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APPROPRIATE TECHNOLOGY FOR SMALL-SCALE INDUSTRIES

Possible roles for development finance institutions in Africa

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KEY APPROPRIATE TECHNOLOGY?

1. Appropriate technology is a meaningless phrase, for no-one would advocate the use of an inappropriate technology. It is, however, a term which has recently entered development vocabulary and it is important to be in agreement as to what is meant. Two examples may best serve to elucidate.
2. Sugar is an important commodity in any national economy. In 1974-1975 India produced 6.1 million tons of crystal sugar. Of this total, 80 per cent is produced in 222 factories utilizing large-scale vacuum pan technology and employing some 200,000 people. The balance is produced in small-scale units utilizing the so-called open pan sulphitation technology and these provide seasonal employment for some 100,000 people who would otherwise migrate temporarily to the cities for four or five months or remain unemployed during the slack season.
3. The first pilot plant for small-scale technology was built in 1956-1957 and has a crushing capacity of 30 tons per day. Continuous development has taken place since then and certain comparative figures between the large - and small-scale plants are relevant. A detailed study in 1973 showed that for the same initial investment of 28 million rupees, one modern plant, using the vacuum pan technology, could be built or 47 small-scale mills. The former would produce a little more than 12,000 tons of sugar per season for a total employment of 900, but the 47 small plants would produce two and a half times more sugar and employ 11 times more people. These ratios obviously depend upon the assumptions about an average mill's performance in an average year. However rough they may be, they show that small-scale technology is more efficient in terms of capital output and employment generation.
4. Not surprisingly, the technical efficiency of the large-scale vacuum pan plants is superior to that of the small-scale units. Another study showed that for ten tons of cane, the average recovery rate in the large-scale factories of northern India was 9.5 per cent. With the small-scale technology, it varied from 7.25 to 3 per cent. The cost of producing 100 kg of sugar thus worked out at 235 rupees with the modern method, and between 223 and 236 (depending on the recovery rate) with the small-scale technology. However, the sugar made in the large plants had to be sold in both nearby and distant markets which meant additional costs for transport. Further, there was always a delay in the disposal of the sugar since a much bigger region had to be covered by the marketing system. These factors added 5 to 7 per cent to the cost and raised it to about 250 rupees per 100 kg.
5. Great success has been achieved in attracting rural investors and entrepreneurs to take up the new small-scale technology. By 1973-1974, 935 units had been set up by small entrepreneurs in the State of Uttar Pradesh alone. Further, a new industry has been established to manufacture the equipment required for the small-scale units. The amount of iron and steel needed for these small-scale units is only about 60 per cent of that required by the large-scale industry for producing the same quantity of crystal sugar. In addition, the machinery design does not require any imported components, thus saving foreign exchange.
6. The above is therefore a good example of small-scale appropriate technology in the agro-industrial sector. The second example, described below, tells a different story.

7. In another country, two plastic-injection moulding machines costing 100,000 dollars each were imported to produce plastic shoes and sandals. Working three shifts and with a total labour force of only 40 workers, the machines produced 1.5 million pairs of shoes and sandals a year. At two dollars per pair, these were better value and had a longer life than cheap leather footwear at the same price. Thus, 5,000 artisan shoemakers lost their livelihood which in turn reduced the markets for the suppliers of leather, hand tools, wax and polish, laces, etc. As all the machinery and the material (PVC) for the plastic footwear had to be imported, while the leather footwear was based largely on indigenous materials and industries, the net results were a decline in both employment and real income within the country.

8. These two case studies illustrate the key argument for appropriate technology, namely that, in the majority of development projects, there is a choice as to the technology which can be used, that the modern 'Western' technology is not necessarily the optimal technology, and that simple technical efficiency is not the sole criterion on which a technology should be selected. Technology is not neutral in its economic, social and political impact. If a Government is concerned not only with economic growth but also with the spread of this growth into different parts of the country (specifically through employment creation in the rural areas and in the poorer sections of the cities), then the choice of technology is crucial.

9. It may be useful to examine briefly some of the other arguments which have been put forward in favour of the development and dissemination of appropriate technology, and also to look at some of the objections. First, in the developing countries, capital is far scarcer than in the industrialized countries where most modern technologies originated. Therefore, the capital requirements for providing maximum employment opportunities through these technologies are frequently beyond the reach of the poorer countries. Labour, on the other hand, is generally an abundant resource and is readily available for production purposes. As against this, it is argued that 'Western' technologies give the greater returns on capital investment and these make available the greatest savings for future investment and thus for future economic growth. Further, labour is not always as abundant or cheap as might be expected. Low productivity may more than offset the low wages and the wage rates themselves may be pushed up artificially by government legislation.

10. Second, the technologies of the industrialized countries are largely geared towards large-scale production to match the size and accessibility of their markets. This may not suit many developing countries whose population may be small and widely dispersed. A case study from Zambia is relevant. In one area of the country, considerable numbers of eggs were being produced and the producers wanted to market them in the urban areas. What was required was a small plant which could produce papier-maché egg trays in which the eggs could be packed for safe transport. Thorough investigation of what was available on the world market showed that the smallest unit which could be acquired (from Denmark) could produce all the egg trays that were needed for one year's supply of eggs in only one month, working only one shift per day. This unit was highly automated and was clearly quite uneconomical, given that it would be lying idle for 11 months of the year.

11. This problem came to the attention of the Intermediate Technology Development Group in London which managed to work out a solution with an engineering company in the United Kingdom, a solution that required the development of a new technology for

one stage of the production process. With this new unit, which was far less automated, the egg tray requirement could be produced over 12 months and the difference in capital cost was at that time £5,000 compared with £120,000 for the unit from Denmark.

12. Third, modern 'Western' technologies often require a high degree of technical and organizational expertise to operate and maintain, and these resources may be lacking in a developing country. In addition, they often involve imports of raw materials and spare parts which can not be made locally. These two factors can lead, on the one hand, to greater dependence on the industrialized countries and an exacerbation of balance-of-payments problems, and, on the other, to substantial under-utilization of capacity and higher unit costs of production. A tanning industry project in one developing country envisaged building a small model tannery to act as a training centre and to demonstrate new techniques, together with a number of new buildings to rehouse existing tanneries. Total capital costs were projected at 2.5 million dollars for an annual output of 15 million dollars. The buildings and some of the machinery were to be made locally, so the import content was small. Labour productivity was expected to increase but the number of workers employed in the industry would remain at 3,000 owing to a 5 per cent per annum expected increase in the demand for leather.

13. The project was, however, dropped on the grounds of not being modern enough, and was replaced by a scheme for a large Government-owned tannery estate costing 15 million dollars, equipped with the latest modern machinery, and with a total capacity 50 per cent in excess of the existing firms. Employment in the industry would be halved, existing equipment made obsolete, owners of present firms made redundant, and the import bill increased by 3 million dollars.

14. Fifth, small-scale industrial units are amenable to a wider distribution among the towns and different regions of a country. Such dispersal **strengthens** the links with the rest of the economy to a greater extent than is possible with a few modern isolated units in large urban centres. Further, small industries stimulate rather than displace the traditional sectors in which most of the rural people work and will, for the foreseeable future, continue to work. In Ghana, the Technology Consultancy Centre at Kumasi University received a stream of enquiries from small local soap makers as to how to improve their production of soap from locally available vegetable oil in order to enable them to compete successfully with the soap manufactured at the Lever Bros. factory which was made mainly from imported raw materials.

15. The Centre succeeded in developing not only a simple plant for making better soap from locally available raw materials - at a daily production rate of 2,500 lb. of soap - but also, owing to the difficulties of procuring supplies of caustic soda on a regular basis and at a reasonable cost, a second unit for the manufacture of caustic soda. A number of both types of plant have now been made and sold to local entrepreneurs.

16. One of the most commonly heard objections to appropriate or intermediate technology is that the quality of the goods produced is inferior. Only capital-intensive methods of production, it is argued, can provide the degree of quality control and product precision required in international markets. However, it is simply not true that the scale or supposed sophistication of a production process is directly correlated to the quality of the product. In the small-scale open pan sulphitation technology for the production of crystal white sugar referred to above, the quality of the product is often indistinguishable from that produced by the large-scale vacuum pan technology.

17. Further, by no means all products are destined for the export market. There may be occasions on which an inferior quality product is better than nothing. For example, in Nigeria the Intermediate Technology Development Group helped to set up a workshop in Zaria which is mainly involved in the production of simple hospital equipment. The design of the equipment produced is unquestionably less sophisticated than the imported models of instrument trolleys, hospital beds, wheel chairs, paraplegic turning frames etc. but the equipment does do the job it is required to do, it does not require foreign currency or an import licence to obtain, it is far cheaper than the imported equivalent and, probably most important of all, it can be repaired in Nigeria by any reasonably well equipped metal workshop. There is not much use in having a sophisticated, chromium-plated item of hospital equipment if, when it breaks down, nobody has the technical know-how or spare parts to repair it and it sits idle for 18 months.

18. Finally, a deliberate policy to adopt appropriate technology wherever possible will not only encourage the use of local resources to meet local needs and thereby promote local and national self-reliance, but it will also stimulate the growth of a national capability for technology research and development. This is the direct counter-argument to that which says that the nature of technical innovations requires the concentration of industries to create a critical mass for competitive innovations. Small-scale decentralized investments, it is argued, will fail to create the necessary environment to stimulate innovations.

19. Reference has already been made above to the Technology Consultancy Centre in Ghana. This body was set up in January 1972 to make available to the public the expertise and resources and resources of the various Faculties of the University at Kumasi and to promote the industrial development of Ghana, and in particular by the small-scale indigenous entrepreneur. Over the five years that the Centre has been operating, it has received numerous requests for technical assistance to improve or develop new processes and products. The example of soap made from local vegetable oil has already been given. Another example is that of the entrepreneur who sought the help of the Centre for the development of a formula to manufacture paper glue from cassava starch and alkali from plantain peel - two raw materials which are in abundant supply in the local market. The University provided the technical know-how and the Centre built a pilot production plant capable of producing 40 gallons of glue per day. Within a year, the entrepreneur was supplying the best part of Ghana's needs for glue, thereby saving substantial amounts of foreign currency. Additionally, the project is providing employment to 25 rural dwellers who would otherwise be unemployed.

20. So much for the "pros" and "cons" of appropriate technology for small-scale industries. It is hoped that the examples given will convince the sceptics that there is a strong case for appropriate technology, that it is not always an uneconomic proposition, and that much greater attention should be given to the choice of technology when considering any development project. At the same time, however, it should not be thought that small-scale appropriate technology must be used in all cases and that large-scale capital intensive 'Western' technologies are unacceptable. What is sought is a mixed technology economy in which some activities will be undertaken using the simple traditional technologies, some will use the most sophisticated large-scale technology available, and the great majority of activities will use technologies which fall between these two extremes.

21. It is crucial to bear in mind the steadily increasing importance of what is called the socio-economic imperative, namely, the need to reduce substantially, even if not eliminate, unemployment. To quote E.F. Schumacher, "No one would suggest that output per man is unimportant; but the primary consideration can not but be to maximize work opportunities for the unemployed and underemployed. For a poor man the chance to work is the greatest of all needs and even poorly paid and relatively unproductive work is better than idleness".

OBSTACLES TO ACCEPTANCE AND APPLICATION

22. If, indeed, the case for appropriate technology for small-scale industries is so strong, why is it that it has not been more widely accepted and successfully applied in the developing countries in Africa? Why, for example, did Zambia build two large-scale modern brick factories which frequently operate at below planned capacity, and therefore uneconomically, when there are technologies available, requiring far less capital and far more labour per unit of output, and yet which can produce bricks of excellent quality and at competitive prices? Why has the Rural Industrial Development Programme in Kenya been so unsuccessful in its objectives? Why has the United Republic of Tanzania decided to increase the capacity of the existing large-scale factory producing agricultural implements and also to build a new large-scale plant to manufacture similar products when a number of small-scale production units could be set up throughout the country not only drawing on the skills of existing blacksmiths and metal workers and providing valuable employment, but also being able to undertake much needed maintenance and repairs? Why is this, what are the obstacles to the widespread application of appropriate technology, and what might the development finance institutions do about removing these obstacles?

23. There are, obviously, many reasons for this situation. In part, they are the same reasons why small-scale industries in general have proved so difficult to promote. However, below a few reasons are given which are specifically related to the technological arena and which are relevant to the interests and resources of the development finance institutions.

"Small-scale technologies do not exist"

24. It is often believed that small-scale technologies do not exist. If they do, it is the accepted wisdom that they are either quite archaic or that, in comparison with large-scale modern technologies, they are hopelessly inefficient in economic terms. There is some truth in this belief but it is a much exaggerated argument. An increasing number of empirical studies have now shown that small-scale technologies do exist, for example, in brewing, shoe-making, textiles, sugar-processing, baking, brick-making, etc. and are in beneficial use in many developing countries. They do not, however, have the prestige and glamour of the modern Western technologies, have attracted little attention, and, in consequence, have been little publicized.

25. In this connexion, mention should be made of three publications which have recently appeared and which have been used in the preparation of this paper. The first is a publication from the Intermediate Technology Development Group and compiled by ECA entitled 'Economically appropriate technologies for developing countries - An annotated bibliography'. Second, there is Gareth Jenkins' annotated bibliography of empirical studies on 'Non-agricultural choice of technique'. Finally, there is a publication from the Development Centre of OECD edited by Nicolas Jequier, entitled 'Appropriate technology - Problems and promises'.

Lack of interest by research institutions

26. There are many instances, it is true, in which technologies appropriate for small-scale industries do not exist, or, more frequently, have not been adapted to suit local needs and resources. Mention has been made of a number of examples of such developments - sugar, soap, papier-maché egg trays, and glue - but for the most part there is an almost total lack of interest by public or private research institutions in developing countries in such activities. The primary reasons for this would appear to be that small-scale technologies do not have the glamour of the modern technologies, that they are not regarded as being as intellectually demanding or rewarding, and that they are not perceived as being so important to the country.

27. It is, however, essential that the interest of research bodies in small-scale technologies be aroused and that some resources be diverted towards research, development and adaptation. In addition to the Technology Consultancy Centre at Kumasi University in Ghana mention should be made of the ASTRA Cell at the Indian Institute of Science. ASTRA, which stands for the Application of Science and Technology to Rural Areas, was set up in the belief not only that a premier intellectual body such as the Institute of Science should be making a contribution towards the development of technologies to alleviate the lot of those in the poorer parts of India, but also that many of the problems faced are as intellectually difficult to solve as those in the 'high' technology arena. The founder of the ASTRA Cell, Professor Reddy, has argued forcibly that only the major academic institutions - universities, research institutes, national laboratories, and institutes of technology - possess the multi-disciplinary competence to tackle the task of developing appropriate technologies.

Lack of funds for proving the commercial viability of new technologies

28. Even where institutions have developed and/or adapted technologies for small-scale industries, there often remains a critical stage before the technology will be accepted by local entrepreneurs and they are willing to put their resources into a plant using the new technology. What is required is a pilot production unit to test the technology on a commercial scale. This is exactly what the Kumasi Technology Consultancy Centre has set up in those few instances where it has managed to raise the funds, the aims being:

- to complete product development under production conditions
- to test the market for the product
- to demonstrate to entrepreneurs the viability of the new industry
- to train managers and craftsmen in the skills of the new process

29. Another recent example of this type of initiative comes from India and a new process for the production of Portland cement on a small scale. Researchers have succeeded in developing a process whereby Portland cement can be produced in small batches with every batch being of the same required high standard. (The vertical kiln process widely used in China and some parts of India has the weakness of occasionally producing below-grade cement. This has obvious dangers.) It is planned to construct a pilot commercial-scale production unit in the near future with financial assistance from the World Bank.

Lack of funds for entrepreneurs adopting unfamiliar technologies

30. There is often no lack of funds available from commercial and development banks for the small-scale indigenous entrepreneur who wishes to set up a new business using a familiar technology (The 'delivery system' for these funds is often a problem but rarely is there a lack of funds per se). There is, however, another area of need for which funds are often never made available and that is when an entrepreneur wishes to set up a business using a technology unfamiliar to his environment but which has been proven in another environment. An example from the Caribbean is relevant.

31. A project has recently been drawn up by the Caribbean Development Bank which proposes the establishment of an Appropriate Technology Service. It is proposed that this Service, which will respond to technical enquiries and also commission research on appropriate technologies, will liaise closely with another element of the project, namely a Credit Fund which will be established within the Bank. The objective of the Fund is to give assistance to enterprises which adopt unfamiliar employment-generating technologies. The proposed creation of this Fund recognizes that the adoption of such unfamiliar technologies by small-scale entrepreneurs is likely to involve a greater risk than the use of more conventional technologies and that normal credit sources are unlikely to be willing to assume such risks.

Institutional resistance to small-scale technologies

32. Another powerful reason for the failure to adopt technologies appropriate to small-scale industries is that the institutional resistance to small-scale projects within a developing country is considerable. For example, a recent Swedish report on the Small Industries Development Organization of the United Republic of Tanzania stated that "the existing vigorous organizational set-up for promoting big industry, i.e. the parastatals, has long since allied itself with the central administration, particularly the Ministries of Finance and Planning and of Industries. The administration knows and is used to the routines accompanying big industry projects whereas the problems of small industries are unfamiliar. The background and training of government officials favours big industry".

33. The attitude of many sources of finance for development projects is similar. There tends to be an administrative weakness for large-scale projects because they require less effort to set up and fewer headaches to administer than a greater number of small-scale projects. Few banks pay regard to the technological aspects of projects in the course of project identification and appraisal. An exception to this, although not in Africa, is the Korea Development Finance Corporation which maintains a close

link with the Korea Institute of Science and Technology. The Corporation has been receiving relevant information and data from the Institute to improve the technological aspects of its assisted projects. (The Asian Development Bank in October 1976 issued a restricted report entitled 'Appropriate technology and its application in the activities of the Asian Development Bank').

34. The government bureaucracy's resistance to small-scale technologies and projects may be reduced by the decentralization of national ministries and the creation of regional development authorities with a measure of financial autonomy. This has happened, for example, in the Upper Volta and the United Republic of Tanzania. However, there is a desperate shortage of experienced competent staff for such regional bodies, especially those with any significant experience on small-scale technologies.

35. One of the reasons for this shortage of staff is that the educational system in the great majority of developing countries tends not only to create a bias towards big projects but also to stimulate a strong attraction in any person of ability for the national capital or major urban areas. Engineers and technicians, therefore, as well as managers and administrators, gravitate to the national ministries, the State corporations and the big private companies with very few being prepared to spend time on the technological problems of small-scale industrial development.

WHAT CAN BE DONE?

36. What can be done, therefore, about these obstacles to the application of appropriate technology? What could be the role of development finance institutions in Africa? Three suggestions will be put forward but, before that, one further comment is required.

37. No form of technology, be it high, low, Western, traditional, etc. is neutral in its social and political impact. So-called Western technology, when applied in developing countries, has tended strongly to reinforce the dual society - on the one hand, a rich elite consisting of some 5 per cent of the population who live almost exclusively in the urban areas, and, on the other, the remaining 95 per cent remainder, principally the rural poor but also, and increasingly, the urban poor. In contrast, small-scale appropriate technology is implicitly designed to increase the productivity and incomes of the rural and urban poor. Unless, therefore, there is political commitment at the highest levels of Government to bring about a more egalitarian society, then there will be inadequate support for the concept of appropriate technology and, in consequence, little will be achieved in trying to promote its application.

38. Assuming, however, that there is the necessary political commitment, three measures can be taken:

Establishment of national appropriate technology capability

39. Development finance institutions could give valuable support to the establishment of some form of national appropriate technology capability. Such a capability, which need not be yet another new institution, would have responsibility for the following functions, either directly itself, or indirectly through existing organizations:

Information/communication

- the operation of a technical enquiry service to respond to requests for information about appropriate technologies;
- the active search for possible appropriate technological solutions to meet identified problems and opportunities;
- giving advice to national ministries, for example those of Planning and Industries, on the choice of technologies available for carrying out specified policy objectives, for example making bricks or cement, and assisting in the evaluation of the alternatives; and
- assistance in promoting the whole concept of appropriate technology by organizing workshops, seminars, etc. by publishing information about relevant technologies, and by putting interested parties in contact with national appropriate technology capabilities in other countries.

Technology development

- commissioning research and development of new appropriate technologies to meet identified needs; and
- commissioning the adaptation of existing technologies to suit different environments.

Technology application

- field testing new or adapted technologies and, if necessary, establishing pilot commercial-scale production units; and
- giving technical assistance to projects in the field.

40. Obviously no single organization will have the resources or competence to carry out all the above functions. Thus a national appropriate technology capability would be essentially a catalytic or co-ordinating body stimulating other organizations to undertake many of the above activities.

41. There already exists a number of such appropriate technology capabilities in various developing countries. Reference has already been made to the Technology Consultancy Centre at Kumasi University in Ghana but there is also a similar body which has recently been set up in Zambia, the Technology Development and Advisory Unit at the University in Lusaka. A proposal for the establishment of an Appropriate Technology Centre in Botswana is well advanced, to be set up as a joint venture by the Ministries of Finance and Planning, Commerce and Industry, and Agriculture, and by the Botswana Development Corporation and the Botswana Enterprises Development Unit. In Asia, there are units in India, Pakistan, Bangladesh and Sri Lanka to mention but four countries. Similarly, in Latin America, there are appropriate technology bodies, one being the Unit on Appropriate Technology formed by SENA, the Colombian Government's national training organization. Again, in the Caribbean there is the proposal to set up an Appropriate Technology Service in the Caribbean Development Bank referred to above.

42. None of these organizations carry out exactly the same functions and there are also great variations in where they are located institutionally. There seem to be four

main possibilities: within a University; as a section in the Planning Ministry; as part of one of the government bodies charged with promoting small-scale industries; and in a development bank. Obviously, in each country, the institutional location will be unique but in the absence of such a technology capability, development finance institutions could play an invaluable role by offering to set up such units, at least initially.

Funds for research, development, adaptation and testing of appropriate technologies

43. From what has already been said, it is clear funds will be required for: the research and development of new technologies; the adaptation of existing technologies; and the establishment of pilot production units for commercial-scale testing. To all these, development finance institutions could make a financial contribution, and especially, perhaps, to the last. If a national appropriate technology capability existed, then such funds could be channelled through that organization. If not, then they could be directed to existing interested bodies, possibly the government agency charged with promoting small-scale industries.

Appropriate technology in education

44. As mentioned, the curricula and course material in technical colleges and universities tends to orientate students towards the large-scale project, towards high modern technology and towards the white collar job in the metropolitan areas. It is important that the majority of students, especially engineers and economists, should be taught about the concept of appropriate technology, and the major role it can play in development. Scientists should be shown that the development of new appropriate technologies often requires at least as much, if not more, intellectual competence as do the technologies for large-scale projects. Further, students need to be taught how to make the choice between alternative technologies, not on the basis of narrow private profit but rather taking into account the wider social, environmental and political factors.

45. If such teaching is to be undertaken, course material will have to be prepared and lecturers found who are competent to present it, possibly specialist personnel who might run short courses or give a series of lectures. It is doubtful whether development finance institutions could be persuaded to provide funds for the preparation of such course material or for such lecturers, but they might be persuaded to provide limited funds for writing up specific case studies. Experience shows that there are, on the one hand, numerous cases of small-scale technologies in successful operation but about which little is known or publicized, and, on the other, university students who are looking for useful work to do during their long vacation.

46. Would it not be possible to arrange for these students to be provided with the very limited funds required - for local travel and subsistence - and for them to investigate and subsequently write up, according to an agreed format, such case studies as could be identified in their own countries? Such an exercise would be a valuable experience

for either one student working on his own or perhaps two students operating as a pair (one engineer and one economist) and of great interest to small-scale industry development agencies elsewhere in Africa.

47. In conclusion, many of the obstacles to the acceptance and application of small-scale appropriate technologies can be reduced by the setting up of some form of national appropriate technology capability in every developing country. This may seem like massive duplication but the fact is that, in the great majority of situations, technologies have to be closely tailored to meet the unique needs and resources of that situation and this is best achieved by a national body. Development finance institutions can clearly play a major role in the establishment of such capabilities either by exercising the undoubted influence such institutions have, or by providing funds in the directions suggested, or by providing a base for these capabilities within the institutions themselves.