology, UNIDO organized the International Forum on Appropriate Industrial Technology. The Forum was held in two parts: a technical/official-level meeting from 20 to 24 November 1978 at New Delhi and a ministerial-level meeting from 28 to 30 November 1978 at Anand, India.

In response to a recommendation of the ministerial-level meeting, UNIDO, with the help of a generous contribution by the Swedish International Development Authority, is publishing this series of monographs based mainly on documents prepared for the technical/official-level meeting. There is a monograph for each of the thirteen Working Groups into which the meeting was divided: one on the conceptual and policy framework for appropriate industrial technology and twelve on the following industrial sectors:

Low-cost transport for rural areas
Paper products and small pulp mills
Agricultural machinery and implements
Energy for rural requirements
Textiles
Food storage and processing
Sugar
Oils and fats
Drugs and pharmaceuticals
Light industries and rural workshops
Construction and building materials
Basic industries

The monograph on the conceptual and policy framework for appropriate industrial technology also includes the basic part of the report of the ministerial-level meeting and some papers which were prepared for the Second Consultative Group on Appropriate Industrial Technology, which met at Vienna, 26-29 June 1978.

PART ONE

Issues and considerations

Note by the secretariat of UNIDO

INTRODUCTION

The pattern of industrialization followed hitherto in most developing countries has generally resulted in a high degree of industrial concentration in metropolitan and urban centres in what is referred to as the centralized-urban pattern. In several countries, small pockets of industry have grown, often oriented to the needs of urban consumption. Although significant import substitutions and exports of processed products by certain countries have developed, industrialization has had very little impact on rural communities, which represent the bulk of their populations. The trickle-down effect of industrialization has been limited in terms of the spread of industry and increased unemployment, and purchasing power in the rural areas continues to be low. Urban migration is not only causing greater pressures in industrial centres but may result in serious imbalances between the large agricultural and rural sector and the small, centralized-urban industrial sector in many of these countries. In this context, it is necessary to ensure that the benefits of industrialization are distributed as broadly as possible through the population by means of an industrial strategy specifically directed towards greater dispersal of industry to the rural areas in a dispersed-rural pattern.

Such industrial dispersal is both complex and difficult. The establishment of a factory in a metropolitan centre with the necessary infrastructure and other facilities is much easier than spreading industrial planning and operations over a wider geographical area. Apart from basic infrastructural elements such as energy and transport, the necessary technological infrastructure must be created in terms of entrepreneurial capability, growth of skills and the like. Furthermore, in the past, productive capacity was adapted to a set of circumstances quite different from those of the present in terms of investment, products, scale of production, and training programmes. Despite its complexity, however, greater industrial dispersal may necessarily have to be undertaken in most developing countries if basic socio-economic needs such as those for greater income and employment in the larger rural communities, are to be adequately met.

With the great variation in factor conditions, levels of growth and socio-economic situations among the developing countries, the nature and extent of industrial dispersal and the range of industrial activities to be undertaken in their under-industrialized regions would vary considerably. For example, a fertile agricultural region might concentrate on food processing and the production of agricultural equipment and inputs. Pasture areas would present greater possibilities for industries related to animal husbandry such as dairy products and leather. Coastal regions may concentrate on fishing and the

exploitation of marine resources. Apart from the variation in local needs and the necessity to upgrade local skills and crafts, the nature and pattern of such industrial activities could also cover a wide range, such as:

(a) Repairs and servicing of machinery and equipment;

(b) The establishment of "foot-loose" industries, i.e. those with low capital requirements and volume, but requiring much labour with relatively simple skills; an example is the manufacture of ready-made clothing to meet local needs;

(c) Setting up processing units for both perishable and non-perishable local produce;

(d) The production of simple agricultural equipment such as farm implements and pumps;

(e) The manufacture of products to meet local needs, such as building materials, cloth and shoes;

(f) The production of components and products for the organized urban industrial sector.

Maintenance and repair, for example, offer considerable potential in most countries. In several developing countries, transport and agricultural equipment is in use that must be taken to distant urban centres for repairs or servicing. Such functions could be performed locally, which would increase local technological capability. The foot-loose industries lend themselves to greater decentralization, either for the whole or part of a production process. A number of local agricultural products could obviously be wholly or partially processed where they are grown. Various farm implements such as ploughs, sickles, knives and spades can be produced cheaply and competitively, if an adequate supply of basic materials is assured. Certain functions, such as welding and casting, could also be undertaken in rural areas. Items such as barbed-wire, fencing, poles and wire mesh could be produced locally, if certain simple equipment and a supply of raw materials could be assured. A number of components and products of various degrees of sophistication could be manufactured for the organized urban sector, if the necessary skills could be developed and certain basic facilities provided.

Generally speaking, industrial dispersal presents significant possibilities for the production of a wide range of goods and services, not only those directly related to local production and consumption requirements but also interlinked with the overall needs of the centralized-urban industrial sector in these economies. It is essential, however, that a proper technological base be created for the effective growth of the rural industrial sector if industrial dispersal is to be dealt with comprehensively.

Apart from providing the basic infrastructure in terms of energy and transport, which may themselves prove to be significant constraints, it is necessary to consider the technological infrastructure that would be required, together with its institutional base. The concept of Rural Workshops or Industrial Centres (RWIC) should be considered in this context as a nucleus for building the necessary technological base for a programme of rural industrial growth. Such RWICs could vary significantly with local conditions and potential, but basically they could provide the necessary base and technological stimulus for initiating and developing industrial activities.

I. OBJECTIVES

The objectives of RWICs include:

(a) Providing a base for the spread of knowledge of industrial operations and the use of modern tools and simple equipment;

(b) Serving as a nucleus for producing a wide range of products for local consumption and use;

(c) Assisting rural artisans in upgrading local techniques, and relating these to the use of modern tools and techniques;

(d) Providing common equipment and service facilities for the maintenance and repair of agricultural and other equipment in local use including transport equipment, diesel engines, pumps, electric motors etc.;

(e) Providing training in skills for the production of components and products required by the centralized-urban industrial sector;

(f) Initiating adaptation and innovations of existing techniques and processes.

While such RWICs would provide the institutional infrastructure for the growth of local skills, they could also serve as nuclei for rural industries adapted to local requirements and resources.

Location

The location of RWICs would depend on the resources and conditions in each region. This would initially need to be related to their spatial and economic structures. Centrally located villages or village market centres could be suitable locations. Obviously, an RWIC should cover a cluster of villages, as far as demands for service and production functions are concerned. The number of RWICs would depend on the extent of resources. Whether a beginning could be made with a few units, which could serve as pilot and demonstration units, would need to be considered in the context of particular countries.

Investment requirements

The establishment of RWICs would need to be related to the specific objectives to be achieved in particular cases. Some could be relatively small units, with investments of less than $10,000, functioning initially as repairs or maintenance units or as training facilities for upgrading of rural artisanal skills. There could also be a fairly large multipurpose unit, with certain basic machinery and equipment. The nature of machinery and equipment could be adjusted to local production and service requirements. In certain units it may also be necessary to provide a cast-iron foundry to provide simple light-weight castings. In other instances, more equipment may be necessary for metalworking and machining or for woodworking. Appropriate combinations would need to be considered, based on local resource factors and endowments.

Patterns of financing

The initial finances for setting up RWICs would need to be provided by the state. Governmental agencies could either set up the units directly, based on a

survey of local potential in different regions, or they could provide grant or loan assistance to local agencies or entrepreneurs. Since the main objective would be to harness and develop local potential and skills, the management and operations should be entrusted to local agencies, with state organizations providing the necessary training and technical expertise. The role of state agencies would need to be carefully delineated as there is a likelihood of such a programme becoming unduldy government controlled. At the same time, initial financing and training would need to be provided by government agencies. One alternative could be to entrust management and operations to local co-operatives or other local authorities, with state agencies providing:

(a) Initial funds, either on medium-term or long-term loans or with 50 per cent or more of initial investment in the form of grants;

(b) Training for personnel in operating skills and in elementary mangement techniques;

(c) Skilled technical personnel in particular trades for varying periods.

It is important that RWICs be primarily viewed as essential infrastructure for technological growth in rural areas. While they may prove economically viable over a period of time, these units should be judged only from the viewpoint of commercial profitability and as industrial units that should yield high returns. The gestation period for local skills would vary from region to region but may be quite long; a flexible approach may need to be adopted in applying standards of commercial profitability to such units.

The size and nature of operation of RWICs would also vary from region to region and would need to be related to the factor situations and potential of each area. Their growth could also be suitably phased so that subsequent expansion could be related to the growth of local skills and capabilities.

Interlinkage with extension services

The concept of RWICs is principally intended to provide a nucleus and technological base for developing local skills and capabilities and to serve as catalytic agents for the growth of rural industries. Such RWICs would obviously not be a panacea by themselves and would need to be closely integrated with field extension services. An effective extension service constitutes a prerequisite for rural industrial growth. Such services should include:

(a) Surveys on industrial potential in particular regions, in consultation with local agencies and representatives;

(b) Assistance in determining the viability of projects in such terms as potential demand and size of investment;

(c) Providing technological information and expertise regarding technological alternatives as related to local resources;

(d) Assistance in securing credit, obtaining machinery and equipment, ensuring regular supplies of the processed materials required, and in marketing and distributing the products.

Technological assistance provided through extension services would often need to be multidisciplinary and require close linkage with R and D institutions that specialize in particular branches of production. The establishment of

"centres of excellence" in particular branches and effective linkage between such centres and field extension services would be especially important. Basic managerial expertise would also need to be provided through extension services providing guidance in functions such as bookkeeping and labour and material costing. Such expertise could also be provided through field institutions and units of banking and credit agencies. The degree of linkage between the RWICs and industrial extension services would depend on particular situations. In some instances the RWIC could be wholly integrated with the extension service facilities; in other cases, however, the RWIC would concentrate primarily on training and certain production functions supplemental to extension services.

RWICs and industrial estates

In several developing countries, industrial estates have been set up to provide certain basic facilities to small-scale enterprises. Such facilities provided by estates range from the basic infrastructure, i.e. work sheds at nominal rental, to various common service facilities, either for a particular industrial sector or of a multipurpose nature. The purpose of industrial estates should be extended to rural areas to provide basic infrastructure and other facilities to rural entrepreneurs. Rural industrial estates would, however, need to be closely interrelated with RWICs. While the latter would principally perform training together with certain production function, rural estates would provide the basic physical facilities for rural industrial units which must be located outside rural households. Thus, rural industrial estates could be set up gradually and established as extensions to RWICs. The production functions of the latter would have to be effectively co-ordinated with activities undertaken in the industrial estates through the industrial extension services.

Policy package for rural industries

Apart from RWICs supported by an efficient extension service and rural industrial estates, a comprehensive policy package would need to be introduced for effective rural growth. Such a package would have to include:

(a) Provision of adequate credit for initial investment and working capital through field units of banking and credit institutions, including arrangements for the hire-purchase of machinery and a liberal and sympathetic interpretation of the credit-worthiness of rural entrepreneurs;

(b) Financial incentives equal to, if not greater than, those provided to organized urban industry, such as the provision of energy at subsidized rates, liberal tax allowances for specified periods, tariff rebates and direct capital subsidies for industrial units located in underdeveloped and rural areas;

(c) Assured supplies of processed materials such as steel or yarn;

(d) Preferential purchase of the products of rural enterprises by governmental agencies;

(e) Possible reservation, for specified periods, of production capacity in certain sectors for units located in rural areas.

In several developing countries, the present industrial policy pattern has tended to favour organized urban industry and basic facilities. Fiscal and other

incentives have often militated against rural industrial enterprises. This policy pattern should be reoriented in favour of industries, particularly small-scale units, located in rural areas. Equal facilities and incentives might themselves not be sufficient; preferential fiscal and other incentives would be required. In some sectors, it may also be necessary to reserve additional production capacity for rural-based enterprises for particular periods, in the way of the infant industry argument. Such a policy of reservation would, however, have to be carefully designed and related to specified periods, in order to ensure competitiveness of rurally based units in both the domestic and export markets.

II. SELECTION OF TECHNOLOGY

Besides institutional facilities and policy measures for rural industrial growth, developing country institutions would need to select suitable techniques for various production activities in the rural sector and ensure adequate dissemination of information regarding appropriate alternatives. This would necessitate, in some cases, the upgrading of existing techniques and processes, which could be undertaken in the RWICs or national R and D centres. In other cases, foreign technologies formerly used, but now discarded in favour of more capital intensive techniques because of rising labour costs, may prove appropriate to the needs of rural-based industries in developing nations. In certain instances, appropriate technology for units in the dispersed rural sector may be available in other developing countries or can be acquired from medium- and small-scale enterprises in developed countries.

While the appropriateness of particular technologies should be assessed in the context of local conditions and circumstances, certain broad criteria which would be generally applicable in the selection of appropriate technology for the dispersal rural sector would be the following:

(a) The technology should be labour-intensive rather than capital-intensive;

(b) Production should usually be undertaken in small-scale and household units, involving lower investment outlays, although large-scale production using labour-intensive techniques would be fully compatible;

(c) Production would be geared to local resources and skills;

(d) Products should be related to local needs and purchasing power;

(e) Production units should be located principally in rural areas.

National institutions in developing countries would need to identify and evaluate alternative techniques for the dispersed rural sector against the above criteria and such other local conditions and circumstances as may be applicable and must thereafter provide an adequate flow of information in respect of:

(a) Products, product design and specifications etc.;

(b) Production techniques and processes, including details regarding such processes and their applicability in particular situations;

(c) Adaptations necessary to suit local conditions and circumstances.

Assistance should also be provided by such institutions in the acquisition of such technologies by rural enterprises. Such technological information would

need to flow both to the user enterprises and to field institutions such as the RWICs and extension services for dissemination to potential units. The RWICs should in turn provide information and experience regarding such techniques and their use in conjunction with local adaptations and innovations.

It is necessary that a national inventory be made of technologies indigenously available, particularly those applicable to the dispersed rural sector, together with adaptations and innovations developed in R and D institutions and, over a period of time, in the RWICs. Such an inventory would highlight the requirements of upgrading in particular cases and identify technological gaps which need to be covered. This task could be undertaken by the national institution dealing with technology and R and D.

III. PROGRAMME OF ACTION

The effective growth of rural industry and technological skills and capabilities in the rural sector would necessitate a comprehensive programme of action, both on the part of developing country Governments and within the framework of international economic co-operation. Such a programme should cover the following aspects at the national level:

(a) Significantly greater resource allocations would be neccessary to provide basic infrastructure facilities, such as energy and transport, for non-urban areas;

(b) To develop technological capability in the use of modern tools, equipment and production techniques in the rural sector. RWICs would need to be set up in selected rural locations. While the detailed nature and structure of such RWICs would be related to local conditions, alternative multipurpose or sectoral models could be considered for adaptation;

(c) The phased establishment of RWICs should be accompanied by an effective industrial extension service for technological information, guidance and assistance in setting up rural production units, which would also be taken up in a phased programme in each country;

(d) The programme of RWICs should be supplemented by the establishment of rural industrial estates, providing basic infrastructure and physical facilities for rural production units;

(e) A programme to extend credit facilities to meet the fixed and working capital needs of rural industrial units should be channelled through the field units of banking and credit institutions;

(f) Comprehensive policy packages should be prepared in the context of particular countries, their objectives being to achieve greater dispersal of industry into rural areas. They should provide fiscal and other incentives, together with other essential facilities;

(g) Institutional facilities would need to be set up for:

(i) Identifying and evaluating alternative technologies that can be applied in the dispersed rural sector;

(ii) Disseminating information on such techniques and processes considered most appropriate in particular sectors;

(iii) Assisting in the acquisition of such technologies by user RWICs and rural enterprises;

(iv) Monitoring the absorption, adaptation and innovations relating to such technologies in RWICs and user rural enterprises.

International economic co-operation in this field would need to cover the following aspects:

(a) The resource requirements for the establishment of RWICs, even on a modest scale, would be very significant. Assuming an average cost of $25,000 for machinery and equipment alone for each, the cost of such equipment for even 100 of them in different developing countries, which could barely serve as pilot and demonstration centres, would come to $2.5 million. Such machinery and equipment could be supplied from both developed and industrially advanced developing countries;

(b) Greater inflow of suitable technology should be encouraged between medium and small enterprises in developed and industrially advanced developing countries on the one hand and rural-based industrial enterprises in other developing countries on the other. This could be channelled through national technology institutions or through international agencies such as UNIDO. A suitable framework of incentives could also be developed to encourage such transfer;

(c) Greater exchange of information and experience could take place, particularly between developing countries, regarding:

(i) The application and use of alternative technologies in different branches, with special reference to rural-based industry;

(ii) The experience of industrial extension services and industrial estates in rural areas, including training programmes for rural artisans.

As and when RWICs are set up, the exchange of information and experience regarding their functioning would also be very useful.

Report of the Working Group

There can be no industrial transformation in the rural areas of developing countries without a massive transfer of new appropriate technologies to these areas and significant improvements in the efficiency and productivity of the technologies now in use. The approach should be an integrated one; that is, it should:

(a) Generate appropriate technologies;

(b) Establish a technology delivery system to ensure, not only the introduction of appropriate technologies but also the fulfilment of their infrastructural and organizational requirements;

(c) Above all, provide sustained policy support, at least in the initial stages of development.

Evaluation of appropriateness of a technology

Technologies evaluated for appropriateness are either already in use or new. With regard to technologies in use, the objective should be to improve their efficiency and productivity without transforming their basic characteristics. Then the transition to more efficient technologies would be easier. With regard to new technologies, each technology must be assessed to determine its suitability and acceptability in the context of the local factor conditions and circumstances. The broad criteria generally applicable in the selection of an appropriate technology are the following:

(a) It should be amenable to wide dispersal in the rural areas;

(b) It should be compatible with local skills and factor endowments;

(c) It should be essentially labour-intensive rather than capital-intensive;

(d) The capital cost of the technology should be within the means of the average rural entrepreneur;

(e) The product should fit into the local demand and consumption pattern and the rural people should be able to afford it. Not only should the technology selected for promotion be appropriate for the specific situation, but also it should evolve standards that would facilitate mass-production (commercialization) and easy adaptation. Also, R and D capabilities and the flow of information with regard to the products, product designs and specifications would need to be greatly augmented to sustain a programme of rural industrialization.

Selection and promotion of appropriate new industries

Rural industries that can be established by new entrepreneurs should include:

Industries linked to agricultural by-products (tanneries, animal feeds) or inputs (fertilizers, pesticides)

Consumer-product industries

Subcontracting industries

Industries linked to agricultural by-products would be somewhat difficult to introduce. Standard equipment may need to be adapted or modified. In some cases, new equipment would have to be designed. Three suggestions are: *(a)* seek the services of experienced engineers; *(b)* utilize academic resources for assistance; *(c)* encourage highly skilled non-academics to try and solve simple problems.

Another problem is obtaining the co-operation of the landowner farmers and the new rural entrepreneurs in setting up such industries. Co-operatives of farmers and marginal entrepreneurs may perhaps be a better form of organization in certain cases.

Encouragement of industries linked to agricultural by-products, if backed by appropriate regulation of the export of the products from the rural areas, would greatly accelerate the development of processing industries based on such by-products within the rural areas.

The consumer-product industries that can be established in the rural areas vary from country to country and from region to region within the same country depending on the local demand, nature of agricultural products and by-products available and also on the raw material of consumer industries elsewhere.

There is a tendency for large industries to be self-sufficient and integrated. To promote a subcontracting industry, therefore, the following conditions must be met:

(a) It should be technically feasible and economically viable;

(b) The technology of the subcontractor must produce products acceptable in quality to the principal industry with which it is structurally integrated;

(c) Government testing centres must be established;

(d) Payments to the subcontractor must be regular and timely and if necessary regulated by legislation;

(e) Governments must take measures to encourage decentralization of the manufacturing operations of the larger integrated units.

Although subcontracting is usually associated with the metalworking and engineering industries, it is equally applicable to other industries. These may include:

(a) Collection and primary processing of raw materials for paper and paper products industries;

(b) Linkages of tanneries and leather goods manufacturers;

(c) Extraction of vegetable oils, whereby the press cake from local crushing would be sent to larger industries for solvent extraction;

(d) Primary processing of various agricultural raw materials so that larger units confine themselves to the production of final products only.

Infrastructural and organizational requirements

Any programme for rural industrial development would need basic institutional infrastructure support in terms of training, extension services, financial assistance, organizational assistance, raw-material supplies, marketing services and above all the political will of the Government to promote rural industrialization.

Existing scattered efforts should be co-ordinated to form a unified and consistent approach to the problems. The role of large private industries is crucial. An example is afforded by the District Industries Centres (DICs), by which the rural industrialization policy of India is institutionalized. These DICs are staffed by general managers with proven administrative capabilities, who are assisted by specialists in economic studies, machinery and equipment, financial operations, marketing research and training, and small-scale and cottage industries. The DICs are provided with captive workshops staffed with personnel on loan from the large industries. Tax benefits are given to larger industrial units participating in the scheme.

In order to reach the poorest in the society, there must be an adequate and comprehensive extension service and active involvement of the informal social leaders in all aspects of the programme. The financing of small industries in rural areas may require the creation of special credit institutions to promote the programme. Government and large enterprises should pool their resources in financing pilot projects and plants.

There are several possibilities for financing the establishment of institutions from international sources:

(a) UNIDO (limited to technical assistance projects);

(b) World Bank (comprehensive studies in which an appraisal team could be sent and the institutional development could be part of the loan component of a pilot project);

(c) Bilateral arrangements (with developed countries and between developing countries).

With regard to assistance to small industries, free service is usually not taken seriously; a token fee, at least, should be levied for the services performed. Also, there must be a better linkage between technological and financial assistance; a total package of assistance is important to small industries.

Consultancy organizations should be granted liberal tax benefits to encourage them to work for rural industries.

When a small industry has been developed and is in operation, the supply of spare parts and maintenance aspects, such as engineering services, becomes crucial. The setting up of common service centres is a possible solution to such problems.

An effective way of assisting small rural industries in places where there are clusters of similar industries is the creation of common marketing services and outlets instead of outright government purchases of the production of such industries.

The training of entrepreneurs should be market-oriented, especially in the consumer industries, where the need arises for new designs to meet market demands. Institutions assisting industries should try to increase the number of

entrepreneurs rather than the number of industries. While institutional industrial training is useful, mobile training schemes and demonstration squads have proved more effective.

Artisans should not, as far as possible, be moved from their original locations in market places to localized production centres of industrial estates elsewhere without proper preparation.

Among the limitations of government assistance felt by small industries are the instability and frequent changes of the procedural arrangements for getting such assistance. The system of taxation and laws with regard to small industries should be simplified and procedural formalities for obtaining various assistance from government and financial institutions reduced to the minimum.

The success of appropriate technologies cannot be ensured unless the new units set up initially prove to be viable. Though every care may be taken to ensure that the technologies chosen are appropriate to the local situations, there are areas where initial success should be ensured so as to create the needed multiplier effect of the new technologies. To offset certain structural problems, arising mainly from location, transport and marketing, it would be necessary, at least in the initial stages, that the disability risks and disincentives are covered by national funds or insurance. One way of pre-empting such problems is to require public sector undertakings to set up ancillary units in rural areas.

Each country must provide adequately for communications, transport and education in rural areas in order to create the necessary climate and enthusiasm for rural industrialization.

The financial policies of funding agencies should be reoriented to give due recognition to invisible and intangible costs and benefits. Small units, particularly those in rural areas, should be freed from complicated legal and tax requirements. Laws and procedures should be simple and capable of observance without straining the available resources.

Technology delivery system

The development of an adequate technology delivery system is a prerequisite for an effective transfer to and absorption of appropriate technologies in the rural areas. The system should start from the grass-roots level and extend to the national government, whose strong and sustained commitment to the success of the system is essential.

Functions of the system

A technology delivery system has two basic functions: to support and upgrade existing traditional technologies and to stimulate the growth of new industries, which should be based essentially on raw materials locally available in the rural areas and oriented towards the rural consumer demand and the demands of urban industries for raw-material intermediates and components.

While the focus of the delivery system would be technological, it would have to comprehend the entire spectrum of services needed by rural industries, which would include the supply of raw materials and equipment, mobilization of financial assistance, provision of managerial assistance, operation of training programmes and provision of marketing support.

An important function of the system would be the establishment of repair and maintenance services, which in themselves could be starting points for new light engineering industries and would also act as catalysts for modernization in the design, standardization and production of machinery and equipment for appropriate industrial technology.

The delivery system should identify a number of new industrial possibilities based on the resources of the new area and prepare investment proposals for them. In doing so, however, it would have to take into account the needs of the community and the response from the potential entrepreneurs or institutions in the village. The delivery system would have to stimulate new entrepreneurs, but in doing so, a balance would have to be struck between purely commercial profit motives and the needs of the community. High priority should be given to improving the living conditions of the poorest section of the community.

The delivery system should actively participate in specific projects by helping in the appraisals of new projects by banks and other institutions. For this purpose, it would have to develop close linkages with the existing credit institutions and help the existing entrepreneurs, as well as the new ones, to obtain credit without becoming a financing agency itself.

It may often happen that a specific project will require only a small amount of money or may not qualify for normal bank finance. In such cases, it should interact with the alternative agencies for obtaining the needed credit.

Organization of the system

A delivery system can be either an autonomous organization or a government department; but it must be flexible and independent. It should also cover a wide variety of technical disciplines and include not only engineers and artisans but economists and sociologists as well.

The Government may select a sponsoring agency to organize a delivery system. The agency selected should develop close contacts with training and education institutions, R and D institutions, large industries, government administrative organizations, financial institutions etc. It should also provide a feedback of the technological problems of the rural industries to the R and D institutions.

The sponsoring organization would need to make frequent appraisals of the effectiveness of the delivery system. Some rough indicators would be the number of new industrial units set up through the system, the amount of increase in the earnings of the artisans, and the size of improvements in productive capabilities. The overall effectiveness of the system could be judged by the degree of awareness of the possibilities in light industry, as well as by the extent of economic and social benefits attributable to the increased production activity. In addition to such periodic appraisals, the Government should review objectively the impact and effectiveness of the delivery system so as to solve any problems that might have arisen in the process of increasing its effectiveness.

The delivery system should be financed primarily by government funds, which may be supplemented by funds from large industries, both private and government-owned, and from domestic and foreign organizations and institutions.

Development of plant equipment for rural light industry

Special efforts are required to develop standard plant equipment for rural light industries, particularly relating to:

(a) Basic industrial skills, such as metalworking, woodworking, plastic-article fabrication and various repair and maintenance services;

(b) Various process industries such as oils and fats industries, agricultural by-products and various types of first-stage processing (i.e. intermediate materials for further processing);

(c) Safe water, energy and other utility provisions, purification and other equipment required for primary public health care.

Thorough research is needed to design, develop and adapt such equipment at appropriate levels of labour and capital input. The maintainability and interchangeability of components, ease of operation etc. are important technical considerations.

The technical developments should be undertaken in the developing countries themselves. When suitable capabilities are not available, their establishment should be stimulated on a priority basis. Similarly, the strengthening of the above indigenous capabilities should also constitute a priority area for international assistance.

The usefulness of model demonstration workshops, including on-the-spot technical assistance, has been recognized for common operations such as tanning, dyeing, wood seasoning, metalworking and forming, and machinery and vehicle repair. Whenever practicable, access to the facilities of the workshops should be assured for rural entrepreneurs for experimental work.

International co-operation

International co-operation in establishment of light engineering and rural industries would greatly accelerate the process of rural industrialization in developing countries. The possibilities of such co-operation may include the following:

(a) Several countries in a region or subregion might set up common institutional facilities such as for training, marketing studies, R and D etc.;

(b) Several countries with common commodity interests might set up a mechanism for co-operation;

(c) Countries with common problems might sponsor common R and D programmes.

The Regional Centre of Technology Transfer for the Asian Region, under the auspices of the Economic and Social Commission for Asia and the Pacific (ESCAP), in which each country designates a focal point to enhance inter-agency co-operation, should also be mentioned in this connection.

Programme of action

Before formulating a programme of action, target groups such as artisans and traditional occupations (carpenters, blacksmiths, potters, tanners) as well as rural industries to be promoted should be identified.

The programme should include identification, adaptation and generation of

technologies appropriate to rural areas; development of systems for the diffusion of such technology; training of personnel; establishment of such supportive services as financing, marketing, supply of materials and equipment etc. It is essential that procedures for the establishment and operation of rural industries are simplified and incentives such as tax exemptions and liberalized credits are provided.

The programme should be in conformity with the overall rural development programmes designed to increase productivity in the agricultural sector and to improve the quality of life of the rural population. It should also aim at generating industrial employment for at least 5 per cent of the rural population in the developing countries by the year 2000. The programme may, in specific regions, begin with the establishment of "growth centres" in selected areas depending on the expected impact of the programme and should be expanded in slow stages as more and more experience is gained with its implementation. Quick proliferation of the programme is likely to create organizational problems and may even strain the limited infrastructure, ultimately weakening the impact of the programme itself.

The funding of the programme should be accorded the highest priority by Governments, which should budget sufficiently for this purpose. It is recommended that assistance, both in terms of money and expertise, should be made available by international and regional agencies and institutions and through bilateral arrangements.

PART TWO

Selected background papers

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Light engineering workshops for rural areas

*P. K. Das**

I. DEFINITIONS

The rural sector is variously defined in different countries and within the same country, depending on the purpose of the definition. For population census purposes, the rural sector in many countries consists of localities with a maximum of 2,000–5,000 inhabitants. In a few countries, this limit goes up to 10,000 inhabitants. In some countries, urban localities are not only defined in terms of a minimum population, but certain qualitative criteria must also be met, such as the proviso that at least 75 per cent of the labour force is engaged in non-agricultural occupations and the density of population is at least 400 inhabitants per square kilometre. In other countries the types of urban amenities and local administration are determining factors.[1] Hence larger localities with over 5,000 inhabitants may also be classified as rural if various qualitative criteria are not met. In considering the industrial needs and possibilities of rural areas, the basic characteristics of these areas, in particular their limited population and the preponderance of primary sector activities, must be kept in mind.

For the purpose of this paper, it would be necessary to include rural market towns which serve largely rural hinterlands and may have as many as 25,000–30,000 inhabitants, so as to cover the whole range of rural possibilities. On the other hand, industries located in suburban areas statistically classified as rural, even though they may represent an extension of the city itself and be geared to urban needs, are not dealt with in this paper, except for those serving both rural and urban areas.

The term "rural industry" also needs to be defined. While rural industry has often been considered to include decentralized industry, this paper will not deal with decentralized large or medium-scale industries in a rural setting, nor with those for which a large skilled work-force, exceeding the resources of a rural community, is needed. Such industries require the setting-up of a new township or enclave in a "green-fields" area. The term rural community used here does not always mean the confines of a single village, but an integrated labour-market area which may include several contiguous villages from which labour can be

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[1]These percentages or numbers vary from country to country.

easily drawn on a daily basis. Decentralized large industry is not considered in this paper because the technology levels, markets, managerial requirements, sources of finance, mechanics of planning and promotion are vastly different from those required or used in rural industries. Rural industries are largely based on rural and local raw materials (from agriculture, forestry, mining etc), and largely supply a local or regional market or meet local requirements for engineering services, and depend on local labour and management. As the process of industrialization deepens, the use of non-rural raw materials in rural industries grows, extending to semi-finished and scrap metals, and to intermediate products obtained from larger plants in urban areas or imported from abroad. Provided the other characteristics of manpower sources and market criteria are met, these industries come within the scope of this paper.

The term "light-engineering workshop" will be used within the framework of the above definition of rural industry. It covers the manufacture of metal and wood-based final or intermediate products (excluding textiles or fibres, and chemical, food, leather, clay or ceramic products), and the provision of engineering services, such as the maintenance and repair of equipment, appliances and tools. The term "light" specifically excludes heavy-engineering products and activities within the engineering group.

The term "light" in the rural context will also have a special significance with regard to the technology levels and size of the workshops. On the one hand, the technologies applied are largely upgraded traditional or intermediate, and not advanced, technologies. While they involve mechanization of traditional manual processes and activities, highly sophisticated techniques and automation are not used. The more capital-intensive the industry, the greater the need for multi-shift production. Rural areas with limited industrial experience are not accustomed to the discipline and rhythm of multi-shift production, as may be observed during high-activity seasons in some food-processing industries located in rural areas. Moreover, the size of the workshops vary from artisan units to small and medium-sized establishments. Thus it may generally be stated that artisan workshops will be in the upgraded traditional-technology groups and the small and medium-sized workshops will have a mixture of both, i.e. upgraded traditional and intermediate technology.[2] Artisan workshops based on traditional technology such as traditional blacksmith workshops, will not be dealt with in this paper as the general objective in a process of industrialization is to upgrade technology in low-productivity and low-income activities so as to reduce the burden of physical work, increase productivity and incomes, and improve product quality. It is recognized, however, that in some rural communities, because of isolation, inadequate rural infrastructure, or lack of demand for sophisticated products, there is a need to promote workshops with traditional or slightly improved traditional technology levels.

With regard to the organization of production, light-engineering workshops in rural areas may be organized on a job-shop, batch-production or semi-continuous production basis, with the first two types of organization predominating except for a selected range of products supplied to large regional

[2]Some activities at the artisan level, such as automobile repair, will belong to the upgraded traditional and intermediate technology group.

markets. Workshops may also be set up or expanded to provide a combination of engineering services (maintenance and repair) as well as to produce components.

II. STRUCTURAL FEATURES OF DEMAND

Before dealing with specific demand for products and services that can be met by rural light-engineering workshops, it is necessary to examine the structural features of demand, on which certain policies are based. First, the rural area should not be seen as consisting of a single type of village with a standard demand structure for products or services, even within the same ecological region. Localities vary in size and activities, but they are economically, socially and culturally interdependent. In economic terms, certain localities have central functions to perform in respect of other localities, and since these functions have an effect on industrial activities, they should be identified and taken into account in considering the development of a particular type of industry in a given locality.

The central functions of certain localities often depend on size of the locality and of the hinterland which they serve, the communications network, and the economic activities and income level of the area. The centres are interrelated through the functions they perform, those at a lower level being generally less differentiated, or less specialized, than those at a higher level. For example, in respect of a single function like servicing agricultural machinery, the lower-level centres are multipurpose and undertake simpler and routine tasks, while higher-level centres perform more complex and specialized tasks. An understanding of the central function of certain rural localities is necessary for the location of both engineering service and engineering production industries, because the latter will also have to depend on obtaining adequate engineering and other services from the locality in which they are established.

It should be noted that the concept of a central locality serving a hinterland does not necessarily imply a concentric relationship, as in a series of circles enclosed by larger circles. Some regions particularly marginal resource areas, may have a linear or axial structure, with higher- and lower-level centres located along an axis such as a highway or railway, or there may be a combination of concentric and linear arrangements. The location of light engineering industries will depend largely on the above-mentioned functional relationships, which will also determine the role of local input and the possibilities of access to raw materials and markets. For example, a motor-vehicle workshop located in a small village along a main highway may have to deliver a fairly complex range of services in an axial arrangement, compared to a motor-vehicle workshop in a small village in a concentric relationship. On the other hand, the central functions of the two above-mentioned villages could be reversed if the workshops serviced agricultural machinery.

It is important to understand not only the localities performing central functions, but also the role of governments in identifying and developing the localities. All programmes of rural development include measures of urbanization, consisting in the provision of certain urban amenities and facilities such as schools, hospitals, recreation centres and administrative offices, and economic infrastructure such as electricity, roads, banks etc. This leads to

dispersed urbanization. The centres not only create a demand for engineering goods and services, but also encourage their development and improvement. In fact, there is a growing feeling that the lack of a wide network of urbanized localities slows down the pace of industrialization. Urbanization, which means more than the development of two or three large cities or metropolitan areas, and industrialization go hand in hand. The greater the emphasis of government policy on dispersed urbanization, the greater the likelihood of increased demand for engineering goods and services from dispersed production units.

Over and above the functional role of localities, it is necessary to understand the ecological conditions of a region, which determine the structure of the main economic activities carried out in it and the level of technology used in these economic activities. Some regional characteristics are described below:

(a) A highly irrigated agricultural region with a variety of food crops, fibre products, oil-seeds, or plantation crops such as tea and rubber, where the needs of the main productive sector will include agricultural machinery, food-processing equipment and engineering goods such as sluice gates and valves for infrastructure work,

(b) A rangeland or pasture area with rain-fed farming and animal husbandry, where there are differences in the types of agricultural machinery and the intensity with which they are used, and sheds and structures are associated with feedlots, dairying, wool and leather industries etc;

(c) A coastal belt with coastal exploitation of marine resources, boat building, fisheries etc.

Thus light-engineering manufacturing or servicing industries in rural areas will very much depend on the ecological characteristics of the area. Traditional technologies are also significant factors. For example, an area with buildings made of wooden vertical structures and sloped roofs will need supporting engineering industries different from those required for an area having brick walls and flat roofs.

In order to determine the most viable light engineering industries for a region, government plans for the region with respect to other non-industrial sectors of the economy and the region's natural growth trends should be understood. For example, a region selected for an intensive multipurpose development project (such as an undeveloped area or a river valley), would have considerable potential for light industry development as compared with similar regions going through a normal growth process. A chain of hamlets developing for the tourist industry along a sea front or in a mountain region will have different requirements in terms of building materials and fittings than an area being developed for intensive agriculture.

Attention has been largely focused on light engineering industries based on markets and services needed in an area. When rural engineering industries producing goods for larger regional markets or components under contracts with larger firms are considered, it has been generally found that they are seldom drawn into areas where such industries have no traditional basis for the supply of local or restricted markets. Sometimes, however, the proximity of or easy access to, large urban centres has spillover effects on some rural localities with regard to entrepreneurial and technical skills.

III. PROMOTION POLICIES

Promotional tools for rural light engineering industries should be discussed. Just as concentration by localities has been shown to have advantages, so concentration in selected sites within a locality would also have advantages. Industrial estates have been found to be an effective promotional tool for small and medium industry development, especially in urban areas. The same advantages of concentration, ease of access, power and advisory services, and possibilities of inter-servicing between units also exist for such estates (possibly organized on a smaller scale) in rural areas, though they have for various reasons met with limited success. There are two distinct types of industrial units which require two concentration patterns. The first is the artisan unit with upgraded traditional or partly intermediate technology, which can perform useful industrial functions and is best concentrated in rural workshop clusters located near a central village (which represents the lowest level of central functions). On the other hand, small and medium-sized rural light-engineering industries can best be organized in small rural estates or have an axial relationship on or parallel to a roadway.

In addition to the industrial estate and workshop-clusters, light engineering industries would need a full range of promotion services suitable for small to medium-scale industries, such as credit, technical guidance through extension services, the supply of controlled materials, marketing services and advice. In addition, they may require the establishment of co-operatives in specific types of industries, largely service co-operatives to facilitate the supply of raw materials and marketing.

With regard to training in rural light-engineering skills, special consideration should be given to rural industries. At the artisan level with upgraded traditional technology, what is needed is not specialized industrial trade skills common to large-scale industries, but certain composite skills covering the whole range of sub-processes and operations required to produce a product. At the lowest level of central functions, where a light-engineering workshop may be established in a rural area, a specialized trade of welding, turning or machining will not make it viable, as there will not be enough rural jobs in such specializations. On the other hand, what is needed is a general metal working tradesman or a general woodworking tradesman (instead of a separate joiner, furniture-maker, polisher etc.). Training institutions to meet such a requirement need to be set up in rural areas. Training requirements for light-engineering work in small to medium-sized rural, modern industries are more or less the same as those in other engineering industries in urban areas.

The technological policies on rural light-engineering industries should give this group of industries broad scope for innovation. As a general rule policy should not be too restrictive concerning higher levels of technological use in this leading industrial group. The general concept of all research and innovation starting at a central research and development institution and extending down to the machine manufacturing industry and then to the user is giving way to an understanding of the innovative capacity of repair and servicing workshops and small engineering workshops. They deal with readily recognizable and priority problems rather than long-term problems, and their answers are often practical

and readily applicable at a level of technology generally understood in a given milieu. A useful promotional tool for such workshops would therefore be to have a small highly technical advisory service to assist and encourage the development of innovative ideas. From such ideas a new product or a part is derived with considerable possibilities. Quite often though rural engineering industries may be equipped to manufacture a product or part, they may not have the necessary drawings or specifications, or the skills to understand the technical details. One of the responsibilities of such an advisory service is to provide both training in the reading of engineering drawings, and drawings and specifications of easy-to-make products in rural workshops.

While consumer demand for light-engineering products is highly differentiated in terms of rural and urban requirements, industrial demand for such products depends on the technological specifications of the processes and products of the urban-based light-engineering industries. Linkages are possible only on the basis of complementarity of production in rural and urban-based industries and not otherwise. Moreover, since both the sources of raw materials and the markets for urban-linked light-engineering industries are in urban centres, there is a tendency for such industries to mushroom and gravitate along the fringes of the urban centres, which does not conform to the definition of rural industries adopted in this paper. Nowhere have urban-linked rural engineering industries grown to serve the needs of urban-based engineering industries or to produce for urban consumer requirements, except in Japan and a few other developed countries like Sweden, in which cases the rural light-engineering industries concerned would elude the definition of rural industries adopted in this paper.

IV. DEMAND PROFILE

Attention has already been drawn to the complexity of demand in terms of the role and size of localities, ecological and regional considerations, government development programmes and industrial traditions. The whole range of possibilities is large, and therefore a demand profile is presented to facilitate selection and detailed analysis.

Although the profile covers all sectors of demand, whether for engineering products or services, it is considered largely from the point of view of the rural and urban sectors. However, rural light-engineering industries will be grouped not necessarily according to whether they serve agriculture, animal husbandry or rural construction, but on the basis of complementarity of technical processes and equipment.

The profile will cover the demand sectors of agriculture, rural crafts and manufacturing, transportation, rural construction and infrastructure, and rural household needs. Urban-linked, rural light-engineering industries will also be briefly reviewed. A second component of the profile will distinguish between engineering services and engineering products. A third component will define the type of service (general or specialized repairs), or the type of product (hand tools, equipment, spare parts, infrastructure items, packaging material etc.).

The needs of the agricultural sector consist in engineering services and engineering products and components. The engineering service requirements will depend on the level of agricultural technology in the region. The technology may be traditional, semi-modern with two wheeled tractors and related equipment, or modern with various sizes of four wheeled tractors and related equipment. The services for the latter two categories may be organized in various ways to deal with technical problems concerning, for example, the following: engine and transmission systems; electrical and instrumentation systems; mechanical and metal parts of tractors ploughs, cultivators, mowers, combine harvesters, pickers, balers etc.; tyre repair and vulcanizing. These services may cover other agricultural equipment such as pumps, sprayers, threshers and shredders. Workshops may specialize further, depending on the density of tractor use in a given area.

Several groups of engineering products and components may be manufactured, including the following:

(a) Agricultural hand tools such as sickles, knives, spades, pickaxes, hoes, forks, pruning-hooks, scissors. This group also includes items such as Persian wheel chains and buckets for lift-irrigation, or feed trays for chicken farms;

(b) Agricultural machinery or components, involving technologies of welding (of plates and hot-rolled sections), casting, forging etc. The items may include agricultural trailers, disc harrows and ploughs, ditchers, cultivators, mowers, seed drills, shovel and bulldozer blades, other components and parts of agricultural machinery, pumps and pump parts (e.g. rotors and blades), sprayers etc.

(c) Items for infrastructure work, such as barbed wire and wire-net fencing and poles, chicken-wire mesh, sluice gates, guides and valves for irrigation systems, sectional or tubular railings and gates for feedlots and pens etc.;

(d) Packing materials for agricultural products, such as light wooden boxes and crates, for which rejects from log sawing plants are normally used.

This list, is not exhaustive but representative of what may be considered for development.

The needs arising from the rural crafts and manufacturing sector may also be similarly large, and will depend on what exists or is being developed or promoted. These may similarly be divided into engineering services and engineering products and components.

Engineering services may be grouped according to whether they relate to an engine (or prime mover) or to the wooden and metal parts of the equipment or electrical systems.

Engineering products and components will vary greatly depending on the craft or industry. The following is a representative sample:

(a) Small hand tools for crafts and industrial processes, including combs and beaters for textile and carpet weaving, hammers, flaying and shaving knives for skins and hides etc.;

(b) Wooden equipment such as looms for cotton and silk weaving, spinning, winding and reeling; wooden trays for silkworm feeding, grading of cocoons, deflossing etc; carved-wood hand-printing blocks; and pallets for the transmission of loads;

(c) Sheet-metal equipment for dyeing yarn and textile materials (vats), storage drums and bins for various industrial processes, reflectors for solar heaters; brick-making moulds (could be of wood); ductwork for coolers, heaters, and solar heat transmission in rural industrial processes; bread-making trays etc.;

(d) Equipment and major components involving welding, forging and casting, for making textile and carpet looms (could be a combination of wooden and metal parts made in separate workshops), disintegrators, pug-mills, screw presses, screens and graders for clay, ceramics, bricks and stone products, rice hullers, rice shellers and wheat grinders or parts thereof. Other multipurpose devices for rural industry and the agricultural, transportation or construction sectors will be small mobile gantry A-frames, chain hoists, tackles and pulleys for lifting or moving water, bricks, materials etc.

As rural industrialization increases in variety, the need for equipment and parts will also increase. Transport needs, including the moving of people and materials from farm and factory to the village centre or a marketing centre, will depend on the communications infrastructure and the volume of traffic. Normally the bullock cart or a similar multipurpose means of transport is used in most developing countries for transport between farms and villages. The manufacture or improvement of the bullock cart is a useful village industry. But with growing affluence, personal means of transport such as bicycles and motorcycles, and specialized transport such as wheelbarrows, trolleys, trucks, pick-ups and dump trucks have come into use. A variety of wheelbarrows, hand trolleys and push-carts are being introduced for activities such as the transport of bricks in brick-kiln operations and of materials in the field, thus eliminating headloads and back loads. In addition to repair shops for bicycles, motorcycles, motor cars and trucks, the making of wheelbarrows and hand carts of various types is a fairly easy rural industry to introduce, and in coastal regions or regions having extensive waterways, existing traditional boat building can be easily upgraded. Such upgrading helps to improve not only manufacturing processing and productivity, but also fish catches, as improved boats are able to venture further out to sea or remain in inland waters in difficult weather or tidal conditions, whereas crudely constructed country craft are not.

Rural construction and infrastructure needs will depend largely on the type of buildings being constructed in the locality and the type of infrastructure being developed. They may include various types of building materials, basic structural materials and fittings and fixtures normally used in rural construction, including bricks, building blocks, cementation and roofing materials, structural frames, doors and windows etc.

Household needs will depend largely on the use of products from rural engineering industries. In traditional societies there may be a need for services such as the sharpening of knives and scissors, and for the manufacture of products from engineering workshops, such as simple kerosene stoves, or sheet-steel buckets, containers, utensils etc. With growing sophistication, needs become more complex and urban-rural differences diminish. At this stage of development, the repair services may cover repair of sewing and knitting machines, radios, televisions, cooking stoves, refrigerators, coolers, electric or kerosene room heaters etc. There may be a fairly large variety of manufacturing

possibilities, involving simple sheet-metal or welding jobs for the making of oil or coal heaters and stoves, simple evaporative (or "desert") coolers, wooden or metal household furniture, containers for water, grain and other household uses etc. Sometimes such work involves acquiring motors, gears etc. from urban industry and using them for the assembly of products such as room coolers.

There is considerable potential for the development of urban-linked rural light-engineering industries, but each product has to be carefully considered. The product groups that have been found suitable for manufacture in rural engineering workshops are, in general, those which are not too bulky for transport to urban areas, or in respect of which the stringency of urban environmental regulations (smoke, noise, dust etc.) can make a considerable difference in capital costs, or for which rural labour is found to be fairly skilled and as it would not require new housing and transport, less costly. In these respects, foundry products (ferrous and non-ferrous), or articles made by sheet-metal spinning (cooking vessels, pots and pans), which may be easily stocked and packed, would be suitable for manufacture in small localities.

V. PROFILE OF RURAL LIGHT-ENGINEERING WORKSHOPS

As stated earlier, workshops will tend to be more multipurpose and perform simpler functions at lower level village centres, and become more specialized and perform more complex functions at higher level centres. This general principle provides the basis for developing a profile of rural light-engineering industry, taking into account the physical, raw material and human resources likely to be available in a locality, and the markets they will serve. Not all types of light-engineering workshops can be described in detail in this paper, but a selection will be made and a profile developed.

The profile presented here distinguishes between two types of localities, namely small communities and rural market towns. The lowest level of small community considered may be called the central village, which is the least concentrated and performs easily accessible services. Since initial efforts by governments to promote rural industries will not cover whole countries, nor even all central villages (sometimes called development centres, service centres, or growth foci), there will be some degree of selectivity with regard to the centres at which such rural industries will be promoted. It is therefore assumed that prior attention will be given to those centres which offer the best prospects for sustained growth, in particular those already provided with electrical power. If such a situation does not exist because no electrical grid is available nearby, but the need for a workshop is considered sufficiently important, then arrangements will be made for a generator to be provided.

Rural market towns, on the other hand, are the highest-level localities servicing rural areas. The market town will be expected to have electricity, and with regard to social infrastructure, it should have at least a secondary school, a hospital or day clinic, and some form of local administration.

The profile presented here therefore deals, on the one hand, with light-engineering workshops in central villages engaged in multipurpose services and special and special-purpose production, and, on the other hand, with

light-engineering workshops in rural market towns engaged in multipurpose services and special purpose production and services.

Technical profiles for selected workshops in each of these categories will also be presented in this paper.

Industries have a greater chance for survival when they are linked to the community in which they are located by providing the products or services they need, or by using local inputs, or both. In small communities the workshops will be small, dispersed, backyard units which are not conducive to growth, and for which the provision of adequate infrastructure would be costly. It would therefore be better to organize the small multipurpose workshops in these communities into workshop clusters, which in their simpler form may consist of low-cost workshop buildings arranged in a row or in the form of an open square. As the size of the locality increases, these workshop clusters will become more complex and tend to become like mini-industrial estates.

The pattern of organization of rural light-engineering industries in rural market towns follows a different pattern from the one at central village level. Here there will be multipurpose workshops performing a variety of manufacturing operations and repair work, but of a heavier and more complicated nature, with heavier, more versatile equipment. For example, a multipurpose metal workshop will be able to repair metal parts of agricultural equipment, and also make to order some components or items such as trusses and sluice gates. Secondly, special-purpose service workshops will also be necessary and feasible. For example, tractor service will become much more specialized at this level. There would be a need for special workshops for calibration of injectors and pumps for diesel engines, or for workshops to deal with electrical problems of agricultural and road transport machinery, or with bodywork, panel beating and painting of motor cars, buses and trucks etc. Thirdly, there would be specialized production workshops, and since these are larger communities, possibilities for industries at this level to cater to regional, rural and urban needs do exist. Some of these specialized workshops will provide production services to other industries in an area, such as electroplating, heat-treatment, the manufacture of small parts, looms for weavers etc. (wire nails or wire mesh cannot be made in workshops since they involve a separate production process).

With regard to rural light-engineering industry linked to urban needs, it is not necessarily true that these urban needs are only those of a neighbourhood urban market. They could be based on a wider regional market. In such a case, three organizational subpatterns are known to exist. First, they could be single units producing final products, such as nails and hinges of various kinds, that are retailed through various retail stores in a region. The second subpattern emerges when an area becomes specialized in making a product, while the components are made in separate small workshops in a group of villages, and there are enterprises which do the final assembly. This is an interlinked subcontract pattern where all units are located in a rural area and each unit supplies its parts to several others. This pattern of organization has developed for the manufacture of padlocks, bicycle parts etc. Different small enterprises become specialized in casting, drop-forging of blanks and shapes, press-work, making tubular parts, machining, electroplating and painting. The third subpattern

arises when a large parent firm in an urban area subcontracts to one or several small enterprises in rural areas. This has occured for cycle parts, sewing-machine parts and similar products. In the second subpattern, a government agency takes the initiative in technology transfer, training, and providing general assistance. In the third subpattern, the parent firm assumes this role.

It is necessary to consider what is appropriate to a given country. There could be an infinite variation in the pattern of small and large workshops and service and production workshops that can be promoted in different countries. What has been proposed in this paper as general-purpose service workshops for central villages can in some countries be promoted in individual medium-sized villages not having much of a service role for neighbouring villages, and in some other countries can only be sustained in rural market towns. Therefore, the size and technological levels of workshops proposed in this paper are only suggestions. The application of such a pattern will require a proper assessment of the spatial and economic structure of rural areas in the country, and the design of a rural industries structure most appropriate to it.

The profiles presented in this paper are technical profiles and not techno-economic profiles. The economic aspects of these proposals including fixed assets, market size, the product-mix, costs of materials and labour, and the prices of products and services which the market can bear will all have to be examined in relation to a specific situation. Such an examination may lead to the combination of two or three workshops into separate workshops as suggested here, or to the splitting-up of the activities of large multipurpose workshops into several smaller ones. The technical profiles are therefore indicative and not definitive, although based on situations that exist or proposals made in selected countries.

While the technical profiles relate largely to capital equipment, it is also necessary to look at the requirements of raw materials, energy and consumables, and their availability in rural areas. For example, some equipment may require a very highly graded raw material falling within a very narrow specification range. Certain equipment may require electricity, gas or other forms of power or heat. Unless these are easily available in rural areas and their costs properly assessed, the danger of selecting very inappropriate equipment will arise.

The starting point of an assessment of what is appropriate to a given country situation is not only what already exists in different types and sizes of rural localities, but also what exists in urban localities as well in the country concerned. This should then be followed up by what constraints have prevented the development of industries in rural areas, and what are the specific needs of those areas. Such an assessment will determine the range of size and technology of the rural industry to be promoted, and forestall proposals that could result in the promotion of rural industries more sophisticated than their urban counterparts and unsuitable for rural needs and possibilities.

Various questions requiring closer consideration are listed below:

(a) Do the definitions of rural localities, rural industries and light engineering industries as given in this paper apply to a given country situation?

(b) Are rural localities performing certain easily identifiable central functions of different kinds? Can such an identification result in rational location

patterns for rural light-engineering industries? What are the contents of rural and regional development programmes and what infrastructural development features of the programmes help in the promotion of rural light-engineering industries?

(c) What is the demand profile for light engineering industries in the country? From what sectors and activities does the demand arise? What is the range of size and technology within which rural light-engineering industries can be promoted in a given country? What are the overall capital-labour ratios which can be used?[3] Is there a role of upgraded traditional technology at the lower end of the scale, lower than those indicated in the technical profiles given for central villages?

(d) What promotional agencies and institutions exist for such a programme, and are they adequate? What support services do they provide in the fields of training, credit, organization and consultancy? Do their services reach out to rural areas and are these services geared to rural needs?

(e) Is there a need for protection of rural light-engineering industries as nascent industries, at least for a specific period? Can regional authorities provide such protection?

(f) What kind of working conditions will be created in rural light-engineering industries, and should those conditions be different in large-scale and small-scale industries? In all the cost elements provided in this paper, there is a need to add basic elements of safety equipment and first-aid facilities. To what degree of sophistication should medical facilities be made available to match those in large industry, and at whose cost?

(g) To what extent should costs of basic elements of infrastructure be prorated to small-scale industries in an area or be borne by governments? Should separate consideration be given to infrastructure specifically needed for enterprises, and that required for a whole area, such as power supply, roads, gas supply, workers, housing etc.?

VI. WORKSHOPS AT THE LEVEL OF THE CENTRAL VILLAGE

Some characteristics of central villages are given below:

(a) It should be a village with a population of 5,000–6,000 and a service area covering 10–15 villages having a total population of 20,000–25,000;

(b) From 40 to 70 per cent of the labour force will be engaged in agricultural and allied occupations and the balance in non-farm occupations;

(c) Adequate infrastructure will have to be created for light-engineering workshops in the locality by means of a workshop cluster;

(d) Electricity will have to be provided from a grid or by generator. Other

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[3]The capital-labour ratios (excluding building costs) of the small workshops considered in the technical profiles vary from $266 to $1,000 per worker for those at the central village level, and from $1,000 to $2,086 per worker for those at the rural market-town level.

central fuel depots for oil and gas, if not already available, will have to be established;

(e) Training and advisory services should be available on a regular basis nearby.

Although the repair and maintenance services of the workshops will be meant for the hinterland villages, production will not be marketed solely in these villages. The size of workshops may therefore vary considerably from country to country. The central village will normally not have adequate infrastructure for the establishment of workshops of this category. Therefore workshop clusters, as described below, will be needed.

Description. The size of the cluster and the number of workshop units required will depend on a market evaluation of the needs and entrepreneurial capabilities of the community. Entrepreneurial capabilities can be improved by suitable technical and entrepreneurial training programmes. The two main functions of the cluster units will be to provide, on the one hand, community-oriented services and some related production, and on the other, small-scale specialized production.

The workshop cluster need not have all units engaged in light-engineering industry. There could be other industries in the field of textiles, food processing, leather products etc., but not units which could cause smoke problems (e.g. timber-drying plants or brick kilns), or foul smells or effluents (e.g. leather tanning).

Ownership pattern. As far as practicable, ownership of the entire cluster should be vested in the community or in the next level of government administration. A village council or a broad-based rural co-operative union would be best suited for such ownership. Land should be donated, government land allotted or private land purchased at minimum cost. Costs of development and construction of workshop buildings should be covered by development bank or government loans on easy terms, and actual construction costs should be controlled. The allocation of premises, management, rent collection and repairs should be at the local level. Units could be sold outright, but the right to recover the premises if not used, or if not used for the particular purpose intended, shall remain with the local body. Working units in a cluster can suffer if a number of neighbouring units remain closed or are used as storehouses, offices, or for social or commercial purposes.

Location and sizes. Since a large number of units will provide services to the community, the cluster should be located close to or within the central village. Adequate land space should be set aside for present and future development. Part of the land should be made available for the construction of workshop buildings based on user specifications.

Assistance required. A government agency will have to provide initial assistance in size selection and layout, and in building designs and specifications.

Layout and building specifications. A variety of arrangements would be possible, depending on the village layout, the configuration of the land, the approach roads etc. Two simple layouts for workshop clusters are shown in figures I and II. One is a straight-line arrangement, the other more complex. The layout

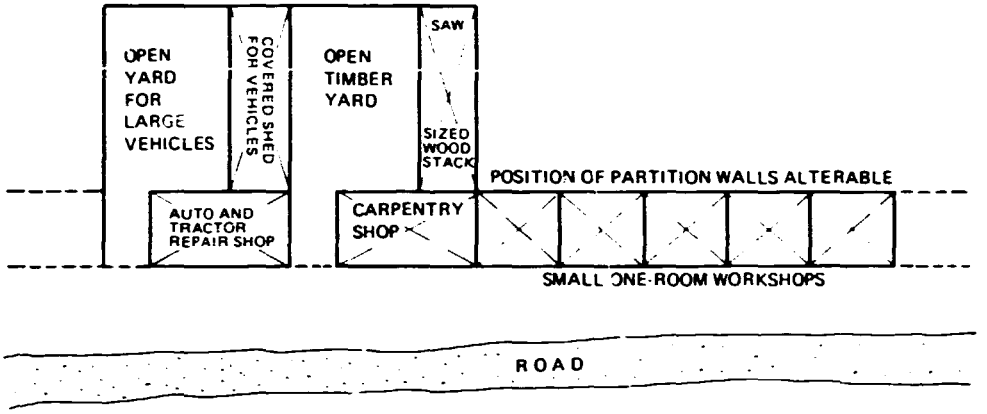

Figure I. Straight-line arrangement for a small workshop cluster

should take into account the need for units that will service motor vehicles or for tractors to have a protected yard. Two building sizes are proposed. The smaller units would be of standard size, while the larger units would be constructed in such a manner that the separating walls between units would be put up after clients have been selected and their requirements are known. The buildings should be of light but permanent construction using local materials and labour as far as possible. The roof should be gabled with light roofing materials if weather

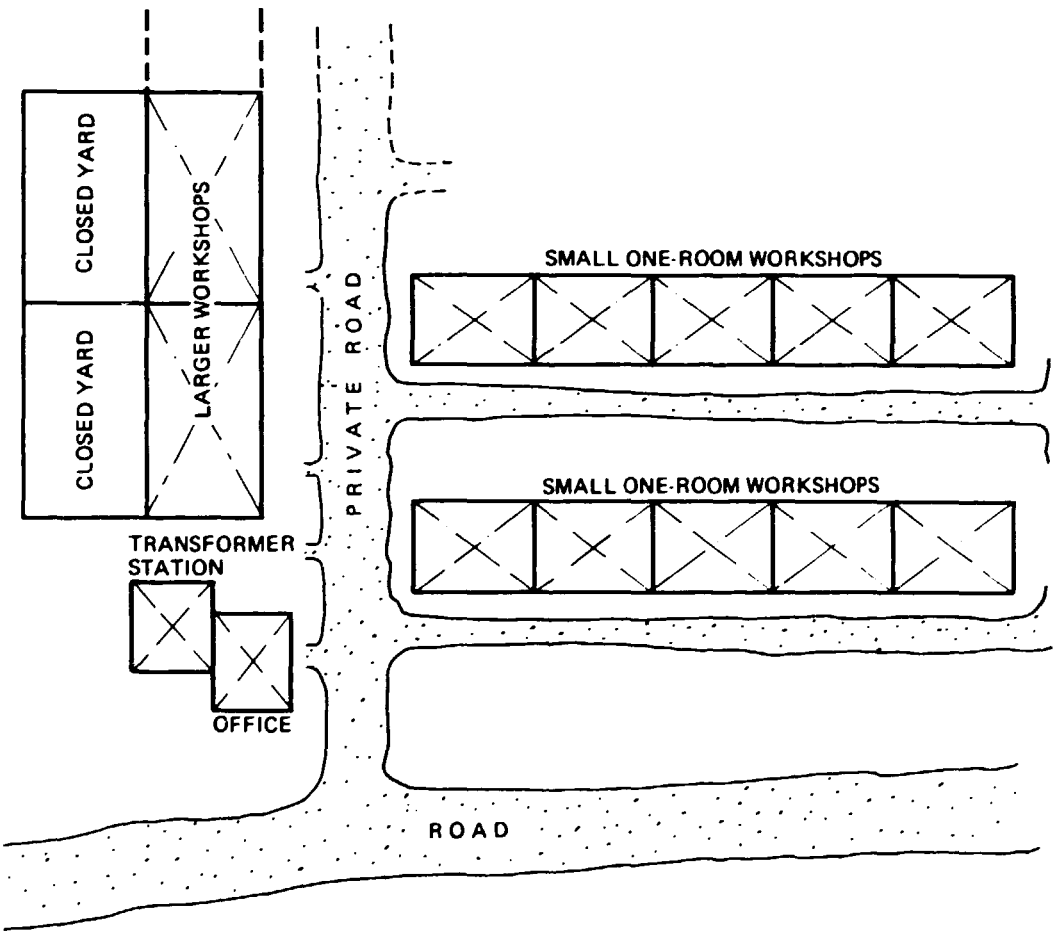

Figure II. Alternative arrangement for a larger workshop cluster

conditions permit, and if possible, not sharply in contrast with local architectural features.

Costs. No cost estimates are given as construction costs vary considerably from country to country and region to region. The rent structure and possible savings will depend largely on government policies on rural industrialization.

A. General-purpose service workshops

Upgraded artisan-level metalworking shop

The shop must be able to provide complete services for all simple machinery and tools used in the area. The servicing of more complicated items such as broken gearwheels or bearings should be obtained from a higher-level village.

Product and service description. The shop will perform a variety of equipment maintenance services for farmers, craftsmen and others, and produce some locally required implements and hardware. The use of improved materials and tools and the training of skilled workers will lead to improved varieties of traditional blacksmiths' products.

A representative selection of products and services is given below:

(a) Sharpening, tempering and hardening of agricultural and handicraft tools and implements such as knives, sickles, chisels, scissors, mower blades;

(b) Manufacture of tools and hardware such as nails, rivets, hinges and wall brackets;

(c) Simple repairs of metal parts of agricultural machinery and tools requiring welding, riveting or bending.

Market aspects. All sales and services will be done at the shop, and sufficient storage space should be available for common materials such as profiles and sections, plates, sheets, ready-made rivets, bolds, nuts and screws. When a number of units are set up in a cluster, or similar units are set up in different clusters, the possibility of co-operative purchases should be examined.

Initial assistance will be required for fitting out the shops, installing machinery and ensuring power supplies.

As the unit will be in a workshop cluster, the other units in the cluster will provide mutually supporting services. Machinery and equipment requirements are shown in table 1.

A covered floor area of approximately 70–80 m^2 is required. Larger assembly and welding jobs could be done oudoors, weather permitting. Therefore an enclosed yard should be available.

Manpower requirements are indicated below:

Labour force	*Number of persons*
Owner, supervisor, worker	1
Welder	2
Blacksmith and fitter	2
Semi-skilled workers	3
Total	8

TABLE 1. EQUIPMENT REQUIREMENTS

Description of equipment	*Number required*	*Estimated price (US$)*
Fitters' work-bench, 60 cm × 200 cm, with 2 vices of 140 mm and drawers	1	700
Drill stand for use with portable heavy-duty drill	1	100
Pedestal grinder, 20 cm, double-ended	1	500
Transformer-type arc welding machine and accessories, 120–150 A		2 500
Portable electric drill-cum-grinders	2	500
Anvil, forge with fan blower and sledge-hammer	1 set	250
Set of measuring and marking tools and holding devices (scales, callipers, dividers, gauges, angles, clamps, V-blocks etc.)		
Set of metal-working hand tools and cutting tools for machines (hammers, wrenches, chisels, pliers, screwdrivers, hack-saws, files, drill bits, screw tops and dies etc.)		2 000
Office table and chair		300
Total		6 850

A part-time accountant may also be needed.

The owner-operator should preferably be trained in a vocational training centre for metal trades, and skilled workers in rural vocational training centres.

The shop could be used by government agencies for on-the-job training programmes after trainees have had an initial period of basic training, with the on-the-job training linked to related instruction programmes.

The shop may start initially without a lathe, which may be acquired later.

Upgraded artisan-level sheet-metal and pipe shop

Product or service description. The shop will perform a variety of repair and maintenance services and small-scale production for rural needs. A representative selection of products and services is given below:

(a) Tinsmiths' work such as repairing lanterns and oil burners and tinning of vessels;

(b) Locksmith work;

(c) Making or repairing simple containers, bins etc. for grains, water and oil. Making medium-sized water tanks;

(d) Making or repairing Persian-wheel buckets and chains where such lift irrigation systems are in use;

(e) Making or repairing brick moulds, bread-baking trays, winnows, trays for dryers of fruits, tea and cocoons;

(f) Making ductwork, rainwater drain pipes and spouts, where such items are used with sheet metal;

(g) Pipe-fitting of pumps, overhead tanks and community water taps, and in public buildings such as village bath houses;

(h) Making wheelbarrows with sheet metal, pipe bending and use of wheels and bearings as purchased components;

(i) Spray painting and brush painting.

Not all these products or services will be required in all central villages in every country. Much will depend on the traditions of the area and evolving life-styles and needs. The combination of two separate trades has been made in order to ensure the viability of the occupation.

Market aspects. Most of the production and services will be done at the shop, except the pipe-fitting jobs, which will be done at the premises of the user. It will be useful to stock some sheet metal and pipes and pipe fittings, washers, taps, etc. A supply co-operative among units in a cluster may be advantageous.

Expert assistance will not be required if the owner or enterpreneur is a trained worker.

As the unit will be in a workshop cluster, the other units in the cluster will provide mutually supporting services.

Machinery and equipment requirements are shown in table 2.

TABLE 2. EQUIPMENT REQUIREMENTS

Description of equipment	*Number required*	*Estimated price (US$)*
Hand shear for sheets and plates up to 3 mm	1	250
Gas-welding machine with cutting, brazing set and oxygen and acetylene cylinders	1	750
Portable electric drill	1	250
Soldering irons, electric and furnace types	4	50
Spray painting set and compressor with rating of 6 bars	1	200
Plate-bending machine (manual) for plates up to 3 mm	1	75
Roll-bending machine (manual) for hot and cold bending		
Straight edges, mallets, hammers, clamps, snips and cutters, punches etc. for sheet-metal work		
Simple measuring and marking devices (scales, callipers, scribers, angles, gauges)		1 500
Tools for pipe work (leg or pipe vice, hack-saws, adjustable pipe cutters, pipe-threading dies, files, pipe benders etc.		
Soldering, brazing, tinning tools and blowlamps etc.		
Table and chair		200
Total		3 275

A covered floor area of approximately 40–50 m² is required. Most of the work can be done inside the workshop.

Manpower requirements are indicated below:

Labour force	*Number of persons*
Owner, worker	1
Tinsmith and sheet-metal worker	1
Gas welder and spray painter	1
Semi-skilled worker	1
Total	4

The owner should preferably have received training in sheet-metal work in a vocational training centre, and the skilled workers in rural vocational training

centres. The shop could be used by government agencies for on-the-job training of workers who have received basic training.

Phased development of the shop would not be necessary.

Upgraded artisan-level joinery workshop

Product or service description. The workshop is intended to meet all production and repair requirements of wooden furniture items, fixtures, building components, wooden agricultural implements etc. A representative selection of products and services is given below:

(a) Making or repairing wooden ploughs where such items are used. If an improved plough is to be introduced, such a workshop would be suitable for producing and promoting it;

(b) Making and repairing of bullock or horse carts, cart-wheels etc., by improved methods of turning;

(c) Making institutional furniture, e.g. school benches, chairs, study tables, furniture for government offices, clinics etc.;

(d) Making household furniture such as that used in the region, e.g. beds, baby-cribs, chairs, tables. Polishing and painting;

(e) Making wooden door and window frames, shutters and simple roof truss components for on-site assembly;

(f) Making or repairing wooden textile and carpet looms, winding devices etc.

Regional needs for furniture, housing, agriculture and crafts will vary considerably. An area poor in forest resources and where wood is costly will make greater use of steel products, tools, and components. A proper assessment is therefore necessary.

Market aspects. Almost all production and services will be done at the workshop. Arrangements would be needed for the supply of good wood, seasoned naturally or in a kiln. A sawmill must be available nearby for sawing timber to the correct size.

No assistance is required if the owner or entrepreneur is a trained worker, except for the initial installation of electrical equipment.

Equipment requirements are shown in table 3.

TABLE 3. EQUIPMENT REQUIREMENTS

Description of equipment	*Number required*	*Estimated price (US$)*
Electrical band-saw, 1 m, with 1.25 cm blade	1	800
Multipurpose woodworking machine (planer, circular saw, groover, mortiser)	1	2 000
Woodworking lathe	1	1 000
Portable electric drill	1	150
Woodworking work-bench with 2 vices	1	500
Measuring, marking, holding tools and fixtures Normal range of woodworking hand tools (chisels, files, saws, hammers, mallets, drill bits, mitre-box with saw etc.)		1 000
Total		5 450

A covered floor area of approximately 70–80 m^2 will be required. An open covered area of 25–30 m^2 will also be required for stacking wood for natural seasoning and storage.

Manpower requirements are indicated below:

Labour force	*Number of persons*
Owner, worker	1
Joiner and band-saw operator	1
Cabinet-maker, universal wood-machine operator	2
Semi-skilled worker	2
Total	6

The owner needs to be trained at a vocational training centre for joinery and cabinet-making. The other skilled workers should be trained in rural vocational training centres for general woodworking.

The workshop could be used by government agencies for on-the-job training of workers who have completed basic training. The on-the-job training period should be linked with related instruction programmes.

Phased development of the shop would not be required.

General electrical workshop

In many rural areas, although electricity has been provided, no facilities for house wiring, simple installations, repairs and maintenance of electrical apparatus have been developed. Such a workshop is designed to meet this need.

Product or service description. The workshop is needed in all central villages supplied with electricity. It will provide all types of services for the households, rural industry and agriculture of the central village and its hinterland, including the following:

(a) Wiring in private houses and institutional buildings;

(b) Wiring and small switchboard installation for motors and other apparatus such as agricultural pumps, small industry fans, mixers and blowers;

(c) Installation of radio and television aerials and earthing in homes and institutions, as well as refrigerators, coolers, stoves and such other domestic and institutional electrical apparatus (including those in hospitals, clinics, schools and offices) as have come into use in rural areas;

(d) Simple repairs and maintenance of motors and electrical apparatus, such as testing of faults in motors, cleaning of commutators and slip-rings, changing of brushes, changing or repairing heating elements in room-heaters, toasters, water-heaters etc.

Market aspects. Some of the services will be provided at user premises and some at the workshop. The workshop needs to store for sale or use ordinary electrical hardware such as bulbs and tube lights, switches, tube-light starters, fuses and fuse wire, wiring, conduits and conduit fittings etc.

Expert assistance will not be required if the owner is a trained worker.

As the unit will be in a workshop cluster, the other units in the cluster will provide mutually supporting services.

Equipment requirements are shown in table 4.

TABLE 4. EQUIPMENT REQUIREMENTS

Description of equipment	*Number required*	*Estimated price (US$)*
Work-bench with small vice of 90 mm and drawers	1	400
Portable electric drill with vertical drill stand	1	300
Multimeter, voltmeter, ammeter, ohmmeter, energy meter, insulation tester, all to be mounted in a switchboard (except the multimeter) with switches, fuses and small transfomers	1 set	150
Wire strippers, wire cutters, insulated pliers, line tester, long-nose pliers, rubber gloves etc.	1 set	50
Common hand tools (hack-saw, screwdrivers, chisels, hammers, pipe threader die, spanners, wrenches)	1 set	100
Total		1 000

The workshop need not be bigger than 3 m^2 for both the retail store and repair work.

Manpower requirements are indicated below:

Labour force	*Number of persons*
Owner, worker	1
Semi-skilled worker	1
Total	2

The owner-operator should have attended a general electrical engineering course covering both house-wiring and apparatus repair in an urban or rural vocational training centre. The semi-skilled worker should preferably have received training in house-wiring only.

There would be no phased development.

Workshop for servicing and simple repairs of agricultural and road transport machinery

Product or service description. The role of the workshop may be compared to that of a first-aid station or day-clinic. It will perform services which are too costly for individual tractor, truck or car owners to undertake on their own premises or to have done in a distant market town. The types of services to be performed are as follows:

(a) Cleaning, oiling, greasing, oil changing, draining and cleaning oil and petrol tanks, changing oil and air filters, checking and changing spark plugs;

(b) Providing a complete battery service, including checking, fluid topping, charging and recharging, and leakage testing;

(c) Providing a complete tyres and tubes service, including pressure testing, changing of tyres and tubes, vulcanizing;

(d) Brake testing, changing of brake pads and liners, bleeding of the system, adjusting;

(e) Testing and correcting of simple electrical faults, cleaning and changing distributor and contact points;

(f) Repairing structural parts of vehicles in collaboration with a metals shop.

The need for such services will depend on tractor density in the central village and its hinterland, and on the density of other materials and personnel transport vehicles in an area. Sometimes if the village is on a highway, it will depend on the density of traffic and the distance from the last unit providing such services. In the latter case, it could be combined with a petrol station.

All services will be provided at the workshop. Items such as oil, grease and common types of oil filters, contactors, fuses etc. could be kept in stock for sale.

No expert assistance will be required if the owner is a trained worker.

If the unit is part of or near a workshop cluster, a considerable amount of inter-servicing could be made easier, such as in welding and fitting, electrical jobs, painting etc.

Machinery and equipment requirements are indicated in table 5.

TABLE 5. EQUIPMENT REQUIREMENTS

Description of equipment	*Number required*	*Estimated price (US$)*
Work-bench with one vice of 140 mm and drawers	1	400
Electronic water pump with hose and nozzle (assuming water is to be obtained from a well or similar source)	1	250
A-frame with chain hoist	1	150
Portable electric drill with drill stand	1	300
Battery charger	1	150
Garage jack	1	500
Tripod axle stands	4	200
Pedestal grinder and buffer	1	400
Diesel-engine nozzle tester	1	300
Coils and condenser tester	1	200
Gear oil dispenser	1	250
Voltmeters, ammeters, plugs	1	150
Switches and switchboard, brake-lining machine	1	500
Vulcanizing equipment	1	50
Tyre mounting stand	1	150
Hand tools, drill bits, files, hammers, wrenches, wheel pullers, grease guns, spanners, screwdrivers, pliers, taps and dies	1	400
Total		4 350

About 60–70 m^2 of covered area will be required, together with a covered ramp and trench for underbody work.

Manpower requirements are indicated below:

Labour force	*Number of persons*
Owner, worker	1
Skilled worker	2
Cleaner	2
Total	5

The owner should have had a course on diesel and petrol engines in a vocational training centre, and the skilled worker should have been trained in mechanics or agricultural machinery engines in a rural vocational training centre.

There would be no phased development. Such a workshop may develop the range of service it provides as the clientele grows.

B. Special-purpose production workshops

Multi-product cast-iron foundry

This type of foundry will be capable of supplying small parts and components weighing up to 20 kg and made of grey cast-iron, grade 14 to 17. Its products will be needed by workshops and establishments at village level producing simple metalworking products. It is possible for such a foundry to expand the activities of related metalworking establishments in 10–25 villages. The viability of the foundry depends on local demand for trained manpower available at central village level.

TABLE 6. EQUIPMENT REQUIREMENTS

Description of equipment	*Number required*	*Estimated price (US $)*
Cupola furnace for melting liquid cast-iron, capacity of 1/2 t/h, inside diameter of cupola, 30 cm, height of cupola, 3.0 m, with blower and motor, roof board and cupola lining	1 set	5 000
Charging hoist and structure, capacity of 0.5 t	1	300
Core oven and sand-conditioning equipment	1 set	2 000
Mould-making machine with maximum casting capacity of 30 cm^3 of steel	1	2 500
Core boxes for floor moulding (various sizes)	40	1 000
Platform scale for weights of 0–1.0 t	1	1 000
Ladles, capacity of 500 kg	1	300
Ladles, capacity of 100 kg	2	300
Hand shanks and ladles, capacities of 10–20 kg	6	200
Crane system with 1-t hoist	1 set	2 000
Shovel, riddles and screens		500
Double-ended grinding machine, wheel diameter of 30 cm	1	500
Tumbler, two air grinders, chipping hammers		800
Wheelbarrows	4	200
Exhaust fan and air compressor, about 50 l/s at a pressure of 8 bars	1 of each	2 500
Pattern-making shop		
Band-saw with a 12.5-mm blade	1	800
Wood-working tools		500
Belt sander	1	300
Hand-operated cross-cut	1	400
Drilling machine of 12.5 mm for mild steel	1	500
Wood-working lathe with a turning diameter of up to 15 cm	1	1 000
Total		22 600

Market aspects. The users would be small workshops manufacturing metalworking products in villages. The method of sales would be based on job orders ranging from single-unit castings to mixed-product batch castings. The potential market would be the local villages. A feasibility study would be necessary before investment.

Expert assistance would be required for training in foundry management and metallurgy, and pattern, core and mould making.

The foundry would be linked with various other industries, in particular the following: multi-product metalworking establishments at village level, woodworking establishments, repair shops for tractors and for automobile and agricultural implements.

The material specifications are as follows: grey cast-iron, grade 14 to 17, maximum casting weight of 20 kg.

With regard to production volume, a cupola furnace with a capacity of one half tonne (t) per hour will be charged two or three times a week depending upon the work-load. Output per week will be 10–12 t of liquid metal.

Machinery and equipment requirements are indicated in table 6.

The following supplies are needed for operating the cupola: pig iron, scrap, coke for casting, wood for pattern making, moulding sand, fire bricks, fire clay, flux, core sand, core oils, wires, rods, chaplets.

The following floor area is required: covered 24 m × 30 m = 720 m²; open 30 m × 30 m = 900 m².

Manpower requirements are indicated below:

Direct labour	*Number required*
Skilled	6
Semi-skilled	5
Unskilled	12
Indirect labour	
Manager and foreman	2
Accounts clerk	1
Pattern-maker	2
Office and sales clerk	1
Watchman	1
Total	30

Special attention should be given to training the following personnel for foundry activities: mould-maker, cupola-charger and pattern-maker.

Figure III shows the layout of a typical foundry of this type.

Multi-product forging shop

Product description. This type of small forging shop will produce simple agricultural hand tools and implements such as spades, digging forks, hoes, cultivators, sickles, scythes, harvesting knives and lifting hooks for wells. These simple hand tools for agricultural operations are mostly used by small farmers in the developing countries. In urban areas they are used for gardening work. It is rather difficult for plants of this size to market their products in urban areas. As they depend on potential demand at village level, the local market should be carefully surveyed.

Market aspects. The users would be gardeners and small farmers holding up to 2 hectares (ha) of land. Sales would be organized through village hardware shops or direct dealings with the farmers. The products could be marketed in about 25 villages. Feasibility studies may not be required, but a realistic market assessment can be carried out before investment in plant and machinery.

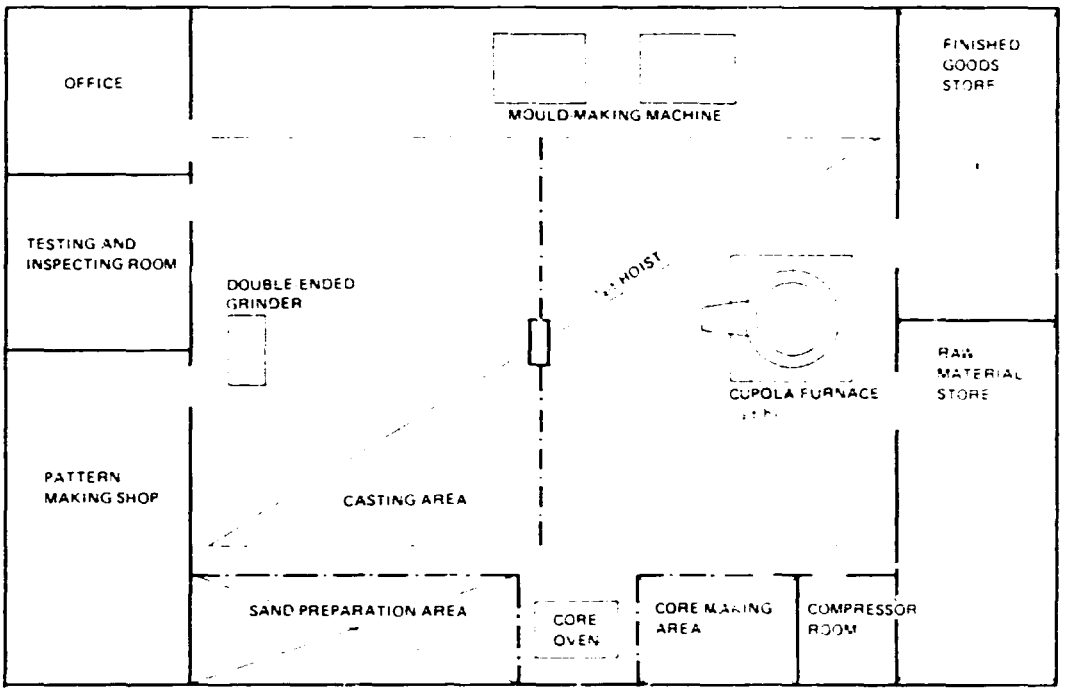

Figure III. Multi-product cast-iron foundry at central village level

Expert assistance would be required for training in various forging techniques. Training in heat treatment would help to improve tool quality.

The shop would be linked with the woodworking industry or local carpenters for the procurement of wooden handles. The material for hand tools must conform to SAE-1078, while the specifications for carbon and manganese are, respectively, 0.72 to 0.85 and 0.30 to 0.60. The material is suitable for forge and heat treatment.

On an annual basis of 250 one-shift working days, the production volume would be as follows:

Product	*Units per year*
Hand spades	2 500
Digging forks	1 500
Hand hoes	1 500
Hand cultivators	2 000
Sickles	2 000
Scythes	2 000
Harvesting knives	2 000
Total	13 500

Machinery and equipment requirements are indicated in table 7.

TABLE 7. EQUIPMENT REQUIREMENTS

Description of equipment	*Number required*	*Estimated price (US $)*
Power shear for 6-mm steel plate	1	500
Coal- or oil-fired furnace, 0.5 hp motor, 60 cm × 60 cm × 45 cm	1	5 000
Quenching tank (steel) of approximately 1.0 m^3	1	500
Anvil with pedestal, weight of 500 kg	4	250
Double-ended pedestal grinder, 1.0 hp, 30-cm wheel	1	400
Double-ended polishing machine 0.5 hp, 30-cm wheel	1	400
Manual roll-bending machine for 12-mm thick rod (hot)	1	250
Manual plate-bending machine for 12-mm thick plate (hot)	1	300
Electric arc-welding machine, 250 A	1	400
Blacksmith's tools, 12-m capacity portable drill, paint can and brushes, standard tools etc.		600
Miscellaneous		500
Total		9 100

A plant of this type requires a covered floor area of 15 m × 12 m = 180 m^2. Manpower requirements are indicated below:

Direct labour	*Number required*
Owner, worker	1
Skilled	5
Semi-skilled	2
Unskilled	2
Indirect labour	
Accounts clerk (part-time)	1
Storekeeper, production recorder, sales clerk	1
Total	12

Special attention should be given to the training of personnel in heat treatment processes.

Figure IV shows the layout of a typical shop of this type.

Multi-product metalworking shop

This type of multi-product metalworking shop plays an important role in village industry. It produces various products and parts for the agricultural sector and for household use and interlinks with many other industries at village level. Improvement in transport facilities will help to increase activities of this type of industry. Its viability largely depends on potential demand at village level. Local markets should therefore be carefully surveyed.

Product description. A plant of this type will produce various sheet-metal welded products, simple agricultural implements and textile equipment, steel joinery and many other metal-based products. Some of these products are indicated below:

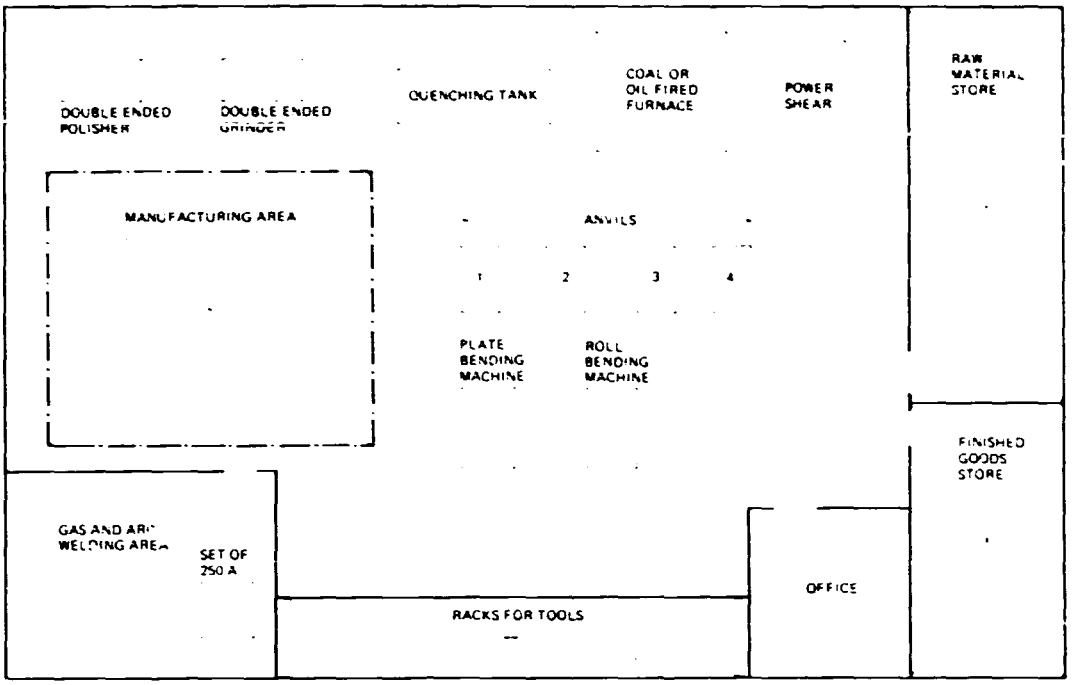

Figure IV. Multi-product forging shop at central village level

Steel joinery: racks, small cupboards, doors and window frames, gates, sluice gates and guides

Steel containers: tanks, small silos, hopper dyeing vats

Household articles: sheet-metal mugs, funnels, cans, buckets, steel T-joints and elbow-pipes

Agricultural implements: assembly of harrows, tillers, ploughs, small (two-wheel) trailers, screw conveyors

Rural textile machinery: dyeing machines, simple textile parts for hand looms, carpet looms

Market aspects. The prospective users of products from this type of plant would include farmers, villagers, textile and hand-loom weavers, small contractors for buildings and village infrastructure and shopkeepers. Some products would be sold directly to the customer and often manufactured according to the customer's order. Some would be sold through retail village stores. The potential market could extend over a wider area. Such a shop can obviously develop only in a central village having a substantial servicing role and a tradition in metalwork.

A feasibility study is not essential, although a detailed market assessment must be carried out before the investment is made. Expert assistance in design and manufacturing techniques will improve product quality. As the plant will handle various types of products, the introduction of simple production management techniques is essential. It will be linked with various other industries, including the following: woodworking, hardware, transport, building contracting and agricultural implements.

The following materials are essential: mild steel, EN 1 series; sheet metal, 12 SWG to 22 SWG, galvanized or ungalvanized; mild steel plate up to 1.5 cm

thick; mild steel section, round, square, hexagonal channel, T, I, Z-sections required for door and window frames.

On an annual basis of 250 one-shift working days, the production volume would be as follows:

Product	*Units per year*
Steel joinery	400
Steel containers	200
Household articles	5 500
Agricultural implements	100
Textile machinery	100
Products made to customer orders	Up to plant capacity

Machinery and equipment requirements are indicated in table 8.

TABLE 8. EQUIPMENT REQUIREMENTS

Description of equipment	*Number required*	*Estimated price (US$)*
Power hack-saw, for rods up to a maximum of 7.5 cm in diameter	1	1 100
Hand shear, for plates up to 3-mm thick	1	250
Pedestal grinder, 30 cm in diameter double-ended	1	800
Upright drilling machine, 2.5 cm in diameter, mild steel	1	5 000
Lathe, 7.5-cm maximum bore, 45-cm swing, maximum length of 1 m	1	6 000
Electric arc-welding machine, 250 A	1	1 000
Gas-welding sets and brazing sets		1 000
Welding fixtures and tools		500
Flyball press, 3 t	1	1 000
Manual roll-bending machine, rod (hot) up to 4 cm in diameter	1	300
Portable hand-drill gun up to 1.25 cm in diameter, mild steel	1	150
Portable grinder with wheel diameter up to 15 cm	1	200
Oil- or coal-fired furnace, 60 cm × 60 cm × 75 cm	1	4 000
Anvils with pedestal, 500 kg	4	600
Quenching tanks, approximately 1.0 m^3	1	300
Various small tools		300
Hand nibbling gun for 1.5-mm thick mild steel	1	300
Paint brushes, mixing tank etc.		200
Total		23 000

A plant of this type requires a covered area of 48 m × 28 m = 1,344 m^2 and an open area for manufacturing work of 30 m × 30 m = 900 m^2.

Manpower requirements are indicated below:

Direct labour	*Number required*
Skilled	12
Semi-skilled	5
Unskilled	6
Indirect labour	
Manager	1
Accounts clerk	1
Draughtsman, foreman	1
Inspector	1
Watchman	1
Labourer	2
Total	30

Special attention should be given to the training of welders, fitters, turners and heat treatment personnel.

Figure V shows the layout of a shop of this type.

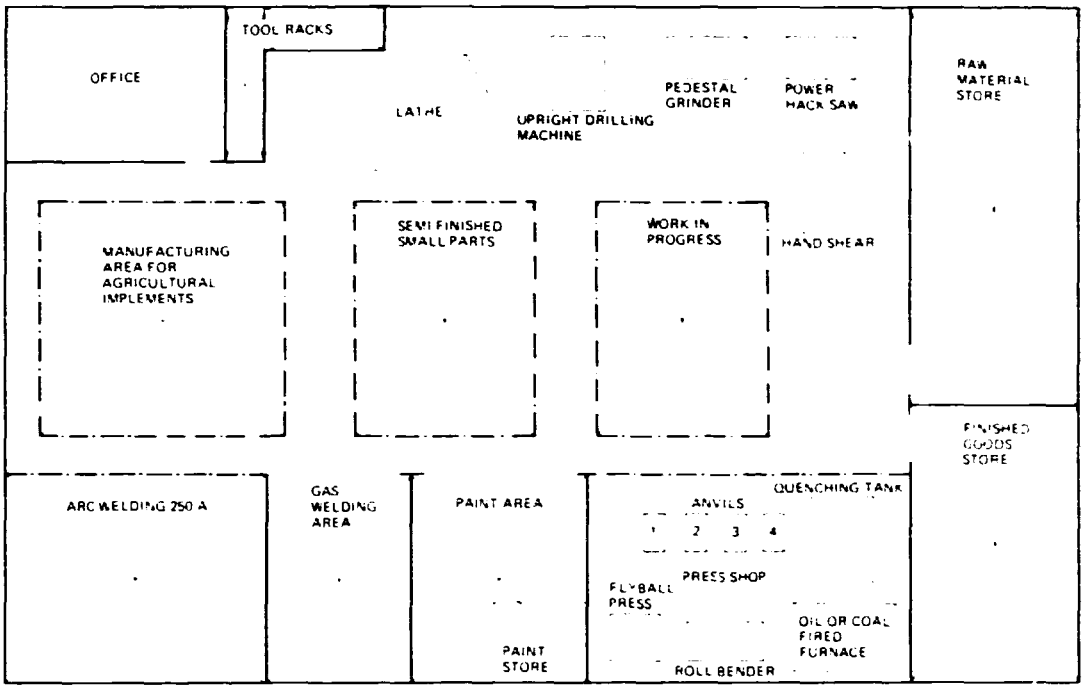

Figure V. Multi-product metalworking shop at central village level

Production shop for fruit and vegetable crates

Product description. This type of small shop will produce the following items:

Wooden vegetable crates, 30 cm × 60 cm × 30 cm and 45 cm × 75 cm × 30 cm

Wooden fruits crates, 25 cm × 45 cm × 10 cm and 45 cm × 75 cm × 15 cm

Wooden pallets, 90 cm × 60 cm × 25 cm, or according to customer specification

Wooden racks

Wooden ladders

These products are essentially required by farmers and shopkeepers. They may be easily produced from any type of cheap wood or even from waste wood of large saw mills in urban or rural areas. The crates may be manufactured by nailing together wooden strips. This type of plant should be set up in areas where intensive vegetable and fruit production takes place. Where better quality crates are required, in some cases for knocking down when empty and reassembly at the farm, then more attention should be given to wood specifications and manufacturing methods.

Market aspects. The users of products from this type of plant would include small farmers, orchard owners, fruit and vegetable buyers, middlemen and co-operatives. The products would be sold directly to the customer. They could

be marketed in 10 to 15 villages. However, the transport of empty crates to long-distance customers is not economical if cheap crates are used. A feasibility study may not be required, and no expert assistance will be needed. These shops will be linked with other industries, including the following: woodworking, packaging, hardware, and vegetable and fruit co-operatives.

The material required is any soft or hard wood, and particularly waste wood from large woodworking or packaging industries.

On an annual basis of 250 one-shift working days, the production volume would be as follows:

Product	*Unit per year*
Vegetable crates	150 000
Fruit crates	150 000
Wooden pallets[a]	800
Racks[a]	200

[a] According to customer specifications.

Machinery and equipment requirements are indicated in table 9.

TABLE 9. EQUIPMENT REQUIREMENTS

Description of equipment	*Number required*	*Estimated price (US $)*
Stationary or hand-operated cross-cut saw	1	500
Planer and thickness planer	1	2 000
Band-saw	1	1 000
Assembly table	1	100
Vice	1	50
Hand-drill gun, mild steel, 12 mm in diameter	1	100
Small tools, hammer etc.		250
Total		4 000

A plant of this type requires a covered area of 30 m × 21 m = 630 m² for the manufacture of crates etc, and an open area of 30 m × 15 m = 450 m² for storage of crates prior to delivery.

Manpower requirements are indicated below:

Direct labour	*Number required*
Skilled	2
Semi-skilled	8
Unskilled	2
Indirect labour	
Accounts clerk (part-time)	1
Sales clerk, supervisor	1
Labourer	1
Total	15

Basic joinery training is adequate.

Figure VI shows the layout of a shop of this type.

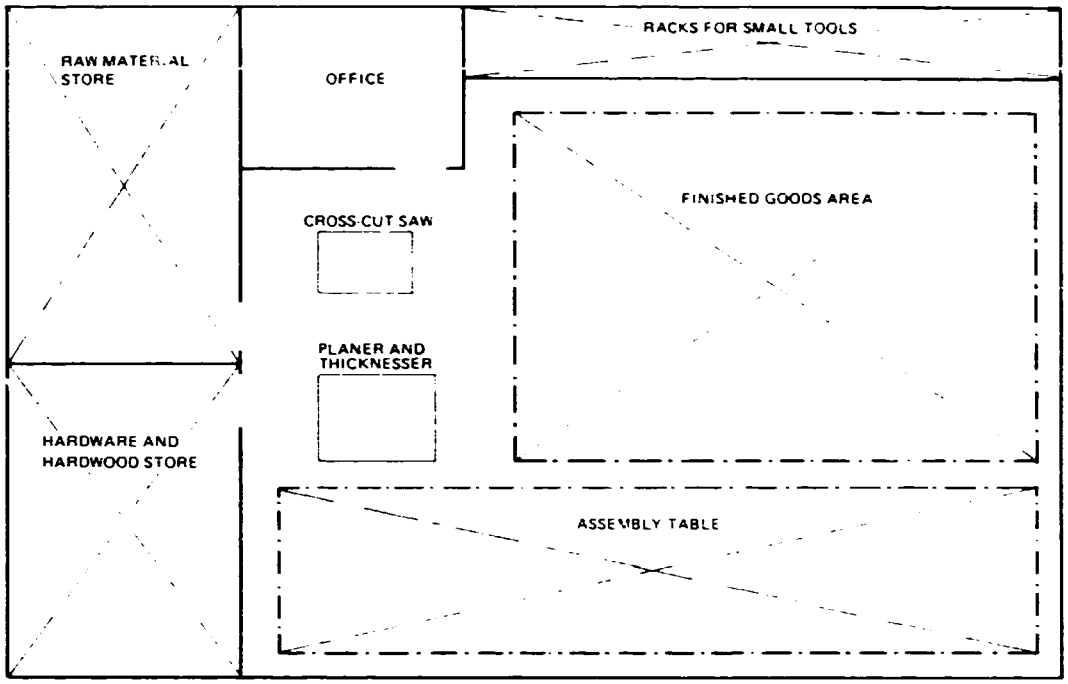

Figure VI. Production shop for fruit and vegetable crates at central village level

VII. WORKSHOPS IN RURAL MARKET TOWNS

The characteristics of a rural market town are as follows:

(a) A smaller percentage of the labour force is engaged in agriculture than in a central village, but most non-farm activities will be designed to meet the needs of rural areas rather than large urban centres;

(b) The demand for materials and products in the market town should be such that an expansion of trade due to the marketing of products and services by new industries can be absorbed;

(c) While some infrastructure for such industries will exist in the market town, more adequate infrastructure will have to be created in the form of larger workshop clusters and small industrial estates;

(d) Power supplies should be available, but additional power will be required for small industrial complexes;

(e) Training and advisory services should be readily available.

While the service industries will meet the needs of the market town and its hinterland, the production units may serve a larger rural and urban regional market.

The specific infrastructure needed for such rural industrial development would be of two kinds. On the one hand, the group of service workshops, whether multipurpose or special purpose, will need to be close to or inside the market town. These should preferably be arranged in the form of a workshop cluster. On the other hand, the group of production workshops, which are larger units, should preferably be outside the town, organized in a small industrial

estate, or established alongside of, but off, a main highway and provided with most of the infrastructure required in an industrial estate, including link roads. The size of such an estate will depend on the growth potential of the town and its hinterland. Workshop clusters are dealt with in section VI, and industrial estates are described in several UNIDO publications.

The assistance required from government agencies will relate to the selection of sites, preparation of site layout, building plans and specifications, and possible supervision of construction. The actual management of the premises, whether it is a workshop cluster or a small industrial estate, will have to remain in the hands of a local or regional body concerned with the market town.

A. Special-purpose service workshops

Workshop for the testing and calibration of diesel-engine pumps and injectors

The highly specialized work of testing and calibrating diesel-engine pumps and injectors can be made into a viable occupation for one person having a workshop in a fairly small room and doing only such work, provided certain conditions are met. Some of these conditions are as follows:

(a) There should be a high density of tractors, diesel road vehicles and diesel stationary engines in the area serviced by the market town;

(b) Owners of such engines should be conscious of the need for such testing, adjusting and calibration in order to avoid fuel waste, pollution etc.;

(c) There are strict government regulations on highways passing through the town regarding pollution arising from diesel fumes.

If the above conditions are met, the servicing of 3–5 pumps a day for 250–300 days a year would be possible.

No detailed profile of such a workshop is provided here, as this is covered below in the technical profile of the large repairs, maintenance and components manufacturing workshop.

Workshop for body repairs, panel-beating and painting of road transport vehicles

Product and service description. This workshop will provide a specialized service for the body work of automobiles, trucks and buses. The main types of service will be as follows: removing body dents, panel beating, shaping and smoothing; applying prime coat of paint, finishing coat and polishing; repairing or changing upholstery, door linings and beadings, seat repairs etc.

Such a specialized service can become viable if there are sufficient motor cars and buses in the area served by the market town. The tractor density of an area will not be important for this purpose, though tractors do require some body work at times. The flow of traffic on a highway passing through the town will also not be important, as highway users passing through a town do not use such a service.

Expert assistance will not be required if the owner is a trained worker. On the other hand, as this is specialized work, links with other service units will be

necessary. Even before dent-removing starts, electrical wires or instrument connections near the dent will sometimes have to be removed or disconnected. It would therefore be useful to have specialists available in these areas. Hence a workshop cluster arrangement is ideal.

Machinery and equipment requirements are indicated in table 10.

TABLE 10. EQUIPMENT REQUIREMENTS

Description of equipment	*Number required*	*Estimated cost (US$)*
Portable electric drill and buffer with vertical stand	1	250
Portable electric or pneumatic nibbler	1	150
Pedestal grinder with wheels, 20 cm, double-ended	1	500
Angle bender	1	
Work-bench with one vice (14–15-cm capacity)	1	400
Garage jack	1	500
Tripod axle stands	4	200
Large screw expander (adjustable)	1	75
Spray paint set with spray gun	1	200
Set of hand tools		500
Total		2 775

The shop requires a covered floor area of approximately 50–80 m². Part of this space will be secluded for spray painting jobs. Preliminary jobs can be done in an open yard, weather permitting.

Manpower requirements are indicated below:

Labour	*Number required*
Owner, worker	1
Panel beater	1
Semi-skilled worker	1
Total	3

The owner should have received training in sheet-metal work and spray painting and finishing, and been apprenticed for at least a year in a good garage. The panel beater should have been apprenticed in such work for 1–2 years.

There will be no phased development. The work may be expanded to include signboard making and painting, and the making and painting of sheet-metal products, provided such items are in demand.

B. Special-purpose production workshops

Large foundry and forging shop

A large foundry and forging unit in a rural market town can act as a launching pad for greater industrial activities, particularly in the wider metalworking sector. On one hand, it would produce parts and objects for capital-goods industries, and, on the other hand, it would promote a subcontracting system for many small industries. The existence of such a basic industry will facilitate rural industrialization. It is possible for a foundry of this

nature to expand the activities of related metalworking establishments to 200 villages. The prospect of viability depends on potential demand both in rural and urban areas. Market potential should be carefully surveyed before the investment in plant and machinery is undertaken.

Product description. This type of plant will produce the following items:

Grey cast-iron castings (grades 14 to 17) of up to 100 kg, for manhole covers, brackets for agricultural implements, various parts for sugar, oil-seed and rice mills, parts for drainage systems, chequered plates, electrical and telephone transmission brackets, junction and cable boxes, small castings for small metalworking shops in village and urban areas etc.

Brass castings up to 40% Cu, 60% Zn of up to 1 kg, for pump impellers, valve gland bodies, taps and water fittings and bush bearings

Aluminium castings (duralumin) of up to ½ kg, for pulleys, wheels, brackets, electrical claddings, junction boxes etc.

Steel products such as shovels, prongs and tongues, cultivators, electrical brackets for high-tension transmission, hammers, chisels and shear blades

Market aspects. The users of products from this type of plant would include metalworking shops, building contractors, roadworks contractors, water supply networks, builders of telephone and electrical transmission structures, agro-industries, automotive industries etc. The products would be sold directly to the customer on a job-order basis. They could be marketed in local and wider rural areas, and also urban markets. A feasibility study would be necessary before a commitment on investment is made. Expert assistance, particularly training, would be required in the following areas: foundry, technology, pattern making, metallurgy and core and mould making. These plants would be linked with industries such as metalworking, coal, wood, agricultural machinery and construction work.

The foundry will be capable of producing grey cast iron from 14 to 17 grade in the form of shaped castings weighing up to 100 kg and brass and aluminium casting weighing up to 0.5 kg and 1.0 kg respectively.

A cupola furnace with a capacity of 1.5 t/h will be charged twice a week depending upon the work load. Output per week will be 30 to 40 tonnes of liquid metal of grey cast iron.

Machinery and equipment requirements are indicated in table 11.

TABLE 11. EQUIPMENT REQUIREMENTS

Description of equipment	*Number required*	*Estimated price ($US)*
Cupola furnace with a capacity of 1.5 t/h for melting liquid grey cast iron; inside diameter of cupola, 60 cm; height of cupola, 4.5 m with blower and motor, roof board, cupola lining etc.	1	10 000
Charging hoist and structure with a capacity of 1 t	1 set	700
Core oven and sand conditioning machine	1 set	3 500
Moulding machine with maximum casting capacity, 45 cm × 30 cm × 30 cm	2	5 000

Description of equipment	*Number required*	*Estimated price (US$)*
Core boxes for floor moulding (various sizes)	100	2 500
Platform scale reading up to 2 t	1	1 500
Ladles, 1-t capacity	2	1 200
Ladles ½-t capacity	2	600
Ladles, 100-kg capacity	2	300
Hand shanks and ladles, 20 kg, 10 kg, 5 kg	6	200
Crane system with 1-t hoist	1 set	2 000
Shovel, riddles and screens		500
Double-ended grinder, wheel diameter of 30 cm	2	1 000
Tumbler, grinder, chipping hammer		800
Pneumatic fettling machine	1	700
Wheelbarrow	3	300
Exhaust fan	1	150
Compressor set, capacity of about 100 l/s at 8 bars	1	3 000
Pattern-making shop		
Woodworking lathe, workpiece of up to 7.5 cm in diameter	1	1 200
Band-saw, blade of 12 mm	1	800
Belt sander	1	300
Hand-operated cross-cut saw	1	400
Drilling machine mild steel, 12 mm	1	500
Woodworking tools		500
Foundry testing equipment		
Core-testing equipment	1 set	300
Sand-testing equipment	1 set	200
Laboratory equipment	1 set	2 000
Non-ferrous brass foundry		
Indirect oil-fired crucible furnace capable of producing liquid brass, capacity of 300 kg per charge, complete with pyrometer, ladles etc.	1 set	8 000
Resin core-making machine and oven	1 set	3 000
Pneumatic fettling machine	1 set	500
Non-ferrous aluminium foundry		
Indirect oil-fired crucible furnace capable of producing liquid aluminium, capacity of 100 kg per charge, other facilities obtainable from the main ferrous foundry	1 set	3 000
Forging shop		
Power shear, 6 mm-thick steel plate	1	500
Oil- or coal-fired furnace, 60 cm × 60 cm × 45 cm	1	5 000
Mechanical spring forge, 10-t capacity for hot forging, 3-hp motor	1	8 000
Quenching tank, capacity of about 1.0 m^3	1	500
Anvil with 500 kg pedestal	4	250
Double-ended polishing machine, 0.5 hp, wheel 30 cm in diameter	1	400
Manual roll-bending machine for 18-mm thick plate (hot)	1	250
Manual plate bending machine for 12-mm thick plate (hot)	1	300
Electric arc-welding machine, 150 A	1	300
Blacksmith's tools		600
Miscellaneous		250
Total		71 000

A plant of this type would require the following covered areas:

Foundry: 1,275 m^2

Pattern-making shop: 15 m × 10 m = 150 m^2

Forging shop: 25 m × 20 m = 500 m^2

The total covered area required is therefore 1,925 m². A total open area of 900 m² will also be required.

The following supplies would be needed to operate the cupola: iron, scrap, coke for casting, wood for pattern making, moulding sand, core sand, fire bricks and clay, flux, core oils, rods and chaplets.

The forging shop supplies would consist of the following:

Steel, specification SAE 1,078, 0.72–0.85 carbon, 0.30–0.60 manganese

Carburizing steel, EN 32, 32A, 34; quenching oil, furnace oil etc.

Supplies for the non-ferrous foundry would include the following: brass ingots 40% Cu, 60% Zn, or 30% Cu, 70% Zn; aluminium ingots (pure or duralumin); core sand (50 mesh), moulding sand, resin, furnace oil, charcoal etc.

Manpower requirements are indicated below:

Direct labour	*Number required*
Skilled	18
Semi-skilled	10
Unskilled	15
Indirect labour	
Manager	1
Foreman	2
Pattern maker	2
Accountant	1
Clerk	2
Sales clerk	1
Inspector	3
Production recorder	2
Storekeeper	2
Watchman	1
	60

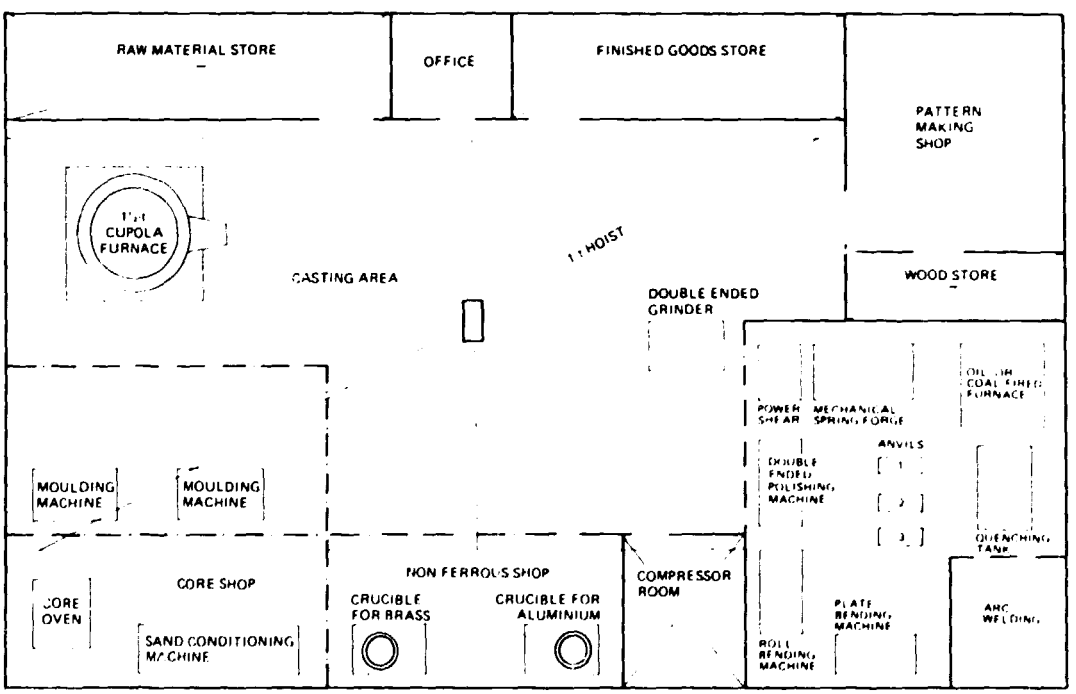

Figure VII. Large foundry and forging shop in a market town

Particular consideration should be given to the training of the following foundry and forging personnel: foundry technologists (ferrous and non-ferrous), mould makers, cupola chargers, pattern makers and heat treatment operators.

Figure VII shows the layout of a shop of this type.

Multi-product household metalware shop

Such a multi-product metalworking shop will cater to the needs of rural households. The products of this industry can even be marketed in urban areas. The prospect of viability depends on potential demand both in rural and urban areas. Potential demand should be carefully surveyed before making an investment decision.

Product description. This type of shop will be able to produce the following items:

Aluminium kitchenware, e.g. pots, pans, cooking vessels, spoons and saucepans, up to 45 cm in diameter

Simple aluminium lampshades up to 25 cm in diameter

Corrugated aluminium roof sheets from aluminium sheets up to 1.5 mm in thickness, size 2.4 m × 1.2 m

Kerosene farm lanterns (mild steel sheet)

Tubular furniture (simple steel tables, chairs etc.)

Market aspects. The users of products from this type of plant would include village, rural market town and city inhabitants, as well as hotel and catering services. The products would be purchased directly from the factory and also through agents, distributors and wholesalers. They could be marketed for local and wider rural and urban market areas. A feasibility study would be important before investment is considered. Expert assistance, particularly training, would be required in the following areas: design, development and adaptation; metal spinning and flow forming; sheet-metal welding and brazing techniques. These shops would be linked with the following sectors of industry: hardware, galvanizing, wicks, rubber, foundries and sheet-metal for ferrous and non-ferrous parts.

The products would have the following specifications:

Aluminium circles, 7.5 cm, 12.5 cm, 17.5 cm and 25 cm in diameter, 0.8 to 1.5 mm thick, with zero annealed condition for spinning

Aluminium sheets, up to 1.5 mm thick, 2.4 m × 2.4 m, giving products 2.4 m × 1.2 m in size

Kerosene farm lanterns, galvanized mild-steel sheet, 18 SWG, 2.4 m × 1.2 m

Kerosene stoves, brass sheet, 20 to 22 SWG, 2.4 m × 1.2 m

Tubular furniture, mild-steel tubing, standard 12, 18, and 25 mm in diameter

On an annual basis of 250 one-shift working days, the product volume would be as follows:

Product	*Units per year*
Aluminium kitchenware (mixed product)	150 000
Aluminium roof sheets	100 000
Kerosene farm lanterns	10 000
Kerosene stoves	10 000
Tubular furniture	10 000

Machinery and equipment requirements are indicated in table 12.

TABLE 12. EQUIPMENT REQUIREMENTS

Description of equipment	*Number required*	*Estimated price (US$)*
Hand shear, mild-steel, 12-mm thick	1	500
18-cm spinning lathe complete with revolving centres, two-speed motor, two-speed starter, 10 spinning tools, trimming and beading slide	1	2 500
30-cm spinning lathe with same specifications as in preceding item	1	5 000
Treatment vats with electrical heating	1 set	1 000
Roll corrugation machine, 3.0-m wide with variable profile corrugation system	1	10 000
Tube-bending machine to bend mild steel tube 25 mm in diameter up to 270	1	2 500
Tube-expanding and tube-narrowing machine	1	2 500
Hammer riveting machine to rivet brass or aluminium up to 6 cm in diameter	1	3 000
Lathe 7.5-cm maximum bore, 45-cm swing, 60-cm maximum length	1	5 000
Upright drilling machine for drilling up to 1.0 cm in mild steel	2	7 000
Pedestal grinder, double-ended, wheel 30 cm in diameter	2	1 600
Double-ended polishing and buffing machine	4	2 500
Capstan lathe with hexagonal turret and attachment wing	1	7 000
Electric argon arc-welding for aluminium, 100 A	1	1 000
Electric arc-welding machine, 250 A	1	1 000
Flyball press	1	250
Portable drill and grinder	2	250
Roll-bending and flat-bending machine	2	500
Compressor set, capacity of about 100 l/s at a pressure of 8 bars with spraying equipment	1	3 000
Spinning dies		4 000
Welding fixtures		2 000
Small tools		1 000
Bins, stillage, racks, pallets		3 000
Delivery van	1	4 000
Miscellaneous		900
Total		71 000

A plant of this type requires a covered area of 60 m × 30 m = 1,800 m² and an open area of 60 m × 30 m = 1,800 m².

Manpower requirements are indicated below:

Direct labour	*Number required*
Skilled	25
Semi-skilled	10
Unskilled	15

Indirect labour	
Manager	1
Supervisor, foreman	2
Accountant	1
Accounts clerk	1
Sales clerk	2
Inspector	3
Production recorder	2
Storekeeper	1
Driver	1
Watchman	1
Total	65

Particular consideration should be given to the training of personnel in the following activities: design and product development, metal flow forming and welding.

Figure VIII shows the layout of a shop of this type.

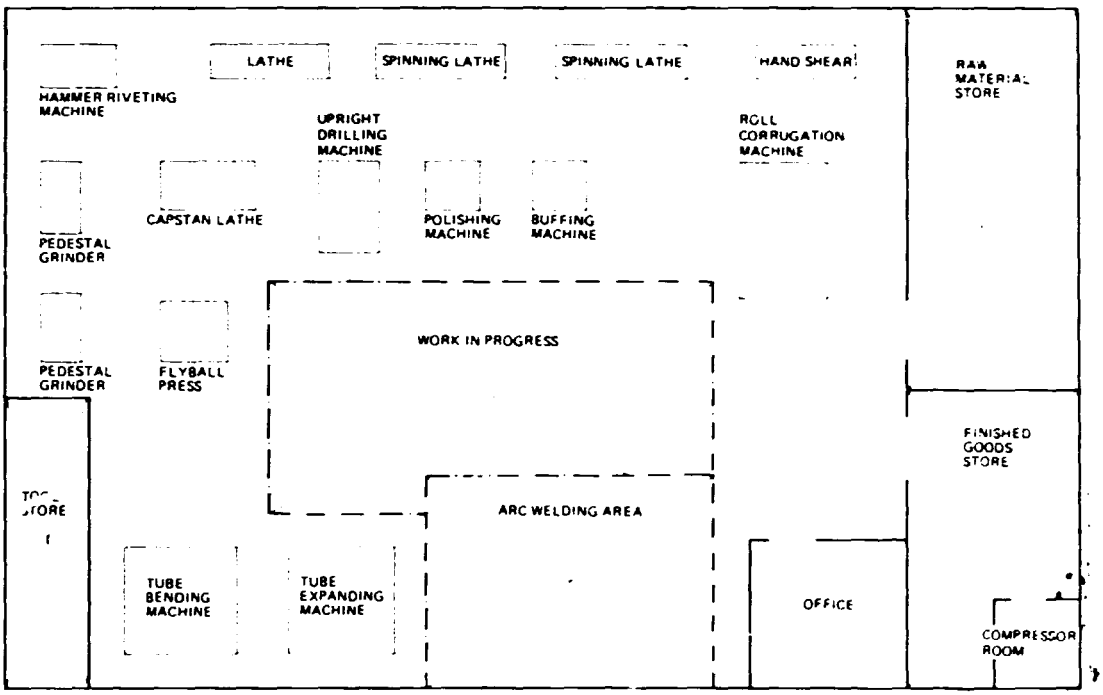

Figure VIII. Multi-product household metalware shop in a market town

Workshop for large repairs, maintenance and the manufacture of spare parts

Large repair, maintenance and spare-parts manufacturing workshops are essential for efficient operation of industries and agricultural machinery in rural areas. This type of service and facilities will improve the productivity of the industrial plant and transport system in rural areas. A careful assessment of market demand for such services is essential before establishing such factories in rural market towns.

These workshops repair automobiles, tractors, electric motors, generators, compressors, air conditioners, pumps, hammer mills, agricultural implements and all types of machinery and equipment for agro-industries. In particular, the following items are repaired: sheet metal (panel beating, painting); exhausts,

inlet manifolds, radiators, pumps, silencers etc. for automobiles and tractors; transmission parts; hydraulic parts; and engines.

The maintenance work includes preventive maintenance of automobiles, tractors, plant and machinery of small factories, including testing of diesel and petrol engines, electric motors, generators, wheel balancing and armature winding.

The manufacture of spare parts includes small items such as flanges, couplings, joints, bush bearings, links and rods, stub axles, gears, straight and helical shafts, splined shafts, keys, pins, special bolts and nuts, pipe joints, connecting-rod pins, crankshafts, rear axles, impellers and bush bearings.

Market aspects. The users of this type of workshop would include private and public transport establishments, private owners of automobiles and tractors, such as farmers and domestic users, and small industries in greater rural areas. The products would be sold directly to the consumers. They could be marketed in local and larger rural areas serviced by a market town. A feasibility study will be necessary.

Expert assistance will be required in the form of training in the following areas: heat treatment; welding; testing (mechanical, electrical and hydraulic); machine shop technology, including various application of tools, jigs, fixtures etc; and preventive maintenance. These shops would be linked with the following industrial sectors: woodworking, hardware, automobiles, agricultural machinery, rubber, plastics, electrical equipment and metals.

The products have the following specifications:

Various mild-steel sections, round, hexagonal, shaped into angles, tees and squares

Sheet metal, 14 to 22 SWG standard dimensions

Ferrous casting, cast iron, 14 to 17 grade

Brass casting, 40% Cu, 60% Zn, ingots and scrap

Brass sections, square, round, hexagonal etc.

Aluminium castings, duralumin

Aluminium sections, round, hexagonal, square

High carbon steel, EN 8, EN 24T, EN 42 (spring)

Case-hardening steel, EN 32 series

Machinery and equipment requirements are indicated in table 13.

TABLE 13. EQUIPMENT REQUIREMENTS

Description of equipment	*Number required*	*Estimated price ($US)*
Lathe for turning and screw cutting with all accessories; maximum swing, 90 cm; between centres, 180 cm; maximum length of thread, 20 cm; maximum diameter of thread, 15 cm; maximum pitch 5 threads per cm	1	15 000
Capstan lathe with hexagonal turret and all accessories; diameter of hole through spindle, 6 cm; maximum swing of spindle under overhead support, 35 cm; maximum distance of spindle flange to turret, 85 cm; maximum length of bar stock, 20 cm	1	12 000

TABLE 13 (*continued*)

Description of equipment	*Number required*	*Estimated price (US $)*
Universal milling machine with compound dividing head and vertical milling attachment with all gear-cutting accessories; capacity, 75 cm × 45 cm × 50 cm; 18 speeds ranging 26 to 1,250 rpm; 18 feeds from 1.75 cm min; universal head, 24 cm in diameter	1	20 000
Knee-type milling machine with accessories, 75 cm × 120 cm × 50 cm; 18 speeds ranging 26 to 1,250 rpm; 18 feeds from 1.75 cm min	1	8 000
Horizontal boring machine with sliding head, swivelling work-table, and all accessories; maximum diameter of face and bore, 150 cm; vertical spindle traverse, 20–160 cm min; revolving table, 120 cm × 120 cm	1	15 000
Cylindrical grinding machine with internal grinding attachment and accessories; grinding wheel size, 50 × 20 × 5-cm bore; maximum diameter, 25 cm; maximum distance between centres, 180 cm; roller face length, 120 cm; maximum weight of roll, 160 kg	1	18 000
Surface grinding machine with magnetic table and accessories; size of table, 50 cm × 20 cm; longitudinal travel, 55 cm; transverse travel, 20 cm; grinding wheel, 20 cm in diameter	1	10 000
Radial arm drilling machine with universal table and accessories; spindle radius, 1.8 m; drilling capability 7.5-cm diameter in mild steel; speeds, 15 to 1,500 rpm in 17 steps feeds, 0.1 to 0.75 mm sec in 6 steps	1	12 000
Upright drilling machine; drilling capability, 7.5-cm diameter in mild steel; speeds, 15 to 1,500 rpm in 17 steps; feeds, 0.1 to 0.75 mm/sec in 6 steps	2	10 000
Heat treatment furnance, maximum temperature up to 1,200° C, oil-fired, 60 cm × 60 cm × 90 cm	1	8 000
Quenching tank, 1 m^3	1	500
Eccentric press, capacity of 50 tons, blank thickness up to 3 mm in mild steel	1	8 000
Tube bending machine; maximum tube diameter, 5 cm in mild steel	1	3 000
Nibbling machine; maximum tensile strength of plate, 80 kg mm^2; edge cutting up to 3 mm; number of strokes per minute, 2,800 to 1,400; maximum circular cutting, 70 cm in diameter		5 000
Shearing machine; shearing mild-steel plate, up to 12 mm; shear length, 2.5 m; strokes per minute, 15	1	6 000
Electric arc-welding machine, 500 A	1 set	2 500
Electric spot-welding machine; maximum thickness of material, 6 mm in mild steel	1 set	3 000
Oxyacetylene welding set	1 set	1 000
Crankshaft turning machine; length of shaft, 90 cm; pin diameter up to 15 cm	1	15 000
Crankshaft grinding machine; length of shaft 90 cm; pin diameter, 15 cm	1	10 000
Crankshaft metal-spraying attachment; maximum deposition, 6 mm	1	3 000
Portable tools and equipment		2 000
Twist drill grinder, 0.8 to 75 mm	1	1 000
Universal cutter grinder; maximum diameter, 20 cm; table, 30 cm × 30 cm	1	8 000
Small lathe; swing, 15 cm; distance between centres, 30 cm	1	3 000
Hydraulic testing equipment with pressure up to 200 bars	1 set	2 000
Electrical motor testing equipment	1 set	2 500
Brake load testing dynamometer for petrol and diesel engines with coupling up to 250 b.h.p.	1 set	5 000

Description of equipment	*Number required*	*Estimated price ($US)*
Wheel balancing machine	1 set	2 000
Electrically driven compressor, 150 l/sec at pressure of 8 bars	1 set	8 000
Forklift truck, battery-operated, with charger	1	12 000
Fitter's bench, cupboards, tables etc.		2 000
Small tools, equipment, accessories		4 000
Armature winding machine with motor of up to 10 hp	1	5 000
Delivery van, 1 t	1	6 500
Mobile crane 2 t	1	17 000
Truck, 10 t	1	15 000
Total		280 000

A workshop of this type requires a covered area of 75 m × 60 m = 4,500 m² and an open area of 75 m × 30 m = 2,250 m²

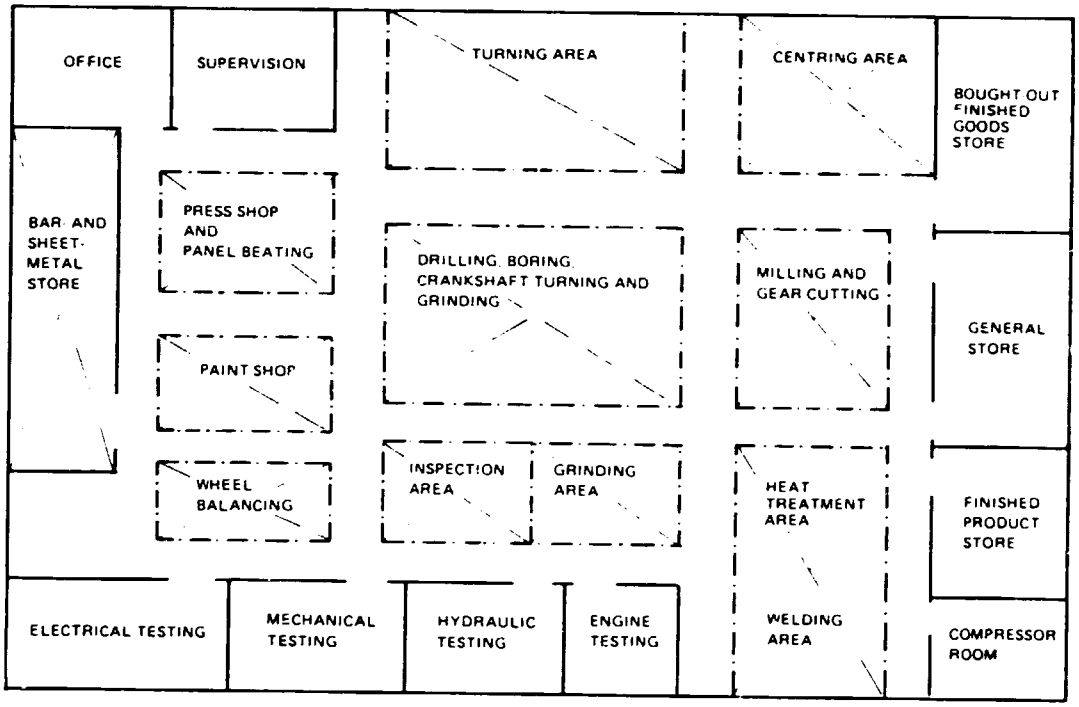

Figure IX. Workshop for large repairs, maintenance and the manufacture of spare parts in a market town

Manpower requirements are indicated below

Direct labour	*Number required*
Skilled	50
Semi-skilled	15
Unskilled	10
Indirect labour	
Manager	1
Designer	1
Accountant	1
Clerks	3

Indirect labour	*Number required*
Checker	1
Supervisors	3
Inspector	2
Foremen	2
Chargers	3
Storekeepers	2
Drivers	2
Watchmen	2
	98

Particular consideration should be given to the training of personnel in the following activities: sheet-metal work (panel beating), general machine-shop work, welding, electrical winding, testing (mechanical, electrical and hydraulic), heat treatment and inspection.

Figures IX and X show layouts of plants of this type.

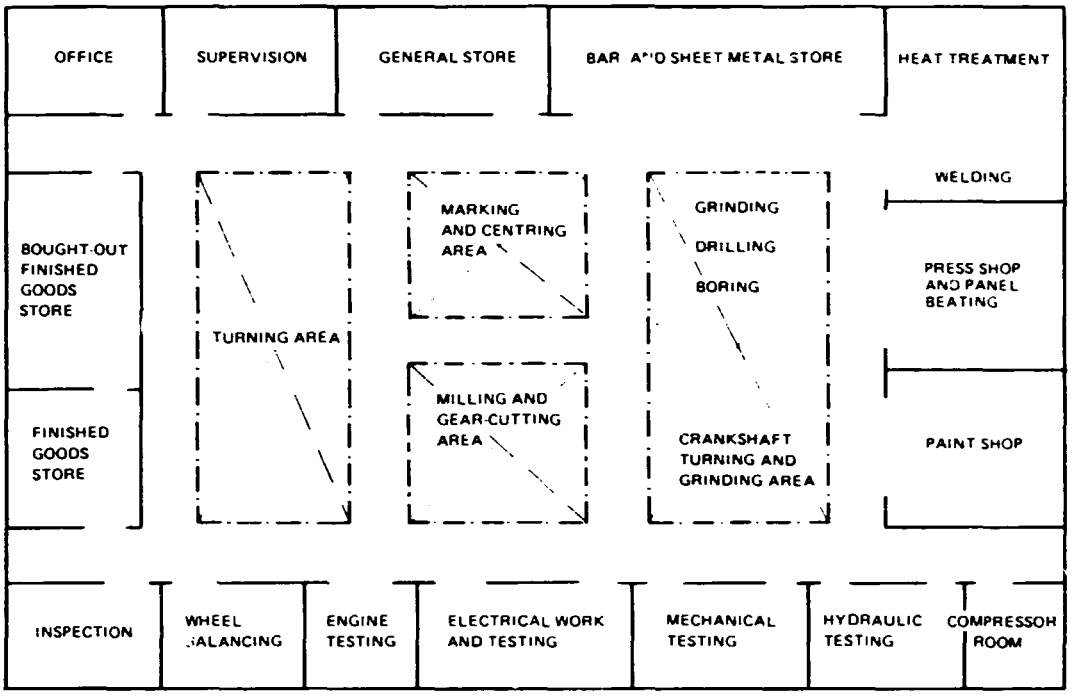

Figure X. Workshop for large repairs, maintenance and the manufacture of spare parts in a market town, alternative layout

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Light industry technologies and rural development

*K. H. Yap**

INTRODUCTION

The introduction of industrial technology into rural areas has various objectives. A primary aim is to create new possibilities and bring to the traditional rural structure new dimensions for development, that is a fresh perspective for evolutionary yet dynamic change. Rural communities have great potential, especially human potential, which has remained dormant because of the lack of an agent for change in the traditional way of life. This catalytic function must be performed by many elements. The contribution of industrial technology consists in the widening of the spectrum of productive skills by adding new skills, thus diversifying the socio-economic basis of rural communities and helping them to achieve higher rates of economic growth and become less dependent on agricultural patterns of production, with their seasonal character and vulnerability to natural disasters. The ability to acquire, utilize and integrate these new industrial skills is essential.

Unlike urban areas, with their distinct infrastructure and institutional facilities, rural areas proved a rather amorphous environment for industrial technology. A number of situations and possible approaches will be explored in this paper. Particular reference is made to the role of technology in rural light industries. The term "light industry" as used in the text is described in annex I.

Annex II describes more typical rural development functions to which light industry can make a contribution. The first chapter of this paper outlines the various elements of rural light industry development; relevant technology application patterns are described in the second chapter, and the third chapter describes the relationship between levels of development and rural industrialization policy.

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ELEMENTS OF RURAL LIGHT INDUSTRY DEVELOPMENT

A. Farm implements, machinery and supplies

Direct support to farmers links industrial technology closely with agriculture. It comprises a variety of activities, ranging from the provision of suitable farm implements and machinery to supplies of fertilizers, phytopharmaceuticals, animal feed and other products. The application of industrial technology is designed to improve farming practices and the utilization of productive potential. As stated earlier, industrial technology is only one of the elements contributing to this development process. Plant-breeding technology is of course the basic requirement for agriculture. Fertilizers and agricultural chemicals assist in soil conditioning and plant protection, while implements and machinery improve productive capacity. Integration is also essential. The combined effect of the various elements would therefore achieve the best results. Such an approach can increase production rates substantially above the population growth rate, even in areas where food production is mainly based on small landholdings. For instance, yields per hectare of rice increased by 70 per cent from 1965 to 1975 in Indonesia, and by 100 per cent in Columbia. Continued increases are feasible, as experience in north-east Asian countries has shown. In those countries, local production of the above-mentioned supplies and indigenous development of agricultural equipment and machinery suitable for small-acreage farming have been found crucial. Small-acreage farming is a common feature in the Asian region and of major importance in Africa and Latin America. Intensification of yields by the above-described means is the main objective. Organizational aspects would have to be taken into account; in particular the availability of adequate extension services and effective distribution methods for the various supplies. It should be noted that large tracts of arable land, notably in Africa and Latin America, but also in certain Asian areas, can still be brought under cultivation. In many cases, however, a major development of basic infrastructure may have to precede the actual cultivation process.

B. Processing agricultural products

The processing of agricultural products provides another major link between industrial technology and agriculture. On the one hand, processing would make it possible to extend the lifetime of agricultural produce. On the other hand, the agricultural materials needed to meet consumer requirements are a significant source of input to industry. Processing does not aim at preservation alone. It should have broader aims, including the utilization of by-products to meet various non-agricultural requirements. Added value may be substantially increased, a factor which could serve as a basis for determining optimum development policy.

Various stages of processing should be distinguished. The first stages, e.g. dehusking of grains, which makes the produce suitable for direct consumer use, is often integrated with the agricultural operations themselves. It emerges as a separate operation only when some progress in economic development has been

achieved. The same holds true for the next stage, consisting in further processing into intermediate materials, e.g. the milling of grain into flour or the extraction of vegetable oils from various types of seeds. Preservation processes also vary considerably, from simple drying and the use of natural preservatives (salt, vinegar) to canning (with sterilization and use of selected preservative agents) and freeze-drying (with related refrigeration methods). Improved durability makes it possible to reach not only local, but also national and international markets. In addition, long-distance transportation and storage technology eliminate the need for certain products to undergo preservation, for example by carrying the final stage of the plant-growth process (e.g. the ripening of bananas) under controlled transport and storage conditions.

The recycling of by-products back into agriculture takes place, first of all, within the agricultural production process itself. Use of compost as a natural fertilizer is a common example. This function is extended in modern non-tillage farming. Mulch coverage has been found to reduce soil erosion, although increased use of appropriate herbicides is necessary in order to ensure proper weed control. Another possibility involves the further processing of selected by-products into protein and vitamin-rich food supplements (e.g. fibres of tangerine peels or the utilization of oil-meals). The use of by products and waste-material as fuel, or as basic or reinforcing components of strawboard, paper and building materials is also common. In these processes a blending with material from other sources would often be appropriate, a blending which could open up new possibilities for developing and diversifying the rural economic base.

Forestry, animal husbandry, fisheries and a variety of cultivated food and fibre crops (such as sugar, tea, coffee, cocoa, cotton and jute) are other areas in which industrial technology can contribute to the rural development process. In many instances a wide range of technological options apply. An assessment based on economies of scale would help to show whether sector specialization is viable in a given locality. The availability of infrastructure would often require separate consideration. In case significant additional infrastructure is needed, it should be considered within a broader framework in which the industrial plant and its ancillary establishments could serve as a rural development nucleus. A similar approach would apply to the clustering of various smaller industries in a particular location. These would then form an agro-industrial or light-industry complex on a relatively modest scale. As indicated above, the development of common infrastructural and institutional facilities would be designed to meet the development needs of an entire area, and should link together its various economic sectors.

C. Transportation and communication

Market-places and small shops in villages and townships are the traditional locations for the exchange of agricultural products. However, they may not be wholly suitable for rural industrial products, and new distributive channels may therefore be desirable. With increasing development a higher rate of inter-area activity will generally occur, requiring an expansion of transport and communication facilities. This must be achieved through the co-operation of

both external and local bodies. External action, for example by the government authorities, would concern networks of major importance such as roads, railways, water-ways, airlines and telecommunication facilities. Corresponding to such action would be the development of local transmission lines. Short-distance transport of goods and persons is a requirement that might, depending on the circumstances, be fulfilled by rural light industries. Similarly, battery-operated transistor radios and other types of electronic equipment could make essential and cost-effective contributions to increasing the communication links of rural areas with the external world.

D. Meeting daily living requirements

Household utensils (of plastic, metal or ceramic material), lighting, stoves, furniture and similar items would be suitable for dispersed production by rural industries. As compared with urban industries, rural industries would have a relative advantage in terms of land and labour costs. On the other hand, ensuring the provision of basic materials and energy supplies might require more attention. However, light industry estates would tend to offer the best rural framework for the optimum use of land, energy and infrastructure.

Home industries can also play a significant role. For example, mat and basket weaving are activities which logically combine with agricultural activities. They are by nature storable items that may be produced in slack periods. They are also articles of use in rural and urban areas alike. Various countries have even succeeded in developing substantial exports of these items to industrialized countries. For traditional crafts, which would in many instances represent full-time employment for highly skilled persons, such a development can be even more pronounced.

Building materials, with their relatively high transport costs and their dependence on the availability of local raw materials represent another sector suitable for dispersed production. Their development depends on construction activities, which in rural areas often involve a large degree of self-help shelter construction. Roofing, walls and other structural elements are primary items. Intermediate building materials such as cement, construction steel and plastic sheets form a second category which should be considered in conjunction with public works and other larger construction programmes. The development of the second category of industries would have generating effects beyond the manufacturing and construction industries, particularly on transport activities. In this connection, the job-creation potential of labour-intensive transport in developing countries is from time to time a focus for international attention. However, transport activities in themselves require little more than exertion of human energy and add little, or are even detrimental, to the development of skills. The use of human energy solely for transport and the handling of materials should therefore be superseded as rapidly as possible. If this is not yet economically feasible, suitable educational and training programmes should be provided for those engaged in transport activities.

Garments and textiles, like the above-mentioned products, can fit rural local needs as well as urban and international requirements. A variety of technical options exist. These options arise from different consumer needs and

preferences and from variations in patterns of supply, the combination of cloth and yarn supplies being the most common. Fibre-crop-growing areas would also be fully integrated, from fibre preparation and processing onwards. In such cases, the processing complex might, as indicated above, serve as an area development nucleus.

Adequate institutional facilities are needed for certain industrial activities such as the production of medical supplies. The manufacture of medicines in dosage form often requires relatively simple equipment, which should, however, be operated only under hygienic conditions by trained personnel. Other industries depend on the availability of medical supplies such as distilled water, which is vital in cholera-infested areas. The preparation of formularies to meet the health care requirements of a country or area, comprising both modern pharmaceutical products and traditional medicines, should serve as a basis for the development of local manufacturing facilities. The establishment of a suitable working relationship with rural hospital facilities would help to maintain quality standards.

II. TECHNOLOGY APPLICATION PATTERNS

The industrialization process depends primarily on technology, in particular manufacturing and related technologies such as energy, mining, construction, transport and communications. A major aim in applying these technologies is to transform and process materials into usable products. A number of distinct application patterns can be distinguished according to areas of interest, such as demand, employment, material resources and the environment. Each aspect must be considered in the context of a specific locality and its development potential. This paper deals mainly with rural areas and the role of light industries in their development.

A. Demand-oriented application patterns

Examples of light industry production oriented towards local, urban, national and export demand have already been mentioned. The production of farm implements, the recycling of some types of by-products, and the provision of various utensils and appliances for use in village households are designed to meet local demand, although some of the items mentioned could also be used to cover broader, e.g. urban requirements. The levels of expendable income of the local population will in most cases determine the economic viability of such light industries. Product sales largely follow traditional practices, although, as indicated earlier, there is a clear need for the gradual development and modernization of distribution and sales methods as income levels improve.

Some localities (including rural ones) become famous for the production of particular items, including products designed mainly for practical use as well as those with a certain artistic value (e.g. ceramics, traditional garments etc.). Such products would be logical candidates for technology upgrading to meet potential export demand. The use of modern technology to produce articles with a national cultural value should also be considered. It may be applied differently

in different countries, depending on cultural backgrounds, levels of development, and overall domestic demand. Traditional clothing, a modernized style of national dress, and toys of folkloric value are examples of the type of article that may be produced.[1]

Wherever possible, technology upgrading should go beyond the mere substitution of mechanical for natural power or the more widespread use of traditional techniques. Fundamental technical improvements and innovations are needed to ensure long-term viability within the present demand structure. The use of new materials, processes, tools and equipment provide scope for considerable innovation. Modern product development and marketing techniques will have to be applied, together with an effective system of dispersed production making use of current levels of skill and methods of work and providing a possibility for continuous upgrading. Quality control and carefully selected production technologies are necessary in order to meet export demand. The choice of technology is determined by many external factors beyond direct control, and by the need to promote internal socio-economic progress. For rural light industries, which have relatively simple industrial structures, the technology choices would concentrate chiefly on the selection of particular processing units or machines. Such a selection should be based on objective information regarding the full range of possible options. Educational institutions and various types of economic incentives help to reveal some of the constraints upon, and the appropriate directions of, general development.

B. Employment-oriented application patterns

Seasonal activities and structural employment have a bearing on rural industrialization. As previously indicated, various home industries may help to meet seasonal employment requirements. On a more organized basis, small-scale assembly operations could be undertaken, generally involving the employment of at least a few persons for year-round activities, while expanding the work-force during slack agricultural seasons. It should be noted in this connection that industries processing agricultural products may distort the seasonal employment pattern, because processing operations and harvesting time generally coincide or overlap. The need to avoid the harmful consequences of conflicting labour requirements should therefore be borne in mind in the establishment of such processing industries.

Light industries have by definition a relatively favourable employment generation effect, i.e. light industries provide, under otherwise comparable circumstances, relatively larger employment opportunities per unit of capital resources employment than heavy industries.[2] This advantage is particularly pronounced in smaller light industries. Typical sectors are garments and footwear, furniture and woodworking, toys and similar articles. The processing of fruits and vegetables and the manufacture of certain metal products may also be included. The conditions of demand pose limits on the extent to which these

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[1]Production of traditional clothing is discussed in annex II, Section B.

[2]A more complete discussion of the term "light industry" is in annex I.

industries could provide new employment opportunities to the rural population. Infrastructure, including in particular power supplies, housing, construction sites, transport and communications impose further limitations, which, as previously indicated, could be effectively dealt with by the establishment of industrial estates. The lack of such infrastructure is one of the main reasons why industries prefer urban locations, which have the advantage of proximity to important markets. For an industrialization policy designed to build up a geographically dispersed industrial structure, the establishment of planned industrial areas is therefore a key factor. However, the establishment of industrial estates and the required institutional facilities would not in themselves suffice. Viable industrial operations remain the central element of which infrastructure development efforts are an essential condition.

A similar approach would apply if one of the industries assumes a general development role and provides structural facilities for use by other industries in the area. The units concerned require a combination of development capital inputs with varying redemption dates, a condition which financing institutions in developing countries are often able to meet only to a limited extent, if at all. The result is a fragmentation of the unit, with an increased risk of losing sight of the main development objectives. Moreover, rural light industry units are relatively small and numerous. To fragment them further would reduce the effectiveness of their contribution to development. Optimum results would be achieved through the dynamic interplay of local initiative and participation within the overall development framework, rather than through comprehensive planning by external sources.

Employment-oriented technology applications may be assessed from various viewpoints. From a socio-economic point of view, the relationship between labour and capital is an important factor.[3] From a technological point of view, versatility and savings on capital and operating and maintenance costs require consideration. Standardized equipment should be adopted to facilitate future replacement and workers trained in its correct usage to reduce expenditure, and to achieve investment savings through collective purchases. Further advantages could be achieved through the establishment of guidelines at national level, relating for example, to the types of equipment which could help to increase electricity supplies to rural populations, only one eighth to one seventh of which are currently supplied with electric power in developing countries.

In general, no compromise on performance quality may be allowed, although technical adjustments of equipment used in various types of light industry may well be justified in certain circumstances.[4] The key factor in the industrialization process remains the development of human skills and innovative capabilities in the broader sense.

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[3]A relationship of direct employment to the fixed assts of a firm is used by the World Bank to illustrate the employment-generating effect of smaller industries (see *Employment and Development of Small Enterprises*, Washington D. C., 1978, World Bank).

[4]Such adjustments, although based chiefly on common sense judgements, are very widespread in developing countries, much more so than would seem to appear from information sources and publications in the industrially advanced countries.

C. Material-resources-oriented application patterns

The processing and use of agricultural products and by-products are examples, previously described, of the application of material resources to the development of light industry in rural areas. The technology application patterns are designed to increase added value. The utilization of forestry resources may serve as an illustration of such an application.

The main industrial uses of forestry resources include the following: preparation of logs for construction purposes; sawing and further processing into panels, building elements, veneers, plywood, furniture and other products; construction of boats and small ships; manufacture of pulp and paper; supply of fuel for domestic and industrial purposes and processing into charcoal as a reduction agent for steelmaking and other processes; and various other uses, such as wood carving. A significant factor in the use of forestry resources is the possibility of recycling waste material (manufacture of particle board, fuel uses etc.). Some of these processes, in particular the manufacture of pulp, paper and board, are highly capital-intensive. In most cases, however, a light industry pattern as described above would apply. For example, when an adequate supply of materials exists, a favourable employment generation effect is produced by capital investment in the woodworking sector. The multiplier effect on other industries is also significant. Large-scale transport is required in log handling, during the various stages of intermediate processing, and in the distribution of final products. The materials are preserved with products of the chemical industries, and maintenance and renovation services are needed.

Unprocessed round wood and sawn wood contribute about 70 per cent of the total wood-export earnings of developing countries. Improved wood-seasoning facilities and further processing to intermediate products (plywood, panels etc.) would be suitable areas for short-term export-oriented development. Planned reforestation may in many developing regions have to accompany forest utilization programmes in order to ensure an optimal structure in which both ecological and economic objectives may be pursued. The domestic and export markets provide ample scope for action on a short- and medium-term basis, while immediate development measures are often possible in the light industry.

New technologies can play a significant role in the development process. For example, experience gained over the past decade for the drying and seasoning of timber in the use of solar kilns showed reduced investments and some distinct qualitative advantages.[5] Similarly, in-depth research is needed in other rural light-industry sectors. In many areas unique phytogeographic conditions have made possible specialization in certain tropical fruits, cultivated crops and fibre resources. The revival and expansion of these sectors, with the further processing and improved added values it would entail, is both desirable and feasible. Technological research can make a vital contribution to these development objectives.

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[5]See *Technology for Solar Energy Utilization* (United Nations publication, Sales No. 78.II.B.6).

D. Living-environment-oriented application patterns

Food and clothing, health and education, housing and the environment are tangible and basic signs of progress to rural populations. The supply of building materials and improved construction elements has been mentioned as one of the areas to which industrial technology could contribute. It could also provide equipment and auxiliary materials (lubrication oils, water purification agents etc.) for the supply of utilities, short distance transport and communication equipment, and related maintenance services. The provision of products for health care (e.g. medicines and food-supplements) is another field to which locally based industrial technology may be applied. However, these activities will depend on the contribution of certain basic industries (e.g. cement, basic metals and bulk chemicals). Local resources permitting, integrated operations would be preferable. Otherwise, link-ups with a broader supply structure would be needed. The identification of possible uses of recycled materials would be useful. When suitable technologies are developed, the possibility of recycling would contribute to the dispersal of the industrial activities concerned.

From a techno-economic point of view, these activities would depend on the amount of disposable income and public funding for area development. Various other factors are also essential, for example the supply of safe water, which is a basic human requirement. It may be provided in many rural areas by moderate amounts of investment in making ground-water sources available through protected wells. A further development would be to provide well-water through a village or neighbourhood system of public hydrants, with a subsequent extension of the distribution system to include house connections. This generally leads to a sharp increase in *per capita* consumption. The investment pattern also shifts from investment chiefly in water production to increasing investment in the distribution system and ancillary facilities, such as a public sewerage system to safeguard the water from contamination. The industrial technologies required also change considerably. Whereas initially local artisans would suffice to maintain the basic system, a more elaborate structure would subsequently be needed. Steps should be taken to ensure that the development of such an industrial structure can be achieved while preserving the quality of the environment.

III. TYPES OF RURAL DEVELOPMENT

A wide variety of industrial technologies is applicable to the rural development process. For each technology a range of options exists. Moreover, technologies are emerging, and continuing innovation should be encouraged. For the application of technology, the type of development required in the area concerned is a major factor. Three broad types of development may be distinguished, in the order of increasing industrial activity: development for the provision of basic requirements; activities of a predominantly agricultural nature; and development concerned chiefly with the promotion of industrial growth.

The provision of basic living requirements, in particular food, water, clothing and shelter, is the first development objective. According to an estimate

based on World Bank data approximately one fourth of the population of the developing countries needs these basic requirements. The preservation of food supplies, logistical operations, and the provision of industrial components for self-help construction programmes are areas to which industrial technology could contribute. The application of industrial technology to the supply of safe water in rural areas has already been mentioned. Moreover, the possibility of using the generally abundant supplies of solar energy available in dry areas is being considered. The methods considered emphasize local initiative and the maximum possible involvement of the local population. Nevertheless, external support will in most cases be necessary at the initial stage and in order to ensure the necessary safeguards. An important safeguard would involve assistance in case of natural disasters or insect plagues, for example. The technology of communications is vital in this respect. Developments in this field of technology have in recent decades wrought fundamental change, making many older methods obsolete. Humanitarian considerations would be a primary element in the provision of relief assistance and in programmes designed to meet the basic living requirements of the population. The generation of productive capacity is essential, so as to enable the economies concerned to become as self-sufficient as possible. In the pursuit of this objective, new technologies, such as those referred to above, could play an increasingly important role.

Light industry technology designed to support agricultural operations require increasing engineering inputs. The particular capabilities to be developed include the following: functional design and production of agricultural implements and machinery, transport and storage equipment, materials analysis, various processing and preservation techniques, packaging, recovery methods, and equipment maintenance and repair. These light industry activities are largely based on human engineering capabilities. A rather high degree of flexibility is needed to deal with differences in local conditions and unforeseen circumstances. Light industries are highly dependent on assured supplies of raw materials, energy and other items. The farm implements industry, with somewhat larger plants supplying blanks and other intermediate items to village-based light industries and craftsmen, is an example of such interdependence. Another example is the relationship between container supplies and the fruit preservation industries. The identification of such links and the framing of provisions to ensure normal conditions of operation is essential.

By diversifying its output to meet a broad range of demand and environmental requirements, light industry could make a contribution to growth-oriented rural development. Such an approach would also help to increase employment opportunities of both a structural and a seasonal nature. The role of local leadership in this development effort is essential. Action should be taken along various lines, including technical training and improved manufacturing methods, the establishment of production facilities, the development of marketing and distribution channels, financing, and building up suitable organization structures. Due account should be taken of local reaction to the need for change. The introduction of new talent is often needed. Young college graduates with a pragmatic outlook and suitably motivated can make particularly valuable contributions.

In order to give impetus to development, specific action of a combined nature may be required. This could involve the concentration of a variety of industrial activities at a particular location, for example as industrial estates, or the integration of manufacturing technology, as in an agro-industrial complex or a rural development nucleus. In both cases a comprehensive feasibility study would be needed, preferably with a separate assessment of the plant-level components and the infrastructure.

Each of the three development stages dealt with would require, based on the present outlook for growth, from 10 to 20 years. For most rural areas, however, the first stage can usually be largely or wholly bypassed. Growth-oriented industrial development could therefore be achieved within a reasonable time frame. In order to bring such development within the reach of the rising generation in rural areas where subsistence-level conditions still prevail, measures to achieve accelerated growth could be considered. This would involve an estimated 700–800 million persons out of a total of 2,000 million persons in the rural areas of developing countries.[6]

[6]Estimates based on data compiled by the United Nations and the World Bank.

Annex I

COMMENTS ON THE TERM "LIGHT INDUSTRY"

The Bureau of Statistics of the United Nations Department of Economic and Social Affairs classifies the following sectors as light industries:

ISIC category number[7]	*Description*
31	Food, beverages, tobacco
32	Textiles, wearing apparel, leather articles and footwear
33	Wood products, furniture
342	Printing, publishing and allied industries
355	Rubber products
356	Plastic products not classified elsewhere
39	Miscellaneous products not classified elsewhere

The term "light industry" used in this paper corresponds largely to the above enumeration so far as the manufacturing industry is concerned. It is, however, used in a somewhat broader sense, and includes construction (ISIC 5), transport and storage (ISIC 71), and repair and maintanance services (ISIC 951). Home industries and handicrafts are also included. In general, therefore, the term light industry is used to describe industrial activities that are mainly skill and labour-oriented than the complementary group of heavy industry sectors.

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[7] *International Standard Industrial Classification of All Economic Activities*, Statistical Papers, Series M. N. 4, Rev.2 (United Nations publication, Sales No.68.XVII.8)

Annex II

LOCAL INDUSTRIAL PRODUCTION TO MEET RURAL DEMAND

A. Farm implements[8]

Local blacksmiths play a significant role in the development and supply of farm implements and other types of metalware. They cover 14–20 per cent of total demand for hoes (jembes) in the United Republic of Tanzania, where a nationwide system is being developed to achieve self-sufficiency in the supply of farm implements. In addition to the production of farm implements, blacksmiths adapt factory-produced implements to meet local requirements, and perform an essential service as local distributors for a market unaccustomed to fixed-price distribution systems.

In order to achieve self-sufficient production of farm implements, rural blacksmiths should belong to small workshops producing various household utensils in addition to farm implements. Such workshops, which would not need electric power, could meet the needs of a rural population consisting of about 9,000 families. An expanded range of products and facilities is envisaged for a second, and possibly third, level of development.

The supply of raw materials, regarded as establishing links between the two levels, is essential. It should be noted in this respect that the traditional technology of iron-smelting, in use for many centuries, is too costly and has ecological and other disadvantages. The major tasks of scrap collection, possible resmelting and provision of semi-finished blanks of various qualities, shapes and sizes to blacksmiths for further forging and processing into final products are to be performed at the second level in the programme described above.

This would make possible substantial savings as compared with the present method of import substitution through large-scale production. In the case of the United Republic of Tanzania, overcapacity and inadequate organizational and technical flexibility, partly due to the neglect or at least underestimation of the role of rural blacksmiths, have been

TABLE 1. SAMPLE PRODUCT LIST

Typical products	*Level of workshop*	
	First	*Higher*
Single-function farm implements (jembes, axes, billhooks, adzes, pangas, knives, sickles, slashers etc.)	x	x
Farm implements with a more composite structure (ground-nut shellers and lifters, maize shellers, hand-operated sprayers and planters etc.)		x
Mechanized farm equipment		x
Simple household utensils (knives, scissors, frying-pans, charcoal stoves, kerosene lamps, buckets, water cans, dustbins etc.)	x	x
Transport equipment (wheelbarrows, handcarts etc.)		x
Repair services for bicycles, equipment and various installations (e.g. water supply).	x	x

[8]Adapted from "Promotion of rural implement manufacture in Tanzania", paper prepared for UNIDO by J. Müller, November 1977 (ID/WG.257/8).

observed. For the suggested product range (see table 1), the progress achieved and improved infrastructure will lead to changes in the activities of the various types of workshop.

B. Traditional clothing

The availability of cloth is of central importance for the batik industries, which arose mainly from local home industries.[9] The batik technique provides for a simple yet versatile preparatory and dyeing process, which permits the development of patterns of a traditionally valued style on fabrics and other materials.

It is best known for its wide application in Indonesia, although the process is recorded as having been originally used in many countries of Africa, Asia and Latin America, where it has been largely replaced by newer techniques. In Indonesia, and particularly on the island of Java, it has been able to withstand this evolution, largely owing to cultural influences and to the development of the batik technique itself. Through refinement of the technique widespread customer support could be maintained, and through simplification its large-scale application could be developed simultaneously. Dye-colour development was also an important contributing factor. Indigo blue used to be the traditional colour, until *soga-brown* was developed and widely applied in southern Java from the eighteenth century onwards. From the qualitative point of view, fabric textures are important, and a certain quality grading has evolved, with cambric and *mori-muslin* types of cotton fabric as the finest texture qualities. Polyester cotton fabrics and synthetic dyestuffs are currently used. A similar evolution is taking place in the preparatory process for dyeing. This involves the preparation of the fabrics with a cover layer, for which various types of waxes have been developed. The broadening of the colour spectrum led to the introduction of new aesthetic concepts, which spread rapidly during the 1960s. Batik-work has since been revitalized and spread from Indonesia to Malaysia, Sri Lanka and other countries, including various industrialized countries, where it is recognized as a distinct form of artwork.

The versatility of the batik technique, suitable for artistic items as well as articles of daily use, and for individual home-based activity as well as organized larger-scale production, is reflected also in the equipment used. Particularly characteristic are the methods for applying the wax layer prior to dyeing, which have evolved along the following lines:

(a) By the method of *tjanting* (the instrument used to apply wax to the fabric), the wax is molten in a pan on a stove. With the tjanting a small part is taken and applied to the fabric. Various types of tjantings are distinguished, ranging from single-line drawing and dot-application implements, to multiple-line drawing implements;

(b) The method of electric tjanting involves the electric heating of the tjanting to keep the wax in the correct molten condition and to ensure a more uniform application. Moreover, a more continuous operation is feasible through the storage of a somewhat larger quantity of wax in the tjanting;

(c) Use of stencils and brushes to apply the wax on the fabric;

(d) By the method of block-printing, the wax is applied to the fabric through copper dies in which the patterns are engraved;

(e) By means of mechanical block-printing, the cruder multiple-layer and consecutive single-layer methods are distinguishable.

Dyeing and washing equipment have been developed for individual batik workers, home industries, and industrial production.

The application of the above-mentioned methods is summarized in table 2.

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[9]Similarly, the supply of yarn is essential for home-based hand-loom industries, a major rural industrial activity in India and other countries.

TABLE 2. BATIK PRODUCTION METHODS

Item	*Individual home industries*	*Collective organizations*	*Industrial production*
Technique			
Tjanting	x	x	–
Stencil pattern	x	x	x
Block-printing	–	x	x
Indicative index of *per capita* investment[a]	20–35	100	150–500

Note: An "x" is used to indicate that a particular technique is applied in a specified type of production unit.

[a]The base (= 100) for the index is the *per capita* investment for a collective group of 100 batik workers (60 tjanting and 20 stencil and block-printing workers) with an adequate dyeing and washing facility.

C. General rural demand[10]

The need to meet local demand was an essential factor in the establishment of a series of rural industries in the southern Jalisco region of Mexico, located about 150 km south of Guadalajara, Mexico's second largest city. It covers an area of about 22,000 km², with a total population of 500,000–600,000 persons. The main townships are Ciudad Guzmán (about 50,000 inhabitants) and Tuxpan (about 15,000 inhabitants). Cane sugar has for a considerable time been the area's main industry.

Local initiative and strong government support, for example through government supply contracts, contributed to the establishment of the rural industries. In addition to industries based on townships, a dispersal of productive activities into the villages was undertaken. A distribution system and central purchasing facilities were required for a total work-force of over a thousand persons employed in seventy workshops. The distribution system included a chain of small shops ("People's Grocery Stores") and area warehouses. A central training workshop was established and a system was evolved in which the workers convened in a general assembly represented the highest authority of the collective organization. Efforts were also made to broaden the range of products and to cater for other areas and export markets. However, economic depression and a reversal of government policy had adverse effects, and many of the employment gains had to be abandoned. By the end of the third year employment approached the same level as at the end of the first year, and further decline was expected, although prospects for stabilization and subsequent re-expansion were not excluded a priori. What the results of the undertaking will be are still unknown. It may however be useful to compare conditions at the end of the two periods of time referred to. A summary of the data is contained in table 3.

In the first place, a rather pronounced trend towards specialization in garments and footwear seems to emerge. Leather jackets and belts, mentioned in the entry "new items", also reflect this trend. Food processing and the supply of locally consumed food products have declined sharply, although fruit-canning for a wider market has retained its position. Printing and soap manufacture have increased the product range, which is designed primarily to meet local demand. Although the growth of this group of industries

[10]Adapted from "The people's collective industries of Jalisco: a case study of rural industrialization in Mexico", a paper prepared for UNIDO by S. A. Ferrer, November 1977 (ID/WG.257/9).

has been largely determined by the need to meet local demand, a significant contribution to rural development could be made by encouraging specialization in the area's strongest product lines and by promoting sales on external markets.

The supply of raw materials has in many cases been identified as a major problem area. With added difficulties caused by inflation, the financial resources of the collective organization were often insufficient, resulting in workshop shutdowns. Moreover, external marketing was hampered by inexperience. The strong employment-oriented approach and the stimulus provided by the Government have led to rapid initial progress. The industrial techniques applied were relatively simple and easy to acquire. With the contraction of the economy and the simultaneous withdrawal, or at least substantial reduction, of government support, considerations of efficiency prevailed. The adverse situation was handled best by the branches with relative local advantages, in particular as regards the availability of materials and access to wider markets. Perhaps somewhat intuitively, the major investment had been made during the initial years.

The experience gained at Jalisco, although covering only a relatively short period, has yielded valuable insights into the viability aspects of rural industrialization projects, from which not only Mexico but also other developing countries may benefit.[11]

TABLE 3. PRODUCT STRUCTURE OF RURAL INDUSTRIES IN SOUTHERN JALISCO, MEXICO

	First year		*Number of workshops*		
Main branches	*Employment*[a] *%*	*Investment ratio*[b]	*First year*	*End of third year*	*Typical products*
Food processing	29.5	80	26	5	Cheese, sausages, bread, canned fruit and juices
Clothing, weaving and shoes	29.0	535	25	83	School sweaters,[c] shirts, trousers, children's garments, furniture-cushions, shoes, sandals
Wood products	18.5	255	3	4	Furniture, wooden toys
Chalk[c]	8.5	305	1	1	
Construction materials	6.5	40	8	3	Cement utility poles
Miscellaneous production	2.0	45	2	1	
New items	–	–	–	22	Straw hats, mattresses, leather jackets, belts, printing material, soap
Non-manufacturing activities	2.5	. . .	4	4	
Warehousing, administration	3.5	. . .	1	4	
Total	100.0		70	127	

[a]Total employment at the end of the first year was approximately 1,000 workers, or about 14 per workshop unit. After further growth, various circumstances led to a substantial decline, which had not yet stabilized at the end of the third year (127 units with a total of about 1,100 workers, averaging 9 workers per workshop unit).

[b]In the first year, investment *per capita* averaged approximately $1,500 in 1975 values. This average is taken as the base (= 100) for the product-line ratiosisted in the table.

[c]Chiefly manufactured under government contracts.

[11]On the basis of the experience gained during the initial development of the Jalisco rural industries, a national law has been passed to facilitate the initiation of similar projects in other regions of Mexico (Law of Social Solidarity Societies, May 1976).

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Rural workshops in developing countries

*S. M. Patil**

Present situation

The concept of rural workshops is not new but in most developing countries the recognition of the need for establishing them is. The idea is partly to modernize village crafts and to provide better tools and equipment to village artisans so as to improve their efficiency. The growth and development of industry in advanced countries such as the Federal Republic of Germany, Japan and Switzerland may be traced to the rural workshops which expanded gradually, modernized and eventually took up the production of a variety of industrial products. Even today, despite giant operations clustered around urban and metropolitan areas, there are multitudes of workshops in rural areas which undertake, among other things, repair and maintenance jobs, and sometimes accept subcontracting work from larger industrial units.

Strangely enough, the developing countries have not given due attention to the development of rural and small-scale industries and workshops. Instead, there has been the concentration of industries in urban areas, neglecting the rural side under the assumption that modern industries should be established mainly in the vicinity of markets and raw material sources and where skilled labour and university trained engineers and technologists are available. This was thought necessary to speed the process of industrialization.

Concentrated efforts had to be made to establish large industries to take advantage of economies of scale and to short-cut the slow evolutionary process of beginning on a small scale and gradually enlarging over the years. Also, since most rural areas of the developing countries lacked the skilled manpower, trained managerial personnel, water, electricity, modern housing, health and hygiene facilities, recreation and other needs of modern society, and most of these were either already available to some extent or could be developed in the existing urban centres within much less time, the Governments and planners of industries of the developing countries preferred to cluster industries in and around cities and other urban areas. Even when some of the large industries had been set up in the rural areas, these localities grew up as modern, self-contained urban satellites, more or less insulated from the vast rural regions in which they were situated. The rural population did not participate in the benefits of these large-scale modern industrial complexes based in the rural areas.

Fundamentally there has been a high degree of self-sufficiency in industrial

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planning and establishment. Certainly some of the heavy and highly capital-intensive process industries may have to be established in such a way that most of the work is done under one roof; very little scope may exist for decentralization and subcontracting of work among various small- and medium-scale units, dispersed throughout a country. The very nature of the product or process may be such that, apart from economy of scale, the production technology may not lend itself technologically to disaggregation of the manufacturing components into different segments. It is therefore not possible to subcontract production of simpler and less critical items and ancillary equipment to rural workshops, or to small and even medium-scale industrial units. There could, however, be possibilities in many areas where appropriate production technology could be decentralized.

Objectives

Within the overall objectives of rural industrialization to create employment and income opportunities for the rural population, the objectives of rural workshops may include the following:

(a) To train the rural population in some of the essential engineering trades and in the use of simple modern machine tools and other mechanical equipment;

(b) To equip rural artisans with knowledge of repair and maintenance of simple machinery employed in farming, for example, tractors, pumps, diesel engines and electric motors;

(c) To acquire modern skills in the manufacture of components, accessories and simple devices as jobbing work from organized sectors of industry;

(d) To transform themselves eventually into facilities for production of industrial goods and components of simple designs. In other words, they could serve as nuclei of small rural industries.

The educational plans of most developing countries include vocational training of young people after they finish their school education. For rural workshops, the relevant vocations are, turning, fitting and filing, milling, grinding, shaping, planing, welding, foundry, smithy and forging shop trades, carpentry, pattern-making and the like. Many developing countries, among them Ghana, India, Indonesia, Mexico, the Philippines and Sri Lanka, have set up Industrial Training Institutes (ITIs) where vocational training in the above and other engineering trades, instructions in shop mathematics, workshop calculations and machine drawing are provided. The main objective of the ITIs and similar vocational training institutes is to create a skilled work-force from which different industries could draw their requirements for skilled personnel. Training for the rural workshops should, however, be specialized, aimed at absorbing the trainees in rural workshops that have been established to produce specific goods or to render specific services, namely, to undertake outside jobbing work from the organized sector of the metalworking and engineering industry, to repair and maintain rural machinery and tools. These rural

workshops should gradually develop into ancillary units of the organized metalworking and engineering industry.

The engineering and manufacturing skills of the rural workshops should be so increased that these workshops could become capable of producing simple components and accept rough machining of components, assembly of simpler units and carry out heat treatment, fettling, sand-blasting of castings such as aluminium covers and blanks, sheet metal and welding work and the like at reasonable prices and at acceptable quality. Some of these rural workshops could develop into rural engineering industries and produce simple industrial products, such as agricultural implements, centrifugal pumps and even small diesel engines, based on designs either licensed by the organized industry or by adapting proven designs of industrial products.

It should be possible for the rural workshops to produce certain industrial products for sale and at the same time carry out satisfactorily the service functions of maintenance and repair of the machines and equipment of village farmers. Also, in order to encourage rural talent to find its equitable price on the open market, it is advisable that a certain proportion of the skilled labour, engineering personnel and the like be allowed to find appropriate positions in large- and medium-scale industry and business in the urban areas. The rural workshops should continuously train the village labour force so that it may supply the large and organized engineering and metalworking industry.

Model rural workshops

Rural workshops may be of various sizes, depending on such factors as type of work, the regional requirements of a cluster of villages and the needs of the organized industries in their vicinity. For the purpose of estimating financial and other implications, however, it is possible to conceive of a model. Assuming that 100 rural trainees must be accommodated and that no expansions are envisaged within the next 3 years, the total capital cost of a model workshop can be estimated at $100,000, of which land, its development, building installations such as water, electric power, roads and compounds should not cost more than $25,000. The plant machinery and equipment would absorb the balance of $75,000. Should there be any specialized requirements for a regional workshop, it could be operated partially or fully with a second shift before additional investment is made. If, on the other hand, there is a permanent work-load for about 200 workers, the total capital expenditure in a model centre may have to be doubled, to $200,000. However, to gain experience and explore further improvements as the scheme of establishing and operating the rural workshop proceeds progressively, it would be better to begin on the modest scale as suggested, that is, with a capital investment of $100,000 per workshop.

Some suggestions in regard to the main items of investment could be made. For instance, the village land could be made available free of cost. The costs of developing the land and providing the connecting roads with street lighting and so on could be kept to a minimum and, as far as possible, existing facilities might be used. This aspect is covered later in this paper in the discussion of suitable locations for the rural workshops.

The architectural design of the building should be simple, and as far as possible, blend with the rural environment. Since no overhead cranes are required, the building itself should be of light construction and built, as far as possible, using village talents, artisans and building materials. Suitable hygienic facilities should be incorporated, and adequate and safe storage space should be provided.

There would be no need to provide residential quarters, although modestly designed rooms could be provided for essential staff like guards. Preferably staff members should stay with the village community, but it may be necessary for village administrations to grant additional financing to provide suitable accommodation for the staff and instructors. Water and electric power should be made available to the workshop either by village administrations or the state or provincial governments, perhaps from rural development funds.

The main cost component, however, is the plant machinery, auxiliary equipment and its installation. The machinery should be modern but not sophisticated. The capital cost of such a workshop should not exceed $75,000. A centralized agency, preferably an autonomous body charged with the responsibility of implementation of the scheme, could be entrusted with the task of purchasing plant and machinery for all the rural workshops in the country. This would provide a better bargaining position for negotiations with suppliers and could result in substantial savings.

Items of machinery and plant equipment could also vary from workshop to workshop, but it is possible to suggest a pattern, since there would be a basic similarity in the types of machinery and equipment needed by the various workshops being established. The requirements of a typical workshop of this kind are listed below.

Equipment

4	Centre lathes, 130/200 mm, 1,000/1,500 mm
1	Turret lathe, 220-mm centre height
1	Capstan lathe, bar type, spindle bore, 63-mm diameter
1	Shaping machine, 500/650-mm stroke
1	Grinding machine, universal type, 130 × 1,000 mm
1	Tool and cutter grinding machine
2	Knee-type milling machine, size 2, one vertical, one universal
1	Hack-saw, 500-mm diameter, bar-cutting capacity
1	Smithy with hammer (drop hammer)
1	Shear, 2,250-mm length
1	"OBI" press–100-t capacity
1	Welding set
1	Salt bath for heat treatment
1	Annealing furnace (small)
1	Crucible furnace (oil-fired) for non-ferrous castings
	Work-benches with machine vices, files, cutting tools, milling cutters, drills, reamers, scrapers and the like
	Miscellaneous workshop equipment and tools

Work-force

50	Machinists
50	Fitters/assemblers, maintenance and repair mechanics

Capital cost

Land and buildings	$25,000
Plant, machinery and tools	$75,000
Total	$100,000

Foundries, training centres and tool rooms

Foundries. While the cast-iron foundry is an important requirement of rural industry, it would be neither economic nor necessary to set one up in every workshop. Instead, one might be established at a central location to supply castings to a number of workshops. Two such rural foundries might be set up for every four to six rural workshops.

Training centres. The cost of setting up a rural training centre would not exceed $100,000. It could be planned and established on a modular concept and cater for the needs of six or more rural workshops. The training programme could be so planned and co-ordinated that in a period of nine months, 100 trained workers could come from each of the training centres and provide the required skilled labour for all six rural workshops. Later, should the role of these training centres be found to be diminishing, some of them could be easily converted into rural workshops with little additional investment.

Tool rooms. The need for tool making for the rural workshops would increase as the production activities in the rural workshops increase, as compared to repair, maintenance and other service functions. The cost of establishing a tool room is more or less the same as that for a rural workshop. As with the rural training centres, one tool room would suffice for six to eight rural workshops, depending on the tooling requirements. If ever the load on tool rooms should be reduced, they could also operate as rural workshops.

Organization of rural workshops

The rural workshops should be carefully organized and administered from their inception, particularly because of their location in rural surroundings and the complexities of their tasks. They must be acceptable to the rural population which, in most developing countries, is generally poor, uneducated and tradition-bound. In some developing countries, however, the villages have had a certain degree of exposure to modern technology and to the impact of education.

The question of establishing rural workshops in any country should be examined in relation to the stage of development of the country in question. It is possible, for this purpose, to classify developing countries into two main groups. One group would consist perhaps of countries that have made some progress in industry and agriculture, but where the bulk of the rural population has not yet benefited from technological progress, and where a rapid increase in population has continued to intensify rural unemployment and underemployment. The second group might consist of the least developed of the developing countries, where there has been little or no progress in either agriculture or industry, and where the majority of the population live in widely dispersed villages with limited educational and employment facilities.

In countries of the first group, where some kind of organized government programme for the development of small-scale industry exists, the problem is one of integrating the programme for establishing rural workshops with the existing economy. The rural workshop programme would have to be sustained and supported by the official organism responsible for the development of

small-scale and rural industries. Experience with the working of other development schemes, however, shows that government controls are not always conducive to efficient management of rural development activities; indeed, it is possible that the entire programme may become hampered by rules, slow-moving and ineffective.

One of the suggested ways to overcome such difficulties would be to entrust the programme to a separate, autonomous, fully empowered control board or corporation. This body should be insulated from bureaucratic and political influences and be managed by professionals of proven integrity and merit, with extensive experience in rural development programmes. Its members should be drawn from large-scale (at top level management) and small-scale industries and financial institutions which actually participate in the scheme in different regions. To facilitate administration, the central board could additionally set up local committees, to which the day-to-day responsibilities of operating the rural workshops in a particular region could be entrusted. The central board may provide policy guidelines and also work out the details of organizational structures for the rural workshops. The appointment of managerial, technical and administrative staff and their service conditions, salaries, and wages should be entrusted to the central board. Apart from accountability for efficient performance, there should be no further controls exercised by Governments in the operation of rural workshops. The central board and its regional committees could, in due course, evolve working arrangements and performance assessment procedures. It is advisable that, at the committee level, representatives of the rural population be appointed.

In the case of less developed countries, it appears that the entire administration of the rural workshops scheme should be the responsibility of the national Government and should be entrusted to a specifically designated authority accountable to the Government for the efficient performance of the various rural workshops within an overall programme of rural industrialization. In due course, the organizational pattern suggested for the first category of countries, namely an autonomous central board, may be adopted to look after an expanded programme.

Relations between the organized sector of the engineering industry and rural workshops

A close linkage between the rural workshops and the organized sector of industry, particularly the engineering and metalworking industry, is of great importance, perhaps for the very survival of the rural workshops. If organized industry does not use the facilities created in rural workshops, the latter may not become viable. It may be necessary, at least in the initial stages, for Governments to provide loan assistance for working capital and even to underwrite some of the working-capital losses that may be incurred by individual rural workshops. In the long run, however, these workshops must be self-supporting and profitable. Any rural workshop must therefore operate efficiently and, like any other business activity, establish its credibility as regards the quality of its products and services, particularly those supplied to the organized industries.

Another solution might be for the organized industrial units to be given financial and fiscal incentives to "adopt" the rural workshops in their region and even supervise their operation. These units have much to gain by establishing production linkages with the rural workshops, including economies in their capital expenditures by obviating investments in items that already exist in these workshops.

Number and location of rural workshops

Rural workshops could fall into the three categories of machine shops, foundries and tool rooms, and further, specialized training centres designed to train skilled personnel for the rural workshops could be considered a fourth category. It might be advisable to begin by setting up a few pilot centres in rural localities near the organized engineering and metalworking industries. In any case, the rural workshops programme should be expanded with great caution and only if justified by experience.

Each training centre should be located in the rural locality nearest the group machine shops it is expected to serve. Similarly, training centres designed for training of skilled personnel for foundries and pattern shops should, as far as possible, be set up near the foundries. The same applies to heat-treatment shops, if it is decided to set them up as separate facilities. If so, they should be located as near as possible to a group of machine shops.

Conclusion

The concept of rural workshops to be set up in the manner described above is comparatively new. Its objective is to create employment opportunities for the rural population in or near their own villages or through the development of rural engineering industries and services. By improving the abilities of the rural population to repair and maintain their farm machines, equipment, irrigation machinery and the like, villagers could become increasingly self reliant. The gains to industry through the utilization of capacity created in these rural workshops could result in both increased production and profitability. It would also lead gradually to an integration of the rural- and urban-based industries.

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Appropriate technology for rural industries

*A. D. Adhikari**

Introduction

The rural economies of most developing countries, being primarily agricultural in character, are now caught in a vicious circle of mass poverty, low productivity and low income levels all adding up to a weak and shrinking market for industrial products. Rural industries in widely scattered locations, based entirely on the traditional skills of the rural artisans handed down from generation to generation, now produce a limited range of articles in small quantities mainly for the local markets. Any attempt to promote rural industrialization must therefore take into account the overall situation of the rural economy on which it ultimately depends. Rural industrialization, in the particular circumstances of the developing countries, must be an integral part of an overall rural development strategy aimed at improving the economic condition of the rural masses through its contribution to an increase of their purchasing power.

Since the entire rural economy of most developing countries is dependent on agriculture, agriculture would provide a point of entry into the vicious circle of mass poverty, declining productivity and shrinking purchasing power of the people. The application of industrial technology in agricultural operations could generate an interactive process of improving farming practices and farm productivity, which in turn could contribute to the expansion of the purchasing power base of the rural economy and provide the ultimate back-up structure needed for a self-sustaining rural industrialization.

Rural needs

In developing countries, any programme of rural industrialization must derive its ultimate support and sustenance from agriculture, which determines both the structure and the character of rural demand.

Depending on the level of agricultural development, rural demand for goods and services required for farming and allied operations can range from simple hand tools and farm implements to sophisticated farm equipment such as tractors, power tillers and power pumps. While simple implements could be

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locally fabricated to improved designs and specifications, it should be possible to encourage the establishment of mechanical maintenance, repair and servicing facilities in rural areas, initially on an itinerant and later on a localized basis. In some cases, the latter might develop into bigger workshops providing engineering support to various agricultural operations and even undertake the fabrication of simple components and spare parts.

Mass-consumption goods such as processed cereals, clothing materials, including ready-made garments, edible oils and soap, as well as agro-based industrial products such as non-edible oils, building and construction materials, animal fodder, small pulp and paper mills based on agricultural residues, handicrafts and traditional products mainly for urban and export markets illustrate the range of rural industrial possibilities in the developing countries. With the intensification of agriculture leading to increased farm productivity and expansion of the purchasing power of the rural population, the demand for various consumption goods increases. A selective approach to the promotion of rural industries, based on a judicious projection of rural demand, would provide an appropriate basis for rural industrialization in developing countries.

Technology

There is a widespread misconception that traditional skills and technology could provide an adequate basis for rural industrialization, that the introduction of improved alternative technologies would invariably create structural dislocation. In actual fact, however, there is hardly any industry in which the traditional skills of the rural artisans have any application or use. The experiences of industrialized countries such as Japan and the United States of America show that requisite skills can be imparted through practical training, provided the industrial technologies sought to be promoted are appropriate to the absorptive capacities of those to be trained in them. Since the products of rural industries must compete in the rural and urban markets with those of large industrial units using better technologies, the former must be cheap and of reasonably good quality to earn consumer acceptance. One of the reasons for the decay of traditional technologies has been the high cost and poor quality of their products.

Grouping of products

One way to make rural industries catering to rural requirements viable is to promote them as multi-product units, which would provide a built-in flexibility in their operation that would enable them to cope with the vicissitudes of rural demand. It should be possible to identify appropriate groups of products or product mixes that could be manufactured by individual units. A few examples or possible combinations are given below:

(a) Fabrication of agricultural implements with mechanical repair and maintenance of farm equipment and machinery;

(b) Processing of cereals with production of animal feed, oil extraction, soapmaking and the like;

(c) Mini pulp and paper mill with a processed cereal or lumber mill;

(d) Furniture making with a mechanical lumber mill;

(e) Building materials, brick and tiles with furniture fabrication;

(f) Textiles with ready-made garments.

Rural workshops can be established to service the requirements of clusters of such groups of industries.

Assessment of plant size and investment requirements

The following industrial options are suggested for the typical rural needs of the developing countries:

(i) Mechanized lumber mill with furniture production facilities
(ii) Mini rice, wheat and oil complex for low-income group areas[1]
(iii) Rice mill complex for higher-income group areas
(iv) Washing soap unit
(v) Brick and tile manufacturing unit
(vi) Printing press and an exercise book and bookbinding unit
(vii) Rural mobile workshop for a lower-income group
(viii) Rural service workshop for higher-income group areas

The broad investment requirements, types and cost of machinery, raw material inputs, assessment of operating costs, employment potentiality for the options suggested above are given below.

1. Mechanized lumber mill with furniture production facilities

It is assumed that sufficient wood is available in the area, at an economic distance from the mill site and that electrical power is available.

Process description: The debarked logs are first sized to the nearest required square or rectangular cross-section, with a horizontal band saw. Wood slabs of desired thickness are then sawn by adjusting the height of the cutting blade manually. The slabs may be sold as such sawn again to various sizes in a vertical band saw depending on customer requirements.

Equipment: Generally, the following equipment is required:

Main 35-hp (26-kW) drive motor with line-shaft arrangement for the transmission of power to the various machines

Horizontal band-saw machine

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[1]In this paper, $150 per annum is considered the median *per capita* income. "Low" and "high" refer respectively to incomes below and above the median.

Vertical band-saw machine
Pull trolley on rails for feeding the logs to the machine
Saw-tooth grinder

Investment required

Fixed capital	($)
Land, 2 acres (0.8 ha)	700
Plant and machinery	9 500
Building and site development	2 500
Initial expenses	1 500
Total fixed capital	14 200
Working capital	15 000

Capacity, logwood processing: 10 m^3 per 8-hour shift

Employment potential	
Administrative	3
Labour force	12
Total	15

Input requirements

Item	*Quantity required per annum*
Debarked logwood	3 300 m^3
Saw blades	(24 sets each for each horizontal and vertical machine)
Grinding discs	
Nuts and bolts	
Beltings and jointing materials	
Grease	

Economic life of equipment: 20 years

Cost of production and profitability
(Basis 1 m^3 of finished product)

Item	*Amount ($)*
Raw material (assuming 30 per cent waste and price of logwood as $81.00 m^3	115.70
Spare parts consumables and energy	2.50
Salaries and wages	3.80
Interest on working capital (12 per cent)	0.55
Subtotal (A)	122.55
Administrative overheads and contingencies (10 per cent of A)	12.30
Interest and depreciation (20 per cent of fixed capital)	0.90
Cost of sales	135.75
Selling price ex factory	140.00
Gross profit	4.25

Gross return on investment: 98.8 per cent

Minimum sales requirement: Break-even will be at 60 per cent capacity on a single-shift (8 hour) without taking into consideration any profits from the sale of waste. In a rural economy, sawmill waste has some value as fuel.

Utilization of waste: Depending on the species of wood used, the waste produced could be the basis of a mini pulp and paper unit. This material also has a good heating value and can be used as domestic fuel. The slicings may be used for making furniture.

2. Mini rice, wheat and oil complex unit for lower-income group areas

Assuming that power is readily available to the industry and sufficient paddy, wheat and similar grains and seed are available in the area.

Process description: The paddy from the fields is first manually screened to remove foreign materials, then threshed, and then manually screened to remove the bran. The rice is polished in a rubber-lined hull unit; the remaining dust can be used as fodder.

For the production of flour from other cereals, the grains are charged into the grinder, and the product screened to separate the ground cereals from the dust which can be used as animal fodder.

Vegetable oils are commonly produced by squeezing the oil-bearing seed in a screw press or by solvent extraction. The seed must pass through the press several times before the extraction is complete. The oilcake produced as a by-product, can be used as fodder or fertilizer.

Equipment: Generally, the following equipment is required:

Main 25 hp (18.5 kW) drive motor with a line-shaft arrangement to transmit power to the following machines:

Paddy sheller

Rice huller

Cereal grinder

Oil extraction screw press

Sieves

Investment required

Fixed capital	($)
Land 1 acre (0.4 ha)	350
Plant and machinery	8 600
Buildings and site development	1 500
Initial expenses	1 500
Total fixed capital	11 950
Working capital	6 000

Capacity per single 8-hour shift	(kg)
Paddy	2 000
Oilseed	600
Cereal	1 000

Yield	(%)
Rice (on paddy)	63
Mustard oil (on seed)	34
Flour (on wheat)	85

Employment potential	
Staff	1
Labour force	10
Total	11

Input requirements

Item	*Quantity per annum (million tonnes)*
Paddy	660
Wheat or other cereal	198
Mustard seed	330
Bearings	
Beltings and jointing materials	
Grease	

Economic life of equipment: 15 years

Cost of production and profitability
(Basis 1,260 kg rice, 850 kg flour, 204 kg oil)

Item	*Amount ($)*
Raw materials (assuming 63 per cent yield of rice on paddy, 85 per cent yield of flour on wheat and 34 per cent yield of oil on seed and prices of paddy, wheat and oilseed as $125, $125 and $315 respectively)	565.00
Spare parts, consumables and energy	6.50
Salaries and wages	27.00
Interest on working capital (12 per cent)	2.25
Subtotal A	600.75
Administrative overheads and contingencies (5 per cent of A)	30.00
Interest and depreciation (20 per cent of fixed capital)	7.25
Cost of sales	637.00
Selling price (assuming prices of rice, flour and oil as $240, $190 and $900 respectively	647.50
Gross profit	10.50

Gross return on investment: 29 per cent

Minimum sales requirement: Break-even point will be at 75 per cent capacity utilization on an 8-hour, single-shift operation. Longer working hours would yield a higher economic return.

3. Rice mill complex for higher-income group areas

Process description Paddy is first loaded on bucket elevators and conveyed to a vibratory screen. When the foreign materials and husk have been removed, the paddy is fed to the sheller. The product is then screened on a multi-deck vibratory screen, and if necessary re-shelled. The raw unpolished rice is fed into a rubber-lined huller machine and the polished rice is then screened on an open vibratory screen to remove dust and broken grains, before it is bagged and marketed.

Type of equipment to be installed: Generally, the following equipment is required:

A main 50 hp (37 kW) drive motor with line shaft arrangement for transmission of power to the different sections

Bucket elevators

Single-deck vibratory screens

A multi-deck vibratory screen

A high-speed disc sheller

A rubber-lined huller

Investment required

Fixed capital	($)
Land 1 acre (0.4 ha)	250
Plant and machinery	24 000
Building and site development	4 800
Initial expenses	2 000
Total fixed capital	31 050
Working capital	7 500

Capacity (tonnes per 8-hour shift)
Paddy processing 10
(Yield of rice from paddy is about 62 per cent)

Employment potential

Staff	2
Labour force	6
Total	8

Input requirements

	Requirement
Paddy	3 300 t/a
Belting and jointing materials	
Bearings	
Grease	
Nuts and bolts	

Economic life of equipment: 15 years

Cost of production and profitability
(Basis: 1 t rice)

Item	*Amount ($)*
Raw material (assuming 62 per cent yield and price of paddy as $125/t of paddy)	201.60
Spare parts, consumables and energy	3.00
Salaries and wages	3.50
Interest on working capital (12 per cent)	0.45
Subtotal A	208.55
Administrative overheads and contingencies (10 per cent of A)	20.90
Interest and depreciation (20 per cent of fixed capital)	3.05
Cost of sales	232.50
Selling price	240.00
Gross profit	7.50

Gross return on investment: 49.3 per cent

Minimum sales requirement: Break-even point will be at 50 per cent capacity utilization on an 8-hour, single-shift working basis without taking into consideration any profits from the sale of waste. The waste is used as fodder.

Utilization of waste: Waste can be used to make building bricks, cement and activated carbon. Oil can be extracted from the husk.

The dust containing broken rice particles mixed with cracked maize, mineral salts and vitamins can be used as fodder.

4. Washing soap unit

In suggesting this option, it has been assumed that all inputs listed below are available at an economic price.

Process description: Linseed oil, castor oil and animal fat are mixed in appropriate proportions and heated with caustic soda in open pans indirectly heated by firewood. More caustic soda is gradually added until saponification is complete. The material is then cooled and the precipitated and saponified product transferred to another pan. The required amounts of sodium silicate, foaming agent and perfume are added and the mixture is thoroughly kneaded. The semi-solid paste thus produced is placed on a die, hammered with a cupped hammer to a 500 g ball and wrapped in bags and marketed.

Type of equipment to be installed: Generally, the following equipment is required:

Pans
Ladles
Small handling implements

Investment required

Fixed capital	($)
Land, 1 acre (0.4 ha)	350
Plant and machinery	950
Building and site development	650
Initial expenses	500
Total fixed capital	2 450
Working capital	9 000

Capacity: 2,000 balls (500 g per 8-hour shift)

Employment potential	
Staff	1
Labour force	8
Total	9

Input requirements

Input items	*Requirement per annum*
Linseed oil	11
Animal fat	66
Castor oil	33
Sodium silicate	167
Caustic soda	26
Foaming agent	
Perfume	

Economic life of equipment: 7 years

Cost of production and profitability
(Basis: 2,000 500 g balls)

Cost component	($)
Raw materials and chemicals	407.00
Linseed oil 35 kg ($1.00 per kg)	35.00
Animal fat, 200 kg ($1.00 per kg)	200.00
Castor oil, 100 kg ($0.60 per kg)	60.00
Sodium silicate, 520 kg ($0.15 per kg)	78.00
Caustic soda, 80 kg ($0.30 per kg)	24.00
Foaming agent and perfume	10.00
Consumables and energy fuel	10.00
Salaries and wages	23.00
Interest on working capital (5 per cent)	3.30
Subtotal A.	443.30

Administrative overheads and contingencies (5 per cent)	22.20
Interest and depreciation (20 per cent of fixed capital)	1.50
Cost of sales	467.00
Selling price	480.00
Gross profit	13.00

Gross return on investment: 175.1 per cent

Minimum sales requirement: Break-even point will be at 70 per cent capacity on an 8-hour, single-shift basis.

5. Brick and tile manufacturing unit

It is assumed that clay of brickmaking quality is available.

Process description: The clay is mixed with the necessary quantity of sand to form a thick slurry, which is then cast in moulds and sun dried. When dry, the bricks are removed from the mould and stacked in an open circular furnace. Firing is started from one end and is continued until the batch is complete. After cooling, the bricks are removed from the furnace and marketed.

Equipment required: The following equipment is required:

Mud mixers
Moulds

Investment required

Fixed capital	($)
Land, 25 acres (10 ha)	8 750
Plant and machinery	1 500
Building and site development	2 000
Initial expenses	500
Total fixed capital	12 750
Working capital	7 500

Capacity: 1 million bricks per annum

Employment potential

Staff	1
Labour force	50
Total	51

Input requirements

Since sand and clay are available at the plant site, only coal (300 t/a) must be brought in.

Economic life of plant

Until the clay deposit is exhausted

Cost of production and profitability
(Basis: 1,000 bricks)

Cost component	($)
Raw materials	0.80
Coal (0.20 t per 1,000 bricks)	4.00
Salaries and wages	13.00
Interest on working capital (12 per cent)	0.90
Subtotal A	18.70
Administrative overheads and contigencies (5 per cent of A)	0.95

Interest and depreciation (20 per cent on fixed capital)	2.55
Cost of sales	22.50
Selling price ex factory	25.00
Gross profit	2.80

Gross return on investment: 22 per cent

Minimum sales requirement: Break even point will be at 90 per cent capacity utilization for only five months of work per annum. If the working period could be increased, depending on climatic conditions, the economic return will be better.

6. Printing press, exercise books and backbinding unit

This option is recommended for an area with a literacy level of around 20 per cent of the population and a *per capita* income high enough to use a printing press.

Type of equipment to be installed: The following major equipment is required:

Printing press
Drive motor of 2 hp (1.5 kW)
Guillotine machine
Binding machine

Investment required

Fixed capital		($)
Land 0.5 acres (0.2 ha)		400
Plant and machinery		20 000
Buildings		2 500
Initial expenses		1 600
Total fixed capital		24 500
Working capital		10 000
Employment potential		
Staff	2	
Labour force	12	
Total	14	

7. Rural mobile workshop for a lower-income group

This option has been suggested for a low-income group where mechanization has recently begun in a modest way. It would render service facilities such as repairs and maintenance of agricultural implements, production of small garden tools, nuts and bolts and the like. The scheme suggested is for an area of 100 km², taking into consideration that electrical power is readily available.

This option has been further subdivided into two: the first with agro-service facilities rendered on an hire-out basis, the second, without agro-services facilities.

Scope of facilities offered

With agro-services facilities	*Without agro-services facilities*
Hiring out facilities of agricultural implements such as power tillers, pumps, harrows etc.	Providing service facilities in inland rural areas
Providing service facilities in inland rural areas	Meeting the immediate requirement for hardware such as nuts and bolts, garden tools and small ploughs
Meeting the immediate requirement for hardware such as nuts and bolts, garden tools and small ploughs	
Rural transportation facilities	

Type of equipment suggested

With agro-service facilities	*Without agro-service facilities*
20 power tillers, 10 hp (7.5 kW)	1 power tiller, 10 hp (7.5 kW)
20 sets of centrifugal pumps with diesel engine, 20 hp (15 kW)	1 bicycle
1 small lathe	1 small lathe
1 arc welding and gas welding set	1 arc-welding and gas welding set
1 drill press	1 drill press
1 bench grinder	1 bench grinder
Blacksmith shop	
Carpentry shop	Carpentry shop
Garage tools	Garage tools
Tools and tackles	Tools and tackles

Investment required

	With agro-service facilities	*Without agro-service facilities*
	($)	($)
Land	700	350
Plant and machinery	4 000	8 000
Building and site development	2 000	1 000
Initial expenses	2 000	1 500
Total capital expenditure	8 700	10 850

Employment potential

	With agro-service facilities	*Without agro-service facilities*
Staff	3	1
Labour force		
Skilled	9	7
Semiskilled	33	2
Unskilled	7	8
Total	52	18

Input requirements

The input requirements will be more or less the same except that those for spare parts, power tillers and pumps for the one with agro-service facilities will be higher. The major inputs will be:

Diesel oil, lubricants etc.

Steel materials such as sheets, bars and rods

Electrodes

Oxygen and acetylene gas
Timber
Spare parts for agricultural implements
Consumables such as cotton waste, and grinding discs

Economic life of equipment. 10 years

Cost of servicing, manufacture and hire out facilities and profitability: (basis: one year of operation). The cost of materials of fabrication, spare parts and consumables will include an additional charge of 5 per cent.

Item	*With agro-service hire out facilities* ($)	*Without agro-service hire out facilities* ($)
Energy and fuel	15 800	2 900
Spare parts for implements	2 500	200
Salaries and wages	40 200	14 600
Interest on working capital (12 per cent)	720	480
Subtotal A.	59 220	18 180
Administrative overheads and contingencies (5 per cent on A)	2 930	910
Interest and depreciation (20 per cent on fixed capital)	13 740	2 170
Cost of servicing, fabrication, hire out facilities	75 170	21 260
Gross sales realization on the basis of working hours and machine running charges per hour (see table 1)	100 905	27 405
Gross profit	25 735	6 145

Gross return on investment: 37.5 per cent, 56.6 per cent

TABLE 1. GROSS SALES REALIZATION

Section	*Running hours per annum*		*Rate of servicing fabrication and hire out facilities ($ hr)*	*Sales value ($)*	
	With agro-service facilities	*Without agro-service facilities*		*With agro-service facilities*	*Without agro-service facilities*
Power tillers	1 500 x 20	1 000	1.50	45 000	1 500
Pumps	1 500 x 20	–	1.00	30 000	–
Blacksmith shop	1 650	1 650	1.00	1 650	1 650
Machine shop	1 980	1 980	10.00	19 800	19 800
Carpentry shop	1 980	1 980	1.50	2 970	2 970
Automobile shop	990	990	1.50	1 485	1 485
Total				100 905	27 405

8. Rural service workshop for higher-income group areas

This option is suggested for a higher-income area where the general inclination of the population is towards mechanization. In addition to providing service facilities for semi-industrialized rural areas, it will have a production unit to meet various rural needs. The surplus production will be diverted to the urban areas. It will also have automobile servicing facilities. The scheme suggested is for an area of 250 km^2, taking into consideration that electrical power is readily available and there is a reasonable number of tractors, power tillers, agricultural pumps and small industries.

Scope of facilities offered: Repair, maintenance and major overhauling facilities for agricultural implements such as tractors, power tillers, pumps, diesel generation sets and machinery for a rice mill, oil mill and lumber mill etc.

Automobile servicing facilities

Production to meet typical rural needs for items such as small agricultural implements, hardware, fixtures, furniture, small tanks and building materials

Type of equipment to be installed in rural service workshops

Garage	*Machine shop*	*Production shop*	*Carpentry shop*
Compressor	Lathe	Gas and arc welding set	Wood lathe
Vulcanizing unit	Shaping machine	Blacksmith shop	Carpentry hand tools
Breakdown and repair tools	Drilling machine		
Servicing equipment	Grinding machine		
	Shearing machine		
	Power hack saw		

Investment required

Fixed capital	($)
Land 1.5 acres (0.6 ha)	600
Plant and machinery	31 000
Building and site development	4 000
Initial expenses	3 000
Total fixed capital	38 600
Working capital	25 000

Employment potentially

Staff	5
Labour force	
Skilled	20
Semi-skilled	10
Unskilled	27
Total	62

Input requirements

Spares for automobiles, tractors, power tillers, pumps, various small industries such as a rice mill, an oil mill and a lumber mill

Steel materials such as mild-steel plates, flats and rounds

Timber

Diesel oil, lubricating oil, grease

Consumables such as gaskets, waste cotton, hack saw blades and files

Economic life of equipment: 15 years

Cost of servicing and production and profitability: On the basis of one year of operation, the cost of materials for manufacturing, spare parts and consumables will include an additional charge of 5 per cent.

Cost component	*($)*
Power	4 500
Salaries and wages	72 300
Interest on working capital (12 per cent)	3 000
Subtotal A	79 800
Administrative overheads and contingencies (5 per cent of A)	3 990
Interest and depreciation (20 per cent on fixed capital)	7 720
Cost of servicing and manufacture	91 510
Gross sales realization based on working hours and machine running charge, per hour as given in table 2	117 480

TABLE 2. GROSS SALES REALIZATION

Section	*Running hours per annum*	*Rate of servicing and manufacture ($ hr)*	*Sales value ($)*
Garage	2 310	4.00	9 240
Blacksmith shop	1 050	2.00	3 300
Machine shop	1 980	35.00	69 300
Carpentry	1 980	3.00	5 940
Manufacture	1 980	15.00	29 700

Note: Gross profit: $25,970.
Gross return on investment: 67.3 per cent.

Linkage between urban and rural industries

Industrial development in most developing countries has been concentrated around urban centres, while rural areas, which provide the bulk of the raw materials consumed by urban-based industries, have been involved in the production process only to a limited extent. For rural industrialization it is extremely important that the rural industries are structurally integrated with larger industrial units located in or near urban centres. Such linkages could be established if some of the primary processing operation of the larger units could be decentralized to the rural areas so that instead of raw materials, intermediates and semi-processed materials may be exported from rural areas to urban-based industries. Agricultural processing industries should also be decentralized to the rural areas where the raw materials intermediates and semi-processed materials may be exported from rural areas to urban-based industries. Agricultural processing industries should also be decentralized to the rural areas where the raw materials for these industries originate. To enable rural light engineering industries and workshops to manufacture standard products, larger urban-based engineering industries should make deliberate efforts to provide the required training facilities, designs, drawings and specifications etc., guidance and supervision, critical raw materials and other forms of assistance. Government policy should also encourage such efforts by larger urban-based engineering units through adequate fiscal and other incentives. Bulk customers in urban areas should also be encouraged by the Government to use the production facilities available in rural areas. Establishment of design centres in rural areas to develop new designs and to

familiarize rural entrepreneurs with market trends would also strengthen the market linkages of rural industries.

Policy incentives and concessions

The national Governments of developing countries should adopt both promotional and regulatory policies to develop rural industries along with large urban industries.

Financial assistance

Liberalized long-term loans at concessional rates of interest should be available for a techno-economically viable project and no interest should be charged during the initial stages. Most rural industries suffer for want of adequate working capital. Arrangements should therefore be made to ensure sufficient working capital at concessional rates of interest. A moratorium on payment of interest should be allowed for a predetermined period depending on the nature of the industry.

Subsidy for the development of distressed areas

There should be outright subsidies on capital investment in industries located in distressed areas. Subsidies on the transport of raw materials and finished products should also be available for areas which have definite locational disadvantages.

Entrepreneurial assistance

Considering the need for intensive training programmes for rural industries to enable them to produce quality products, the national Government should establish centres for training of prospective entrepreneurs in project planning and evaluation, financial management, material and marketing management, inventory control etc.

Sales assistance

Rural co-operative sales organizations should be set up for marketing the products of groups of rural industries and for carrying out market surveys of both existing products and new ones that could be produced in rural areas.

Purchase assistance

Rural industries may at times suffer for want of raw materials, chemicals and utilities. The setting up of government purchasing units would definitely help in removing these constraints. The Government may also establish raw material banks to maintain a ready stock of all critical raw materials.

Research and development assistance

Research and development centres for rural industries should be set up in different areas. The centres would provide technical assistance to industrialists in product design or any other technical matters.

To ensure the availability of sufficient amounts of cheap power, the cost of energy may have to be subsidized during the initial stages of development.

Certain commodities may be exclusively reserved for manufacture by the rural industries and no urban-based industrial unit should be allowed to manufacture them.

Wage policy

The wage policy of the Government should be designed to help offset the disadvantages from which new industries established in rural areas may suffer as a result of their location. The wage policy should not act as a disincentive to the development of rural entrepreneurship and the flow of capital from urban to rural areas.

Infrastructure

Adequate infrastructure, including housing, schools, hospitals, drinking water, transportation etc., should be provided by the national Government in rural areas.

09802

The light engineering industries of the Philippines

*A. V. Arizabal**

Introduction

The engineering industry of the Philippines, although still in its development stage, is involved in a wide range of processes and products and accounts for about 11 per cent of the value of Philippine manufactures and about 2.6 per cent of the GDP. There are thousands of different engineering products reflecting a wide variety of sizes, designs, constructions, qualities and styles.

The engineering industry of the Philippines is primarily concerned with forming machine components and other useful products from metal. It essentially produces equipment components and maintains equipment for all of the productive sectors of the economy. These manufacturing activities range from straightforward metal fabrication, casting and machining to the assembly of finished equipment. Consequently, the industry can produce an almost infinite variety of products. Specialization has not, however, been achieved except in larger companies and a few small ones, owing to the highly fragmented market.

While production is mainly intended for the domestic market, export markets have been developed to a limited extent for some items of durable goods such as sewing machines, bicycles and pumps.

The country depends heavily, however, on imported industrial machinery, including that for the mining, iron and steel processing, metalworking, machine tools, cement, electric power, paper and textile industries.

Other imported features of the engineering industry are its linkage between products and processes and its ability to supply other industries with specialized goods. Different products that are turned out by the same plant are linked together; on the other hand, different establishments may be associated because they manufacture sub-assemblies or components that make up a single finished product.

In the Philippines, there is much subcontracting by enterprises in the engineering industry. It is carried out at various levels, so that primary subcontractors may let out some of the items they need to smaller subcontractors. A large volume of machining work is being let out by metal manufacturers, machine shops, appliances, agriculture and the transport

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industries. Aside from machining, most machine shops farm out castings, plating and fabrication jobs, in that order. The manufacturers of metal parts subcontact most plating, casting and heat treatment jobs. There is much subcontracting in the automotive industry for items such as brake linings, disc brakes and exhaust systems.

In the appliance industry, some heat-treatment, enamelling, casting, pressing, blanking and machining jobs are done externally. Most jobbing foundries produce rough or machined castings to be assembled with other components to produce a certain unit. Most subcontracting is carried out by job shops, which usually have a considerable amount of underutilized machinery.

The principal raw materials used in the industry are sheets (base metals and coated metals), plates, bars and rods, wires, pipes and tubes, tool steels and welding rods. Most of these basic products were originally imported, although there has always been a significant production of reinforcing bars and other billet-derived products as well as products cast from locally available scrap. At present, the percentage share of local production to total consumption of these intermediates is greater than the percentage share of imports.

Status of the engineering industry

The development of metal-products manufacture started with small ironworks, machine shops or foundries making replacement parts, gradually progressing into the production of ordinary metal products such as nails, wire and sheet-metal products, finally shifting to a more diversified production of other and more complex products. At present, there are a total of 2,005 enterprises engaged in metal-products manufacture dispersed thoughout the country. About 91 per cent of them are concentrated in the main island of Luzon.

The distribution of engineering firms according to their activities is given in table 1, and the annex contains a breakdown of the activities.

TABLE 1. DISTRIBUTION OF FIRMS ACCORDING TO ACTIVITY

Industry sector	*Number of establishments*	*Proportion of total (percentage)*
Service	947	47
Manufacture of metal products	692	35
Machine tools	51	3
Farm machinery and equipment	97	5
Transportation equipment	58	3
Appliances	31	2
Power-engine machinery	17	1
Construction and mining machinery	8	–
Electrical machinery and electronic equipment	29	1
Food-product machinery and equipment	23	1
Textile and machinery	29	1
Chemical-processing machinery	23	1
Total	2 005	100

The typical machine shop is highly diversified in its production and services rendered. Its products include components or replacement parts such as pins,

bolts, gears, shaftings, bushings and valves. Engine reconditioning refers to the rebuilding, refacing, reboring, sleeving and resizing of automotive, marine and stationary engines. Among the industries served are the logging, electrical, mining, textile, cement, glass, oil-refining, industrial chemical, paper, food processing, sugar, grain-milling and containers branches.

The machine tool sector is still in its early stages of development. Most of the companies involved in it produce machines for their own use and repair or assemble a limited number of machine tools such as lathes, drills and shapers. There are about 14 pioneering manufacturers of machine tools. Although this industry is still young, the production of tools, dies and jigs has been developed to a greater extent. Several manufacturers, who are usually small subcontractors, have acquired the capability to fabricate quality tools.

The manufacture of electrical equipment is gaining headway. This sector concentrates on prime movers (motors) and power-transmission equipment such as transformers and switchgear. At present, only fractional horsepower motors are produced in fairly large quantities. They are used for electric fans, air conditioners, blowers and the like. A few firms also produce appliances, distribution and power transformers, switches, fuses and electrical lamps.

Most food processing, textile and shoemaking equipment is imported. Only small components such as replacement parts for processing mills are fabricated locally. Bakery equipment such as mixers and bread slicers are batch produced by several firms. Similarly, only spare parts of equipment in the chemical-processing sector are locally manufactured. Fabricated parts are mostly moulds for rubberworking and plastic injection-moulding machines.

Some agricultural machinery and implements of various capacities and models, suitable for different seasons and farming practices, are locally manufactured. Manufacturers of power or hand tractors, grain dryers and the like are scattered throughout the country. The transport industry sector is presently being developed to become a major part of the engineering industry. Hundreds of jeep and truck body-builders are operating in almost every part of the country on a jobbing basis, but a few firms also manufacture on volume scale. Bicycles and pedicabs are being manufactured and fabricated in comparatively large volumes.

Appliance manufacturers are mostly engaged in semi-mechanized operations. There are a few large manufacturers of refrigerators and air conditioners and several medium-sized producers specializing in the fabrication of such equipment, particularly centralized-type air conditioners. There are also manufacturers of other appliances such as electric irons, electric fans and sewing machines.

Pumps of different makes and capacities are usually fabricated by medium-size firms. Centrifugal pumps of common types are being produced, ranging in capacity from a few litres to about 800 litres/min. The local manufacture of construction machinery is also limited. The items being manufactured include replacement parts for tractors, earth-moving, materials handling and rock agreggate processing machinery. Smaller fabricators produce concrete and mortar mixers and hollow-block-making machines. Electric arc and gas welding equipment are also produced domestically.

The manufacture of metal products involves a great variety of items, of

which the ironworks producers represent a large proportion. There are many fabricators of iron grilles, doors, windows and frames. Most of them are small enterprises.

Manufacturers of cutlery are concentrated in the Bicol region of Southern Luzon island.

Numerous furniture, fixtures and hardware products including hand-tools, garden tools and edge tools, are locally produced by blacksmith shops. In nearly every region of the country there are centres of manufacturing for simple tools used in agriculture, carpentry and metalworking.

Steel wires are locally fabricated into many articles for a wide variety of uses, such as nails, springs, hoops, rivets, fencing materials, screens and a host of others, each of which consumes large amounts of wire.

To date, the engineering industry has a total employment of about 49,500 workes distributed throughout all parts of the country. Firms with fewer than 10 employees account for about 65 per cent of the total number of firms in the industry, while those with more than 500 employees account for only about 1 per cent. Table 2 presents the distribution of engineering establishments by number of persons employed. The great majority of the workers employed in the industry are semi-skilled.

TABLE 2. DISTRIBUTION OF EMPLOYMENT IN THE ENGINEERING INDUSTRY

Employment	*Number of establishments*	*Number of persons employed*	*Average number of workers*
Less than 10	1 249	4 754	4
10–19	205	2 860	14
20–49	249	7 473	30
50–99	101	6 893	68
100–199	59	8 172	138
200–499	28	6 946	248
Over 500	16	12 422	776

Capitalization

Although the engineering industry is generally labour intensive, it may be capital intensive in certain cases. Table 3 shows that about 72 per cent of the firms have capitalizations of less than 50,000 Pesos (P). These firms are classified as small-scale. The overall picture is therefore that of a highly diversified industry with many small-size firms, making a wide variety of products.

TABLE 3. FIRM DISTRIBUTION ACCORDING TO CAPITAL

Capitalization (Pesos)	*Number of firms*	*Percentage distribution*
50 000	1 445	72
50 000–100 000	189	9
100 001–500 000	221	11
500 001–1 000 000	58	3
Over 1 000 000	92	5
	2 005	100

Employment

The engineering industry consists of extremes: the large, well-organized establishments and the small, one-owner operations. With few exceptions, the large plants are generally well managed; they have adequate facilities and they manufacture metal products that conform to standard specifications. Very few of the small-sized individual firms have the financial resources to employ engineering designers and professional production, metallurgical or quality-control personnel. Most of these companies have been founded and managed by one person who may be an engineer, an entrepreneur or skilled worker who, through the years, has learned the rudiments of the trade. It is common, especially in small shops, for the manager-owner to take charge of technical, managerial and business matters, sometimes functioning as a production worker as well. A number of plants, however, employ supervisors, foremen, clerical, workers, engineers, and the like to maximize productive efficiency.

Some of the larger firms are related to transnational corporations as licensees, partners or wholly owned subsidiaries. In this way these local firms are provided with the technical assistance in plant organization and product engineering support initially needed.

Local production

An assessment of the engineering industry shows that it is largely composed of small-scale enterprises essentially engaged in jobbing and low-volume order activities. Most of these small-scale establishments can be classified under the service industry and manufacture of metal products sectors. The engineering industry in the Philippines can therefore be considered as still being essentially in the light engineering stage.

A certain degree of manufacturing sophistication has been achieved in certain sectors as in the automotive and appliance industries. Despite certain drawbacks, including technological, financial and marketing problems, local production has increased from about P 838 million in 1971 to approximately P 2,021 million in 1975. The construction, appliance, transport, power and mining industries have been responsible for much of the growth of the engineering industry. The growth of industrial activity in recent years has generated much of the expansion that took place within the industry.

Status of the light engineering industry

The Philippines has a comparatively short industrial history. At present, the development of its light engineering industry is beginning to level off because production has been principally oriented toward import substitution. In addition, the limited size of the domestic market frequently results in idle capacity, inadequate scales of production or too great a diversification of production. The lack of opportunity for specialization has brought about various technological problems.

In this paper, the light engineering industry is broadly classified into metalworking (pressing, forging, rolling etc.), metalcutting (machining) and casting (foundry).

Metalworking and fabrication firms

The manufacture of metal products through metalworking and fabrication involves a great variety of items. The ironworks, welding shops and press shops represent the largest in terms of firms, and most of them belong to the small-sized enterprises. Some products included under metal-products manufacture are: iron and sheet-metal works; wire and wire products; hand tools; hardware; metal fasteners; furniture and fixtures; lighting and plumbing fixtures; safes, vaults and storage cabinets; cutlery; kitchenware and appliances; ornaments; hospital equipment and supplies; tin-plate containers; springs; ordnance; and other miscellaneous metal articles.

The demand for metal products is confined to the domestic market. The metalworking and fabrication sector is generally supported by the construction industry, the commercial sector, the manufacturing and the household sectors. Local production of metal manufactures increased from P403 million in 1971 to about P731 million in 1975.

In some parts of the country, there are centres of manufacturing that specialize in the production of such specialized metal items as cutlery. The Philippines has achieved a certain degree of technical proficiency in being able to meet about 55 per cent of the total requirements for metal manufacture. Local manufactures, however, still suffer from competition from imports because of certain technical and financing problems.

Establishments engaged in metal manufacture, which grow at an average rate of 15 per cent yearly, accounted for about 70 per cent of the total number of firms in the engineering industry. These plants and workshops are generally concentrated in major cities and towns in the country.

A classification of firms engaged in metal manufactures based on the number of employees is shown in table 4. As a measure of size, the majority of firms (65 per cent of the total) belong to the small-scale enterprises employing only 1 to 20 persons. About 7 per cent of the firms are considered medium-to large-scale employing over 100 persons.

TABLE 4. EMPLOYMENT DISTRIBUTION

Employment (persons)	*Number of firms*	*Percentage distribution*
1–20	456	66
21–100	187	27
Over 100	49	7
Total	692	100

Machine shops

Existing machine shops in the Philippines are basically jobbers, engine rebuilders, fabricators and small-scale subcontractors. They cater to nearly all sectors of industry.

At present, there are about 873 machine shops in the country and about 121 engine reconditoners, making them together the largest group in the engineering industry, representing about 60 per cent of the total number of

establishments. These are mostly small, open-front shops in industrial centres, lining the roads and servicing numerous industries. Most of these shops have five general-purpose machines for undertaking machining, drilling and welding jobs. Their products, however, depend on the needs of their customers. Most worn-out parts of machines are brought to these shops for copying and fabrication, although certain standard items are made in small quantities. These machine shops are primarily engaged in the repair and maintenance of practically all types of machinery and industrial equipment, motorized and non-motorized vehicles, and electrical and non electrical machinery, and in the fabrication or duplication of machine parts based on imported models and customers' designs.

The performance of these machine shops, as measured by the total earnings of the firms, averaged about P65 million in the five-year period 1971–1975. Their share of the total engineering industry output was maintained at about 5 per cent. Historically, the machine shops represent a small-business industry. Firms with fewer than 10 employees account for about 77 per cent of the total number of firms, while those with over 20 employees account for only about 5 per cent.

Foundries

Cast metals play an essential part in the Philippine economy, specifically in meeting the requirements of equipment, machinery and spare parts manufacture. To date, 147 foundries are engaged in the production of various cast products. Most of them are geograhically concentrated in Metro Manila and account for 72 per cent of the total production of castings. Foundries have been in existence for the past three decades; the industry has continued to grow by expansion and proliferation. Most of them, however, are still manual in operation; only a few are semi-mechanized. With regard to their size distribution, about 37 firms, or 25 per cent, employ less than 20 workers, which account for only 4 per cent of total employment. There are 27 foundries that employ more than 100 workers; they constitute about 18 per cent of the total number of establishments but account for 59 per cent of total employment.

The range of products turned out by domestic foundries covers diverse applications as they are utilized by a wide range of end-user industries. Production in 1973 totalled 69,230 t, increasing to 99,200 t in 1976. Casting production showed notable gains owing to the increased activities in the agriculture, mining, transport and construction industries. These also gave rise to the emergence of new foundries to meet the increased demand for castings from the end-user industries. Production in the foundry industry was dominated by 24 firms which accounted for about 79 per cent of total output. The growth and development of the foundry industry has been linked to the progress and expansion of the country's major industries, such as mining, construction, transportation and agro-based industries. Domestic foundries usually turn out replacement parts of machinery and equipment, but some firms are now able to manufacture original components for the transportation, appliance and agricultural machinery industries.

Problems of the industry

Financing has always been a major problem of the industry, which is very much undercapitalized. Tight credit continues to restrain the business establishment from further expansion of their productive capacity. Such financial constraints as lack of equity capital and difficulties in securing loans have resulted in the inability of most firms to achieve an efficient production level. Working capital is almost always financed from internally generated funds, which are often inadequate. The need for more working capital is acutely felt by small entrepreneurs owing to lack of readily available loans. As a result, some firms prefer to continue with obsolete methods of manufacture rather than to modernize as to do so would require more investment.

The main technical and manufacturing problems of the industry are low-quality raw materials, lack of standards, frequent machinery breakdowns, faulty production scheduling, insufficient design knowledge and lack of proper tools and devices. Production planning and quality control are lacking in most establishments. These problems often hinder the production of precision parts and other high-quality products and the possibility of entering the export market.

The shortage of funds and workshop space and the restricted volume of orders usually prevent the entrepreneurs from purchasing specialized production machines. More often, it is necessary to switch from one type of product to another, and enterprises therefore maintain general-purpose machines.

Considerable ingenuity is developed in designing simple jigs, fixtures and tools and improvising machinery to carry out the multitude of processes encountered by the small-workshop entrepreneur. Sometimes the acquisition of a costly, sophisticated machine is technically required but its capital and operating costs are so high and its volume of production, so small, that it is uneconomic to acquire it.

The lack of well-trained workers is a perennial problem of the industry. Since it is basically labour intensive, the engineering industry's greatest asset is necessarily its trained work-force. Ironically, the industry suffers from shortages of qualified workers because of the limited training facilities available to it. In many cases, the workers develop only to the semi-skilled level; only large establishments have well-organized training programmes. Under such circumstances, many firms prefer to hire skilled workers developed by other companies, attracting them with higher wages.

There is substantial underutilization of capacity in the engineering industry owing to a variety of factors such as too many plants in too small a market, and shortages of raw materials, financing, skilled workers and skilled supervisory personnel. Lack of product diversification, deficient design and production engineering and the continued use of outmoded machinery are also limiting factors. This situation underscores the fact that a poorly utilized machine inevitably results in a high capital-to-output ratio.

Imported machinery sometimes cannot be used for lack of spare parts or skilled operators. This is a very serious problem, because the equipment manufacturer's representatives may respond to complaints only after long delay.

It sometimes happens that a machine that has broken down must be sent abroad for repair, owing to the absence of competent local mechanics or adequate maintenance facilities. Seriously affected are small and medium-scale manufacturers who may have borrowed heavily to invest in expensive machinery which, if idle, generates no income to pay interest on borrowed capital and wages to workers and office staff.

Annex

INDUSTRY CLASSIFICATIONS

Servicing

Machine shops
Engine rebuilders

Manufacture of metal products

Tin cans, metal closures and other tinware
Hand and garden tools
Edge tools
Handsaws and saw blades
Cutlery
Furniture and fixtures
Hardware
Ironworks
Sheet-metal work
Pressure tanks
Metal stamping
Metal fasteners
Lamps and lighting fixtures
Safes, vaults and cabinets
Wire and wire products
Steel springs
Ordnance
Extruded shapes
Office supplies
Ornaments and novelty items
Other metal products

Machine tools

Lathe machines
Metalworking press
Sawing and filing machines
Shearing and forming machines
Cutting tools, dies and jigs
Woodworking machinery

Farm machinery and equipment

Cultivating farm machinery
Harvesting and grain-processing machinery

Transportation equipment

Passenger automobiles
Trucks, buses and jeepneys

Shipbuilding, boatbuilding and ship repair
Motorcycles, bicycles and pedicabs
Material handling equipment

Appliances

Electric appliances
Washing machines
Sewing machines
Refrigeration and air-conditioning units

Power engine machinery

Pumps and compressors

Construction and mining machinery

Construction machinery parts
Mining machinery parts

Electric machinery and electronic equipment

Motors
Transformers
Electrical distribution and control apparatus
Welding machinery and equipment
Electric lamps
Transistors
Batteries and parts, such as grids and plates

Food-product machinery and equipment

Bakery equipment
Food-processing machinery
Coconut-demeating machines

Textile and shoemaking machinery

Textile fabric machinery parts
Shoemaking machinery parts

Chemical-processing machinery

Plastic-working machinery parts
Rubber-working machinery parts
Cement-making machinery parts

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Swedish experience in small-scale industry: the role of Government policies and institutional mechanisms

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Introduction

It is not easy to define precisely what small-scale industry is; but a small-scale industry is regarded as one employing fewer than 200 persons. Within this group there is the very small-scale industry (employing less than 50 persons) and the medium-sized industry (employing 50 to 200 persons). It is necessary to differentiate between the small-scale industry that is a part of a big concern or that has a special relationship with a large company and those independent small-scale industries that are privately owned, for example, the family-owned small-scale industry.

The small-scale industries play an ever-increasing role within the Swedish economy and they account for an important part of the total industrial employment. The Swedish population is approximately 8.2 million, and the size of the work-force is 4 million, of which, 2.1 million are employed in the public sector and approximately 1.9 million in the private sector. Of the 1.9 million who work in the private sector, approximately 1 million are employed in the small-scale industries. Table 1 shows the distribution of the total work-force employed in the private sector according to the size of industrial units.

TABLE 1. BREAKDOWN OF INDUSTRIAL WORK-FORCE

Company size by number of persons employed	*Number of companies*	*Number of persons employed*
0–4	160 500	185 000
5–199	46 000	850 000
200–	1 150	865 000
	207 650	1 900 000

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Companies with less than 50 employees accounted for 34 per cent of the total employment in the Swedish economy. The medium-scale companies accounted for 15 per cent of the total employment. Most of the small-scale companies are family-owned and are fully independent within the manufacturing sector. The number of such family-owned companies is 95 per cent. The family-owned companies accounted for 32 per cent of the actual employment in the industrial sector in 1975.

There is a great regional variation in the number of small-scale companies. There are more small-scale companies in the forest districts and areas with high unemployment. In towns and other densely populated areas there are more large-scale companies and fewer in the category of 5 to 49 employees. In certain areas of southern and central Sweden, the economy is dominated by the small-scale companies.

Industrial sector

Within the industrial sector the population of small-scale companies varies between the branches. The forest-product industries and the textile industries are the branches in which the small-scale companies' proportion of the total employment is most dominant (74 per cent and 63 per cent, respectively). Between the regions there is a large difference between the number of people employed by small-scale industrial companies in relation to the total employment. The small-scale industrial company employment figures are of the greatest importance in Jönköping, Kronoberg and Jämtland counties, which in these places account for two thirds or more of total industrial employment.

Many small-scale industrial companies work solely or to a great extent as subcontractors to other, often large industries. The small-scale industrial company working as a subcontractor produces a highly specialized component part and is therefore very dependent upon one or, at most, a few special customers. According to research carried out by several different industrial institutions, one quarter of Swedish small-scale light industrial companies work in this manner. In a number of other branches this type of subcontracting is not as significant. The majority of the subcontractors are small-scale light manufacturing industries. The smaller the company is, the more dependent is it upon subcontracting orders. This is directly proportional to the size of the company, except in the case of the very small-scale company.

The reasons for the large amount of subcontracting present in certain parts of the industrial sector are as follows:

(a) The buyers want a limited financial and technical involvement in order to maintain flexibility;

(b) The large-scale industrial company can more easily buy specialized components from the small-scale company than it would cost to produce them;

(c) The need for a highly specialized product that the large-scale company lacks the ability to produce;

(d) The limited need for the component part provided by the subcontractor, as would be the case in a special one-time order.

Around 40 per cent of Swedish industrial production is exported. The large-scale companies exported up to 86 per cent of the total export in 1975; the

small-scale companies accounted for about 14 per cent, a figure that can be compared to the small-scale companies' part of the total industrial turnover of 26 per cent.

Many small-scale companies are indirectly involved in the large-scale companies' export through their subcontracting roles. A research report has shown that around one fifth of the small-scale companies deliver an important part of their production to Sweden's 30 largest industrial concerns. It is these large industrial concerns that dominate the export market.

The small-scale companies' limited part of the export market reflects their limited opportunities and resources for entering foreign markets and actual product borders, which means that a small-scale company often has a geographic limit, imposed by a strict local demand for the product.

By 1975, the total investment in the Swedish economy increased to 28 billion Swedish Kronor (SK) and total industrial investment rose to SK 14 billion; of which 24 per cent was accounted for by small-scale industries. However, considering that the small-scale industries accounted for 44 per cent of the total industrial employment, the amount of investment was low. This is because the small-scale industries use more labour-intensive production techniques due to to the basic problem of financing. Lacking the opportunity to receive easy financing, the small-scale industries are forced to develop better production methods with less costly equipment.

Innovative developments within the industrial sector are in direct proportion to the size of the company. The variations between the different size categories are significant. Many small-scale companies, owing to their specialized nature or role as subcontractors, are not in a position to expand resources for new developments. Both foreign and Swedish studies show that, in branches characterized by high capital intensity and extended long series production, the small-scale companies accounted for a larger number of the patent applications than could be expected from the employment and production figures. R and D within the industrial companies, according to official statistics, is highly concentrated within the large company sector. However, within the textile, forest-products, rubber and plastics industries as well as the manufacturing industries, the R and D of small-scale companies is important.

New companies

The number of new companies within the manufacturing industry has decreased during the last decade from around 1,700 from the mid-1960s to around 1,100 in 1975. The newly established small-scale companies account for 5 to 8 per cent of the total number of existing small-scale industries during the last ten-year period.

The light manufacturing industries have been dominant among the new companies during the 1970s. Within the light manufacturing industries, metal-products industries have expanded most. Certain other industrial branches have also shown high rates of expansion, such as the plastics industries during the first three years of the 1970s. But there was relatively weak expansion in the farming, mineral and forest-product industries.

There are several significant regional differences affecting the number of

newly established companies. Until 1974, the densely populated areas had a higher proportion of newly established companies within the total light manufacturing industrial sector. After 1974 these differences evened out. The development of new companies within the light manufacturing sector has not been consistent with overall economic development.

A reduction in the number of newly established companies in the industrial sector can be explained by a number of factors, which include:

(a) A greater utilization of resources within existing companies;

(b) The limited size of the market;

(c) The difficulties in initiating marketing and distribution systems;

(d) Decreasing demand in the domestic market owing to a significant rise in imports, which have doubled in the last decade, making it extremely difficult for a new domestic company to enter the Swedish market;

(e) Difficulty in obtaining capital, especially starting capital;

(f) The increased government procedural formalities making it difficult to start a small-scale company.

The motivation to start a new company today is in many ways the same as it was ten years ago. The desires to accomplish one's own ideas and to be independent are still common reasons. There is a strong profit motivation associated with many newly established companies and in fact this can be seen as the primary motivation in most cases. During the Second World War and the decade following it, a basic survival motive was important, but this has lost much of its significance in contemporary Sweden. Among the secondary reasons for setting up a new company are the development of new ideas and products. So-called "innovative new companies" have played a minor role in the development of new companies at the end of the 1960s and the beginning of the 1970s. Most of those that have succeeded have come directly from the research laboratories of technical universities.

Within the industrial sector are sub-branches that have been dependent upon artisan or highly specialized production, over a long period, and have experienced a rapid rise in the number of newly established companies. As previously mentioned, this has been especially true in the areas of the light manufacturing industry and in one plastic industry. Newly established companies are most active in branches open to new products and ideas.

The contribution of newly established companies to technical advances is uncertain. A newly established company is seldom built upon a single product idea or new production methods. But a company which does build on its own new product ideas will often have a faster growth rate than a company established on another basis.

The opportunities for the Government to carry out a regional policy depend upon the degree to which the Government can successfuly encourage people to build new companies within specific regions. In this sense it can also be stated that higher employment would result from decentralizing or relocating a company than from subsidizing a totally new company. This has been the most effective short-term policy. However, from a long-term point of view, it is also valuable to subsidize newly established companies.

Closure

A significant number of companies close each year, most of them without economic failure, and in a limited number of cases as a result of bankruptcy. A particularly high rate of closure can be seen in periods of low economic activity. The reasons for closure vary between branches and will be taken up later in this paper.

Very small-scale companies (less than 50 employees) accounted for 98.3 per cent of the total number of bankruptcies during the period 1956–1970. Only 1.7 per cent of the bankrupt companies were in the medium-scale category. Small-scale companies with 5 to 49 employees accounted for a much greater proportion of bankruptcies.

The causes of the bankruptcies included the following: insufficient profits; high cost of operations; poor internal planning; a lack of basic management skills; insufficient credit and difficulties in meeting existing credit payments; and limited business experience within the management.

Some of the unique problems of the small-scale company in Sweden are examined below.

Capital resources

Small-scale companies do not have access to the capital market, which normally provides 20 per cent of the capital resources of the rest of the industry. Small-scale companies are often less solvent than the large-scale companies and are forced to borrow money to finance their projects and new products. Financing new products or making changes in production techniques is often beyond the financing capability of the small-scale company. The need for and availability of capital rarely coincide. Many small-scale companies have extreme difficulties in generating internal resources because of their low profitability, and in providing satisfactory security for their outside financing. This is primarily due to the fact that the small-scale company is directly dependent upon the personal resources of a few individuals with limited ability to put capital into the company. The problem of providing satisfactory security in connection with non-material improvements (i.e. marketing) is a significant one. The credit rating of small-scale companies is of the utmost importance. Most credit is arranged directly through the normal banking system. While the Government is on record in support of the small-scale company, real financial assistance seldom takes place. Government support is primarily of a complementary character, and from the viewpoint of the banker, it is a high-risk venture to finance small-scale companies.

Company services

Information, access to expertise and training are often important factors in providing a company with a positive growth rate. A lack of information concerning expanding products or market areas can severely limit company expansion. Small-scale companies are generally outside the mainstream of information concerning technical questions and market conditions. There is a lack of both information and trained people to deal with the complex information available.

In order to compensate small-scale companies, the Government has attempted to assist them during the last few years. The Swedish Export Council (SEC) has provided training and assistance in international marketing. Regional development agencies have attempted to inform small-scale companies of technical developments and provided technical expertise when available. The Government has given the regional development agencies greater resources with which to assist small- and medium-scale companies with financial advice and expertise.

The complexity of managing a modern company

A major problem facing modern companies consists in the institutional demands that the Government has put upon private individuals who attempt to start a company of their own. The small-scale company has a limited capability of dealing with this increased demand for information on the part of the national authorities. The relative magnitude of the employer's contribution to the employee's social welfare and the high tax rates in Sweden are other examples of obstacles to the activity of small entrepreneurs. Many small-scale companies have complained about this situation, and attempts have been made to correct it. Concrete proposals have been made to reduce and simplify the amount of paperwork. In the last decade, the Government has introduced an even larger number of new procedures to help small companies, but with an unfortunate corresponding increase in paper work for the companies.

Labour market legislation

The increased legislation concerning the labour market has been seen by many small-scale companies as a hindrance instead of a help. Measures to assist small-scale companies in complying with the legislative provisions have been planned.

State contributions within the small-scale company sector

The Government has taken a number of steps to reduce the difficulties confronting small- and medium-scale companies. This can primarily be seen in the area of credit, but also applies to the small-scale companies' need for outside expertise, training and other services. During the last decade, the Government has intensified its efforts to provide assistance to small-scale companies.

Regional development agencies

Regional development agencies (so called *företagareföreningar*) were established at the end of the 1930s in areas with a particularly high rate of unemployment. Their aims were to advise, to provide credit support, to encourage the establishment of new companies, and to promote the development of existing companies in depressed economic regions. The objective was to increase production in the artisan and other small-scale industries through a clear-cut regional policy.

Both national and regional subsidies contributed to the achievement of these aims. The regional development agencies are able to obtain direct

government financing. Included in the membership of regional development agencies are company owners and associations, local officials, other private parties and even organizations that can be expected to work to achieve the agencies' goals.

At the end of 1975 the regional development agencies had a total of 17,400 members. The majority of members came from companies within the manufacturing industries. Companies that have obtained financing from the regional development agencies must be members, but those using only the other available services are not forced to join. From 1959 there have been regional development agencies in all 24 Swedish counties. Since establishing a new regional assistance policy in 1965, the goals of the regional development agencies have included support for increased production within the regions. They are also responsible for providing special support to newly established companies in depressed regions.

The responsibility of the regional development agencies can be divided into three main categories; company services, financial support and support for establishing new companies.

Company services

Company services consist mainly in the provision of information and consultancy services to the company on different matters, such as financing, tax regulations, marketing, patent applications, product standardization, product testing, safety conditions and environmental regulations; training in technical, economic and administrative areas, including marketing; and technical expertise on product development, producing a prototype and testing.

Financial support

Financial support is available to the following:

Manufacturing industry

Companies within the general agricultural sector that do not quality for financial support from the existing agriculture associations

Construction companies

Production companies

Material suppliers

Transport and machine-leasing companies (services available, but no credit)

Legal, economic, administrative and technical consultancy firms

All manual service industries

These establishments have been chosen because they are considered to create more opportunities for employment and to influence the economy of the country in a more positive way than efforts in other branches.

Support for establishing new companies

One of the primary responsibilities of the regional development agencies is also to assist in establishing new companies. This has involved assembling new

development ideas and providing both information to potential leaders and technical expertise and training during the period in which the new company is being established. The contributions are both general (creating a positive regional environment for new ideas and projects) and specific (responding with direct assistance to the new companies, demands), and include summaries and analyses of the total regional production and estimates of regional needs to promote expansion.

There are a number of areas in which the regional development agencies can assist planning, including the following:

(a) Information and training in "starting your own company" or how to develop an idea from a business viewpoint;

(b) Advice and assistance at the planning stage, for example, market summaries, estimates of capital needs, investment estimates and help with the actual physical development of the company;

(c) Establishing contacts between, on the one hand, the potential entrepreneur, and, on the other, potential partners, customers, councillors, consultants, bankers and local government authorities.

Availability of capital resources

To help meet the need of small- and medium-scale companies for long-term credit, special credit institutes were established 40 to 50 years ago. The Industrial Credit Agency Ltd (AB *Industrikredit*) was established in the mid-1930s and the State Artisan and Industrial Loan Fund (*Statens hantverks- och industrilånefond)* in the mid-1940s.

Because of the increased demand of small- and medium-scale companies for capital during the 1960s, a number of new, highly specialized institutes have been created to assist them.

These special credit institutions have very unique guidelines as regards risk capital. Some of the institutions, such as the State Business Capital Agency (*Företagskapital AB),* "SVETAB" and Investment Bank Ltd *(Investeringsbanken AB),* founded in 1974, 1969 and 1967, respectively, can finance widely different groups of companies with their own capital resources. The most common form of credit is given in the form of long-term capital loans. Long-term credit can also be obtained through the General Pensions Fund *(Allmänna Pensionsfonden)* and even some special support for companies in depressed regions (for example, support for buying machines). Through State Industrial Credit Ltd *(AB Industrikredit)* and other special regional programmes, long-term credit guarantees handled by the Regional Development Agencies may be obtained. The National Swedish Industrial Board (SIND) offers them in the form of industrial loan guarantees (1954) or as structural guarantees (1972).

The Norrland Development Fund *(Norrlandsfonden),* the Board for Technical Development (STU) and the State Development Fund, founded in 1967, 1968 and 1973, respectively, were established to give loans with conditional repayment protection, that is, repayment dependent on whether or not the actual project resulted in a profit.

Information and expertise

The state-agencies support services responsible for assisting the small- and medium-scale companies deal primarily with technical and industrial development, training and marketing. The provision of information and expertise and the establishment of contacts are important company services. Such services, which have been an essential part of the activities of the regional development agencies, have greatly expanded in the last few years.

Providing expertise and marketing analyses are other important services of the regional development agencies, which in the last few years have concentrated primarily on product development and domestic and export marketing. Within each agency there is a special training consultant who is responsible for analysing the training needs of the local companies and recommending appropriate courses for them.

Through the Board for Technical Development (STU) private individuals and small- and medium-scale companies can present technical questions and receive technical expertise. The Board provides the following services: expertise and information on innovative research, advice on patents; the application of the results of innovative research to industrial use; and the stimulation of creative and innovative research within the various research institutes and companies.

The Foundation for Industrial Development for the Norrland *(Stiftelsen för industriellt utvecklingscentrum)*, which has been operating in *Skellefteå* since 1971, provides both personal and technical resources for marketing research, technical consultancy and product testing for primarily small- and medium-scale companies.

Training

The need for training the employer and employees in small- and medium-scale companies has increased significantly during the last few years. The objective is to support the technical and economic development of small- and medium-scale companies and at the same time to delineate the structural changes taking place within certain branches.

A complete training programme is administered by the National Swedish Industrial Board *(Industriverket)*. The National Swedish Industrial Board works together with industrial organizations and other training units in order to get a total view of both planned and on-going activities, and to co-ordinate them. The National Swedish Industrial Board has a unit for company development, SIFU, which provides courses especially designed for small- and medium-scale companies. The most important training takes place in the technical and economic areas and their related functions within the economy. The local communes provide further adult training for those who wish to keep in touch with technical developments and other changes within the industrial sector. This training is available in nearly every commune.

Export assistance

The Government provides assistance primarily through the export council *(Exportrådet)*, which, as the central export organization, is responsible for

planning, co-ordination and the provision of assistance to promote the Swedish export market. The cost of services provided by the Export Council to small-scale industries is reimbursed by the Government.

A number of regional development agencies organize regular conferences with the Export Council to provide information on the export market and to pass on feasibility analyses of different products. The Export Council also co-ordinates arrangements between foreign industries and Swedish subcontractors. Each year the Export Council deals with at least 6,000 specific requests from abroad concerning Swedish companies. Their co-ordinating work consists of passing on addresses and specific requests to the subcontractors concerned.

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Small-scale rural industries: light engineering workshops

*V. Austin**

INTRODUCTION

Small-scale rural industries

The term "small-scale rural industries" has been interpreted in many ways, and there is not yet one agreed definition or set of criteria for determining what constitutes a small-scale industry. There is also an equally difficult task of defining what is rural, and usually this is attempted by a definition based on population, i.e. size of communities, which may vary from 2,000 to about 10,000. A recent paper concludes: "Therefore for purposes of considering a policy and programme for rural industries development, the 'rural milieu' should be considered more in functional terms, and if the legal definition varies considerably from functional attributes of the rural sector, then a programme for rural industries promotion can be frustrated" [1].

Although the term small-scale rural industries can be defined in a number of ways to suit local circumstances, there should always be a certain amount of flexibility in the use of the definition for selecting beneficiaries of promotional assistance. As a general guideline, the smallest industries with potential to assist in the objectives of rural development should be given full government assistance, and as they grow or become more urbanized, they should receive less government aid.

Size and importance of small-scale industries in the rural economy

Small-scale industries are a significant part of all non-farm activities in rural areas, the importance of which is described by a recent World Bank paper [2]. Non-farm activities are a primary source of employment and earnings for approximately one quarter to one third of the rural labour force in most developing countries, and a significant source of secondary earnings for small landless farmers during the slack agricultural seasons. The above-mentioned paper estimates that between 20 and 30 per cent of the rural labour force in

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15 developing countries is engaged in non-farm work, and 20 per cent to 30 per cent of the non-farm work is in manufacturing. After making an allowance for the servicing functions of rural industries in addition to manufacturing, the total proportion of rural industry employment in the non-farm sector probably exceeds one half.

The breakdown of employment within the rural industry sector is more difficult to generalize, and the actual proportional distribution between categories of industry varies considerably. The above-mentioned World Bank paper shows how the metal, machinery and manufacturing sectors of rural industry vary between 6 per cent and 21 per cent for five selected countries.

Location of industries in a rural area

Industries which might be located in a rural area can be divided into the following three categories:

(a) "Foot-loose" industries. These industries are characterized by products of relatively low weight and volume but high value, requiring small quantities of materials and large amounts of labour. They are able to perform the whole production process, such as the mass production of clothing, or only part of the production process, such as assembling part of a watch or another intricate device. Not only are these industries foot-loose within a country, but they also move from one country to another as relative advantages change;

(b) Rural industries supplying markets outside the district. The viability of these rural industries would depend to a large extent upon the freight rates. Exceptionally low freight rates for raw materials taken out of the district would decrease the viability of many rural industries. High freight rates would be advantageous in some of the sectors listed below:

(i) Industries based on materials which lose greatly in weight or bulk during processing or manufacturing, for example sugar-cane;

(ii) Industries based on perishable materials, for example soft fruit;

(iii) Industries based on materials which cannot be substituted, for example most crop processing;

(iv) Industries based on a small number of materials, for example primary processing of crops, timber, livestock and minerals;

(c) Industries supplying markets within the same rural district. The viability of rural industries supplying their own local market depends to a large extent upon both freight and passenger transport rates and the speed and ease of travel. Where the transport rates are high and the journey slow and inconvenient the following sectors will probably be the most important:

(i) Industries based on materials which increase in weight, bulk or fragility during processing or manufacturing, for example rigid boxes and barrels, large ceramic bowls and jars, and furniture;

(ii) Industries producing highly perishable goods, for example bread;

(iii) Industries which require personal contact between the producer and the consumer, for example maintenance and repair of machinery for both individuals and industries;

(iv) Industries which supply a relatively small local market with various

products, for example animal-drawn ploughs, harrows, digging spades and knives of local design.

The above review of the location of rural industries is based primarily on technical and economic factors. In practice, other factors may have a considerable impact, such as the Government's social and political objectives, which in turn may be reinforced by policies to concentrate development in a limited number of growth centres.

Contribution to basic socio-economic and technological needs

Contributions through inputs to rural industries

In most developing countries the poorest people make up the rural population, within which the neediest cases occur among those families which have neither land nor capital.

Small-scale rural industries are one of the few alternative sources of employment and income open to many, on either a full-time or part-time basis. In addition to direct employment and income creation, such industries also have an indirect effect as both forward and backward linkages. As an example of how this might work, one can consider maize milling and processing, which in the forward linkage may lead to increases in employment and income through the mixing of animal feedstuffs, livestock and poultry rearing, and finally wholesaling and retailing the food product. The backward linkage in some countries may lead to the construction of low-cost laterite brick units for drying the maize, which in turn would require the supply of laterite and perhaps locally manufactured, laterite brick-making machines.

Indirect employment and income generation may be even more important than the direct effects, and when the multiplier effect is also considered the total impact may be several times greater than the direct promotion of employment and income.

Contribution through outputs from rural industries

Small-scale rural industries can make a significant contribution to the supply of basic needs for rural communities. Many large-scale and urban industries and certain foreign-based industries tend to supply the higher-cost product range, which may be technically superior, but may also be beyond the price range acceptable to the rural poor. For many basic needs, simple utilitarian products are quite sufficient to meet the requirements of rural people.

APPROPRIATE LIGHT-ENGINEERING PRODUCTS AND SERVICES

Manufactured products

In general, small blacksmithing industries, employing perhaps three or four persons, concentrate upon manufacturing cutting edge tools and simple sheet-metal products to local designs mainly for traditonal agricultural and allied operations and primary agricultural processing. There are also other

market outlets for traditional manufactured products, including the transport, domestic construction, woodworking and other local rural industries.

Source of product designs

The majority of product designs are traditional and handed down from generation to generation. Even if the basic design is well suited to its requirements and may be the most acceptable to the local rural community, there is still considerable scope for improvement. The communication of product designs from outside the rural locality depends upon information services in the form of demonstrations and exhibitions or, more commonly, literature. A good example of literature used to disseminate information, based on the experience of both developed and developing countries, is the quarterly journal, *Appropriate Technology*, published by the Intermediate Technology Development Group, London.

In some instances, existing local designs may be inappropriate for one reason or another, and there may be no readily available alternative design which is more appropriate. In this case a decision may have to be made to undertake product development to meet local needs. A recent project in Nigeria involved a sequence of activities for local rural industrial development. The first and possibly most difficult stage was product planning, which included market research and product development. The second stage was to train skilled local artisans and help them to become independent of the project ([3], p. 66).

Rural services

The range of services required in any geographical area will depend on many factors, and may involve assistance in a number of fields, including agricultural, fishing, forestry, mining, crafts, manufacturing, processing and construction industries, transport, infrastructure and household needs. In addition to supplying products such as hand-tools and other simple devices for agricultural use, small-scale, rural light-engineering industries also provide essential repair and maintenance services, such as reshaping and sharpening edge tools, either for their own simple products or for more sophisticated products manufactured outside the rural area. These products manufactured outside the area cover an immense range, from equipment required for primary operations such as jungle clearing and earth moving, followed by primary tillage by means of chisel, disc and mouldboard ploughing, to the requirements for planting, irrigation, weed and pest control, harvesting, processing, and finally storage prior to sale or use. The importance of a repair and maintenance service is seen in the case of the tractor, a product manufactured outside the rural area and common to all agricultural systems. It has been recorded that in a developing country the repair and maintenance cost throughout the life of a tractor may be approximately 150 per cent of the purchase price, and although this would include costly replacements such as tyres, a large proportion would still represent income to rural servicing industries.

Sources of servicing knowledge

There should be no real problems of maintenance and repair of products

manufactured by rural industries, but for more sophisticated products there may be substantial problems. These problems can be overcome to a large extent by training, for a trained worker with a minimum of facilities may be able to improvise and avoid the need for special equipment and tools. An example of light-engineering servicing using a minimum of facilities is given later in this paper.

APPROPRIATE LIGHT-ENGINEERING PRODUCTION PROCESSES AND TECHNIQUES

The rural market

As the population is relatively dispersed in rural areas, the markets for specific goods are also dispersed. Further, the design of some products, particularly agricultural implements, often changes from one district to another, although the products are essentially the same.

The rural population is usually also relatively poorer than the urban population, and hence rural market demand is for relatively low-cost goods. The rural market situation therefore involves meeting relatively small demand at a low-cost. Until the market expands, the majority of rural industries, including light engineering, will of necessity use more labour-intensive techniques.

Factors of production

A study of capital and labour as factors of production will reveal that neither are homogeneous and that the possibilities of substitution, for example between the different levels of skills, are complex. The choice of factors of production may also vary over geographically short distances, as illustrated by construction work in a recent project in Nigeria which experimented with laterite cement block-making, an intermediate technology falling between the labour-intensive method using laterite and the more expensive one using sand and cement blocks. Preliminary research showed that the optimum technology for a specific building depended on the proximity of the site to supplies of cement, sand and suitable grades of laterite [3]. The above observations show that the choice of the most appropriate factors of production and hence the most appropriate technology is often complex. More detailed examples from light engineering are given below, first for the manufacture of hand-tools, and then for servicing.

An example of light engineering: the manufacture of machetes

One-off and small batch production

Machetes are manufactured by hand in most developing countries, often under different names such as pangas and cutlasses. The capital costs of production are relatively small, because many of the manufacturing hand-tools, such as tongs, fullers and swages, would be made by the artisan who would only have to purchase the anvil and some parts of the forge. The cost of purchased tools and equipment may amount to only $10 ([4], p. 183), although the

ownership of land and buildings may increase costs to approximately $200 ([5], p. 56).

To equip a workshop in the price range indicated above would require very simple devices, such as an oil-drum forge and anvil made from a railway line, as illustrated by a recent publication ([6], p. 24). To improve the technical efficiency at a higher capital cost would require a power-driven forge, preferably with a water-cooled tuyère and perhaps, as an added refinement, an oil bath with pyrometric control for tempering ([7], pp. 23, 24, 93).

The typical labour force consists of a skilled blacksmith and two or three assistants. With this labour force it is possible to produce 10 to 20 machetes a day, which is usually far in excess of local demand. The cost of the final product is usually far less than that of a mass-produced machete, but the quality of the steel and of the heat treatment is also usually less if the smith has access to only scrap-metal and the simplest equipment.

Technically the one-off and small batch-produced machete made by simple equipment is usually inferior, although it may have a more acceptable local design than mass-produced machetes. With a suitable industrial extension service and improved equipment, this technical disadvantage could be eliminated. Economically and socially, the lower-priced, locally-made machete may be the only one within the reach of low-income rural workers, and one of the few products which enables the village blacksmith to remain in business and provide services to local households and farms.

Batch production

Batch production is largely unable to satisfy, at competitive prices, either mass market demand or local demand for specific designs. It is therefore relatively rare in both developed and developing countries. To replace assistants using sledge-hammers will require equipment such as pneumatic hammers, which cost over $10,000 each. An added problem is that the operator must be highly skilled and capable of working with precision at high speeds for sustained periods of time.

Mass production

It is possible to buy blades which have been forged, hardened and tempered, and are ready for polishing, sharpening and fitting with a locally-made handle. The minimum-size plant for finishing only would involve an annual production of 300,000, and fixed and working capital requirements would be of the order of $100,000. To produce the machetes from blanks would require three times the above estimate, and both estimates are clearly outside the definition of small-scale industry.

An example of light-engineering servicing: engine repair

Using equipment of minimum cost

Let it be assumed that an engine must be lifted out of a vehicle and then stripped down to component parts. On some vehicles it may be necessary to lift the engine vertically, and this can be achieved by using a fixed overhead point,

which may be a roof joist, or even a tree if it is sufficiently strong. In the absence of an available overhead point, shear-legs can be constructed from steel pipe or other sections which will not bend, or from large strong timbers. Even at this very first step it is clear that there is a wide range of alternatives.

When stripping the engine, no economy should be made on various types of good spanners, for ill-fitting spanners will damage nuts and bolts, and, even if successful in removing the nuts and bolts, may not replace them sufficiently well for a technically acceptable finish. For other operations it may be quite acceptable to improvise with simple home-made devices, such as locally made wheel-pullers, which will remove wheels without damage to the wheel and shaft, although the life of the puller may be less than a more expensive one from a specialist manufacturer. Other cost-saving devices will be known to experienced mechanics, such as a piece of wood with a vee cut in the end to replace a valve spring compressor. The decision on which technique to use should be based on the premise that the technical standards must be sufficiently high to ensure a technically successful service, and that costs are saved solely at the expense of time.

Using modern workshop equipment

The amount of capital that may be used in vehicle servicing is immense, and can range from high-pressure water cleaners to equipment for manufacturing or modifying component parts. ([8], pp. 27, 28.) As described above, an engine may be lifted vertically by either an overhead crane running on fixed joists in the roof of the workshop, or a portable crane on three wheels which may also have jacks to raise the wheels clear of the ground during the lifting operation. The actual lifting may be powered by an electric motor and remote-controlled by a push-button switch.

Sources of technology

Technological design

In some cases, small-scale rural light-engineering industries may rely on original research and development (R and D) in their own countries, but the major source of appropriate technology will probably consist in the adaptation of older technologies, as described in a recent paper:

"The Japanese techniques (of can making) are important because they show that efficient techniques can be found which are more labour-intensive than newer capital-intensive ones, but which can produce at a much lower private as well as social cost. These techniques are interesting also because they seem to be up-to-date variations of techniques which were used in Europe and the United States in the 1920s or before. These modern techniques, derived from older technologies, can be used to make high-quality products. They have been developed in countries where wages are low by comparison with those now paid in the United States and Europe" ([9], p. 106).

Rural industry

For the rural industrialist there is an immense problem of restricted knowledge. The knowledge available tends to be restricted to equipment and

tools retailed by a local agent, which in many cases involve imported capital-intensive technologies. To look beyond this narrow range of knowledge requires considerable effort, such as obtaining names and addresses of alternative manufacturers, which in many public libraries will be foreign manufacturers of capital-intensive technology. In this situation, many rural industries are faced with a choice of utilizing the available local technology, or buying from a foreign source which has been selected almost fortuitously.

A recent report on the engineering industry in Colombia supports the view that an increasing effort should be made to establish local sources of appropriate equipment and tools. The report states, in particular, the following:

"An indigenous capacity for machine fabrication and some degree of development of the engineering industry as a whole are virtually essential if labour-intensive technical change is to be generated in developing countries. No attempt to increase labour-intensity is likely to be successful unless it is accompanied by technical change in the labour-intensive direction. The development of a local capital-goods sector is required, first in order to supply light machines for the small-scale informal sector as well as for the modern sector. Secondly, it facilitates the introduction of new machinery designs and of labour-intensive technologies and processes that are more suited to the local factor endowments of the developing country. In the absence of industries producing capital-goods, the range of technical choice will tend to remain narrow" ([10], p. 241).

The above-mentioned report also found that the manufacture of machinery is one of the more labour-intensive branches of industry, and that this manufacturing can be carried out on a small scale. In order to establish local manufacturing capability there is a strong case for co-operating with established manufacturers who in many cases may be foreign and already have a share of the market. This co-operation may involve one or more of a range of possibilities, such as paid advice, consultancy for part or all of the project as in a turnkey project, licensing, joint ventures or partnerships. The high quality of many products manufactured in developing countries can be attributed to foreign co-operation ([11], p. 35).

CONSTRAINTS TO GROWTH

In order to meet the demand for rural industrial development, there is a need for improvement in four major areas of constraint, namely information, skills, infrastructural services and organizations.

Information constraints

One of the first constraints faced by the rural manufacturer is a poor communication of market information. Within the immediate locality the rural manufacturer may be well aware of market requirements for established products, but the possibilities of expansion or diversification are unknown. Even if the manufacturer is aware of market opportunities, it may still be difficult to obtain or develop new product designs.

Similar information problems face the rural servicing industrialist. Each major piece of machinery, from small items such as irrigation pumps to large items such as bulldozers, will have servicing and workshop manuals. In the case of pumps, the manuals may be a few pages only, and in that of a large earth-moving machine, they may run to several volumes. Thus it is almost impossible for every servicing centre to have a library of information for all the types of machines which may require servicing. This problem of servicing is, of course, aggravated by the use of capital-intensive technologies which are usually complex and sophisticated.

Constraints with regard to skills

A second major area of constraint relates to skills, for even where information is available, the local entrepreneur may have considerable difficulty in achieving success. At the lowest educational level, there is often a lack of modern manual skills to supplement traditional, and in many cases highly developed, craft skills. A simple example of this is tool grinding for metalworking machine work. Although a tool may remove metal to its profile as in screw-cutting on a lathe, to achieve the best finish and minimize the load on the lathe, it is essential to grind the tool to the correct rake and clearance angles for the specific metal being machined.

Constraints relating to infrastructural services

Infrastructure is generally acknowledged to be of high importance, and a recent paper has even identified it as the major constraint on rural industrial development. "The implications . . . are that an absolute pre-condition for a rural industrial development programme is that an infrastructural development programme is initiated simultaneously. We would even go as far as asserting that the infrastructural development programme is the more important programme and therefore needs to be a step ahead of the industrial development efforts. This is so because we have been convinced that the existing craftsmen are skilled and capable of developing themselves and their technology, given improved common conditions of production" ([12], p. 35).

Financing

A very common complaint among small-scale industrialists is that they are short of both working and capital equipment. Observations at the factory level suggest that the contrary is also true ([13], p. 91), and a recent experiment in Nigeria led to the conclusions "that more capital equipment is not necessarily the 'open sesame' to increased production and sales", and that "the alternative approach of planning and marketing new products for the metalworking master-craftsmen produced more s gnificant results" ([3], pp. 66, 67).

Although many proposals are made for easing financial arrangements for small-scale rural industries ([14], p. 17; [4], p. 84), the actual constraint is often

the absence of sound and feasible project ideas, as identified in a recent study in Bangladesh:

"Virtually untapped sources of capital for the individual industry enterprises are the Divisional Development Boards, which have money to invest in co-operation with the entrepreneurs. The main problem is the inability of cottage industry entrepreneurs to put forward feasible proposals" ([5], p. 19).

Materials supply

One of the greatest constraints to rural industries is the shortage of materials, and to overcome this shortage many are forced to work with inferior materials.

In addition to facilitating the supply of raw materials, consideration should also be given to the essential consumables which may have to be imported, such as high-speed-steel twist drills and milling cutters. A recent study in Bangladesh also observed this need for other rural industries:

"Often the major constraints were relatively minor miscellaneous imported items such as good quality cotton thread, scissors, machine and hand needles and spare parts for sewing machines" ([5], p. 18).

Common facilities

A recent paper from the Philippines combines a request for the purchase of uniform batches of steel having a known composition and appropriate specifications with a request for final heat treatment of the pieces so produced in an electric furnace or similar facility on a co-operative or sub-contract basis.

The world-wide experience of common facility centres appears to be very mixed, with some having moderate successes ([3], p. 68), others having fundamental management problems, ([15], p. 45), and some remaining inactive ([5], p. 17). The answer would appear to be careful planning at the stage of feasibility studies and good management.

Industrial estates

Industrial estates are essentially integrated infrastructural institutions in specific geographical locations providing land, electricity, water and perhaps gas. Other infrastructural services may include an advisory service, banks and post offices. In turn, the above may attract private enterprise services such as toolmaking and repair and maintenance specialists.

As with common facility centres, the world-wide experience of industrial estates in rural areas is very mixed, and the key to success may once again be careful planning and good management [16].

Marketing

A summary of the situation in Bangladesh reflects the situation for many small-scale rural industries throughout the world: "Local sales are usually through private middlemen or shopkeepers, while export sales are through a wide range of bodies from private enterprise to voluntary groups. There are at present virtually no marketing services for cottage industry entrepreneurs, although there are limited services for exported. Equally there is no systematic

market research for handicrafts and other cottage industry products either in the local or in the foreign markets" ([5], p. vii).

Another recent report from Kenya mentions the success of direct assistance to groups of rural artisans to enable them to secure orders, for example through tenders ([15], p. 45). Many large wholesalers in developing countries may be persuaded to give some preference to rural industries, as reported in connection with a project in Nigeria:

"It should be placed on record that one large firm gave preference to rural producers for goods of equal specifications and price" ([3], p. 66).

Constraints relating to infrastructural organizations

Two important infrastructural organizations which can help to promote small-scale rural industries are youth clubs for school children and perhaps for those in the transitional stage to adulthood, and industrial co-operatives for adults. To organize and manage these organizations requires both professional skills and dedication, as illustrated by the following quotation:

"Combining the collective manufacture of goods with a system of regional distribution under the control of the producers themselves has proved to be a most necessary and effective way of coping with competition from outside industrial products. The experience of the People's Collective Industries suggests however that co-ordinating these two functions within a single organization is a difficult task. The distribution function becomes particularly complex once the organization expands into the national market, where competition is stiffer and the infrastructure required to sustain a marketing effort by a collectively run organization is largely lacking" ([17], p. 61).

A POLICY FOR APPROPRIATE AND BALANCED GROWTH

A conceptual approach

A policy or series of policies can be designed to meet the needs of rural areas in all countries. Small-scale rural industrial development is so closely interwoven with all the other sectors of rural life that it must be considered part of an integrated approach to rural development. This entails integration in national macro-planning, district micro-planning, field-level integrated rural development projects and rural infrastructure. Small-scale rural industrial development should be a long-term venture, if the rural industries are to become viable enterprises. This is particularly true if the long-term objective stresses assistance to the younger generations.

The long-term objective of public policy should be one of helping people to help themselves. This can be applied equally to field-level services assisting individual rural industrialists, to national services backing up the field-level service staff, and to international technical co-operation supporting both field-level and national service staff. The primary responsibility of the

Government should be to encourage and assist in the development and application of appropriate technology ([18], p. 52).

A specific action programme

A national programme

It is convenient to divide a national programme into three parts, namely national policy, national services and field-level services. A number of recent reports have emphasized the need for suitable policies which will assist the growth of small-scale rural industries and appropriate technology, through, for example, the removal of legal constraints, the reshaping of fiscal measures, and the teaching and promotion of technical skills in the general educational system. These policy measures are fundametal to an environment in which rural industrial development may take place, but equally important are the services to small-scale rural industry.

In order to organize and support a field-level service, it is essential that there should be an adequate national service. This may be comprised of four main components: management and administration; market research and product development services; appropriate technology R and D services; training programme development services.

These components have been covered fully in technical literature and international forums, including regional technical meetings of the International Labour Organisation in co-operation with UNIDO and the Economic and Social Commission for Asia and the Pacific [19].

The third component of national programme is the provision of field-level services which will actually reach down to assist individuals engaged in small-scale rural industrial development. Field-level services can be considered under four main activities:

(a) Extension services to non-factory rural industries, (e.g. cottage industries): mass, group and individual contacts;

(b) Services to factory rural industries: advisory, consultancy and training services;

(c) Infrastructural services: financing, materials supply, common facilities, rural versions of industrial estates, marketing, management information;

(d) Infrastructural organizations: youth clubs, industrial co-operatives.

An international programme

For many developing countries the one major constraint to implementing or expanding any national programme for the development of small-scale rural industry is the shortage of trained and experienced personnel. In order to overcome this problem there is a need for a massive programme to help train national trainers, and then to assist these trainers within their own national training institutions. The national trainers could be trained in a whole range of activities necessary for rural industrial development, and then a suitable selection of specific courses could be given in their national training institutions for personnel such as the following: district-level planners, integrated rural

development project managers, rural industrial development national and field organizers, rural industrial development extension officers, rural bank officers etc.

An important part of the training course would be in-the-field project work and on-the-job training. The second major constraint which an international programme might help to overcome concerns the availability of information.

Designing and implementing action programmes

A recent assessment of international technical co-operation projects designed to promote small-scale rural industrial development has led to three important conclusions which should be borne in mind in future by the organizers of action programmes. First, with regard to project management, both care and luck are essential factors in the recruitment of experts, and there is a need for autonomy from political interference and bureaucratic struggles and for the timely provision of inputs. Secondly, the relatively successful projects have generally sought to provide a single missing ingredient or to remove a single bottleneck. Thirdly, large-scale multi-expert projects seldom work well because of attempts to build new capacity, which involve increased outside interference, and severe management problems ([20], pp. 351, 352).

There is a need for considerable skill and experience in the implementation of an action programme which might include several projects. This was brought out in the conclusions of a recent paper, which stressed the many factors that can influence decisions, especially human factors such as power, contacts and wealth. The paper contained in particular the following conclusions:

"The only way in which administrators can function is by recognizing the realities of the situation, and indeed by utilizing them and by incorporating them into their own activities. Any attempt to bolster the egalitarian aspects of the programme by redesigning the rules of access or distribution would be futile, given the existing structures of power" ([21], p. 51).

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Light engineering and rural workshops in Egypt

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Until 1959, a rural and small-scale industries development programme formed part of a comprehensive rural development programme covering all aspects of rural life and activities. Implementation of the programme was entrusted to Combined Units established for the purpose and functioning through co-operatives, rural reform associations, village project committees and other private local organizations. Each Combined Unit was designed to serve about five villages with a total population of about 15,000. The objective of the Combined Units programme was to co-ordinate the activities and functions of various Government departments in rural areas so as to produce a combined impact on the rural situation.

Rural and small-scale industries development programme

After a separate Ministry of Industry was established in 1956, a comprehensive five-year industrial development programme was drawn up, with the development of rural and small-scale industries as one of its main objectives. The following outline of the rural and small-scale industries development programme was issued in 1959:

(a) Establishing production and training centres for different rural and small-scale industries in rural areas throughout the country to serve as demonstration centres;

(b) Establishing small- and medium-scale factories to supply semi-processed raw materials and industrial services to small entrepreneurs;

(c) Building marketing centres for marketing the products of rural and small-scale industries;

(d) Granting soft loans of up to approximately $4,600 to rural and small industries;

(e) Encouraging the establishment of industrial co-operatives as a tool for developing rural and small industries;

(f) Establishment of a central co-ordinating body responsible for small-scale industries (the General Egyptian Organization for Productive Co-operation and Small Industries was established in 1961);

(g) Established of an institute for providing services to small industries.

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The General Egyptian Organization for Co-operative Production and Small-Scale Industries (GEOCPSSI) was established in 1961 by the Ministry of Industry to carry out the five-year plan for the promotion of rural and small-scale industries. GEOCPSSI founded 20 branches in each of the governorates and each branch was designed to provide financial and technical services to rural and small-scale industries in the governorate and to have enough autonomy to work within the plan of the central organization. The GEOCPSSI also built 160 production and training centres throughout the country managed by GEOCPSSI branches. The production and training units covered the following fields of rural and small-scale industries: carpentry workshops, repair and maintenance of equipment workshops, handweaving, carpets and rugs, textile fibres, plant fibres treatment for industrial uses, palm-date dehydration, women's knitting and embroidery, *Khan el Khalily* products.

In 1969, GEOCPSSI was converted into the "General Authority for Crafts Development and Productive Co-operative" under the Ministry of Local Government. In 1971, the productive units and training centres of the Authority were transferred to the local councils and governorates. Three years later, it was found that there was a great need for central machinery for planning and supervising the rural and small-scale industries sector. As a result, the Handicraft Industries and Productive Co-operatives Organization (HIPCO) was founded in 1973 as a governmental organization under the supervision of the Ministry of Local Government. It has two major functions:

(a) Planning and research relating to artisanal and allied small-scale industries, including the formulation of general plans and policies regarding the development of these industries, studying the marketing needs of their products in both domestic and export markets and determination of the foreign exchange requirements of raw materials, new machines and spare parts;

(b) Establishment and supervision of industrial co-operatives.

The role of co-operatives

Co-operative societies have been formed in various rural and small industrial branches. There were 332 industrial co-operatives in various production sectors in 1976 with a total membership of over 65,000. Light engineering accounted for 20 per cent of the total number of co-operatives and 23 per cent of total membership. The geographical distribution of productive co-operatives is quite wide and points to their potential in providing a useful range of services to the artisanal sector. Co-operative societies are providing valuable services to industries in rural areas. They make bulk purchases of materials using their own funds as well as by obtaining short-term loans from banks. The co-operative societies are also able to obtain medium-term loans on behalf of its members for the purchase of equipment.

Co-operatives are a very important factor in the development of rural industries in Egypt. The progress achieved in the development of co-operative societies of all types of rural and traditional industries is remarkable. The co-operatives have been given technical, financial and marketing assistance. But the impact of the co-operative programme on the overall growth and development of light engineering industries has so far been limited.

Technical assistance

Technical assistance to rural industries is given through training centres distributed throughout the country and supervised by HIPCO. Instruction is provided in woodworking, car repairs, fitting, turning, welding, sheet metalwork, casting, blacksmithing, printing, shoe-making ready-made garments, carpets and artistic handicrafts. The number of trainees attending these centres is, however, comparatively low. The reasons for this low participation are the disappointing quality of the training programmes offered, poor equipment and inadequate funds. As a result of their limited funds, the centres are also unable to provide adequate stipends to trainees.

Institute of Small-Scale Industries

The Institute of Small-Scale Industries (ISSI) was established within the framework of the second five-year development plan jointly by the Government of Egypt and the International Labour Organisation (ILO) in November 1962.

Its objectives are to render services in the fields of applied technical and economic research, development and application of industrial techniques, training and extension services, industrial consultation and management, so as to assist medium- and small-scale public sector undertakings, private entrepreneurs and Government-sponsored, industrial co-operatives and production organizations in the promotion, establishment, operation, development and modernization of small- and medium-scale industries.

ISSI is made up of the following sections:

(a) A technical research section, which undertakes applied technical research, industrial investigation and studies of methods and techniques of production so as to advise on the problems of modernization of small- and medium-scale industries;

(b) An economic research section, which undertakes applied economic research and surveys in the fields of financing, management, administration and marketing;

(c) An industrial engineering section, which undertakes the introduction and application of industrial engineering techniques;

(d) A section for training, demonstration and extension, which organizes training schemes and carries out demonstration and extension programmes, including on-the-job training and industrial consultancy;

(e) A product design section, which was organized to work jointly with the technical research section to serve small-scale industries in designing tools, gadgets, jigs and fixtures, machine parts, mechanical spare parts and small prototype machines;

(f) An information section, which undertakes the collection, processing and dissemination of statistical data and technical marketing information;

(g) Industrial workshops consisting of group production facilities, each designed for a group of related industrial products, for example, light engineering, pottery and ceramics, textile weaving, dyeing and printing; coarse vegetable fibre products; carpentry, woodwork, furniture etc.;

(h) A laboratory section consisting of three laboratories rendering

specialized services to small and medium-sized industries in the following fields: chemistry; development of processes and materials testing; and industrial technology.

Engineering and Industrial Design Development Centre

The Institute of Small-scale Industries was attached, in January 1977, to the Engineering and Industrial Design Development Centre (EIDDC), which is affiliated to the Ministry of Industry, Petroleum and Mining. The combination of ISSI and EIDDC led to a greater emphasis on light engineering industries. The following services to light engineering industries in several fields should be noted:

(a) Design and development of the following products: consumer goods such as fans, gas cookers, heaters etc., engineering components for mechanical feeding industries (turntables, screw-jacks, axles), furniture, economy housing, interior outfitting, chairs, tables, electrical switches, sockets etc.;

(b) Production technology and tool design for all engineering and mechanical components, household goods, agriculture elements or tools, metalworking, cutting and blanking tools, plastic moulds and heat treatment of special parts;

(c) General assistance in study and revision of projects for processing industries, assistance in revision of various projects in view of local production facilities;

(d) Consultancy services and training courses in engineering fields.

Egypt Urban Development Programme

The main objective of the Egypt Urban Development Programme (EUDP) is to provide employment and urban services for the lowest income groups in distressed areas in Alexandria, Asyout and Cairo. Through the development of new sites and services, the project would improve living conditions and increase employment opportunities for a population of about 100,000 persons in the three distressed areas. The EUDP include a number of interrelated components to strengthen and expand the economic base of the three areas through assistance to the small business section, while at the same time improving the technical skills of local residents.

Services to light engineering industry

On each project site a number of plots would be prepared for use as light engineering workshops. A programme has also been established to assist small entrepreneurs through loans, technical guidance, infrastructure facilities etc., and to provide vocational training to the three main project sites. The development and expansion of small business will be further assisted through small business loans, extension services, manpower training, and consultant and advisory services.

The vocational training programme will be given to school drop-outs in the age group of 12 to 18 years. Courses would be of approximately two years duration and incorporate six months of practical workshop experience. The programme may be extended to include courses to upgrade the skills of adults

with previous job experience or technical training. The training courses will be in furniture and woodwork, welding, sheet metal, automotive repair, and mechanics and electricity. Extension services would be provided to small entrepreneurs through local Governments.

Technical services and regional coverage

The extension service for small-scale industries to be organized and operated by EIDDC will have two functions:

(a) To undertake analytical surveys of enterprises in the target group, pinpoint technical problems associated with the production process and recommend appropriate solutions which can be implemented by the firm on its own or with the help of the survey team;

(b) To assist individual firms in obtaining specialized services from the centre.

The programme to upgrade skills will also be implemented by EIDDC using the centre's mechanical engineering and woodworking workshops. For successful implementation of the training programme, trainees will be paid a reasonable daily stipend. The accelerated training programme to be implemented by the Productivity and Vocational Training Department of the Ministry of Industry is intended to prepare unskilled workers for semi-skilled and skilled jobs. The trainees involved are turners, f tters and sheet-metal workers (120 of each); and machinists, welders and auto-mechanics/electricians (90 of each, giving a total of 630 trainees). Trainees will also be paid a reasonable daily stipend.

The management consulting service, which will undertake consultancy assignments for interested firms, will be a longer term objective. The objective will be to undertake case studies on typical management problems of local small-scale industries as an input to the training programme. Many of the light engineering enterprises benefiting from the project will be clients of the Industrial Development Bank, and others are likely to become its clients.

The regional coverage for this pilot project has been restricted to Cairo and, for part of the programme, Alexandria, where most light engineering workshops are located. Given sufficient progress and experience in the Alexandria and Cairo areas, the project could then be extended to other governorates.

Rural industries and their ranking

Rural industries fall within the artisanal sector.[1] The 1966–1967 census of industrial production records 144,000 establishments employing less than ten workers, providing employment to some 293,900 persons, or 33 per cent of the total manufacturing labour force. About 51 per cent of the establishments are operated by a single individual, while 49 per cent employ five or fewer persons. Table 1 below provides a ranking of the eight most important branches in the artisanal sector in terms of the number of establishments and value added, accounting for about 70 per cent of the sector.

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[1]Establishments employing less than ten workers are considered to belong to the artisanal sector.

TABLE 1. BREAKDOWN OF ESTABLISHMENTS IN THE ARTISANAL SECTOR AND GROSS VALUE ADDED (1966 1967)

ISIC* group	Branch	Employment		Establishments		Gross value added	
		Number	Rank	Number	Rank	Amount	Rank
322	Clothes and garments	63 623	1	42 926	1	8 690	1
332	Furniture and fixtures	27 849	2	15 447	2	6 667	2
81	Metal products	27 706	3	13 404	3	5 493	4
321	Spinning and weaving	20 835	4	9 685	5	2 830	7
324	Shoes	18 874	5	9 693	4	3 702	5
3117	Bakeries	14 258	6	2 955	8	5 625	3
3116	Grain milling	14 222	7	3 747	7	2 972	6
9513	Car repairs	12 213	8	4 749	6	2 214	8
	Total	199 580		102 606		38 193	

*International Standard Industrial Classification

Organization and operation of light engineering industries in Egypt

Ownership. The most common forms of ownership in light engineering industries are individual proprietorship and partnership. In the artisanal sector ownership by an individual is the common form. Entrepreneurs in many cases have risen from the shop floor. They started as apprentices and became artisan entrepreneurs before graduating to modern small-scale industries.

Operating conditions. The majority of skilled workers in light engineering workshops have received on-the-job training and only a small fraction come from vocational training schools. In Egypt, there is a continuous loss of skilled workers in light engineering industries, as a result of emigration to oil-rich Arab States where they are attracted by much higher wages. There is need for upgrading skills in tasks requiring precision work. In the engineering field fitters and machinists should be trained to become capable of making press tools, dies, jigs and fixtures. In furniture making, skills are needed to operate machines such as copying lathes, multipurpose equipment etc., and to ensure strict compliance with technical specifications. The increasing emigration of skilled workers in light engineering industries has led to a steady rise of the wage level in this sector. The bulk of the machinery in use is of foreign origin. The Government permits the importation of such machinery provided it is not more than three years old. Some lathes and milling machines are produced locally by large Government factories. A good part of the machinery used in metalworking industries is obsolescent, and this has an adverse effect on productivity. Concerning the degree of utilization of equipment, it can be said that the jobbing engineering shops, with only a few exceptions are used intensively. In the furniture industry, however, machinery is not fully utilized. A large number of light engineering workshops in rural provinces have poor premises that are too small for the machinery they contain. Raw materials in light engineering industries are mostly imported. A certain amount of soft wood, iron, steel and copper are produced within the country. The entrepreneurs are allowed to obtain the imported raw and intermediate materials they need through co-operatives and other sources.

Sources of finance. Institutional finance to small-scale industries is provided by the National Bank, the Nasser Social Bank and the Development Industrial Bank.

The National Bank provides short- and medium-term credit to artisans. The Nasser Social Bank provides short-term credit mainly for social purposes, but also finances working capital requirements in the artisan sector. The Development Industrial Bank is the major source of short- and medium-term finance to small-scale industries.

Rural workshops and small-scale industries in dispersed localities have not been able to derive much benefit from the above-mentioned banks. The main problems of small-scale and rural industries in Egypt are as follows:

(a) Lack of basic statistics on investment, production, employment, raw materials and credit requirements;

(b) Lack of co-ordination between various government departments operating independently on the basis of a loose classification of industries into three categories;

(c) Inadequate technical assistance and advisory services for the selection of processes, products, product design and materials, for quality control, technical improvements, maintenance etc.;

(d) Complex and lengthy procedures for dealing with raw materials, which is complicated by the existence of a number of independent agencies responsible for decisions and approvals;

(e) Inadequate financial assistance, particularly to entrepreneurs operating in remote areas;

(f) Lack of skilled and trained manpower; which is further aggravated by mass emigration of skilled workers;

(g) Inadequate linkages with large-scale industries.

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Establishment of small-scale rural workshops (for light engineering goods) in East Africa

*A. Hojbak**

Introduction

The Lima Declaration and Plan of Action envisages that at least 25 per cent of world industrial production should originate in developing countries by the year 2000. Achievement of this target presupposes an enormous expansion of industrial output both of the "modern sector" based on urban and export markets and the "informal sector" based on rural and local needs. Many industrial products cannot be considered for production in the informal sector in the rural areas. However, light engineering is appropriate for small workshops in the rural areas of any developing country, especially if it is directed towards producing the means of production, such as agricultural implements, tools etc.

This paper deals with the conditions in the informal sector primarily exemplified by present conditions in the East African region. The paper concentrates on three case studies, which are typical good projects. They are:

(a) The *Utundu* programme. A programme specifically designed to promote the village blacksmiths of the United Republic of Tanzania who represent a strategic productive force in the country's development programme;

(b) The fishery programme A soft technology solution to an integrated small-scale fishery set-up for tropical coastal societies;

(c) The Sister Industries Agreement. A programme whereby know-how, technology, management etc. from an industry in an industrialized country is transferred to a similar one in a developing country through a special agreement.

The "Utundu" programme

Utundu is the Swahili word for "stubborn" in its positive sense of insisting, inventing, innovating, trying again. The aim of the *Utundu* programme is to promote small-scale manufacturing and repair of iron and metal items, such as farm implements, tools for other small industries, and households utensils. It has two components, namely a product and process development component, and a

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regional implementation component. The first is the direct responsibility of the Small Industries Development Organization (SIDO) and consists of compiling documentation and information on new product prototypes and improved iron techniques. Experiments are co-ordinated and subcontracted to local workshops, for example to industrial estate general engineering shops sponsored by SIDO. As the district centre, village and *Utundu*-sponsored workshops gradually become consolidated, the new products and techniques are eventually expected to be disseminated in careful and cautious stages through a technical extension service and skill upgrading programme component.

The first phase of the second component, regional implementation, is designed to consolidate existing blacksmith and tinsmiths' groups rather than to expand them.

Identification of groups

The first step of the regional implementation component is to identify the active smithing groups in the districts. These groups are then encouraged to organize themselves into co-operative production groups.

Selection of groups

Following the identification survey each group is then categorized into A, B or C workshops according to the system shown in the accompanying table. This is the first step towards deciding what kind of support the *Utundu* programme possibly could give the respective groups.

As a rule of thumb and planning indicator, the following figures will be used for initial selection and spacing of prospective *Utundu* workshops, mainly based on market size considerations:

Group C workshops: A market base of at least 9,000 families
Group B workshops: A market base of at least 18,000 families
Group A workshops: To be determined in each case

This means, for example, that if a district has 18,000 families (or a population of about 80,000), either two group C workshops or one group B workshop could be supported initially through the programme. Roughly speaking, it also means that a maximum of a little more than 300 group C workshops can be supported, or something like 15 per region As the *Utundu* programme gradually becomes successful, and particularly when the raw materials supply and the marketing problems are solved, the planning figure for Group C workshops can be decreased, but not before.

PRODUCTS

Just as the *Utundu* programme builds upon existing skills it also initially builds up production of the types of implements already being made. The aim is to improve the working processes and product quality. Only when a group has shown itself capable of making such improvements should suggestions be made as to what other items could be produced and what other smithing techniques could be used.

SYSTEM FOR CATEGORIZING WORKSHOPS

Characteristics	*Group A*	*Group B*	*Group C*
Location	District or regional centre	Rural centre, village or district centre	Village or rural centre
Physical set-up	Permanent workshop building with electricity from mains. Comprehensive set of hand tools, some power tools and machinery, welding equipment	Simple work shed. Hand tools only; mix of traditional and modern. Some hand-operated machines, partly or mainly self-made	Simple work shed. Mainly traditional hand-tools partly or mainly self-made. Few hand-operated machines, self-made
Manual	One or more formally trained in medium-level technical and managerial skills, semi-skilled and unskilled workers and apprentices	One or more informally trained in low-level technical skill. Semi-skilled and unskilled workers and apprentices	One *fundi* skilled worker assisted by 1–3 relatives; skills mainly inherited
Organizational set-up	Partnership or co-operative	Partnership or co-operative	Individual
Production	Mainly machinery and tools for other small industry units. Ancillary items	Agricultural and other implements	Manufacture of agricultural and other implements, mainly repair and traditional weapons
Material supply and marketing	Material supply through formal trade channels (RTC) marketing through RTC or to order. Local and national markets	Mainly scrap material. Sales to local market, mainly to order	Only scrap material. Sales to local market, mainly to order

It is therefore not necessary at the outset to specify the types of products the workshops should make; the smiths know this already. Moreover, it would at present be an impossible task to specify all the products, and what is useful in one district is not necessarily useful in another. However, some examples of products are listed below and grouped according to category of workshop (see the table) which possibly could make them.

1. *Products suggested suitable for group C workshops*

Farm implements
Jembes (i.e. hoes, of various types, kinds and shapes)
Axes (choppers)
Billhooks (local design)
Adzes
Pangas; cutting knives (cane and sisal)
Sickles
Slashers
Household utensils
Knives
Scissors
Frying pans
Charcoal stoves
Kerosene lamps

2. *Products suggested suitable for group B workshops*

All the group C items plus:
Buckets
Water cans
Dustbins
Chicken feeders
Garden shears
Repair of bicycles, water installations etc.

3. *Products suitable for group A workshops*

Group B products, plus:
Farm implements
Axes (round eye)
Ground-nut shellers
Maize shellers
Ground-nut lifters
Hand-operated sprayers
Planters (hand-operated)
Wheelbarrows
Ox-carts;
Handcarts
Assembling and repair of ploughs

Tools for small industries
(including tools used by group C and B workshops)
Forging hammers
Pedal operated air blowers
Holding tongs
Chisels
Planer blades
Sheet-metal corrugating machines
Sheet-metal shears
Soldering rods

Tools and equipment for the groups

This is one of the crucial points where the *Utundu* programme can be of direct assistance. Two things seriously prevent the smiths from expanding and improving their production: lack of tools and lack of funds to buy them.

The first is perhaps the more serious because even if the smiths have money, the necessary tools are not available. Thus, by simply arranging for the tools to be available for sale at the respective Regional Trading Corporations (RTC) which are responsible for distribution of state-controlled articles, SIDO can bring these smiths considerable support.

The latter point is also a general problem, so hire purchase, soft loans or subsidized prices are arranged. A SIDO policy decision is made and communicated to the regions, together with detailed instructions on the necessary administrative procedures. The *Utundu* programme does not provide free tools. This principle also applies for working sheds.

Tools recommended for a model group C workshop

Anvil on wooden trunk (50 kg)
Foot-operated air blower
Various sizes of forging hammers
Holding tongs
Hack saw with blades
Medium-size vice
Chisels

Tools recomended for a model group B workshop

All the group C tools plus:

Hand-operated grindstone and drill, with set of bits
Water-pipe die machine (hand-operated)
Soldering tools
Fastening tools
Metal-grooving machine
Hand-operated metal-cutting machine

Tools recommended for group A workshop

Each case must be considered separately, depending on the available electricity supply, but the following seems reasonable:

Basic blacksmith and machine shop tools
Arc-welding set (100–200 A);
Gas-welding and cutting torch set
Table drill press (up to 25-mm capacity)
Table grinder (two wheels)
Die and tap set (1 mm to 20 mm)

Raw material supply

In many regions the supply of raw materials is quite the most serious obstacle to the expansion of the smiths' production. The problem must thus be attended to even before the supply of tools. Most smiths now rely on collecting whatever scrap material they can find.

The first step will be to arrange a systematic search in the region for scrap, for example, in the garage yards of the various ministries. Secondly, SIDO is negotiating with Ubango Farm Implements (UFI) manufacturing company (a public sector undertaking, that manufactures a wide range of agricultural tools, implements and processing equipment) for the purchase of scrap of various qualities.

Thirdly, the sale by UFI of semi-finished blanks of various specific steel qualities, shapes and sizes is being considered. These will be distributed through the RTC or directly through regional SIDO offices. The third step in particular might take a long time to implement. Regions should therefore be fully prepared at the outset to exploit the first and second possibilities. As a rule SIDO cannot commit itself to carrying out the actual material deliveries.

Technical extension service

Initially no specific technical advice is foreseen. At some later stage, for example when the semi-finished UFI blanks are distributed, a technical extension service may be needed. Also when the product and processes development component of the *Utundu* programme has results to disseminate, they will be considered with extension advice.

Marketing

Marketing is of utmost importance. In the initial stage of consolidation, reliance on the existing local market is necessary and apparently sufficient. For example, in certain cases where smiths were claiming to have problems with the supply of raw materials, this was found to be a sign of heavy demand for their products.

When improved tools are introduced, care must be taken to ensure that a market survey is made. Decisions on the granting of loans must not be allowed to foster over-optimistic production levels. Whenever a group wishes to produce for a market outside the district, consultations with RTC must be carried out in advance. RTC usually requires the products it handles to be highly standardized.

The fishery project

In the poorest parts of the developing countries fishing takes place mainly in ocean-facing villages without harbour facilities. It is usually the main occupation and activity on which the life of the local population depends. Fishing in these societies is based on a sturdy, traditional technology with scope for development through the application of "soft" technology methods.

However, many of these small societies are threatened by big industrial nations that overfish in the offshore waters of developing countries. It is becoming increasingly difficult to meet the needs of the population of small societies based on traditional fishing. The catching areas will have to be expanded by improving both the fishing fleet and the equipment used.

A temporary solution to the first problem, involving an extension of national territorial waters, is being tried, although traditional fishing methods would hardly be able to take advantage of the extended areas.

There is a widespread belief that expansion of local small-scale fishing cannot cope with the bigger catches made possible by the new fishing limits. Consideration has therefore been given to large-scale fishing projects involving the larger harbours in developing countries. Such projects raise problems for developing countries: they are capital-intensive, require foreign exchange, and are based on economic conditions and techniques developed and utilized in the powerful fishing nations.

Without any doubt there is a need for establishing modern large-scale fishing fleets for the supply of big cities and for export. However, many possibilities exist for supporting the coastal fishing industry. By utilizing local knowledge, skills and traditional techniques it is possible to ensure the broad, integrated expansion of the fishing industry and generally promote the economic growth of coastal societies. Such a programme has been taken up on the initiative of a group of people trying to modernize the traditional fishing industry on the coast of East Africa. Its success will depend on various factors. First of all, the fishing boats must be able to land directly on the coast and pass coral reefs. Secondly, construction, repair and maintenance should as far as possible be undertaken by local people with local materials, knowledge and skills. The fishing fleet must also be able to operate without being solely dependent on fuel supply, and adequate storage facilities would need to be built up.

The programme involves the development of a prototype sailing vessel, useful for trawling lines and nets, and the development of a mobile ice factory. Both can be adapted to local conditions. The prototype is for trial purposes. It has an overall length of 10.5 m and a beam of 4 m, and a draught of 0.7 m without, and about 1.8 m with, the centre-boards down. The shape of the hull and the use of centre-boards is a prerequisite for operating the boat on any coastline without any sort of harbour facility. The ship is self-bailing, as all decks are above the water-line. There is a small cabin for the crew to use during bad weather. Ferro-cement is used for the construction of the hull, because it is cheap, easy to work with, and may be repaired locally. The maintenance cost is low, as expensive antifouling paint is not required. The hull is a strong shell construction with all lines curved. To make such a concrete hull, a permanent formwork produced in a well-equipped workshop will be necessary. After being transported to the place of production it can be used over and over again by the local shipbuilders.

Because of ever-increasing oil prices, supply problems and the need to save foreign currency, the ship is equipped with sails. The rig is simple and easy to build and handle. The vessel will be adaptable to local conditions and traditions. Sailing boats are well known and accepted in most small fishing societies in developing countries where wind conditions normally are quite regular. In many cases a small engine will still be valuable as a supplement to the sails. Thus the vessel is designed for easy installation of a small diesel engine. The prototype will have a simple air-cooled 5–8 hp (4–6 kW) engine with belt transmission. This equipment is cheap and easy to maintain. It may also be possible to install more traditional marine engines. A serious problem in tropical areas is that of keeping the catch until landing, marketing or processing has taken place. The boats will therefore be equipped with a well-insulated fishhold divided into four

compartments so that one can be used without a temperature change or loss of ice in the others.

The other part of the project consists in the development of a mobile ice factory. In most cases local landing spots will be far away from existing iceworks, and thus the limited marketing possibilities will severely hamper fish landings. The idea is to develop iceworks consisting of a big floating container.

As mentioned above, the project is specially designed for implementation in the poorest parts of the developing world where for generations fishermen have worked without harbour facilities of any kind and with inefficient equipment and material. On the one hand, the project is technologically simple and independent of fuel supply, and, on the other, it requires very little education, training and supporting technical facilities. It is based on the know-how and experience of small societies of fishermen in the countries concerned.

The Sister Industries Agreement

The Sister Industries Agreement is based on ideas which have been tried out by the Swedish International Development Authority in Botswana, Swaziland and the United Republic of Tanzania. Such an arrangement may involve a different type of co-operation between a small or middle-sized industrial unit in an industrialized country and a planned or newly established unit (sister industry) in a developing country. Thus technical know-how and managerial experience for a particular type of industry could be transferred to a new unit in the developing country. Such an agreement could make it easier to start production and to obtain guidance and training, including fellowship arrangements, during the first crucial 5–10 years of production. It could eventually develop into a commercial agreement in the form of a joint venture, subcontracting etc. between units in the industrialized and the developing countries concerned. Different types of metalworking industries especially those manufacturing farm implements and tools and simple machinery for other small-scale industries, could be of considerable interest. The manufacture of educational equipment may also be important.

Annex I

SELECTED DOCUMENTATION PUBLISHED OR COMPILED BY UNIDO RELATING TO THE SUBJECT

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Sales no.: 78.II.B.10.

The effectiveness of industrial estates in developing countries. New York, UN, 1978. 110 p. tables. (ID/216)
Sales no.: 78.II.B.11.

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Annex II

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Printed in Austria
79-1866 – May 1980 – 10,000

ID/232/11