Economic Development, Employment and Public Works in African Countries

THE MAIN QUESTION discussed in this paper [1] is why it is important for economic reasons to improve the productivity of public works carried out on a labour-intensive basis. It is hoped that this discussion will encourage further study of how to improve productivity and lead to a wider adoption of more productive methods.

It is possible, technically speaking, to carry out much of the public works in Africa on a labour-intensive basis, and at least a few operations leave no choice but to do so. However, in recent years increasing use has been made of heavy equipment, most of it imported, mainly (but not exclusively) because its employment is believed to save money. None the less, there remains an economic advantage in employing much labour and little capital where there is a choice, as is the case in public works and comparable activities, because of the large and growing number of unemployed and underemployed workers in many parts of Africa whose manpower is going to waste, and because capital is insufficient and should be conserved for high priority projects where it is indispensable. Improving the productivity of labour promotes economic growth. It also reduces the cost, and increases the economic advantage, of employing labour instead of machinery. This is especially important where, as in many parts of Africa, wage rates are rising. The expansion of employment also has a social value recognised by most political leaders.

In the first section of this paper the dual purpose of public works in Africa—to contribute to economic development and to employ available manpower—is stressed. Then the relative costs of different production techniques are analysed. Limitations on the scope for using labour-intensive techniques and ways of reducing the money costs of labour-

[1] This paper was presented to the I.L.O.'s Technical Meeting on Productivity and Employment in Public Works in African Countries, held at Lagos, December 1963.

intensive public works are examined. Reasons are given why money costs may not reflect real economic costs accurately—an effort to appraise the latter would give further support to the choice of labour-intensive methods! It is then noted that a country that succeeds in creating many new jobs quickly in the production of capital assets may have to take special measures to meet the increased demand for consumer goods, and particularly for food, coming from the newly employed who were formerly unemployed or underemployed. In a concluding section attention is drawn briefly to the significance of wide variations in local conditions in different parts of Africa. This is followed by a short account of the discussion arising out of the paper. Two case studies form an appendix.

The dual purpose of public works in Africa

Generally speaking, the purposes of public works in African countries are twofold: one is to contribute to economic development and the other is to provide employment and incomes to the currently unemployed and underemployed.

The first purpose—contribution to economic development—requires no emphasis. Practically all African countries have a great task on hand to build up the economic and social infrastructure, without which economic development can hardly proceed. The infrastructure includes such productive capital assets as transport and communications systems (e.g. railways, roads, waterways and harbours), dams, power-generating facilities, irrigation, drainage and soil-conservation works, housing, water-supply facilities, schools, hospitals and many other things. In these countries, as in most others, investments undertaken in this sphere are mainly in the public realm; the construction and other works carried out under these investment projects are public works, which are planned and administered by public authorities and on which the workers employed are paid out of public budgets. To promote economic development, governments of many African countries in recent years have allocated considerable shares of public capital expenditure to public works on infrastructure projects of various kinds. Although detailed breakdowns of such allocations are not readily available a high priority appears to have been commonly accorded to the development of transport systems, which are generally regarded as a necessary condition for the expansion of production in these countries.[1] Hence improving the productivity of public works can increase the effective level of real investment obtained with limited government funds in a major sector of the economy and can make an important contribution to economic development.

[1] For sectoral distribution of government capital expenditure in the development programmes of African countries, see United Nations: *Economic Bulletin for Africa* (Addis Ababa), Vol. II, No. 2, June 1962, p. 22.

The second purpose—provision of productive jobs to the unemployed and underemployed—is important in view of the employment needs of a great many African countries. In countries of North Africa such as Morocco, Tunisia and Algeria there is serious unemployment among the working population and the situation is likely to deteriorate further in the absence of effective remedial action. In Morocco, for example, it is estimated that despite the 400,000 new jobs expected to be created under the Five-Year Plan (1960-64) the number seeking jobs will increase to some 2.3 million in 1965 (460,000 due to population growth, 1,640,000 to underemployment in agriculture and 220,000 to unemployment in the towns).[1] South of the Sahara the employment situation is more diverse and also less clear owing to lack of adequate information. Nevertheless, there are certain features which indicate substantial unemployment and underemployment prevailing in these countries. First, there has been a constant flow of young people from the countryside to the towns seeking regular jobs which the towns cannot provide. A second and related feature is acute unemployment among primary-school leavers, who possess no particular skills but do not want to go back to traditional agriculture. Third, in agriculture not only are productivity and incomes exceedingly low but there is also pronounced seasonal unemployment especially in savannah and semi-arid zones.

Thus in both North Africa and tropical Africa public works on development projects can be a powerful instrument both of development policy and of employment policy designed specifically to meet the employment and income needs of the unemployed unskilled manpower. Indeed, many governments are adopting or planning to adopt this line of policy. Improving the productivity of public works contributes substantially not only to economic development but also to the expansion of employment, since it reduces the cost of creating new jobs. It does this by reducing both labour costs and the amount of capital equipment required to maintain output at an acceptable level of efficiency.

The range of techniques

In public works, more especially in earthmoving operations, a wide range of techniques from wholly manual to highly mechanised is often available. The criterion for the choice of technology in public works differs according to the purpose or objective of public works policy. For development objectives the methods to be used need to be as cheap as possible, whereas for employment objectives they need to be as labour-intensive as possible. When the same technique is the least costly and also provides the most jobs it will be the obvious one to choose. But in the

[1] Ministère de l'économie nationale, Morocco: *Plan quinquennal 1960-1964* (Rabat, 1960), p. 54.

more usual cases where the cost criterion does not point to the same choice of techniques as the employment criterion, two important questions arise:

(1) Can the conflict between cost considerations and employment considerations be eliminated or diminished by reducing the costs of labour-intensive techniques?

(2) To the extent that this is not possible, what principles should govern the choice that will have to be made between these considerations?

These questions are discussed later in this paper. Before coming to them it may be useful firstly to make a few brief comments on the nature of the capital costs and the labour costs that are likely to be incurred in different types of public works and secondly to discuss briefly the opportunities for substituting capital for labour, or labour for capital, in public works, and the factors that limit the possibilities of doing this.

CAPITAL COSTS

One dominant element in the capital costs of large-scale construction projects in newly developing countries is the expenditure of foreign exchange on imports of heavy construction machinery and its spare parts, and in many cases also on imports of the fuel necessary for the machinery. Furthermore, because of high transport costs (and frequently also import duties) such machinery often costs considerably more than in the countries of manufacture. For purposes of illustration one might cite the example of the multi-purpose Volta River Project in Ghana. As estimated by the Preparatory Commission, " the capital investment in the project over the eight years of construction would be well over £100 million (excluding interest), but over two-thirds of this would be external in character, representing imported plant, equipment and materials ".[1]

Foreign exchange is one of the most scarce capital resources of developing countries. And the true value of foreign exchange as determined by supply and demand in these countries is, as a rule, much higher than the official rates of exchange in terms of domestic currency, which is usually overvalued. The foreign exchange that could be saved by using more direct labour in place of imported construction machinery might, in fact, be more profitably used for the purchase of other types of machinery and equipment, such as industrial equipment needed for projects in which, unlike public works, labour cannot be substituted for capital. Or it might be spent on imports of intermediate goods (such as fuel, raw materials, spare parts), the shortage of which often prevents the economy from running at full capacity. To the extent that the foreign

[1] Preparatory Commission for the Volta River Project: *The Volta River project* (London, 1956), Vol. I, p. 85.

exchange so released can be utilised for more productive uses [1], it will lead to a higher rate of economic development than would otherwise be possible.

The experience of newly developing countries with highly mechanised techniques in construction projects also tends to suggest that the unit capital costs are higher than in economically developed countries for similar levels of mechanisation; this is due to the low rates of utilisation of equipment over its lifetime and on the job, poor maintenance, frequent breakdowns and costly repairs.[2] The repair and maintenance of heavy construction equipment presents a serious problem in many of these countries and frequent breakdowns of equipment in the hands of inexperienced labour necessitates the hiring of a large repair and maintenance crew; skilled labour of this kind is again a scarce resource for which there are many unsatisfied competing demands in the economy. In countries of Africa the problem is perhaps more serious because the shortage of skilled workers is even greater than in many other developing countries.

LABOUR COSTS

The wage rates of unskilled construction workers in Africa are generally low relatively to the interest charges on capital. The productivity of such workers is, however, also generally low. Hence in terms of money the cost of labour per unit of output (say, per thousand cubic metres of earth moved) may not be as low as the prevailing wage rates would suggest. In many cases, because of the low productivity of manual labour, mechanised techniques in public works may still yield a lower total money cost per unit of output even though poor utilisation and maintenance of construction machinery increases the unit capital cost. Labour-intensive methods are often rejected for this reason.

Nevertheless, in terms of benefits to the economy as a whole, where there is unused unskilled labour there is still a case for employing this labour in public works by labour-intensive methods even if the unit money cost at the prevailing wages is higher than it would be under more mechanised methods. (This question is further discussed below.) The reason is not only that labour-intensive methods create more employment but also that to put unused labour to work creates additional output without entailing offsetting losses in output elsewhere in the economy, since the labour was unused and produced nothing. On the other hand, the scarce

[1] It will not be fully released if, following the switch to more labour-intensive methods, the increase in consumption accompanying the expansion of employment is not entirely met from greater local production but occasions some rise in the imports of consumer goods. The main point is that domestic production of consumer goods can be increased more easily than domestic production of capital equipment.

[2] See " Capital intensity in heavy engineering construction ", in United Nations: *Industrialization and Productivity* (New York), Bulletin No. 1, Apr. 1958, pp. 35-48.

resources—foreign exchange and skilled labour—can, as already indicated, be channelled into other more productive uses, and so contribute to an increase in output in other branches of production.

LIMITATIONS

The limitations on the use of labour-intensive techniques in public works are of several kinds.

In certain situations the use of heavy construction machinery may prove indispensable. One example is the construction of trunk roads capable of sustaining heavy traffic, for which heavy machinery is necessary. Another instance is the construction of the Aswan high dam in the United Arab Republic. In this project all of the diversion canals and much of the other excavation work are on the east bank, which is solid rock. Blasting with dynamite is essential and most of the large pieces of rock debris have to be moved by large excavators and trucks.

Then there is the time factor. According to a report of the Third Regional Technical Conference on Water Resources Development, held in December 1957 by the Economic Commission for Asia and the Far East, a two-yard excavator with about ten men can do a piece of work in one day which the same number of men will take one month to complete by manual labour.[1] The disadvantage of manual labour is particularly serious in cases where the working space is restricted as, for instance, in work on concrete dams. If speed of construction is of over-riding importance there may be no choice but to use mechanical techniques, even at a higher unit cost.

There is a financial aspect of the time factor. Large projects, such as the big dams under construction in different parts of Africa, involve the payment of heavy interest charges, and it is important that the time elapsing before they contribute to an increase in national production, which will help to meet their interest charges, should be as short as possible.

On certain construction operations the quality of work by manual labour may not be as satisfactory as by machine. This appears to be true of compacting. It has been observed that " where large quantities of earthworth have to be compacted, as in the construction of a dam or high dykes, there is no alternative but to use machines for compaction ".[1]

Under certain conditions highly mechanised methods of earth-moving are cheaper than traditional manual methods. This is often the case with large-scale operations which give mechanised methods a great advantage in economies of scale, with operations involving long leads and lifts or where the productivity of traditional manual methods is very low. For certain projects, " break-even " points can be readily located beyond

[1] E/CN.11/WRD/Conf. 3/L.1 (mimeographed), p. 10.

which unit money cost under traditional manual methods becomes increasingly greater as compared with mechanised methods. In some cases there may be no break-even point at all. For instance, on the basis of cost data collected, the I.L.O. field investigations of earthmoving in road and railway construction in Nigeria and Tanganyika [1] revealed that, at the present low productivity of manual labour and at the prevailing wage, scrapers of from 14 cubic yards to 4½ cubic yards are cheaper than manual labour with any form of transport at the rates of utilisation of the equipment considered in the investigations and at all the " leads " (distances carried) between 100 and 2,000 feet.

Furthermore, in making cost comparisons attention is frequently drawn to the substantial additional expenditure on workers' temporary housing, health, amenities and welfare facilities associated with the use of labour-intensive construction methods. For example the high cost of providing such services for the workers was one of the considerations in the recommendation made by the Preparatory Commission for the Volta River Project for keeping the labour forces to a minimum by using mechanised methods of construction.[2]

Even if manual methods were potentially cheaper than mechanised techniques their use on very large construction projects may raise difficult problems of organising and supervising the vast labour force on the work site. The difficulty in management and the shortage of supervisory staff are often adduced as important factors in favour of mechanised construction methods for very large projects.

Such limitations to the use of manual construction methods give rise to two problems in the planning of public works policy:

(1) What scope is there within them in African countries for labour-intensive public works using traditional manual methods?

(2) How far and in what ways might they be overcome so that the scope for labour-intensive public works could be further extended?

As regards the first problem the available data on the composition of public works in African countries in terms of degree of labour intensity are extremely scanty. The observations made below, which deal separately with normal public works and small local rural development works, can therefore be only of a general character.

NORMAL PUBLIC WORKS

In the conditions prevalent in Africa it seems important not to exaggerate the limitations of manual methods in normal public works and particularly in earthmoving. Despite those limitations manual

[1] See Appendix.

[2] See *The Volta River project*, op. cit., Vol. I, pp. 26-27 and Vol. II, pp. 280-282.

methods of earthmoving are still suitable in various circumstances, depending on such factors as the level of wages, the quantity of earthmoving work involved, the size of working space and so on. In at least one important case they must be used: road building, which is a crucial element in the development and integration of the African economy. In many areas roads have to traverse thick jungle and their construction has sometimes been held up because of the formidable cost involved. Much of the clearing has to be done by hand, and even those operations which can or should be mechanised have to be carried out in areas inaccessible to heavy equipment. Methods of improving the productivity of manual labour, including untrained local rural labour, in road building through jungle would have great economic significance.

Although systematic information is not available there are sundry cases in which public works by traditional manual methods in African countries are not inferior to mechanised methods in terms of money costs. Thus in Tunisia the experience of the Ministry of Works was that " while large irrigation canals and other works demanding the removal of large quantities of earth could normally be done much more cheaply by machine, secondary canals and lighter work of this type was often cheaper by hand ".[1] In Ethiopia a labour-intensive highway project was reported to have cost less than a capital-intensive highway project of a similar size. In Kenya, too, there is some recorded experience of certain types of earthmoving done by manual labour of well-selected workers at lower costs than by machines. Some of the findings from the current I.L.O. investigation of earthmoving in the Sharavathi Valley Project in Mysore State, India, are also of relevance here. The investigation has found that—

(a) the cost per cubic metre dug with a mechanical shovel was nearly four times as much as with traditional manual methods by the best workers;

(b) the cost of stone-crushing by manual labour with hammers was cheaper than by machine;

(c) the cost per kilogram of masonry lifted was the same for both cranes and manual labour carrying granite by bamboo ramps.[2]

These findings, though obtained under the cost and productivity conditions of India, may also be applicable in varying degrees to the conditions of African countries.

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[1] " The scope for work study in earthmoving operations " (Paper prepared by the International Labour Office), in United Nations: *Earthmoving by manual labour and machines* (Bangkok, 1961), p. 67. (Sales No. 61. II. F. 4.)

[2] See I.L.O.: *Men who move mountains*, An account of a research project concerned with manual methods of earthmoving (Geneva, 1963) (mimeographed).

In general, normal public works in African countries fall broadly into the following categories:

(1) Direct labour projects (works executed directly by the department or ministry of public works).

(2) Contract projects, including—

(a) contracts with foreign firms under foreign aid programmes;

(b) foreign commercial contracts; and

(c) local commercial contracts.

The degree of labour intensity appears to be much greater in direct labour projects than in contract projects; among the latter those under foreign contracts are perhaps again more capital intensive than those under local contracts. The difference in the types of work undertaken explains in part the difference in labour intensity between these categories. The direct labour projects are usually on a smaller scale and of a simpler nature (minor road works, building construction, maintenance works on roads and bridges, etc.), while the contract projects are mostly large-scale development works (national highway construction, major dam and irrigation projects, and so on).

There may be institutional, social and psychological factors that make the degree of capital intensity and mechanisation in contract projects higher than is necessary for either technical or economic reasons. In such cases one should use more manual labour in place of machines and at the same time possibly reduce the unit cost of construction, even working with the traditional or prevailing manual methods. The extent of such possibilities deserves to be carefully ascertained and lines of action to take advantage of them thoroughly explored. This aspect of public works planning seems to be of much practical importance in African countries, since the proportion of contract projects in the category of normal public works in these countries is not only high but also rising.

LOCAL RURAL DEVELOPMENT WORKS

One significant feature of public works in certain African countries is the national programme of small rural development works undertaken on a local or village basis. These are designed deliberately to utilise as fully as possible the local unused manpower—mostly seasonally unemployed—to build up the local rural infrastructure by traditional manual methods using but the simplest types of implements. These are not normal public works in the generally accepted sense. The administration of these programmes, though centrally directed, is usually delegated to provincial or local governments and outside the sphere of public works departments. The system of remuneration to the workers employed is also far more flexible. In some countries the wages are lower than those

prevailing in normal public works, and part is paid in the form of food from the United States surplus food disposal schemes. Further, in some communal projects (e.g. building local schools) workers are often willing to contribute their labour without wages.

The outstanding examples of rural development works of this type are the *Programme de promotion nationale* in Morocco, the rural employment creation programme in Tunisia and, more recently, the programme of *travaux au ras du sol* (basic works) in the Malagasy Republic. In Morocco and Tunisia, in particular, rural underemployment is an acute problem; the approach adopted in the above programmes is consequently just as much in evidence in their employment policy as in their rural development policy. The tendency has been to concentrate these programmes increasingly on small but genuine local investment projects—soil conservation, reafforestation, land reclamation, irrigation and drainage, roads and tracks and the like. The basic aim is to increase agricultural production and productivity by what is known in Africa as " human investment ".[1] According to the available figures, work done under these programmes provided 7 million man-days of work in Morocco in 1961 and 73 million man-days of work between 1 April 1958 and the end of 1960 in Tunisia, and created employment for 450,000 men in the Malagasy Republic in 1962. In Tunisia it has been estimated that the small rural development works have raised the rate of investment from 10 to 12 per cent. of national income.[2]

A rural public works programme along the lines described above has great potential for wide extension in most African countries. Unlike normal public works projects individual projects under such programmes are in most cases precluded by their smallness from the use of imported heavy machinery. They could bring about a quick expansion of agricultural output without entailing the use of many scarce material resources. However, if such labour-intensive works programmes are to yield expected results, many problems (which it is not proposed to enter into in this paper)[3] will need to be solved, including those relating to their financing, the fixing of rates and forms of remuneration to the workers employed, organisational arrangements and training for leadership. The problem of raising the productivity of workers in such small rural works will nevertheless be considered below, for at very low levels of productivity public works of this sort might easily degenerate into unemployment

[1] The basic notion underlying " human investment " is that a lack of capital in Africa can be compensated by making fuller use of the relatively abundant supply of manpower whenever capital is replaceable by labour in development works. Human investment also tends to imply that the labour might be almost costless or even given free.

[2] For a more detailed analysis of the programmes in these three countries, see Gabriel ARDANT: " A plan for full employment in the developing countries ", in *International Labour Review*, Vol. LXXXVIII, No. 1, July 1963.

[3] For a discussion of these problems see I.L.O.: *Employment and economic growth*, Studies and Reports, New Series, No. 67 (Geneva, 1964), pp. 173-182.

relief with little or no beneficial effect on the development of the economy. Moreover, if a satisfactory level of efficiency can be maintained, there is very great scope for such works, because of the untapped reserves of rural manpower available and of the great extent of the useful works which can be carried out without much capital and which are of considerable and often immediate benefit to the local people.

Reducing the costs of labour-intensive public works

We now return to the questions asked earlier in this paper, the first of which is: what can be done to reduce the costs of labour-intensive techniques in public works, and so make them competitive with capital-intensive methods in cases where they are not so at present? It is very important that all feasible measures to this end should be taken, so that the authorities do not have to make a painful choice between techniques that cost less money on the one hand and techniques that provide more badly needed jobs on the other.

So far as this result can be achieved through work study and other techniques to raise productivity, the question can be dealt with very briefly here.[1]

From various studies it appears that in the developing countries generally the productivity of manual labour using traditional methods of earthmoving could be increased markedly by simple productivity improvements requiring little additional capital. One significant finding of the case studies in India and in Nigeria and Tanganyika (reproduced in the Appendix) is the feasibility of doubling the productivity of manual labour by introducing improvements within the general framework of the traditional methods and thereby reducing the unit money cost under such methods by nearly half. In the Nigeria and Tanganyika study it is observed that a 100 per cent. increase in the productivity of manual labour makes it a practical possibility for manual labour to begin to compete with machines at middle rates of utilisation and to compete effectively at lower rates of utilisation even with the most efficient machines. This possibility of doubling productivity by simple improvements perhaps also exists in many other African countries. In Tunisia, for instance, some cost data have shown that earthmoving work on certain secondary canals cost 160 millimes/cu.m. by machines as against 250 millimes/cu.m. by manual labour at an output per worker of 1 to 1.2 cu.m. per day and a daily wage of 300 millimes.[2] Thus with a doubling of productivity the unit cost by

[1] See also the Appendix. Other documents prepared for the meeting on this subject include *Some basic principles of using mechanical earthmoving equipment* (D. 34/1963); B. BENZINEB: *Programmes of public works in the fight against underdevelopment and unemployment* (D. 36/1963); and *Manual of basic instructions for building "self-help" roads under a community development programme* (D. 35/1963).

[2] Figures from BENZINEB, op. cit.

manual labour, which was formerly much higher, becomes considerably lower than by mechanised methods.

The most effective manner of raising the productivity of manual labour would be to introduce simultaneous, and not isolated, improvements bearing on each and every aspect of manual operations including the following:

(a) the organisation of the work unit;
(b) tools;
(c) methods of using tools;
(d) the ratio of productive work to ancillary work;
(e) incentives;
(f) food;
(g) supporting services, e.g. temporary housing, medical facilities, amenities, arrangements for essential provisions and for tool and appliance maintenance.

In applying this general principle the various specific measures to be introduced and the degree of importance to be assigned to each measure will have to be decided on the spot after a thorough study of the actual situation. In the Indian earthmoving study it was discovered that beyond the 100 per cent. increase referred to above, further substantial increases in the productivity of manual labour will require the introduction of more efficient implements, particularly the replacement of " mumtys " by shovels and of headbaskets by either wheelbarrows or tipping trucks. The shovel-wheelbarrow combination would increase the over-all output per worker by from 30 to 100 per cent. and the shovel-tipping-truck combination by from 3½ to 4½ times, depending on the length of the lead. Other far-reaching measures suggested in this Indian study are communal eating arrangements to improve the diet and hence the strength of the workers, organisation of labour co-operatives to obviate the exploitation of workers by petty contractors and payment of wages in such a way that the major share of savings produced by productivity improvements goes direct to the workers.

The Nigeria and Tanganyika study also sets forth suggested measures based on the observed conditions. These measures include the correction of lack of balance between digging, loading and carrying and the use of improved tools (pick-point instead of chisel-end for certain earth, shorter-hafted shovel with a special handle design and the redesign of the head-pan)—all calculated to bring the increase in productivity of manual labour up to the 100 per cent. target. One interesting finding of this study concerns the attitudes to work: the workers on the construction site are mostly seasonally unemployed subsistence farmers, who are unused to disciplined work for regular hours, and the only kind of work to which such a man reacts favourably is some form of task work, either on the

paid task basis or " finish-and-go " or a combination of both, under which he feels that he is working for himself. It was suggested that the application of this basic incentive principle would not only increase the output per worker but also reduce the number of supervisors needed on the site as compared with payment by flat time-rates.

These studies show that though each improved measure appears simple, the designing of the right kind of measures to redress particular defects in the methods of working and the choice of the best combination of measures in a given situation demand a great deal of ingenuity on the part of the productivity experts. The spreading of improved methods discovered in demonstration projects requires, furthermore, a considerable amount of training, which calls for separate measures to be carried out. The suggestion made in the Indian study that vocational training centres should be set up by the labour co-operatives themselves merits wide attention.

Productivity may be improved and costs reduced not only by techniques designed primarily to have this effect but as a result of improvements of a more general character in the management of the labour force. The importance of paying attention to nutrition and to incentives has been emphasised above.

In addition to the need to raise the productivity of manual labour on normal public works of a large or medium scale in which there is a choice between manual labour and machines, there is also a need to raise it in small rural development works (which, almost by definition, preclude the use of highly mechanised methods) in order to increase the economic returns on the labour invested in these small projects. Here the main approach is perhaps to expand rapidly the facilities for training rural labour and, as a first step, for training project supervisors. One observer, stressing the importance of raising productivity in such projects, wrote—

> Of course there is nothing to be lost by starting to teach them the rudiments. For example, there is no need to do without technicians when there are technicians available; and simple techniques for organising work and improving working methods must be brought within the grasp of the people. Now in this respect there is a great deal to be done. The man working with a shovel without having really learnt to use it often makes efforts out of all proportion to the results. In Africa qualified observers have estimated that suitable training would double or treble the productivity of unskilled workers. Like many others, I was struck by the time wasted using baskets on men's backs instead of wheelbarrows. This was in Tunisia, but it could have been anywhere in Africa.
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> Similar observations have been made by René Dumont, the agronomist, who considered that the African peasant's efficiency would be quadrupled if the all-purpose cutting instrument was replaced by an axe and a saw. As a start improved hand tools could be made in workshops which themselves occupy some of the surplus manpower.[1]

[1] Gabriel ARDANT, op. cit., p. 30; see also *Employment and economic growth*, loc. cit.

The problem of developing the most effective ways of training the rural people in simple methods of productivity improvement thus seems to be one of high priority in the organisation of rural development works programmes.

The choice of techniques

If, when all feasible measures to reduce the costs of labour-intensive techniques have been taken, it is found that public works carried out with much labour and little machinery still cost more than the same work carried out with little labour and much machinery, what should be done? Should the possibility of providing more jobs be sacrificed to the need for having the work done as cheaply as possible? Or should somewhat higher costs be considered acceptable if this enables many more people to be provided with jobs?

If techniques other than the cheapest in terms of money cost are selected, one of two consequences will result. Either a smaller volume of public works will be completed than could have been completed for the same amount of money, or the government will have to raise additional funds from some source—presumably by imposing additional taxes or by cutting down other public expenditure.

If public works have been selected because of the need for them and the importance of the contribution they can make to economic development it will be very undesirable and bad for economic growth to accept a smaller public works programme than could have been financed for the same money. Most African governments find themselves short of money for a great many very urgent purposes. They cannot spend as much as they would like to do on schools, hospitals, agricultural extension work and many other desirable things. They will find it difficult either to divert money to a public works programme from other types of expenditure or to raise additional revenue.

These are arguments in favour of choosing the cheapest techniques in public works even if this means leaving many people without work who badly need it.

There are, however, arguments on the other side. It is very undesirable to leave people idle when they want to work and when their work could contribute to economic growth and development. And the question arises whether money costs of alternative methods of work do in fact reflect real costs in a more fundamental sense. Many authorities take the view that the rate of interest payable on the capital used in many projects in developing countries understates the real cost of using the capital while the rate of wages payable overstates the real cost of using labour. The point was explained in a recent I.L.O. report in the following terms:

> There can hardly be said to be an organised market or a market price for capital in many developing countries. Finance may be made available from public sources

or with a government guarantee for some privileged types of investment in the modern sector at rates of interest lower than would have had to be paid in an open market, while usurious rates may be payable in the traditional sector. While rates of interest for certain types of borrowing may fail to reflect the true scarcity of capital, wage rates on the other hand may fail to reflect an abundance of unskilled labour. Wages have to be looked at from two points of view—as an income and as a cost. As an income, wages in developing countries are often barely, if at all, sufficient to enable even urgent needs to be met. . . .

But if there is much unemployment or underemployment even very low wages may overstate the real cost of employing labour, in the sense of the value of the alternative production there would have been if the worker had not been employed where he is. The value of the alternative production forgone, so far as the activities of the worker himself are concerned, will be nil if the worker was wholly unemployed, and may be very low if he was greatly underemployed.[1]

Economists who find this argument convincing, as most do, believe that in countries with " surplus " labour it will be advantageous to choose methods of production, in public works as in other sectors of the economy, that use more labour and less capital than the methods that are cheapest in terms of money. How much allowance should be made for the underpricing of capital and the overpricing (from the point of view of real costs) of labour is another question, and one on which the data required for making a scientifically acceptable calculation are scarcely ever available. A decision by the government of a country with surplus labour to choose labour-intensive methods in public works so long as the money costs exceed the money costs of more capital-intensive methods by not more than a certain percentage could be supported by respectable arguments, but the choice of the particular percentage would be a matter of judgment.

It seems reasonable, in any case, that techniques selected in public works as in other types of production should reflect the degree of scarcity or abundance of different productive resources. In African countries capital is very scarce and labour relatively abundant, as compared with the situation in industrially advanced countries. This suggests that African countries should, at least for the present, try to use more labour-intensive techniques than are usual in industrially advanced countries, so as to provide more jobs for their people, and reserve scarce capital so far as possible for other uses in which labour cannot be substituted for it.

But governments that decide to give a preference to labour-intensive techniques in public works even at the expense of accepting some increase in money costs will have to find some way of raising additional revenue if they want to maintain the volume of their public works programmes.

[1] I.L.O.: *Employment and economic growth*, op. cit., pp. 137-138. The report points, in addition, that there may be other elements in costs to society that cannot be neglected. Unless wage-earning employment can be provided on the spot, workers will have to move in order to take it up and this will involve costs of transport. If they move to towns, they will have to be provided with somewhere to live, and other forms of social capital. They may also need various forms of training which, however desirable, cannot be provided without costs. All these things will make demands on resources which will constitute real costs to society.

While in most developing countries there probably are ways of raising additional revenue by methods that do not impede economic growth and do not make excessive demands on the country's machinery for assessing and collecting taxes, such methods are seldom easy to find.

Labour-intensive public works and expansion of consumption

One other consequence of a decision to favour labour-intensive public works should also be noted. This is the problem of meeting the additional consumption by the newly employed workers on public works. These workers are engaged in the production of additional capital goods (e.g. dams, roads, etc.) but not additional consumer goods. But those of them who are drawn from the ranks of the formerly unemployed or heavily underemployed will be earning more than before and will be able to consume more than before.[1]

The sources from which the additional consumption might be met are, briefly, as follows:

(a) concurrent increase in the output of consumer goods consequent on the fruition of previous investments or on greater incentives to produce, especially in agriculture, provided by the demand stimulus or due to other favourable factors;

(b) redistribution of consumption from the rest of the community to the newly employed workers on public works (e.g. replacement of imports of luxuries by food imports, tax policy, rationing, etc.);

(c) transfer of resources from other uses to those which can increase immediately the supply of consumer goods (e.g. using the foreign exchange which would otherwise be spent on construction machinery for additional food imports);

(d) financing by foreign aid such as bilateral food aid or the World Food Programme.

Economic planners preparing for a wide extension of labour-intensive public works will therefore need to devise appropriate policy measures through mutual adjustment of the various elements mentioned above to prevent too great a lack of balance between the additional demand for

[1] For the economy as a whole the net additional consumption thus generated varies directly with—

(a) the number of unemployed and underemployed persons put to work on public works projects; and

(b) the level of wages earned by these workers;

and inversely with—

(c) the amount of savings set aside by those workers out of their newly earned incomes (e.g. for repayment of debts incurred during unemployment or accumulating a minimal cash balance for precautionary motives, etc.); and

(d) the amount of savings set aside by the former supporters of these workers.

The last two factors are probably much less important. The decisive factor is the additional wage bill, which is the product of wages and additional employment.

consumer goods (which will, to a large extent, consist of foodstuffs) and the additional supply of these goods to meet this demand. Otherwise, an inflationary situation may arise. One important consideration in meeting this demand is to avoid diversion of resources from uses for other productive investments, since this would affect adversely the rate of economic growth.

In certain types of labour-intensive public works projects which are designed to bring to the workers direct and immediate benefits, the unemployed and underemployed may be willing to contribute their labour voluntarily without earning wages. Under such arrangements the problem of financing additional consumption by these workers during the construction phase will hardly arise.

Differences in local conditions

This paper has attempted briefly to emphasise the economic importance of improving the productivity of labour in African public works as a major step toward making fuller use of abundant manpower. It would be wrong to conclude without some reference to differences in local conditions in various parts of Africa.[1]

Account must be taken of the widely varying attitudes and motivations to work affected by incentives, traditions and mores, the political situation, inter-tribal relations and so forth. It may be hard to improve the productivity of a group of workers whose supervisor (however competent) comes from a different tribe. Some people are more industrious than others, possibly because they have long had to make a living in unpropitious regions and hard circumstances. A gentle and fertile environment can have the opposite effect. Morale and productivity will tend to be low in a public works department of a government or colonial administration that does not have popular support or whose rule is either too harsh or too easy going.

Many other factors besides climate and the challenge of circumstances affect capacity for work. Most important is health—debilitating diseases are widespread in Africa. In some areas malnutrition leads to debilitation whereas in others a plentiful supply of food—in some cases combined with time-consuming participation in rituals and other non-productive activities—may render underemployment a voluntary and accepted situation.

[1] For much more detailed discussion, with references to some of the authorities on the subject, see: I.L.O.: *African labour survey*, Studies and Reports, New Series, No. 48 (Geneva, 1958), Chapter V; U.N.E.S.C.O.: *Social implications of industrialisation and urbanisation in Africa south of the Sahara*; Inter-African Labour Institute: *The human factors of productivity in Africa* (London, C.C.T.A., 1957); W. E. MOORE: *Industrialisation and labour: Social aspects of economic development* (New York, Cornell University Press, 1951); P. KILBY: "African labour productivity reconsidered", in *Economic Journal*, Vol. LXXI, No. 282; B. GUSSMAN: "Industrial efficiency and the urban African", in *Africa*, Journal of the International African Institute (London), Vol. XXIII, 1953; C. H. NORTHCOTT: *African labour efficiency survey*, Colonial Research Publication, No. 3 (London, H.M. Stationery Office, 1949).

The degree of stability, absenteeism, punctuality and pride in work can be greatly affected by both motivations and capacity for work, as well as by conflicting demands and obligations which draw upon the African workers' time and energy.

On the side of management and administration, it must be admitted that a number of factors can in certain instances have an irrational and unpredictable influence on the way public works are organised and carried out, whether by labour-intensive or capital-intensive methods, by direct labour, by contract, by foreign or local firms and so on. In this sphere the effects not only of political considerations but also of corruption—from which no country in the world is completely free—cannot be ignored. Also the attitude of the administration to employment in public works has its effect—no effort may be made on the management side to render them more efficient; if they are regarded as mainly for the purpose of unemployment relief, or on the workers' side if the workers think (rightly or wrongly) that their main interest lies in work spreading.

Yet local conditions do not always stand in the way of efforts to improve productivity—on the contrary many factors can have a positive influence. Those parts of Africa, for example, where there has been a good response to the call for human investment provide useful case studies indicating how much can be done by the local people—with the immense asset of their local knowledge and the motivation of their own interest in the work undertaken, with the right kind of leadership, support and evocation of their own interests.

The development of human investment through productivity improvement is a means of extending the scope of normal public works and mobilising manpower in economic development which African countries have taken a lead in evolving. Their experience can be of considerable interest to countries in other developing regions faced with similar problems.

* * *

Comments and conclusions of the experts at Lagos

Many of the points in the above paper led to discussion by the delegates, who were drawn from both public works and economic planning departments in different African countries.[1]

ECONOMIC SIGNIFICANCE OF PUBLIC WORKS IN AFRICA

Before the majority of African countries can progress very far along the path of development it will be necessary to carry out immense programmes of work to build up the physical infrastructure, involving civil

[1] The countries represented at the meeting were the Central African Republic, Chad, Congo (Leopoldville), Ethiopia, Guinea, Ivory Coast, Kenya, Libya, Malagasy Republic, Mali, Morocco, Nigeria, Sierra Leone, Sudan, Tanganyika, Tunisia, the United Arab Republic and Uganda.

engineering works at all levels from large-scale works of national importance to small-scale projects. In those countries which are at an early stage of development the expansion of the physical infrastructure constitutes a particularly heavy burden on slender domestic resources since it has to precede productive investment (in farms, mines, factories, etc.) and has to be financed well before the latter investment has progressed to a point where the new roads, railways, water supplies and so forth can be used to full capacity. This burden should be lightened as much as possible by improving productivity in public works and mobilising unemployed or underemployed workers to add their contribution to output in work where labour-intensive methods of production are possible or can be made worth while by increasing efficiency. Improvement of productivity in public works would lead to a better return on the capital invested in them and thus to more capital for them, including foreign aid. An increase in the scope for labour-intensive public works could open up wider possibilities for making use of food aid, notably from the World Food Programme, it being understood that the use of such aid should be a transitional measure. This would meet the problem of inflationary demand for food which sometimes results from expansion of employment.

The term " public works " was used in a wider context by the meeting to connote government direct labour, public contract, or publicly supervised and supported communal and self-help action, including the preparation of terrain for agricultural use. In Tunisia efforts were being made to develop an unemployment relief programme into a productive programme to supplement normal public works and contribute to rural development. The programme in Morocco included works to improve drainage and irrigation, to restore and preserve soils and to bring new land into production, as well as road maintenance and construction. The work in these two countries is remunerated partly in cash, and partly in food provided under food aid programmes. Similar work had been successfully undertaken on an unpaid basis in the Malagasy Republic. Experience in these and other countries—including India (see the case study in the Appendix)—suggested that even at present levels of productivity manual labour can often produce as cheaply as machines. In a majority of African countries the most immediate need is to extend and ramify the physical infrastructure in rural areas: the building of feeder roads, in particular, has an immediate and substantial benefit for agriculture development.

FACTORS AFFECTING THE CHOICE OF OPERATING METHODS

Capital-intensive methods of operation tended to be more costly than labour-intensive ones: that was why the latter were still widely used and could be more so if productivity were improved. Also there was a need to have more precise information about comparative costs and to

bear in mind that prevailing levels of interest rates, exchange rates and wage rates, used in cost computations, fail to reflect accurately the real costs of employing capital, foreign exchange and labour.

A number of points had to be considered when weighing the pros and cons from a technical point of view of mechanised as compared with manual methods of operation. First, the advantages of machines in certain circumstances were clear. Manual labour might be able to compete in terms of cost, but it could rarely attain the high rates of output possible with machinery. On a major earthmoving project the work force required to match the rates of output which machines could achieve might well be unmanageably large.

Where the work had to be done quickly, mechanical methods might be better. This was often the case with emergency works undertaken to repair the ravages of national disasters. It might also be the case with non-emergency works, as for example in the building of a dam to impound waters for electricity generation or irrigation when the industrial or agricultural development of a large area, and with it many new opportunities for employment, might have to await the completion of the project.

There were some jobs which either could not be done satisfactorily by manual labour or which could be done much better by machinery. Where the work site space was confined there might be room for machines but not enough to deploy a labour force of equivalent productive capacity. No manual method produced really first class compacting of earth. Excavation under water, lifting materials through great heights, and the breaking up of hard materials were examples of work which was generally better done with the aid of machinery. Another case for using machines arose when it was undesirable to attract a large body of men into a particular area.

The greatest disadvantage in the use of manual labour, particularly in large projects, was its slowness. But if the productivity of manual labour could be doubled, for example, then the same work force would be able to do the job in half the time.

Another consideration to be borne in mind (one common to all high-cost capital equipment) was the need to ensure the fullest possible utilisation of available equipment, not only during a single project (that for which the machines might have been purchased) but also throughout all the projects on which the machines were to be employed during their useful lives. If they were not used intensively the true cost of the work actually done by them might be very high indeed. This was particularly true of special-purpose machinery which might not be employable on projects other than the one for which it was bought, so that the whole cost of the machine might have to be charged to the initial project.

One of the principal operational advantages of manual labour was its flexibility: men could circumvent obstacles which would impede machines, and could often work on sites which would need much prior clearing if

machines were to be employed. For small and scattered projects in the conditions obtaining in most African countries the use of manual labour was more effective, often more economical, and sometimes the only feasible method, even with the present relatively inefficient methods of working. Manual labour tended to be less competitive as the size of the project grew. Large projects offered greater possibilities for the efficient use of machinery, and when machines were used well and exploited fully, manual labour could rarely produce results so cheaply.

There were other considerations associated with the use of labour-intensive methods which had to be taken into account when choosing the methods for a particular project. The efficient control and use of large labour forces called for good organisation and a high degree of managerial and supervisory skill, which were not yet plentiful in developing countries. When the work site was remote from the main sources of labour or difficult of access it would normally be necessary to provide ancillary services (such as housing, medical care, transport) and to organise food supplies.

On the human side there were sometimes problems of ensuring regular attendance from large numbers of workers unaccustomed to working regular hours; the maintenance of discipline and the motivation of the workers make heavy demands on the skills of management personnel and leadership. In addition, when a project had lasted a long time the workers might feel that they had become entitled to continuing employment, which might be difficult to provide if there were little other work in the area. This problem was lessened when the workers were prepared to travel to other projects, and sometimes jobs might be created as a result of the project which had been completed.

Such problems, although they complicated the use of labour-intensive methods, were not insoluble, provided that there was good management and supervision.

Some countries had carried out, and others were carrying out, large-scale projects using manual methods almost entirely. Such projects were common in Asia, especially in countries where labour was traditionally mobile. Asian experience (for instance the building of the embankments on the Kosi river in India) had shown that very large workforces, well motivated, could not only carry out work more cheaply than machines but could also get on with the job at once, so that the work might in fact be completed before heavy equipment could have been delivered to the site.

RAISING THE PRODUCTIVITY OF MANUAL LABOUR

The productivity of manual labour was often far lower than it need be. However, with comparatively little effort, with small expenditure on better tools, simple transport devices and locally made appliances, a considerable and worth-while improvement could be made.

Low productivity was due to a combination of factors, the importance of which varied somewhat in different areas. The case study made in India showed strikingly that there were marked differences in performance between groups of workers on the same site and working under the same general conditions. These differences were found to correlate with the nutritional value of the workers' diets.

It also seemed that some, if not all, of the factors causing the present low levels of performance could be modified so that improvements of up to 100 per cent. and even more would be attainable in the performance of manual labour, provided the basic step of ensuring adequate diets was taken.

The factors which influence the productivity of manual labour might be considered to be five:

(a) the tools and the working methods used;

(b) the planning and organisation of the work and of the work site;

(c) the physical condition and psychological attitudes of the workers;

(d) the quality of supervision and management; and

(e) the conditions of employment, including incentives and amenities.

SHORT-TERM ACTION TO RAISE PRODUCTIVITY

Extensive studies of manual labour operating in varying conditions and of the effectiveness of mechanical equipment, would be necessary before it was possible to determine how far productivity of manual labour in earthmoving could be raised without any substantial capital investment. On the other hand, action could be taken quickly to improve working and living conditions on many sites, by providing clean drinking water and better sanitation; by tightening camp discipline; and by the provision of food affording balanced diets. In this last respect workers needed to be educated to understand basic facts about nutrition and hygiene. It might also be advantageous to ensure the purchase of foodstuffs at reasonable prices. The World Food Programme was able to provide balanced diets for workers on selected labour-intensive projects and it was recommended that full advantage should be taken of this.

The will to work was basic to the attainment of high performance, whatever the other conditions. Projects created largely for the purpose of providing work for the unemployed did not generally elicit much enthusiasm from those engaged in them, unless the locality or region clearly benefited. When, however, the workers felt that they were contributing to national or regional development, and especially when they themselves expected benefit from the project, experience showed that good levels of performance could be attained. This was confirmed by the Tunisian experience.

Direct incentives were a powerful stimulus. They should be based on accurate performance standards derived from the application of work study, but such standards generally took time to compile and interim schemes might have to be used. The development of a complete range of standards for all types of earthmoving operations was a matter of urgency, not only as a basis for incentives but also for planning and costing purposes.

Workers' fears that they might work themselves out of a job more quickly by co-operating in measures to improve productivity were unfounded so far as public works departments are concerned, for in this sphere the effect of such measures was to increase the volume of work which could be done within existing budgetary limits. Employment would be reduced only in cases where budgets for public works were cut, and the possibility of this occurring grew smaller rather than greater as public works became more efficient and offered better value for money. Admittedly, in the case of both local works and public works accomplished under contract, there was not the same guarantee of continuing employment. There was, however, a hope—which could be increased by a sound choice of projects—that local works could lead to an increase in permanent employment locally and that workers who had worked in the construction might remain permanently in jobs created as a result of the projects. Co-operation in matters affecting the interests of the workers would be assured only if they or their representatives were consulted and the reasons for any changes proposed were fully explained beforehand.

The level of productivity was directly related to the quality of management and supervision. Good management involved personal leadership, capable of stimulating subordinates at all levels to give of their best. The training of supervisors and the training and development of engineers and project managers in modern methods of management was essential if high productivity was to be achieved and maintained. Such training should include work study and the modern techniques of decision-making, planning and control, as well as industrial relations and the management of men. Improving management through further training and development was one of the quickest and cheapest ways of increasing productivity, and projects of management development and productivity in countries with large public works programmes should include experts on management in this field.

FURTHER CONSIDERATIONS RELATING TO LABOUR-INTENSIVE METHODS

Case studies in both Africa and India (see Appendix) drew attention to the relatively small proportion of the amounts paid to petty contractors (for work done) which was, in fact, disbursed to the workers. Although the system of contract labour might have certain attractions to some public works authorities, notably in that it might relieve them of the work

of recruitment, labour administration and supervision, in areas where there was much unemployment or underemployment it put workers at the mercy of the petty contractors, and might force them to accept wages which were unreasonably low. In order to protect the workers it might be advisable to stipulate minimum wage rates to be paid on publicly controlled contracts. The promotion of organisations of the co-operative pattern, with the workers owning their tools and simple equipment, was another means of ensuring fairer sharing among the workers of the money paid out for work done, while at the same time relieving the authorities of the problems of recruitment and control of labour.

Labour-contracting or workers' production co-operatives could be an efficient means of improving the working and living conditions of workers. Experience in other countries had shown how necessary it is, especially in the case of this particular form of co-operative, that all members and future members realise the advantage of joint action and understand its economic implications, that the staff possesses the managerial and technical skills as well as leadership qualifications, and that appropriate facilities are created to submit work-plans and estimates, to use contracting techniques efficiently and to ensure a systematic award of contracts.

Schemes for the recruitment and administration of direct labour, such as were operating successfully in Morocco, Tunisia and the United Arab Republic, appeared to have merits where workers had to be recruited for sites remote from their homes, and also as one means of helping to ensure reasonable remuneration and conditions of employment.

PROPOSALS FOR ACTION

The conclusions of the meeting included proposals for action. First, in view of the vast amount of work needed to build up infrastructures in Africa—a task that had to be accomplished soon if the rate of economic development desired was to be achieved—the meeting recommended that African countries should consider further and more extensive recourse to human investment schemes for the mobilisation of unemployed and underemployed labour to supplement what could be achieved by regular public works departments.

Secondly, there was a need for the I.L.O. to carry studies and experiments much further in order to provide sufficient data on different conditions and methods of operation as a guide to steps for improving the productivity of public works.

Thirdly, drawing upon the results and findings of these studies and experiments as they became available, the I.L.O. (in collaboration where appropriate with other international agencies) should provide practical assistance to national and local authorities in the following forms:

(a) advice as to what methods, tools, transport equipment, etc., are best suited to specific conditions, and on the use of mechanised equipment in connection with manual methods;

(b) advice on the forms of organisation best suited to the various conditions, including, possibly, practical assistance in the formation of co-operative types of organisation for manual workers;

(c) the compilation and dissemination of output standards embracing as wide a variety of conditions of terrain and climate as possible and covering the use of various types of tools and equipment;

(d) information on questions of housing, nutrition and health, sanitation and allied matters relating to the well-being of the workers;

(e) collection and dissemination of information on relevant experience in all parts of the world and in all conditions, and on economic aspects of labour-intensive methods of operation;

(f) the development of training programmes and assistance in putting them into effect. Such programmes might include technical assistance in the development and training of senior managers, engineers, foremen, local headmen, instructors and workers, and also the holding of seminars and technical meetings. Special attention should be given to training for employment promotion programmes;

(g) the preparation and publication of manuals, simple instruction books and pamphlets, films, and other aids to instruction;

(h) the preparation of programmes to make use of aid from the World Food Programme.

The meeting concluded by stressing that action to put these proposals into effect should be undertaken as early as possible.

Appendix: Extracts from Two Reports on Studies of Manual Earthmoving

I. India

The Working Party on Earthmoving Operations, convened by the Economic Commission for Asia and the Far East, recommended in 1959 that work study techniques of investigation should be applied to manual earthmoving, and requested the I.L.O. to assist. In 1961 an I.L.O. mission in India started such a study in Mysore State, in collaboration with Indian engineers. Work on the project is still continuing.

Indian engineers have found that manual methods are often as cheap as, or cheaper than, working with heavy earthmoving machinery, even with traditional methods of working. Most earthmoving machinery is imported,

and requires foreign exchange not only for its purchase, but also for spare parts. It is thus extremely costly, and as the utilisation rates for machinery are often much lower than in the industrially developed countries costs per cubic metre of earth moved are high.

On the other hand, there are some operations for which machines are essential and others for which they are desirable. One of the main drawbacks to the use of manual labour is the slow rate at which work is done. The experimental project was designed not to replace machinery but to widen the scope for the use of manual methods, particularly by speeding up the rate of output. It was considered more important to arrange that some of the benefits of increased productivity accrued in the form of higher living standards for the workers than to apply the benefits wholly to reducing the cost of the work done.

Such evidence as was available at the start of the project suggested that success in increasing the workers' productivity would not come from one measure alone—such as, for instance, the adoption of different hand tools—but would probably result from the combination of several changes. It appeared necessary to study organisation; methods of payment; feeding and diets; density and quality of supervision; provision of housing, drinking water and other amenities; and the tools and the skill with which they were used.

THE WORKERS

The first stage of the project was designed to measure exactly the outputs which were attainable with traditional methods. This was done at the Sharavathi Valley Project, in Mysore State, where a large dam was under construction and had been for the previous six years. The climatic conditions at Sharavathi were rather better than those obtaining on most work sites in India. More than 20,000 workers were employed, of whom about 7,500 were engaged on earthmoving. The proportion of males to females in this group was 12½ : 1, although in the workforce as a whole it was 4:1.

The workers were nearly all contract labour, recruited and supervised by " pieceworkers ", who were paid by the main contractors on the basis of the output produced by their gangs. About 80 per cent. of the gangs had between ten and 15 workers in each, though some were as large as 50 strong. The labourers were drawn from all over the southern states of India, some coming from as far away as 1,000 kilometres.

Most workers were paid at daily rates, though a few were paid on output. Male labourers were most usually paid 73 U.S. cents per day, except Malabaris, who received 84 cents. Female labourers were usually paid 53½ cents, and boys 42 cents. These rates were a good deal higher than those commonly paid on minor work sites in India. Workers were provided with hutting materials free. Most workers were paid weekly, though Malabaris drew their wages only once a month.

The best workers came from Malabar; they made up about 10 per cent. of the total workforce. Malabaris work longer hours, do more effective work in the day, take less rest, and carry heavier loads than other groups. The end result is that the Malabari output per worker is 80 per cent. greater, on average, than that of other workers.

The Malabaris use the same tools and methods. They are not more skilled. In stature and in average age there is little to distinguish them from others.

The only significant difference is that they are customarily fed communally by their employers as part of their emoluments (they also receive the highest cash wages). A check on the diets showed that the Malabari workers were consuming an average of 4,500 calories per head per day, as against 2,880 by workers who bought and cooked their own food. There is some evidence that many workers suffer from parasitic infestations.

TRADITIONAL METHODS

Earth is first loosened from the embankment or borrow pit by the use of crowbars or pickaxes. The loose earth is then filled into woven cane head-baskets by means of a " mumty "—a mattock-like tool with a blade roughly at right-angles to the haft. Baskets are lifted to the heads of carriers by the carriers themselves, assisted by another worker.

Malabari workers carry an average earth load of 38 kg., whether " leading " (carrying) on the level, up, or downhill. Other workers average 31½ kg. For all except the shortest leads, the relay method of carrying is adopted, the basket being passed from head to head along a chain of workers, at intervals of 0.3 to 0.4 of a minute.

Heights are sometimes scaled by means of interlinked ramps cut into the face of an embankment, the ramp slope being about 1 in 3. Sometimes heights as great as 40 to 50 m. are scaled in this way. Similar arrangements are made with bamboo scaffolding to give access to dams and buildings.

Spades are not used, nor are shovels or wheelbarrows. Donkeys are sometimes employed on other work sites, though not at Sharavathi, where the conditions were thought to be too humid for them.

SOME MANUAL AND NON-MANUAL OPERATIONS

When a mechanical shovel was used for digging, the output per worker was found to be 26 times as great as that of the best workers using traditional methods. Each cubic metre dug was, however, nearly four times as costly with the machine.

Stone-crushing, when done mechanically, produced an output per worker which was only 1.2 times that of manual labour—breaking stones with hammers. The cost by manual labour was lower.

The vertical lifting of masonry by cranes produced an output per worker which was 7.6 times that of manual labour carrying granite rubble up bamboo ramps. The cost per kilogram lifted was the same for both cranes and manual workers.

THE SEARCH FOR BETTER METHODS

An analysis of the possibilities of improvement showed that it ought to be feasible to raise the productivity of the best workers by 20 to 30 per cent. and that of other groups by 100 per cent. (provided they were fed adequate diets) by detailed changes within the broad general framework of the traditional methods.

To achieve greater improvements than these, the load to be carried must come off the head and on to a wheel of some sort for horizontal movement

or a rope of some sort for vertical lifts. This entails the introduction of appliances.

The appliances required should offer at least 100 per cent. improvement, but not more than 400 per cent. They should be comparatively cheap, rugged, easily made from locally available materials, and easy to maintain. They should preferably handle earth in lots considerably larger than a headload, be versatile so that they can be used on all kinds of work sites, and yet be easily transportable. The equipment should also be socially acceptable, and preferably should not result in the exclusion of women from the work sites.

As the ratio of workers carrying earth to those engaged in digging was 6:1, the studies concentrated on transportation. The simplest appliances which seemed to meet the requirements were wheelbarrows and narrow-gauge tipping trucks running on rails, the latter being used with a winch for uphill work. They were therefore tried out, as also were shovels.

Loading with shovels was faster than with mumtys and headbaskets, and much faster when the loading was done to a height of not more than 85 cm. A Swedish pattern of shovel gave better results than a locally made one.

Leading with tipping trucks along level ground produced outputs per worker which were from 1,200 to 2,300 per cent. of those attainable by the best workers when carrying on the head. Up a slope of 1 in 80, the outputs varied from 400 to 750 per cent., depending on the length of lead. When the slope was 1 in 40—the steepest that can be managed by manual pushing—outputs were from 284 to 530 per cent. Downhill, outputs per worker were between 1,600 and 3,000 per cent. of those of head-carriers.

However, the over-all improvement offered by tipping trucks is not as great as might appear, for the effect of their introduction is to require that the greater part of the workforce be used to dig and load rather than to push.

The introduction of shovels and trucks should increase the over-all output per worker by anything from three-and-a-half to four-and-a-half times, depending on the length of the lead and whether it is on the level, up or down flattish slopes, or up steep slopes (when a winch is used also). Making handsome allowance for interference, delays, mishaps, and the time needed to lay and move rails, it can confidently be predicted that shovels and trucks should increase worker outputs to at least three times those attained by the best workers when using traditional methods.

If the workers using the new methods worked only 6 hours a day, instead of the 7¾ hours put in with traditional methods, the saving in unit cost, after making conservative provision for depreciation and maintenance of equipment, would be 60 per cent.

The wheelbarrows provided for trial were poor specimens, so that it was not possible to find out with them exactly what the output of experienced workers using good wheelbarrows would be: however, they gave a good general indication.

It seems probable that the introduction of shovels and wheelbarrows would result in an over-all increase in output per worker of 30 per cent. on a level lead of 30 m.; 70 per cent. on 60 m.; and 100 per cent. on 120 m. The steepest slope up which a 90 kg. pay load could be managed for a 50 m. stretch without pause was 1 in 20.

Traditionally, it is the woman's job to carry in India—so long as she carries on the head. Pushing wheelbarrows is not suitable work for women, however, and if their use were to be enforced there would be little or no work for women on the work sites.

An experimental trolley was constructed and used to investigate the mechanics of wheelbarrow operation. The trials showed very great improvements from the use of pneumatic-tyred wheels. The data produced by the experiments are being used to design a standard wheelbarrow which will be simple to make and yet will give good service.

II. Nigeria and Tanganyika

The object of the earthmoving survey, undertaken by two I.L.O. experts between January and October 1963, was to determine by work studies and examination of local conditions whether the productivity of manual labour could be improved and if so by what means, related to the following possibilities:

(a) the undertaking of public works more cheaply;

(b) the creation of extended employment by enabling manual labour to compete better with machines;

(c) the saving of foreign exchange used for the purchase of imported machinery.

The survey consisted of an examination of the output, productivity and cost of manual labour and of general purpose machines operated by contractors on roads and railway embankments, and was confined to work which could be performed either by machines or by man (or man assisted by animal or tip-truck transport). Since no cases of manual work on roads or railway embankments were found it was necessary to study manual digging in quarries, river beds, borrow pits and drainage channels, and the transport of the material to the placement area on head-pans, tip-trucks or donkeys. The data were then applied to a standard construction layout of uniform measurements and quantities based on average conditions encountered, as also were those of machine operation, to enable a direct comparison of the two methods to be made.

The manual tools were pick, round-nosed shovel and metal head-pan. The machines were dragline, mechanical shovel and scraper.

MANUAL LABOUR [1]: PRODUCTIVITY, METHOD OF PAYMENT AND EARNINGS

The varying level of productivity of a manual worker may be likened to the walking rates of a man, say 2, 3 or 4 miles per hour, the latter being a rate he can maintain, given adequate rest periods, without undue fatigue. If we call 4 miles per hour 100 per cent., the normal walking rate of 3 miles per hour will be 75 per cent. and the " strolling " rate of 2 miles per hour will be 50 per

[1] The manual workers were all males, with an isolated exception in the Nigerian tin mines, where women from the families of men on task work assisted with the carrying of material dug.

cent. A man walking for short spells at 4 miles per hour—100 per cent.—and having disproportionate rest periods, or idle time, could finish up with an average of 2 miles per hour—50 per cent—or less.

The average level of productivity observed in the work studied was of the order of 50 per cent.; the national over-all level for this type of work is considered to be below 50 per cent.

The three basic methods of payment encountered were—

(a) Flat rate. Workers were paid the statutory rates for the locality. The amount of their output depended mainly on the effectiveness of the supervisors, who represented some 20 per cent. of the workforce.

(b) Finish-and-go. A fairly easy set task was usually completed in 4 to 5 hours, after which the worker was free to leave; for this he received the local statutory flat rate. This was a form of direct incentive, with free time as the premium. Supervision was 4 to 5 per cent. of the workforce.

(c) Paid task. Workers were paid by unit of work produced and were usually free to come and go as they chose. This was piece-work with a direct financial incentive. Supervision varied from 4 per cent. to zero.

The highest productivity observed was under the paid-task system at 60 per cent. or more, while for flat rate and finish-and-go the range observed was from 45 to 53 per cent. The figure depended noticeably, in the case of flat rate, on the quality of supervision.

The daily level of earnings varied with the locality, sometimes markedly. The range of earnings per eight-hour day at the seven work sites for which statistics were available was 3.4 to 6.7 shillings (48 to 96 U.S. cents) an average of 5.1 shillings (73 U.S. cents).

Of the three methods of payment described, evident advantages lie with the last two, since they are related to productivity and cheapness of supervision. The cost of paid-task work in the cases observed in Nigeria, however, was inflated because the system was operated only through independent petty contractors. Where the direct labour cost per cubic yard was over the range 1.1 to 1.2 shillings, middlemen were being paid from 2.1 to 5 shillings, without bearing transport expenses. This is an increase over the direct cost of from 70 per cent. to 350 per cent.

SOCIAL FACTORS

The social factors observed on moving sites like roads and railways relate mainly to subsistence farmers recruited from scattered villages over a wide area and available seasonally only outside planting and harvesting times.

The following arrangements by a large road contractor illustrate the general customs applying to itinerant labour:

(1) Quarters were provided for labour brought to the main camp but not for that engaged locally. The cost of a lateritic soil round-house of 10 feet diameter with grass roof was £15 to £17 (43 to 49 U.S. dollars): rebuilding occurred each year.

(2) Labour was transported to and from the work site in lorries.

(3) Food was not provided: drinking and cooking water were taken to the work site in lorries.

(4) A monthly shopping trip to town (30 miles) in lorries was provided for all labour.

In the one case observed where food was given, this consisted variously of yams, beans, garry, rice, cooking oil, green vegetables and peppers. A communal meat-stock soup was also provided daily.

Permanent labour was difficult to obtain. One site manager claimed to have engaged some 2,000 labourers over three years in order to establish a permanent workforce of 200. The important factor is the attitude of the subsistence farmer to paid work, which he usually takes periodically to fulfil some particular financial need or obligation.

EFFECTS OF QUANTITY, DISTANCE AND TIME ON PRODUCTIVITY

Three of the most important conditions influencing productivity in manual earthmoving are the quantity of material transported at a time, the distance it is transported and the speed of transport. The average headload carried was observed to be 56 lb. This would be transported at some 2 to 3 miles per hour over a varying distance depending on the relative locations of the digging and the placement areas.

If the cost of digging 56 lb. of average soil, loading it on to the headpan and placing it on the head is expressed as one unit, then transporting it 120 feet and returning to the digging site is also one unit, and so is every additional 120 feet travelled between the digging and the placement areas.

It will thus be seen that any increase in the journey distance rapidly increases the cost of labour. It is therefore evident that some alternative form of transport, which either carries a greater load per trip or carries it faster (or both) warrants serious consideration: tip-trucks and donkeys have been considered for this purpose.

IMPROVING PRODUCTIVITY IN MANUAL EARTHMOVING

The sort of situation that has to be dealt with is well illustrated by the following example.

A minor Nigerian contractor was asked to supply sand, to be paid for on the basis of lorry-loads delivered. He contacted a senior worker in a nearby village whom he knew and asked him to assemble a gang of labourers to carry out the work, at an agreed rate to be paid daily and shared among the group pro rata to the work performed by each. Over a period of six days the following points were observed:

the daily attendance at work varied from 12 to 25 men; the daily working hours varied inconsistently between 5 and 10; the daily lorry-loads delivered —from 6 to 38—were not in proportion to attendance or hours worked.

In spite of these variations, however, the over-all output averaged one lorry-load per man per day, a not inconsiderable performance of 65 per cent.— equivalent in the analogy of walking rate to 2.6 miles per hour.

The example shows the attitude towards work of the villagers from among whom most of the labourers are recruited in the Northern Province of Nigeria, and inquiries and observations in other parts of both countries visited have indicated an identical outlook. Brought up in the communal village life

and nurtured in its tradition the villager is unused to artificial curbs, will work when he has the need or inclination, and likes to take his leisure or conduct his private life at his own convenience. It is not in his nature to attend work for regular hours on six days a week all the year round.

Given, however, the opportunity to work in his own way, he can show an output that not only matches but outstrips that of the regular labourer on flat rate. The one kind of work to which he reacts favourably is some form of task work, under which he feels he is working for himself. This is a very natural reaction in a man of his temperament and upbringing.

The effect on productivity of increasing the load transported and reducing its transport time was discussed in the previous section. Increasing the load carried by using donkeys for transport increases productivity over distances of 100, 500 and 1,000 feet by 20, 110 and 190 per cent. respectively, while the use of the tip-truck over the same distances increases productivity by 100, 360 and 670 per cent. These and other transport devices suited to particular localities and terrain are worth fully investigating as aids to productivity.

It is also evident that the worker will respond favourably to some form of incentive, such as paid task work. In the example of the Nigerian contractor productivity was at least 30 per cent. higher than the average. It is conditions such as these that may have to be accepted as a starting point of a reorganisation, a process made easier if the workers have a direct interest in the results. The correction of the work balance on this site, for instance, would alone have improved productivity by a further 20 per cent.

Public bodies find themselves restricted in the use of any form of paid task work, although petty contractors freely (and expensively for the public bodies employing them) practise the system. If a country is to make the best of its manpower resources such restrictions must be reviewed.

An examination of the efficiency of different types of pick, shovel and carrying vessel for various earths would certainly yield useful results, as also would an investigation into the normal load that a worker can carry without undue fatigue. It is considered that the improvement of tools and methods of work and the elimination of idle time could lead to an increase in productivity of some 80 per cent., rising gradually to 100 per cent. or over.

OBSERVATIONS ON EARTHMOVING MACHINERY

The groups of machines studied and costed were the following:

(a) mechanical shovel with bulldozer for digging and piling soil, and tip-truck for transport;

(b) dragline with ripper for breaking up earth, and grader for levelling after piling.

(c) large, medium and small scrapers (14, 7 and 4½ cu. yd.) with bulldozer as pusher (the times for the medium and small scrapers were estimated).

There are probably as many ways of calculating the hourly cost of machines as there are machine users. The method adopted was to estimate the life of the machine in working hours according to the working conditions encountered, and to spread its landed cost over the hours worked according to its utilisation; for instance if it worked for six hours in a working day of 12 hours, its hourly cost would be double that for working the full 12 hours. To the hours actually

worked were then added the relatively constant operating costs of maintenance, spares, fuel, lubricants and labour.

The vital factors then are the landed cost of a machine in the country and the degree to which it is utilised. It is true to say that the best use of a machine is its greatest possible continuous use over as long a period as is economically feasible. A machine standing idle is costing money.

The degree of utilisation is crucial to any comparison of the cost of manual labour with that of machines because machine utilisation is machine productivity, which must be contrasted with the productivity of manual labour in any comparison. For instance manual labour even at its present admittedly low level of productivity can, if assisted by donkey or tip-truck transport, compete with the mechanical shovel unit in the lower and middle utilisations; but if its productivity were increased by from 80 to 100 per cent., it would be in direct competition with the shovel unit and become competitive with the scraper unit in the lower utilisations. It is not easy to assess the real degree of utilisation of machines because accurate records are seldom kept. Large contractors on roads and railways, who must make machine operation pay, had a utilisation range of some 50 to 85 per cent. On the other hand estimates by some public works bodies indicated a range of 10 to 50 per cent.; others considered that they could operate at 75 to 80 per cent. if they were not restricted by the non-availability of funds.

Among the chief reasons for a reduction in utilisation are lack of work due to lack of forward planning; time for maintenance, breakdown or stand-by; travel to the work site; and the weather. It is by no means a simple matter even for practised hands to keep machine operation in the middle or higher utilisations and in the absence of strict controls it can quickly fall to a grossly uneconomic level. Another factor vitally affecting the use made of machines is the manner in which they are operated. It cannot be too strongly emphasised that specialised skills are required for their effective use and maintenance, particularly as they become more complex. To invest in a complex earthmoving machine and expect it to work to maker's specifications in unskilled hands and without proper care and attention could prove financially disastrous. Skills are properly acquired only through a sound technical training and extended practical experience, and developing countries would be well advised to consider what skills are available locally and the best means to employ for developing them to the required standard.

CONCLUSION

This report has dealt with a sample of the problems to be encountered in earthmoving in two countries. The extent to which its findings apply to other countries will depend on the conditions and social factors operating in them and on the kind of projects undertaken.

No small part of the problem is to balance the population's earning power with the supply of consumer goods necessary to increase the standard of living and at the same time to reduce the level of unemployment. This increase in earning power should, in a healthy economy, go hand in hand with a general increase in national productivity and the reduction of unemployment by a more widespread use of available manpower.