Agricultural Mechanisation and Employment in Latin America

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AGRICULTURAL PRODUCTION is on the whole much more mechanised in Latin America than in the other developing regions of the world. At the same time Latin America is the region with the fastest growing labour force, and there is substantial unemployment and underemployment. Since most mechanisation tends to replace labour, this situation is paradoxical and calls for investigation.

If the labour that is replaced can be absorbed in other activities, either in agriculture or outside it, mechanisation brings many advantages. But if, as at present in most countries of Latin America, non-agricultural jobs cannot be created fast enough, the agricultural labour force is still growing, and unemployment and underemployment are spreading, the pace and pattern of agricultural mechanisation require careful examination. Even if an advanced degree of mechanisation is highly profitable at the level of the individual farm, at the national level it may lead not only to waste of the abundant factor of production, labour, but also to misallocation of the scarce factor, capital (and of foreign exchange as well).

Although mechanisation has been quite rapid, it has penetrated only a small part of Latin American agriculture. It is mainly confined to some of the larger farms, where it has often displaced hired labour, and in most countries to the larger farms in certain geographical areas. Most of the region's agricultural population still work without the help either of machinery or of other technological improvements.

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The profitability of mechanisation to the operators of the larger farms has been enhanced by a number of factors, not all of them reflecting deliberate government policy to promote mechanisation. Most governments have granted tariff and tax concessions in respect of agricultural machinery, and cheap credit for its purchase. In addition, however, overvalued exchange rates and the low or even negative interest rates prevailing in inflationary conditions have reduced the cost of investing in capital equipment. Minimum wages and social security payments have raised the price of hired labour in some countries. And, in many of the labour-surplus economies of Latin America, the economic attractions of labour saving for the operators of the larger farms have been reinforced by the mounting social unrest in the labour force.

Most of the attempts so far made by Latin American governments to encourage and assist mechanisation have been characterised both by the indiscriminate nature of the support and by its fluctuating level. Especially now that the employment situation has become so difficult, this haphazard approach needs to be replaced by consistent agricultural mechanisation policies, conceived not only as part of over-all technological policy for agriculture but also as part of the development strategy as a whole. In the last few years a number of governments have been trying to devise policies of this kind.

In doing so, however, they are faced with many difficulties. The factual basis for determining the relationship between mechanisation and employment is limited. Powerful vested interests are involved, especially those of large farmers and the manufacturers and importers of agricultural machinery. Conflicting advice is often received from agricultural engineers and social scientists. The former have a vision of the future in which all the advances of modern science are applied to agricultural production, and the labour force freed from degrading toil. The latter are much preoccupied with the fact that, unless an increasing number of workers can be employed in agriculture during the current difficult transition period, many will be condemned to open unemployment or underemployment.

Both engineers and social scientists could make common cause on the need for more consistent government policies. And the policies that they themselves want to promote may well not be all that far apart. The social scientists wish to ensure that mechanisation takes place on a step-by-step, selective basis, so that any major displacement of labour is delayed until the economy as a whole (rather than the individual large farmer) needs it. On the other hand, the engineers' vision of the future cannot be realised overnight, and they could probably agree on a gradual, selective process operating over roughly the same time period.

For the formulation of such policies, it will be necessary to weigh carefully which types of mechanisation are imperatively needed to meet national production targets, and which must for the time being be

eschewed for employment reasons (as well as on account of shortage of capital and foreign exchange). For the effective implementation of more selective mechanisation policies, it will be necessary for the government fiscal and related measures that influence the decisions of individual farmers to be altered, so that they correspond more closely to national needs and priorities. At the same time a major effort will be needed to diffuse and assist technological improvements like the use of fertilisers, pesticides and better seeds, which do not generally reduce employment and are applicable by large and small producers alike.

Action of this kind would make an important contribution to turning the present vague employment objectives in national development plans into concrete policies and measures. Even though the extent to which agricultural mechanisation has contributed to current unemployment and underemployment cannot be precisely determined, there is little doubt that in the future the choice of the technology to be used in meeting production targets will be one of the principal means by which governments can influence the level of agricultural employment.

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The themes outlined above are examined in more detail in the following pages, on the basis of the information available for Latin American countries. For over-all data on production, imports and use of agricultural machinery in a large part of the region, an invaluable recent source is a survey carried out by the secretariat of the Latin American Free Trade Association (LAFTA).[1] But, as with all current studies of agricultural employment, analysis is greatly impeded by the scarcity of information on what actually happens at farm level.

Data and examples are quoted from as many countries as possible, in order to arrive at a preliminary survey of the situation in the region as a whole. Although broad generalisations obviously cannot be made for so large and diverse a region, the Latin American countries do appear to share a number of common problems concerning agricultural mechanisation and employment.

Employment situation

It is not the purpose of this article to deal in detail with the over-all employment situation and problems of Latin America. However, before taking up the specific issue of agricultural mechanisation in relation to

[1] Latin American Free Trade Association (LAFTA): *Estudio sobre la maquinaria agrícola en los países de la ALALC* (Montevideo, Sep. 1970). Unless otherwise specified, the basic data used are drawn from this study.

employment, it is necessary to sketch at least some of the general background and to discuss briefly the role of the agricultural sector in alleviating employment problems. A few figures will first be presented, to illustrate the dimensions of these problems.

It has been estimated that open unemployment in Latin America as a whole affected 8.9 per cent of the economically active population at the end of the 1960s. In addition there is a massive backlog of underemployment, especially in the agricultural and service sectors, and the same source estimates that, including this underemployment converted to a basis of full unemployment, the total unused labour amounted in 1960 to 27.4 per cent of the active population and at the end of the decade to 28.2 per cent (or 25 million persons).[1]

In the agricultural sector underemployment appears generally to be much more serious than open unemployment. For example, it is estimated from household survey data that only 0.5 per cent of the agricultural labour force of Brazil was unemployed in the last quarter of 1968 (as compared with 2.3 per cent of the total labour force).[2] But the same data indicate that 13.8 per cent of the agricultural labour force worked less than 35 hours a week in the third quarter of 1968.[3] Moreover, according to the 1970 population census, 25 per cent of the agricultural labour force worked less than nine months in the year preceding the census, and in six states of the north-east the figure was as high as 38 per cent (almost a million people in absolute terms).[4]

For Chile it has been estimated (on the basis of 300 working days per year) that only 363,000 workers were needed to obtain the agricultural production of 1955, in comparison with the actual work force of 664,000.[5] Effective employment in Peru has been estimated as requiring 57 per cent of the agricultural labour force actually available on the basis of a year of 200 man-days and 46 per cent on the basis of a year of 250 man-days.[6]

Another major feature of the agricultural employment situation is constituted by the large seasonal fluctuations that occur in the demand for labour. These are particularly relevant to mechanisation and also

[1] ILPES/CELADE: *Elementos para la elaboración de una política de desarrollo con integración para América Latina* (Santiago), document INST/S.4/L.2/Add.2 of 7 July 1969, pp. 7 and 10.

[2] Allan Broehl: *Aspectos da fôrça de trabalho no Brasil* (Rio de Janeiro, IPEA, Centro Nacional de Recursos Humanos, 1970), CNRH/Ser.MO/DT, Doc. 113 (mimeographed), p. 24.

[3] F. S. O'Brien and Cláudio L. Salm: *Desemprêgo e subemprêgo no Brasil* (Rio de Janeiro, IPEA, Centro Nacional de Recursos Humanos, 1969) (mimeographed), p. 17.

[4] Departamento de Censos: *Tabulações avançadas do censo demográfico—VIII recenseamento geral—1970, resultados preliminares* (Rio de Janeiro 1971), pp. 7 and 43.

[5] Comité Interamericano de Desarrollo Agrícola (CIDA): *Chile: tenencia de la tierra y desarrollo socioeconómico del sector agrícola* (Santiago, 1966), p. 27.

[6] E. Thorbecke and E. Stoutjesdijk: *Employment and output: a methodology applied to Peru and Guatemala* (Paris, OECD Development Centre, 1971), Development Centre Studies, Employment Series, No. 2, p. 49.

partly explain the high levels of underemployment referred to above. Generally speaking, over the year as a whole the larger farms in Latin America require a substantial amount of casual labour, whereas the smaller ones have a considerable labour surplus. While there is a sizeable movement of labour between these two subsectors, they are far from fully balancing one another. The surplus of labour on the smaller farms is usually much greater than the labour deficit on the larger ones. The seasonal peak of demand on the larger farms rarely coincides with the peak supply on the smaller ones, unless widely separated geographical areas are considered (although it should be noted that some of the seasonal labour migration extends over great distances and even across international frontiers).

In Chile the total demand for agricultural labour in July is estimated as 63 per cent of that in March.[1] In Peru the demand in September is estimated as only 27 per cent of that in June, and in one province in February it is estimated to be as little as 0.4 per cent of that in May (these estimates are, however, confined to crop production).[2] A particularly striking example of seasonal labour demand may be quoted from Cuba, where no less than 1.2 million workers from outside agriculture (as many as 200,000 at one time during the peak period) had to participate at some stage in the record sugar-cane harvest of November 1969 to July 1970.[3]

The role of the agricultural sector

The population and labour force are increasing faster in Latin America than in any other region of the world. Because non-agricultural jobs have not become available fast enough to absorb all of the increase, the potential agricultural labour force continues to rise in absolute numbers, even though declining as a proportion of the total labour force. The only exceptions are Argentina and Uruguay (where the rate of population growth is very low) and the state of São Paulo in Brazil. There, the agricultural labour force has been decreasing in absolute terms for some time, although it is noteworthy that these areas too have not been immune from employment problems in recent years.

In the rest of the region the amount of time it will take before the agricultural labour force begins to decrease will, of course, depend mainly on the over-all rate of population growth and on the rate at which additional non-agricultural jobs are created. As regards the first of these

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[1] Ministerio de Agricultura, Oficina de Planificación Agrícola: *Plan de desarrollo agropecuario 1965-1980* (Santiago, 1968), Vol. 2, pp. V-112.

[2] Convenio para Estudios Económicos Básicos: *Requerimientos mensuales de mano de obra para la agricultura por hectárea, por cultivo, por provincias y para la actividad pecuaria, año base 1967* (Lima, Nov. 1970). The over-all figure quoted above is for a random sample of 15 of the 143 provinces covered.

[3] "Dos años de desarrollo agropecuario cubano, 1968-1970", in *Economía y Desarrollo*, No. 4, Oct.-Dec. 1970, p. 29.

variables, some countries such as Brazil and Chile seem already to have passed their peak rate of population growth, but for most of the others this seems unlikely to be so for some time. As for the second variable, the shortage of investment capital, low incomes, the small size of most domestic markets and the decreasing labour intensity of modern industry impose severe constraints. Thus it is certain that in most of the countries of Latin America the agricultural sector will have to contrive to find productive employment for increasing numbers of people for many years to come.

The time when the agricultural labour force at last begins to decline has great significance in regard to the productivity of labour, and hence in regard to mechanisation. Until then, at least part of the increase in the demand for agricultural products can be met by the new entrants to the labour force without any increase in labour productivity, and indeed must be met in this way if unemployment and underemployment are not to get worse. Once the agricultural labour force starts to decrease, all of the increase in demand for agricultural products will have to be met by raising the productivity of labour at a rapidly accelerating rate, such as is made possible by mechanisation.

The demand aspect is fundamental, and the continued expansion of the agricultural labour force would matter far less if the demand for agricultural products were growing more rapidly. The work being done for the FAO's perspective study of agricultural development in South America [1] indicates clearly that insufficient demand for, rather than the shortage of productive resources, is the main limitation on a more rapid growth of agricultural production (and hence of agricultural employment) in most of the region. Measures to stimulate the demand for agricultural products, for example through income redistribution, the free or subsidised distribution of food under nutrition programmes, and the lowering of tariff and other barriers to the exports of developing countries, can therefore have an important bearing on agricultural employment.

It is obvious from the recent experience of Brazil in particular that even a very high rate of growth of the economy is insufficient by itself to take care of employment, and that deliberate policies to increase labour absorption, often outside the agricultural sector, are needed. In the long run the creation of new industrial jobs is the principal key to the solution of problems of employment and underemployment, and in this connection more attention might usefully be paid to the labour-intensive methods so readily advocated for the agricultural sector. Other crucial factors are the reduction of population growth and the measures already mentioned for the stimulation of demand. But in the shorter run (which may last many years yet) the agricultural, or at least the rural sector, has an essential role to play.

[1] To be published in mid-1972.

This role appears primarily to involve slowing down rural-urban migration to a rate which is closer to that at which productive urban employment can be increased. It implies retaining far more labour than is really needed to meet the market demand for agricultural products, now that improved technology leading to rapid increases in labour productivity is fairly accessible to the larger commercial farmers. If, as has happened recently in many Latin American countries, the main emphasis is on increasing labour productivity on the larger farms, very little of the market demand remains to be met by the rest of the agricultural population, who are condemned to serious underemployment and living conditions barely above the subsistence level.

For agriculture to play this role, a wide range of measures is needed, many of them in the broader rural rather than the strictly agricultural sector. Such measures include, in addition to the implementation of effective land reform, the provision of non-agricultural job opportunities in rural areas (in particular because of the highly seasonal nature of so much agricultural work), some correction of the serious imbalance between rural and urban amenities, and increased participation by rural people in development decisions affecting them. The introduction of more rational policies concerning agricultural technology and mechanisation is obviously only one of the means whereby the agricultural sector can be enabled to fulfil its employment role, but it is hoped to demonstrate below that it could well be one of the most powerful.

The pattern and trend of mechanisation

Mainly for the sake of simplicity, but also because of the availability of information, mechanisation is considered in this study predominantly in terms of tractors. Tractor use does, in fact, provide a rough indication of the over-all level of mechanisation. The tractor is the " general factotum " of farm machinery, and the purchase of one usually implies the purchase of auxiliary equipment as well. In Argentina and Brazil tractors are estimated to represent some 60 per cent of the total value of the market for farm machinery. They also accounted in 1966-68 for about the same proportion of the total farm machinery imports of the LAFTA countries.

Table I presents some basic information on tractor use for seventeen countries for which fairly comparable recent estimates are available. They cover almost 90 per cent of the 607,500 tractors estimated by the FAO to be in use in Latin American agriculture in 1969.[1]

About one-third of the tractors are in Argentina alone, and another third in Brazil and Mexico. The intensity of tractor use in relation to the

[1] FAO: *Production Yearbook 1970* (Rome, 1971), Vol. 24, p. 486.

TABLE I. TRACTOR USE IN SELECTED COUNTRIES OF LATIN AMERICA

Country [1]	Year	Number of tractors	Average horsepower	Cultivated area [2] per tractor (ha)	Horsepower per cultivated ha [2]	Number of economically active persons in agriculture [3] per tractor	Per head income [4] (US$)	Percentage of population urbanised [3]
Cuba	1969	48 800	.	63	.	18	.	59
Uruguay	1968	28 000	40	90	0.45	6	628	76
Argentina	1968	180 000	48	155	0.31	8	851	75
Venezuela	1968	15 850	50	164	0.31	51	765	68
Chile	1968	25 000	41	180	0.23	28	585	67
Colombia	1968	23 000	53	220	0.24	109	336	51
Peru	1968	10 000	43	280	0.15	164	386	44
Costa Rica	1965	3 000	40	291	0.14	71	521	32
Nicaragua	1965	2 850	40	351	0.11	105	299	37
Brazil	1969	100 000	56	360	0.16	126	314	44
Mexico	1968	70 000	40	370	0.11	100	631	58
Guatemala	1965	3 800	40	418	0.10	224	337	29
El Salvador	1965	1 590	40	477	0.08	349	307	34
Paraguay	1969	1 700	50	590	0.08	203	257	32
Honduras	1965	1 400	40	640	0.06	300	229	24
Ecuador	1968	2 500	45	1 290	0.03	330	286	43
Bolivia	1968	1 600	50	1 930	0.03	583	184	33

[1] Ranked in ascending order of cultivated area per tractor. [2] Arable land and land under permanent crops. [3] 1965. [4] Gross domestic product per head at factor cost, 1968.

Sources: LAFTA, op. cit., p. 7; estimates for Central American countries from unpublished studies by the FAO Advisory Group for Central American Economic Integration; " Dos años de desarrollo agropecuario cubano, 1968-1970 ", op. cit., p. 49; FAO: *Production Yearbook 1969* (Rome, 1970), Vol. 23, pp. 21-22; United Nations: *Statistical Bulletin for Latin America*, Vol. VI, No. 2, Sep. 1969 (New York, Sales No. E/S. 70.II.G.2), p. 23; United Nations, Economic Commission for Latin America: *Economic Survey of Latin America 1968* (New York, Sales No. E.70.II.G.1), pp. 39-40.

cultivated area also varies sharply among the different countries. Cuba, which has engaged in very large imports of tractors in recent years, emerges as the Latin American country whose agriculture is most intensively tractorised. In Argentina, Chile, Colombia, Uruguay and Venezuela there is one tractor for roughly every 100 to 200 hectares, which is close to the level found in such developed countries with relatively extensive agriculture as Australia and the USSR. At the other extreme, mechanisation is almost negligible in Bolivia and Ecuador. Most of the remaining countries have one tractor for between 300 and 600 hectares. More accurate comparisons would involve somewhat difficult adjustments for the different types of cultivated land and for fallow; although the results of such adjustments are substantial in some countries, they do not greatly alter the general ranking shown in the table.

If the intensity of tractor use is measured against the agricultural labour force instead of the cultivated area, there is the same wide range between the different countries and their ranking remains more or less the

same. The degree of tractorisation appears to be quite closely related to the level of income per head and the extent to which the population is urbanised, indicating the likely importance of higher wage rates in stimulating mechanisation.

Apart from the countries covered in the table, the only others in Latin America with substantial numbers of tractors appear to be the Dominican Republic (4,400 in 1969), Guyana (3,650 in 1969), Jamaica (4,900 in 1966) and Puerto Rico (5,000 in 1969).[1] In the remainder they are numbered only in hundreds, although in some cases this represents quite an intensive level of use.

Taking the region as a whole it will be seen that agriculture is much more highly mechanised in Latin America than in the other developing regions of the world. The regional average of one tractor for about 220 hectares of cultivated land compares with that of one per 440 hectares in the Near East, one per 560 hectares in Africa, and one per 1,540 hectares in the Far East, although still well behind the level of one per 40 hectares in North America and that of one per 25 hectares in Europe.[2]

Agricultural mechanisation is, however, strikingly concentrated not only in certain countries but also in limited geographical zones within those countries. In Argentina 70 per cent of the machinery is in the pampas, in Brazil 95 per cent is in the centre-south zone (especially the state of São Paulo, with more than 70 per cent of all the tractors), in Colombia 70 per cent is in eight departments (out of a total of twenty-one), in Mexico 70 per cent is in the north and Pacific north zones and in Uruguay 80 per cent is in the south and west. In most of these areas there is one tractor for 50 to 100 cultivated hectares, which is not far short of the ratio of 1: 40 found in North America.

This geographical concentration of farm machinery has a number of causes. Because of the generally abundant land resources of the region, in most countries only limited zones have so far been intensively developed for agricultural production. Many areas with steeply sloping land do not lend themselves to mechanisation. Certain crops, such as cereals, oilseeds, cotton, sugar-cane, potatoes and fodder crops like alfalfa are more susceptible to mechanisation than others, and in many countries mechanisation is heavily concentrated on a very small number of them.

Above all, however, the pattern of mechanisation is linked to the notoriously uneven size distribution of farm undertakings. The vast majority of holdings are far too small for the economical use of a tractor [3], or for their owners to be able to afford one. A small minority,

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[1] FAO: *Production Yearbook 1970*, Vol. 24, op. cit., pp. 481-482.

[2] Ibid., pp. 8 and 486.

[3] It is generally accepted that tractors of 40 to 60 h.p. require an arable acreage of more than 40 to 50 hectares for their economical use. In view of the fairly extensive agricultural production of much of the region the figure may be somewhat higher.

which, however, possess the major part of the land area, have the choice of either employing a large force of hired labour or mechanising, and most of them have opted for at least some degree of mechanisation. Thus farms bigger than 50 hectares had 93 per cent of all tractors in Chile in 1963 [1], 66 per cent of all tractors in Colombia in 1960 [2], and 75 per cent of all farm machinery in Mexico in 1960.[3]

The proportion of the cultivated area estimated as partially mechanised ranges from only 8 per cent in Paraguay, 14 per cent in Peru, 15 per cent in Ecuador, 18 per cent in Mexico (but as much as 40 per cent in the irrigation districts), 23 per cent in Colombia and 29 per cent in Venezuela, to 46 per cent in Chile, 49 per cent in Argentina and as much as 90 per cent in Uruguay. Whereas in Argentina and Chile, for instance, the remainder of the area is cultivated by animal traction, human labour provides the only source of power on at least 25 per cent of the area in Peru and on 65 per cent of farms in Colombia. In many countries there is only human power on wide areas of steeply sloping land, where draught animals cannot work.

In most Latin American countries the number of tractors increased rapidly in the years following the Second World War, but more recently the increase has tended to slow down. Consistent long-term series are available for very few individual countries, but for the region as a whole the FAO estimates indicate an annual rate of increase of 11 per cent in the 1950s and 7 per cent in the 1960s.[4] The annual rate of increase fell in Argentina from 11.3 per cent in 1947-52 to 7.1 per cent in 1960-68, in Mexico from 17.6 per cent in 1940-50 to 3.2 per cent in 1960-68, and in Uruguay from 6.4 per cent in 1951-61 to 1.8 per cent in 1961-68. In Cuba, in contrast, the most rapid increase has been in the last few years. In Brazil, where the rate of increase fell off sharply in the second half of the 1960s, there appears to have been a marked upturn in 1970 and 1971.

With few exceptions (e.g. Argentina, where there were already 1,800 tractors in 1922 and 21,500 in 1937), the tractor park has grown from almost negligible numbers at the end of the Second World War. The higher rate of growth in the 1950s than in the 1960s partly reflects the very small numbers at the start of the period but also the greater availability of foreign exchange for tractor imports during the Korean War boom, economic difficulties in the agricultural sector of some countries during the 1960s, in some cases the effects of the increasing

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[1] Corporación de Fomento de la Producción (CORFO), Gerencia Agrícola, Departamento de Mecanización Agrícola: *Mecanización agrícola en Chile: diagnóstico a 1963* (Santiago, 1969), Vol. I, p. 62.

[2] Departamento Administrativo Nacional de Estadística (DANE): *Censo agropecuario de 1960* (Bogotá).

[3] Centro de Investigaciones Agrarias/Comité Interamericano de Desarrollo Agrícola (CIDA): *Estructura agraria y desarrollo agrícola en México* (Mexico, 1970), Vol. 1, p. 497.

[4] FAO: *The state of food and agriculture 1970* (Rome, 1970), p. 142.

proportion of more costly domestic production, and the fact that with the passage of time a growing number of the new tractors replace worn-out stock rather than adding to the total.

The increase in the number of tractors has generally been accompanied by almost as rapid a change in the ratio of tractors to the cultivated area, with the main exception of Brazil, where the extension of the cultivated area has roughly kept pace. At the same time the average horse-power per tractor has in most countries risen from 20 to 30 at the end of the Second World War to some 40 to 50 at the present time and is still increasing.

Probably more than half of the agricultural machinery used in the region still has to be imported. There has been a domestic tractor industry in Argentina since 1959, in Brazil since 1960 (producing small motor cultivators as well as agricultural tractors) and in Mexico since 1965. A number of other countries are considering the domestic assembly or production of tractors, but have so far been deterred mainly by the small size of the local market and the high cost of the domestic product in relation to imports. There are already substantial industries producing other types of agricultural machinery in Chile, Colombia, Cuba, Uruguay and Venezuela, as well as in Argentina, Brazil and Mexico. But in 1966-68 the LAFTA countries still had to meet 47 per cent of their agricultural machinery requirements through imports costing US$112 million, or amounting to 1.3 per cent of their total imports.[1] Especially in Chile, Colombia and Uruguay there have been sharp year to year fluctuations in agricultural machinery imports because of foreign exchange difficulties.

Effects of mechanisation

A precise assessment of the effects of agricultural mechanisation is not possible. Apart from the scarcity of farm-level information, it is difficult to isolate them, because the farmer who mechanises is often the progressive one who goes in for many other improvements as well, which interact.[2] However, although this impedes academic analysis of the effects of mechanisation, it matters less in practice. What is important in operational terms is to determine the over-all technological package that will enable production targets to be met and at the same time provide as much employment as is feasible.

Bearing in mind these limitations, the main effects of mechanisation are discussed below. After a brief account of some of the more general

[1] The LAFTA countries include most of the major producers of agricultural machinery in the region, and the only ones with domestic tractor industries. Thus it is likely that Latin America as a whole still has to import well over half of its agricultural machinery supplies.

[2] José Olivares Díaz: "Estudio de la mecanización agrícola en la provincia de O'Higgins, año agrícola 1958-1959", in Universidad de Chile, Facultad de Agronomía: *Boletín Técnico* (Santiago), No. 15, Feb. 1962, pp. 42-43.

ones, the effects on employment, including employment in agricultural machinery industries, are discussed in more detail.

The principal effect of mechanisation on the level of agricultural production is achieved through the expansion of the cultivated area that it makes possible. Some land clearance can hardly be performed at all without machinery. But the most important aspect is the much greater speediness of mechanised land preparation. This is crucial in overcoming the seasonal labour shortages that occur even in labour-surplus economies, for example in arid areas where only a limited time is available for land preparation and in tropical areas where multiple cropping is possible, provided the land can be prepared quickly for the next crop.

The direct effect of mechanisation on yields per hectare is much smaller. Better soil preparation, including such operations as deep ploughing and subsoiling that are only possible with mechanisation, increases yields per hectare. But it is generally agreed that improvements such as the use of better seeds, fertilisers, pesticides, herbicides and water control have a far greater impact on yields, even though some mechanisation can sometimes be an essential part of the over-all technological package. Mechanisation can of course have a considerable indirect effect on yields by releasing labour for tasks connected with the improvements just mentioned.

The big increases in labour productivity made possible by mechanisation are well documented. However, in the Latin American context two aspects in particular should be noted. First, labour productivity can also be increased by the other types of technological improvement mentioned above. Second, although mechanisation raises the average productivity of the total agricultural labour force, what happens in practice is that labour productivity rises only for the small number of workers employed on the mechanised farms, and this is partly offset by a decline in the productivity of other workers who (as discussed below) are displaced by mechanisation.

Moreover, although mechanisation raises the productivity of labour, in the conditions prevailing in most Latin American countries its benefits have gone mainly to swell the profits and rents of the large landlords and the wages of the few tractor drivers and other machinery operators, so that it has tended to have a regressive effect on income distribution which has been felt not only in the agricultural sector as a whole but also within the labouring class itself. In Brazil, for example, it is estimated that there is thirteen times as much machinery and working animal investment in the south as in the north-east. But the higher productivity in the south is only slightly reflected in cash wages and income distribution is less even in the modern agriculture of the south than in the north-east.[1]

[1] William H. Nicholls: "The Brazilian food supply: problems and prospects", in *Economic development and cultural change* (Chicago (Illinois)), Vol. 19, No. 3, Apr. 1971, pp. 384-387.

The effect of mechanisation on costs and returns clearly depends on the relative costs of using more machinery or more labour. As is discussed later, the private costs to the farmer do not normally reflect the relative availability of capital and labour in the economy. Furthermore, as conventionally calculated, they do not even truly reflect the internal cost structures of the farm units concerned. On the one hand, they do not reflect the gains from inflation obtained in some countries by farmers purchasing machinery with government credit. On the other hand, since labour on family farms is costed at the price of hired labour, the costs of non-mechanised production are greatly overestimated.

Bearing in mind these considerable limitations in the cost data, it appears that in the state of São Paulo in Brazil, and in Colombia, mechanisation has led not only to higher yields per hectare but to lower costs per unit of product. In São Paulo this is because the increases in yields per hectare have more than compensated for higher costs per hectare [1]; in Colombia mechanisation seems to have led to a lowering of costs even on a per hectare basis.[2] In Paraguay also, costs per hectare appear generally to be slightly lower with mechanisation.[3]

By replacing work animals, mechanisation can free additional land to supply direct human requirements. Although this may not be very important on the large, underutilised farms of the region, even there it may make possible the concentration of production on the better land. It should be noted, however, that it is probably much more in the form of public transport for people and goods than in the form of agricultural tractors that the internal combustion engine has replaced work animals and freed land. While the number of tractors in Argentina rose from 21,500 in 1937 to 155,000 in 1965, the number of horses fell from 9.4 to 3.2 million during the same period. This would imply that one tractor replaced as many as forty to fifty horses, whereas the normally accepted ratio is five or six horses per tractor. It would therefore appear that, at least in Argentina, other vehicles have been several times more important than tractors in replacing horses.

Finally, the lightening of agricultural toil is one of the most important effects of mechanisation in the context of employment problems. A major dilemma in determining a mechanisation policy to meet employment needs is that, while tractors contribute to driving people out of agriculture, it is nevertheless difficult to see how the younger generation can be persuaded to stay in agriculture without some lightening of the work involved.

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[1] Data supplied by Divisão de Economia da Produção, Instituto de Economia Agrícola, São Paulo.

[2] Ministerio de Agricultura: *Consideraciones sobre el papel de la maquinaria en la agricultura colombiana* (Bogotá), document MIN.AGR.-OSPA-051, Mar. 1971 (preliminary), pp. 10-17, table 4.

[3] Ministerio de Agricultura y Ganadería: *Cuentas culturales, principales productos agrícolas, 1969-1970* (Asunción, 1971), pp. 3-6, 29-30, 53-54.

Employment effects

The employment effects of agricultural mechanisation must be discussed in more detail. There is abundant evidence from the developed countries of the huge displacement of labour that can be associated with mechanisation. In the United States, for instance, labour requirements for wheat production fell from 160 man-hours per hectare in 1830 to only 6 in 1930, and for other crops the figures are only slightly less spectacular.[1] Agricultural production has steadily increased, while the agricultural labour force has been falling for the past fifty years or so. Between 1869 and 1953 the labour input per hectare was reduced by two-thirds, while the machinery input per hectare rose more than sixfold.[2]

Concerning Latin America, estimates are shown in table II for Brazil, Chile, Colombia, Guatemala and Paraguay of the labour requirements per hectare for some of the main field crops, with and without mechanisation. The figures refer to the present situation in these countries, and thus do not represent the effects of full-scale mechanisation.[3] For Colombia, in addition to the inclusion of figures for the " traditional " and " modern mechanised " subsectors referring to the actual situation, largely theoretical estimates of the situation of " modern " agriculture without mechanisation have been included in an attempt to isolate the effects of mechanisation.

Labour requirements differ substantially from crop to crop, both with and without mechanisation, and this already suggests one possible line of approach to employment planning. The table shows that for barley and wheat they have been particularly sharply reduced by mechanisation in each case for which there are data. Potatoes and sugar-beet, with the highest labour requirements of all, are the least affected by mechanisation (potatoes in Colombia are the only crop requiring more labour in modern mechanised than in traditional agriculture), although it should be noted that the figures for the mechanised production of these two crops do not include the mechanisation of harvesting.

Looking at the averages for all of the main field crops together, it is of particular interest that in Colombia labour requirements per hectare

[1] Quoted by Rómulo A. Franchelli: " Síntesis de la evolución del trabajo y del rendimiento agrícola: nuestra contribución al cultivo mínimo moto-mecánico-químico ", in Instituto de Tecnología Agropecuaria, Instituto de Ingeniería Rural: *Boletín No. 24* (Buenos Aires, 1968), pp. 1-10.

[2] John W. Kendrick: *Productivity trends in the United States.* (Princeton, for the National Bureau of Economic Research, Princeton University Press, 1961), pp. 305-307 and 367.

[3] The estimates for most of the countries covered in the table are representative of two fairly sharply divided subsectors of agriculture. Where the contribution of these subsectors to the total production of each crop is known, such estimates provide a basis for employment planning. In the case of Brazil in particular, however, there is a whole spectrum of technologies, and the figures in table II can only be taken as indicative of the situation at particular points in the spectrum (apart from the fact that they refer only to a single state).

TABLE II. LABOUR REQUIREMENTS PER HECTARE, WITH AND WITHOUT MECHANISATION, FOR SOME MAIN FIELD CROPS IN SELECTED COUNTRIES

(man-days per hectare)

Crop	Brazil [1]		Chile		Colombia			Guatemala		Paraguay	
	Animal traction	Mechanised	Without mechanisation	With mechanisation	Traditional	Modern [2]	Modern mechanised	Human energy only	Human and mechanical energy	Without mechanisation	Semi-mechanised
Barley	.	.	27 [3]	8 [3]	44	(62)	6	.	.	.	.
Beans	.	.	70 [3]	50 [3]	62	(82)	18	57	44	.	.
Cotton	98 [4]	77 [4, 5]	.	.	82	(120)	66	107	94	57	26
Maize	69	43	60 [3]	35 [3]	49	(78)	30	56	44	48	8
Potatoes	.	.	75 [3]	65 [3]	125	(193)	156	162	153 [6]	.	.
Rape-seed	.	.	18	8	.	.	.	.	.	.	.
Rice, irrigated	.	.	48	33	71	(93)	36	103	54	85	26
Rice, rain-fed	127	59	.	.	42	(54)	19	.	.	.	.
Sesame-seed	.	.	.	.	52	(68)	36	.	.	.	.
Soya-beans	72	27 [5]	.	.	.	.	.	.	.	.	.
Sugar-beet	.	.	100	90	.	.	.	.	.	.	.
Sunflower-seed	.	.	45	30	.	.	.	.	.	.	.
Wheat	.	.	26 [3]	10 [3]	32	(63)	7	103	47	16	6 [7]
Average [8]	.	.	52	37	62	(90)	41	98	73	.	.

[1] State of São Paulo. [2] Theoretical situation of improved agriculture without mechanisation. [3] Irrigated. [4] Excluding harvesting. [5] With animal traction. [6] 116 with human, animal and mechanical energy. [7] Fully mechanised. [8] Unweighted.

Sources: Unpublished data for 1971-72 from Divisão de Economia da Produção, Instituto de Economia Agrícola, São Paulo; Banco del Estado de Chile, Servicio Agronómico; Ministerio de Agricultura: *Consideraciones sobre el papel de la maquinaria en la agricultura colombiana* (Bogotá), op. cit., table 4; Ministerio de Agricultura: *Síntesis de la situación del sector agropecuario de Guatemala* (Guatemala, 1963) (quoted in Thorbecke and Stoutjesdijk, op. cit., p. 106); Ministerio de Agricultura y Ganadería: *Cuentas culturales, principales productos agrícolas, 1969-1970* (Asunción, 1971), pp. 3-6, 29-30, 53-54.

are increased by 45 per cent if (theoretically) traditional agriculture is modernised without mechanisation but are reduced by 34 per cent if mechanisation is included in the modernisation package.

Assuming that a tractor is used on an average of sixty cultivated hectares and that the average working year for farm labour is 220 days, it may be calculated from the data in table II that, at the levels of mechanisation at present prevailing in these countries, the introduction of one tractor implies a reduction in average labour requirements for the main field crops amounting to 4.1 man-years in Chile, 5.7 man-years in Colombia, and 6.8 man-years in Guatemala. The smaller reduction in Chile than in the other two countries can probably be accounted for mainly by the high proportion of irrigated crops and the greater use of animal traction there (in Guatemala no animal traction at all is used in the two technologies that are compared).

Labour replacement in a particular operation or for a particular crop is not, of course, the same thing as the displacement of labour from agriculture. In theory at least, the labour released by the mechanisation of one operation can be used for other operations, such as tending and harvesting the larger crops made possible by the increased cultivated area or by multiple cropping and more careful irrigation, weeding and pest control. The labour that is released from working on one crop can be used on others, or for livestock production. Thus mechanisation may sometimes even be associated with increased total labour requirements.

There are, however, other factors that work in the opposite direction. Once a tractor is introduced for the mechanisation of a certain operation or crop, its use will tend to be extended to others. And tractors may replace draught animals, not only in operations directly related to production but also for the transport of produce, fertilisers, etc., thus releasing the labour used to look after the animals.

A major but apparently often unnoticed characteristic of mechanisation is that its effect on the actual number of jobs may frequently be greater than its effect on labour requirements. Especially by the reduction of seasonal peaks of labour demand, mechanisation tends to concentrate labour requirements on a smaller, more continuously employed labour force. Thus it affects the lives of even more people than would appear from the changes it causes in labour requirements. Many small farmers who formerly worked part of the year as hired labourers on adjacent larger farms find themselves condemned, as a result of mechanisation on these larger farms, to a subsistence-level existence on their own minute holdings.

For Latin America as a whole it is generally accepted that in the last two decades about three-quarters of the increase in agricultural production has come from the expansion of the cultivated area and only about a quarter from increased yields per hectare. Although a case is cited below where increasing mechanisation has been associated with increasing

labour use in one of the most progressive farming areas of Chile, it therefore seems unlikely that much of the labour replaced by mechanisation in Latin America has found compensating employment through the intensification of production. Many of the larger, more mechanised farms in the region are notorious for their under-utilisation of land and their owners' lack of interest in intensifying production. Probably most of the compensating employment has come from the expansion of the cultivated area, although it must be noted that by no means all such expansion has resulted from mechanisation.

Bearing in mind these factors, it would probably be fairly generous to assume that about a third of the labour released by mechanisation finds compensating employment in the ways mentioned above. Applying this adjustment to the figures derived from table II, it may be roughly estimated that about three workers are displaced by each tractor in Chile, and about four in Colombia and Guatemala.

Some further statistical evidence is available for Chile and Colombia. In O'Higgins Province, one of the most progressive agricultural areas of Chile, the most mechanised farms in 1958-59 were generally the most intensively operated and gave employment to the largest labour forces, although there was not necessarily any direct causal relationship.[1] In Cautin Province the same situation was found on the smaller farms in 1968, but on farms of 50 to 200 hectares a second tractor was associated with the displacement of about 0.5 man-years and a third tractor with the displacement of about two man-years, while on farms bigger than 200 hectares each tractor after the first displaced about four man-years.[2] These figures tend to confirm that, as the size of the farm increases, less advantage is taken of the intensification of production made possible by mechanisation and of the consequent possibility of providing alternative employment for the labour that is replaced.

For Colombia, it may be estimated from the data in table III on the number of tractors and labour requirements on farms of different sizes (in terms of cultivated area) that, in passing from the situation on farms with less than 50 cultivated hectares to those with 50 to 199 cultivated hectares, as many as 18.9 workers are displaced on the average by each tractor. In passing from the latter group to farms with 200 or more cultivated hectares, the substitution ratio drops sharply to 2.3 workers per tractor.

Being on a per hectare basis, these estimates do not make it possible to discern the effect on employment of the increased cultivated area permitted by mechanisation. Labour is calculated in terms of requirements rather than actual use. The tractor use may be underestimated by the

[1] José Olivares Díaz, op. cit., pp. 23-29.

[2] Centro Nacional de Mecanización Agrícola: *Evaluación de la maquinaria agrícola para el sector reformado* (Los Andes, 1971) (mimeographed), Ch. 4, pp. 28-33.

TABLE III. NUMBER OF TRACTORS AND LABOUR REQUIREMENTS ON FARMS OF DIFFERENT SIZES IN COLOMBIA, 1960

	Cultivated area (hectares)		
	Less than 50	50 to 199	200 and above
Total cultivated area ('000 ha)	2 276	581	466
Total tractors ('000)	5 165	4 172	6 024
Total labour requirements [1] ('000 workers)	799	150	114
Tractors per hectare	0.00227	0.00718	0.01293
Labour requirements per hectare [1] (workers)	0.3512	0.2582	0.2446
Labour replaced by one tractor (workers)	18.9	2.3	

[1] Including requirements for livestock.

Source: Basic data from Programa Regional del Empleo para América Latina y el Caribe: *Antecedentes para una política de empleo en Colombia* (Santiago, 1970) (mimeographed).

exclusion of contractual services (except to the extent that these are provided from within the same farm-size group). But, in spite of these limitations, the figures do provide a further element for consideration. They indicate that, as is indeed to be expected, the greatest labour displacement occurs in the earlier stages of mechanisation.

Evidence of a different type for Brazil and Mexico also throws some light on the employment effects of mechanisation. Information on sugar-cane production in the different states of Brazil indicates that, comparing the states where this crop is most and least mechanised, labour requirements per hectare in 1963 in São Paulo were only 42 per cent of those in Pernambuco.[1] Since sugar-cane is mainly grown under monoculture, this probably provides a fair indication of what happens to employment when this crop is mechanised in Brazil. From discussions with Brazilian officials, labour displacement also appears to have been particularly serious in some cases where traditional crops have been replaced by others, for example rice by cotton and pasture in southern Goias, and yerba mate by wheat in the south of Mato Grosso.

The rapid increase in Mexican agricultural production in recent years has been associated with a steadily falling share of labour input and a steadily rising share of machinery investment. Hired labour has been displaced particularly in those areas where the demand for it was previously greatest. It has been calculated that if the *ejidos* (common land farms) achieved their present level of output with the more mechanised techniques used on the larger farms, almost a million further workers would be displaced. If all of the country's present agricultural production

[1] Instituto Brasileiro de Economia, Fundação Getúlio Vargas: *Pesquisa sobre condições e custos de produção da lavoura canavieira* (Rio de Janeiro, 1965).

were accounted for by large farms with their current techniques, 2.3 million workers would be displaced. In both cases, of course, the remaining labour force would have much higher productivity and income levels than at present.[1] This is an encouraging prospect for the future, but for the time being it would mean that most of the existing labour force would be out of work.

The information summarised above is all that has been found to indicate the effects of mechanisation on agricultural employment in different parts of Latin America. It is obviously quite insufficient as a basis for any reliable quantitative estimate of these effects in the region as a whole. However, it does show definitely that labour has been displaced by mechanisation, and that the displacement may possibly have been very large. Taking, purely for illustrative purposes, the rough estimate, arrived at earlier, of about four jobs displaced by each tractor in Colombia and Guatemala, this implies that a total of approximately 2.5 million jobs have been displaced by the tractors at present in use in Latin American agriculture. All the indications are that this is a highly conservative estimate.

As regards the future, it appears that there will be less labour displacement if mechanisation is intensified mainly where there is already a substantial amount and more if it involves new areas that are only just beginning to mechanise.

Employment in agricultural machinery industries

An assessment of the total employment effects of mechanisation must also take account of the employment generated by the manufacture, distribution, maintenance and repair of agricultural machinery. It is often argued that this goes a long way towards offsetting the displacement of agricultural labour by mechanisation, but the limited available evidence for Latin America suggests that this is not so.

Argentina's agricultural machinery industry, which is the biggest in the region, accounting for half of the total production of the LAFTA countries and supplying 94 per cent of the national market, employs about 20,000 people directly and probably a similar number in ancillary activities. Mexico's much smaller industry directly employed less than 7,000 in 1965 (excluding tractor production). There is also some separate information on employment in tractor manufacture in Argentina and Brazil.

These are unfortunately the only employment figures available.[2] But using them to make fairly generous estimates for the other countries, and

[1] Centro de Investigaciones Agrarias/CIDA, op. cit., p. 632.

[2] They must be regarded as only the roughest approximations. In particular the figure for ancillary employment probably includes people concerned with other inputs as well as machinery, while a bias in the other direction is the omission of those employed in the production of intermediate goods.

TABLE IV. ESTIMATED EMPLOYMENT IN AGRICULTURAL MACHINERY MANUFACTURE, DISTRIBUTION, MAINTENANCE AND REPAIR IN LAFTA COUNTRIES

Country	Agricultural machinery			Employment				
	Domestic manufacture		Total sales [1]	Domestic manufacture		Intermediate products [2]	Ancillary [3]	Total
	Tractors	Other		Tractors	Other			
	US$ ('000 000)			('000)				
Argentina	67	50	122	5	15	7	20	47
Brazil	50	28	98	2	17 [4]	6	16 [5]	41
Mexico	18	8	87	1 [6]	7	2	14 [5]	24
Others (8)	—	8	129	—	5 [4]	2	21 [5]	28
Total	135	94	436	8	44	17	71	140

[1] Including imports. [2] Based on estimate of 34 per cent purchases on the internal market in Argentina. [3] Distribution, maintenance and repair of agricultural machinery (including imports). [4] Applying the average of the Argentine and Mexican ratios to production. [5] Applying the Argentine ratio to total sales. [6] Rough estimate.

Source: Basic data from LAFTA, op. cit., pp. 11, 13, 18, 82, 85, 179, 343. The basis of the additional estimates is indicated in the footnotes.

adding a very rough estimate of employment in backward-linked industries producing intermediate goods, it seems likely that total employment in agricultural machinery manufacture and related activities in the eleven LAFTA countries is less than 150,000 (table IV). Although these jobs are at much higher productivity and income levels than agricultural jobs, their number is almost insignificant in the over-all employment situation.

Tractor manufacture appears to employ particularly little labour. In Argentina 4,544 persons were employed on 31 December 1968 in an industry that produced an annual average of 9,418 tractor units in 1968 and 1969. In Brazil, where the industry is much more horizontally integrated with automobile manufacture, 1,978 persons were employed in 1968 in the production of 9,644 tractors. The total investment in the existing factories is estimated at US$ 48 million in Argentina and 10 million in Brazil, although the latter figure, particularly, should probably also include some share of the investment in the automobile industry.

These two cases suggest that an investment of up to US$ 10,000 is required to create one job in tractor manufacture, which will produce from two to five tractors each year. Possibly, with some additional investment, one further job may be associated with the distribution of these tractors and the maintenance and repair of the existing stock (although many of these ancillary jobs will already have been created on the basis of imported tractors) and about one-third of a job in backward-linked industries. Thus, only about 2.3 non-agricultural jobs result from the production of two to five tractors a year, or one such job from the

production of 0.9 to 2.2 tractors. This number of tractors is produced year after year and, assuming that about 10 per cent of them go to replace worn-out stock rather than adding to the total number, the addition to the tractor stock associated with the creation of one non-agricultural job amounts over ten years to between eight and twenty tractors. Even the lower number could, on the basis of the estimates for Colombia and Guatemala discussed earlier, be associated with the displacement of upwards of thirty agricultural workers every ten years. Thus there is little doubt that the net employment effect of tractor production and use is very substantially negative.

Factors stimulating mechanisation

Most of the agricultural machinery in Latin America is owned by large-scale, private farmers.[1] The reason why they have chosen to mechanise is obviously because it has proved profitable and convenient to them. Some aspects of the profitability of mechanisation will already have emerged from the account of costs and returns provided above in discussing the effects of mechanisation. But a number of factors have enhanced both the profitability and convenience of labour-saving mechanisation to the larger farmers in the labour-surplus economies of Latin America. Factor prices have tended to be distorted, so that the private entrepreneur (in industry as well as in agriculture) has had to pay for capital at less than its opportunity cost to society as a whole and for labour at more than its opportunity cost.

Factors affecting machinery costs

The complaint is frequently made that farmers in most Latin American countries have to pay something like twice as much for imported tractors as is paid by farmers in the developed countries where the tractors are produced. This has not, however, prevented the fairly intensive mechanisation of agriculture in quite a number of areas.

Indeed the foreign exchange component of the cost of imported agricultural machinery may actually be less (in terms of local currency) than it ought to be in view of the scarcity of foreign exchange in the economy as a whole. Exchange rates tend to be overvalued in most developing countries. Although no satisfactory method has been devised for measuring the extent of this overvaluation, the frequency and magnitude of currency devaluations in so many Latin American countries would certainly suggest that at most given moments it is substantial.

[1] The main exceptions are those used in the socialised agriculture of Cuba and that belonging to government machinery pools in other countries (especially in the reformed sector following land reform) and private machinery contractors (particularly important in Argentina).

Most of the governments of the region have made considerable efforts to promote mechanisation. Farm machinery is exempt from import tariffs in most countries, except for those items which are produced domestically in substantial quantities, and domestic production enjoys considerable tax exemptions. Credit for the purchase of a tractor or other farm machinery is obtainable from government institutions for 70 to 100 per cent of the purchase price at much less than the commercial rate of interest. Some governments have attempted to lower machinery prices through various measures to rationalise distribution (e.g. the bulk purchase imports in Chile) and controlled prices.

In contrast to the purchase price of tractors, tractor fuel is much cheaper in most of Latin America than in very many developed countries. In a number of Latin American countries free training is provided at government schools for tractor drivers and mechanics, although this appears in general to be insignificant in relation to the number of new tractors added to the stock each year.

Government support for mechanisation has tended to fluctuate from year to year, mainly according to the availability of foreign exchange. The fact that in Latin America generally there was less foreign currency available in the 1960s than in the 1950s has already been noted, and in several countries imports of agricultural machinery and spare parts have been stopped completely from time to time. Deteriorations in the terms of trade for agricultural exports have also tended to reduce the incentive to mechanise (although, equally, the sudden boom in these terms of trade as a result of the Korean War in the 1950s provided a major stimulus for mechanisation).

Perhaps the greatest anomaly in government support for mechanisation is that, while farm machinery is generally exempt from import tariffs, spare parts for such machinery are sometimes subject to a heavy import duty. This is highly surprising, in view of the need for the countries concerned to make the best use of the capital equipment that can be afforded by the economy.

But in general it seems that deliberate government efforts to promote mechanisation have been somewhat dwarfed by what may be described as more extraneous factors. Overvalued exchange rates have already been mentioned. The provision of subsidised credit for machinery purchase has also had some unexpected results.

In the conditions of rapid inflation prevailing in many Latin American countries, the average rate of interest effectively charged by public institutions in recent years for an agricultural machinery loan has frequently been negligible or even negative—roughly speaking from –6 to –13 per cent in Argentina, Brazil and Venezuela, for example, so that farmers have therefore had to pay back only from 50 to 80 per cent of their loans.

At least two governments have taken steps to stop these gains from inflation.[1] In Uruguay machinery and other loans obtained under the Livestock Programme are now adjusted according to the rate of inflation. In Chile it was found in the early 1950s that, because of the high rate of inflation and a preferential exchange rate, farmers had to pay back only about half of the agricultural machinery loans obtained from the *Corporación de Fomento de la Producción* (CORFO). It was decided that this rate of subsidy could not be continued, and CORFO loans were therefore suspended from 1955 to 1960. Much of the demand for loans was transferred during this period to the State Bank on less favourable terms (i.e. a higher interest rate reduced the gains from inflation), and agricultural machinery imports dropped from US$ 17 million in 1955 to 9.2 million in 1956. Since the CORFO credits were resumed in 1960 they have been adjustable in line with inflation. Although agricultural machinery imports have picked up again, they have generally remained below the 1955 level. Partly, of course, this reflects the expansion of domestic production and also foreign exchange difficulties. But, like the rate of inflation, this latter factor is accidental rather than a reflection of government mechanisation policy.

Factors affecting labour use

The trends outlined above have been accompanied by a number of developments which have raised the cost of hired labour well above its opportunity cost in labour-surplus economies. Many Latin American countries now have minimum wage regulations and many also have social security systems which greatly increase the cost of employing labour. Although both of these measures are much less effective in agriculture than in manufacturing industry, partly because of the isolation of many rural areas and because a portion of the agricultural wage is often paid in kind (including housing) rather than cash, they are gradually becoming more effective, and especially on the large, progressive farms that have been the major employers of hired labour. For example, social security payments nominally add about 40 per cent to the wage bill in Chile, about 20 per cent in Peru, and almost 50 per cent in Argentina.

While minimum wage and social security regulations must undoubtedly be defended as a fundamental and often hard-won part of workers' rights, it is important to be aware of their effects on the use of the different factors of production in Latin American agriculture. They have

[1] Similar steps may also shortly be taken in Brazil, where an expert committee is examining the effects of fiscal and related policies on employment. While some government loans are already subject to adjustment in line with the rate of inflation, this does not yet apply to agricultural machinery loans. There is, however, some limitation on the inflationary gains, since the purchaser never sees his loan, which is paid direct to the seller of the machinery in instalments, with the result that the purchaser loses the 25 per cent discount for cash purchases.

clearly contributed to a substantial rise in the cost of employing hired labour in some areas in recent years. In Brazil, although social security payments for agricultural workers come out of a special fund (the FUNRURAL) derived from production and sales taxes, minimum wages (which are the same in agriculture as in industry) and related social legislation, combined with changes in the legislation regarding share-croppers, appear to have led to a substantial reduction in the permanent agricultural labour force in the state of São Paulo and increasing reliance on casual labour paid by the day. In Uruguay it has been recognised that social security payments tend to act as a tax on the employment of labour and for agriculture they are now assessed per hectare instead of per worker. Changes in the incidence of social security payments are also under consideration in Argentina.

The effect of minimum wage regulations is sometimes accentuated by trade union activity. Thus on the Paramonga sugar estate in Peru the cost of cutting cane by hand has been bid up by the permanent labour force to the equivalent of about 30 soles per ton, compared with about 10 soles at the statutory minimum wage and the cost of about 4 soles per ton at which the factory is able to obtain cut cane from surrounding farmers, who cut by hand at a much higher level of productivity. The estate has therefore reduced its labour force to 120, as against the 500 required to cut all of its cane by hand, and is cutting most of its crop by machine at a cost of about 20 soles per ton.[1]

Even where labour is still cheap, it is much easier on large farms to organise the work of a few skilled machinery operators and their equipment than that of large numbers of unskilled workers and the associated numerous draught animals. The latter require careful rearing and attention, and their feed requirements are substantial (generally about 1 hectare per animal).

But above all the attractions of hiring more labour are nowadays severely limited by the social unrest that is spreading increasingly from the towns to the countryside.

Others factors

While the above factors affecting the relative profitability and convenience of using machinery or hired labour have probably been the major ones in stimulating agricultural mechanisation in Latin America, a number of other factors have also contributed. Some are less rational, including the prestige associated with the possession of tractors and other mechanical equipment and the consequent difficulty of resisting the lure of the glossy catalogues of the machinery manufacturers and their high-powered salesmen.

[1] Unpublished study by T. Alberts.

At the national level tractorisation has tended to seduce governments anxious to modernise agriculture. International loans have been fairly easily obtainable for mechanisation projects and have financed many of the credit schemes for machinery purchase by farmers. Each of the LAFTA countries has received one or more agricultural machinery loans from the World Bank, the Interamerican Development Bank, the United States Eximbank, or the United States Agency for International Development. There are also many other government and commercial credit arrangements for the import of machinery. Some have been on such easy terms as to amount to the " dumping " of surplus production, and there is at least one case of tractors produced in Latin America being dumped at marked-down prices in a neighbouring country.

The attitude of many of the foreign technicians advising developing countries is affected by the situation of labour shortage and high-cost labour familiar to them in their own countries. Similarly, many of those nationals now running large farms or in responsible positions in ministries of agriculture in Latin America were exposed to such conditions during their early training in North America and Europe. In those cases where foreign advisers have advocated simpler forms of mechanisation, including improved animal draught equipment, they have often met with a stony reception from these people.

The tendency for Latin American countries to produce or assemble their own tractors, which is likely to gather force in the context of the various regional integration schemes, will probably add to the pressures favouring the use of tractors.[1] All of the tractor factories in the region are operating at far less than full capacity (several have had to go out of production already), and are therefore very interested in exporting under preferential regional arrangements. They appear to have been established on the basis of over-optimistic projections of future demand. The fact that they are almost totally dependent on government credit schemes for the purchase of their products indicates the strength of the likelihood that they may prove a major force in urging governments to pursue a mechanisation policy.

Finally, a major consideration is the virtual absence of any readily available technological alternative to fairly advanced labour-saving mechanisation. Only about 6 per cent of the world stock of agricultural tractors is in the developing countries, and they represent so small a proportion of the total market for agricultural machinery that the manufacturers in developed countries have understandably taken little interest in devising types of machinery that are specially suited to their conditions. These manufacturers, together with the commercial importers of their equipment, have to a large extent called the tune in setting the pattern of

[1] The LAFTA study already cited proposes a substantial intra-regional trade in tractors and other farm machinery if preferential arrangements can be worked out.

mechanisation in Latin America. Thus, the average horse-power of the tractors in use in Latin American countries has followed, even though a good way behind, the rising trend in the developed countries. And some types of animal-draught equipment are becoming increasingly difficult to import.

Governments and manufacturers in the Latin American countries themselves have shown hardly any greater interest in devising more suitable types of machinery. There are a number of university departments and specialised institutes working on this question, but their investigations rarely go much further than the testing of different types of imported machinery. Moreover, these investigations are normally carried out in the limited context of agricultural engineering rather than in the broader one of agricultural technology as a whole.[1]

Government policies

Past government policies concerning agricultural mechanisation have thus been somewhat haphazard and inconsistent. The level of support for mechanisation has fluctuated, and the measures taken have revealed curious inconsistencies such as the exemption of machinery but not spare parts from import tariffs. In addition to the deliberate government measures to assist mechanisation, the use of capital equipment rather than labour has received considerable, and presumably unintended, stimulation from such factors as overvalued exchange rates, rapid inflation, and the gradual extension of minimum wage and social security provisions to the agricultural sector. Moreover, in most countries the government assistance has been indiscriminate in that there has been little control over the types of machinery for which, for example, credit has been extended.

Consistent, clearly defined agricultural mechanisation policies have always been needed in order to ensure that the best use is made of the important part of the scarce capital and foreign exchange invested in agricultural development. But the present employment crisis increases the urgency of the need for such policies and adds a new dimension to them.

Development economists, who until recently were emphasising the role of agriculture in " releasing " labour to the other sectors of the economy, have now generally recognised that the population explosion has grown up into an explosion of hands to be employed as well as mouths to be fed, and that for some time to come many of these additional hands must continue to be employed in agriculture if they are to find any employment at all. Governments too have become sharply

[1] This has been recognised in Argentina, where one of the purposes of the recent reorganisation of the *Instituto Nacional de Tecnología Agropecuaria* is to ensure that machinery research is more closely integrated with that concerning other aspects of agricultural technology.

aware of the employment crisis, including its political implications. Virtually all Latin American governments now list employment promotion as one of their principal development objectives. But few of them have yet got very far in working out the detailed policies and measures required to attain this objective. This is particularly the case with agricultural mechanisation and related technological policies, which, it is contended here, can have a powerful effect on the volume of employment.

The experience of the developed countries affords little positive guidance on the type of policy needed at the present stage in the developing countries. Mechanisation in the developed countries took place over a long period, and was accompanied by low rates of population growth and the rapid expansion of non-agricultural employment. People were sometimes thrown out of work by the introduction of agricultural machinery, but generally they were soon able to find alternative employment. Almost all of the existing types of agricultural machinery have been devised to meet the needs of these countries, where the most rational use of productive resources involves the steady displacement of scarce and costly labour from agriculture into more productive employment in the rest of the economy. In most of Latin America, in contrast, labour is not scarce, and the rate at which it can be displaced from agriculture is very far as yet from being a limiting factor in development.

There is still a widespread reluctance to believe that mechanisation actually displaces labour. This is to ignore what is perhaps the most relevant aspect for the developing countries of the experience of the developed countries in regard to agricultural mechanisation. Although the estimates of the displacement of labour by mechanisation hazarded in this article are not intended to be taken too literally for the purpose of measuring what has happened in Latin America, they should leave little doubt that labour must have been displaced and that the quantity involved may have been quite large. They should also make it clear that the effects on actual jobs, and thus on people's livelihoods, may often be far greater than on the purely statistical concept of " labour requirements ". Certainly mechanisation is by no means the only cause of rural-urban migration, but it could be a major factor in accounting for the considerable margin by which the rate of such migration exceeds the rate at which urban jobs are being created.

The policies that are needed in Latin America at the present time have been defined as policies of " selective " or " planned " mechanisation, in contrast to the somewhat haphazard approach followed hitherto. The details of such policies have so far been worked out mainly in the context of the so-called " Green Revolution " in certain densely populated, tropical Asian countries, and it is necessary to try to define them further for Latin American conditions.

Selective mechanisation would attempt to limit further mechanisation for the time being to what is strictly essential for meeting production

targets, and would exclude any mechanisation whose only purpose is to save labour. It has generally been envisaged primarily in terms of particular operations in the agricultural calendar. Soil preparation, for example, would be mechanised where this is necessary to expand the cultivated area, or to overcome seasonal labour bottlenecks in arid zones or in tropical zones where multiple cropping is possible. Similarly there would be no objection to the mechanisation of such operations as the pumping of irrigation water or the sowing and harvesting of artificial pastures, or of storage, processing and other post-harvest operations in circumstances where they would not lead to any appreciable reduction in employment. But generally speaking it would be necessary to avoid the mechanisation of post-planting operations, which can be performed over a fairly long period without incurring labour bottlenecks, and of harvesting (except where this has to be performed extremely rapidly).

There are also some other possible approaches to selective mechanisation, all of them to some extent overlapping with one another and with the approach outlined above. It could be thought of mainly in terms of particular crops [1], so that restrictions would be placed on mechanisation in the case of those which at present make the largest contribution to employment—such an approach has been suggested for Brazil.[2] Another possibility is a regional approach, in countries where there are substantial regional differences in the level and type of agricultural technology (again Brazil is a good example). Finally, in countries where there is a sharp division between a traditional and a modernised subsector of agriculture—the Andean countries for instance—these two subsectors may provide the basis for selective mechanisation. A methodology for this approach to agricultural employment planning is being elaborated in the FAO's perspective study of agricultural development in South America.

Each of these approaches has its difficulties and disadvantages. The implementation of a policy based on the mechanisation of certain operations and not of others is likely to give rise to considerable administrative problems, and these will be discussed later. The crop, regional and subsectoral approaches involve the danger of accentuating the present duality, especially as regards income distribution, in Latin American agriculture.

One further aspect must be emphasised. Selective mechanisation should be dynamic and forward-looking. The intention is not to freeze

[1] The sharp differences in labour requirements for the different crops were mentioned earlier as a possible basis for employment planning, subject of course to the limitation that the pattern of production must be largely dictated by the pattern of demand. However, there may sometimes be scope for giving preference to more labour-intensive crops, for example in countries like Chile where, in theory at least, a choice exists between expanding wheat production for import substitution or paying for imported wheat by expanding production and exports of, for instance, fruit and wine.

[2] Maria José Cylhar Monteiro and Peter Eugene Minoga: "A mecanização na agricultura brasileira", in *Revista Brasileira de Economia* (Rio de Janeiro), Vol. 23, No. 4, Oct.-Dec. 1969, pp. 71-180.

Latin American agricultural technology at an " inferior " level, but to ensure that the technology introduced is more in line with the current stage of development of the region and that its benefits are more widely spread than at present through the whole farming community. It is to be hoped that the Latin American countries will not always be in a position where increases in productivity per man must be held back because of the need to retain surplus labour in agriculture. The foundations must already be laid for the time when all the achievements of modern technology, including the most advanced labour-saving mechanisation, will be needed to raise the productivity of a declining agricultural labour force.

This consideration, together with the fact that the need for a substantial expansion of mechanisation is implied even at the present time, ought to make it clear that selective mechanisation as propounded here is a far cry from the all-out pursuit of labour intensity—the caricature so often presented of the views of those who are worried about employment.

There are two other policies that must be pursued alongside policies of selective mechanisation. First, it is imperative to ensure the best use of such capital investment in agricultural machinery as is considered desirable. This mainly implies the removal of the present anomalous restrictions in some countries on the import of spare parts (generally something like 10 per cent of the value of the tractor park should be available in the form of spare parts), the provision of more and better maintenance and repair facilities, and the training of more tractor drivers and mechanics. In most circumstances it is also probably necessary to guard against accidental de-mechanisation, resulting from the restriction of imports to a level that is insufficient to replace worn-out stock (in some countries the tractor park is already badly in need of renovation).

Second, it is essential that, for the operations, crops, regions or subsectors for which mechanisation is to be limited, an alternative technological basis should be provided, not only so that production targets can be met but also to prevent the further accentuation of dualities. Reduced emphasis on mechanisation should in fact release resources for the promotion of such improvements as irrigation and the use of better seeds, fertilisers and pesticides. It is perhaps natural that so far less attention has been paid to these yield-increasing measures in Latin America than in the densely populated, land-scarce countries of Asia, but they will have to be turned to increasingly in the future.

A considerable research effort is still needed in order to provide a fully adequate basis for appropriate mechanisation policies in Latin America. Much more information is required on the employment and other effects of the mechanisation of particular operations in the different regions and farming systems of each country. Attention should be paid to the hitherto neglected area of improved technology for the labour-intensive subsector, including better animal-draught equipment. It is

necessary to devise systems of agriculture that are capable of absorbing in other agricultural work as much as possible of the labour that is replaced by the mechanisation considered desirable.

Much would be gained if some agricultural machinery research could be conducted not purely in the engineering context, but in relation to the whole technological package and to economic, institutional and social factors as well. Some joint research at the regional level may be necessary for this purpose.

All the research that is ideally needed will take a lot of time, but this is no excuse for inaction. The problem is urgent, with unemployment and underemployment spreading rapidly, and some broad policies have to be defined immediately. There is already a sufficient basis for this to be done, as is indicated by the fact that several countries have recently tried to formulate more consistent mechanisation policies.

Selective mechanisation policies in Latin American countries

Cuba has for some time been an exception to the generally haphazard approach to mechanisation. It is, however, a special case in that, in an economy so heavily based on the monoculture of sugar-cane, the huge labour demand at the time of the harvest provides a special reason for mechanisation. The aim, already almost achieved, is the complete mechanisation of the cutting, loading and transport of the cane harvest. Mechanisation policy for other crops is less clear.

In Brazil the Government's policy is to continue to support mechanisation where it has already been introduced, but to try to promote greater labour absorption elsewhere, particularly in the north-east and in the new Amazonian settlements. Loans for machinery for the cultivation of cotton, groundnuts, maize, rice, soya-beans, wheat and artificial pastures in the centre-south are given priority. In the Amazonian settlements the policy is to promote labour-intensive methods by providing no credit or other encouragement for mechanisation, and thus to avoid what happened with the earlier settlements along the Belém-Brasilia road, when very large plots of land were allocated and there was very little increase in employment. It already looks, however, as if there may be some difficulties in implementing this policy. Many of the settlers come from the relatively modern agriculture of the centre-south, and there will be strong pressure to let them use their " know-how " in Amazonia. The domestic tractor industry, working well below full capacity and heavily dependent on government credit for the purchase of its output, is also likely to press for a change in policy.

In Chile a very detailed study has been made of all aspects of agricultural mechanisation, including the employment aspects, going down to the level of particular operations for each of the main crops in the various agricultural zones of the country. The study makes proposals

for mechanisation policy for six separate zones, based on the need to relieve employment bottlenecks at certain periods of the year and to maximise the demand for labour at other periods. It also makes recommendations concerning the measures needed for the implementation of certain aspects of mechanisation policy, such as credit, imports, and training.[1]

For Colombia, also, a number of studies have been made of agricultural mechanisation in relation to employment. In fact much more detailed proposals have been worked out for a selective mechanisation policy in Colombia than for any other Latin Amercain country so far.[2] These proposals are not yet government policy, and soon after publication they were strongly attacked by the agricultural machinery importers.[3] It is not the intention here to discuss their suitability for Colombian conditions, but it is useful to summarise them for illustrative purposes.

The proposals start from the premise that it is necessary to emphasise those types of mechanisation that provide the most effective complement to other yield-increasing improvements. In the case of Colombia these are identified as mainly the mechanisation of soil preparation and planting and of the harvesting of rice. Efficient soil preparation and planting are of crucial importance in obtaining the maximum benefit from improved seeds, and also make it possible to maximise the cultivated area. While this can be achieved with animal traction, tractors provide the essential element of greater speed. Rapid harvesting of rice frees labour for double cropping in the tropical irrigated areas. In all these operations, therefore, any adverse effects on employment should be accepted because of the production advantages. The mechanisation of irrigation is also considered to be justified, as it displaces little labour. Somewhat surprisingly, it is recommended that most pesticide application should be carried out by aeroplane. Most other types of mechanisation, in particular post-planting operations and the harvesting of crops other than rice, should not be encouraged for the present because they displace too much labour in relation to their benefits. The reduction of costs through the replacement of labour is not in line with the Government's employment policy, and should not be considered a justification for mechanisation. Increased production should be sought mainly through encouraging the use of improved seeds, fertilisers, pesticides, etc. A selective policy of this kind would, it is claimed, only very slightly diminish the addition to yields and would require an average of sixty-five man-days per hectare, which is more than the present labour intensity of traditional agriculture (see table II above). No attempt should be made to de-mechanise, but the present tractor park is probably sufficient for the mechanisation of soil

[1] CORFO, *Mecanización agrícola en Chile: diagnóstico a 1963*, op. cit., Vol. III, pp. 180-181.

[2] Ministerio de Agricultura: *Consideraciones sobre el papel de la maquinaria en la agricultura colombiana*, op. cit., pp. 31-35 and *passim*.

[3] *Maquinaria agrícola*. Special supplement to *El Tiempo* (Bogotá), 29 May 1971, p. 34.

preparation and planting, and future imports should therefore be limited to replenishment needs. Small two-wheel tractors have not yet proved themselves in Colombian conditions, and further investigations are needed.

In order to appreciate the revolutionary character of these proposals, it is worth while quoting a more conventional opinion, expressed only shortly before: " Our studies show a need for approximately 300,000 two-wheel 8 to 12 h.p. tractors and 83,000 four-wheel tractors, using 30 to 40 h.p. as a basis of calculation, for the mechanisable land presently in production"[1] (note that only about 23,000 tractors, averaging about 53 h.p., are at present in use in Colombian agriculture).

Implementing selective mechanisation

While it is not easy to formulate appropriate policies of selective mechanisation, or to get them agreed in the face of some of the vested interests involved, it is likely to be even more difficult to devise the necessary measures for their implementation.

One problem concerns the types of agricultural machinery to be encouraged under a selective policy. It is often suggested that developing countries may in many cases not need all of the elaborate innovations that have been introduced in the machinery now in production in the developed countries, as reflected, for example, in the steady increase in the size, power, speed, manoeuvrability and comfort of tractors. Simpler machines would be more in line with the mechanical skills of many of the operators in developing countries, but there might be problems in obtaining spare parts and they would not always reduce costs. For example, fewer cylinders and lower revolutions per minute do not necessarily make a tractor cheaper (or even simpler), and horse-power is cheaper in bigger tractors, which also economise on fuel consumption. Small two-wheel tractors are frequently advocated, but (except in the case of their use by the market gardeners of Japanese extraction in the state of São Paulo, Brazil) they have not generally proved suitable for Latin American agricultural conditions so far. Several Latin American countries are trying to rationalise their machinery imports by limiting the number of makes but, while this has some advantages, it should probably not be carried too far—" matched quality equipment, not make " should be the over-riding consideration.[2]

But the main problems are likely to concern government fiscal and related policies, rather than these engineering questions. If the factor proportions used in Latin American agriculture are to approximate more

[1] University of Nebraska, Mission in Colombia: *Five-year plan 1971-1975* (Bogotá, 1970), p. 135.

[2] C. M. Downing: *Selection and adaptation of farm machinery for local conditions* (Rome, May 1971), FAO document AGS:MIS/71.47, p. 6.

closely to the factor endowments of the countries concerned, these policies will have to be modified so that the prices paid by farmers for the different factors of production are closer to their opportunity costs.

The most obviously necessary modification is to remove the gains from inflation obtained by those who take government loans for the purchase of agricultural machinery. The experience of those countries that have so far attempted to tie such loans to the rate of inflation indicates, however, that there are considerable administrative problems. While ideally the rate of inflation should be calculated separately for the producers of different crops, in practice it is difficult to use more than one over-all index of inflation, which will obviously cause discontent among those producers whose economic situation has not moved in line with that of the country as a whole.

Government credit is the most powerful tool in implementing a policy of selective mechanisation, especially as such a large part of the agricultural machinery in use in Latin America is purchased with the help of such credit. The granting of credit in line with a selective policy may prove administratively difficult, but some way of doing it has to be found. It would probably be easier if the policy were applied on a crop, regional or subsectoral basis than on the basis of the mechanisation of particular operations, although (as already noted) these approaches present other disadvantages.

The Colombian proposals for selective mechanisation go so far as to suggest restrictions on tractor imports, and raising the price of tractors through tariffs or taxes. While any proposals to tax agricultural inputs should be looked at very carefully, it must be admitted that in most countries the use of machinery has been quite heavily subsidised up to now. The normal purpose of a subsidy is to promote the use of a new input and, once the use of this input becomes established and the subsidy consequently becomes costly, there is much justification for dropping it. Moreover, administratively simple means of taxing the agricultural sector have to be found. In India recently a tax on fertilisers was introduced, with apparently no substantial effects on fertiliser consumption. A special problem involved in taxing agricultural machinery, however, is that under a policy of selective mechanisation exemptions would probably be needed for certain types and uses of machinery, and exemptions notoriously give rise to administrative abuses.

On the labour side, other countries would do well to study the arrangements in force in Brazil and Uruguay under which social security payments for agricultural labour do not operate as a tax on labour use. At first sight it would seem tempting to try to devise some system whereby at least part of minimum agricultural wages could be paid in a similar way. However, it would be administratively very difficult to implement such a system without considerable risk of evasion. Probably, therefore, no attempt should be made to alter minimum wage systems.

Efforts to reduce the present deliberate and accidental subsidisation of agricultural machinery will have to overcome the political opposition of the larger farmers and the machinery producers and importers. Some of the farmer opposition might be lessened by simultaneous improvements in guaranteed price systems for agricultural products.

Although the reduction of subsidies would greatly affect the private profitability of using agricultural machinery, it is far from certain that it would have much effect on farmers' decisions concerning the extent of their use of machinery or hired labour. Minimum wages will continue to spread, and such decisions are also influenced by non-economic considerations, including the difficulty of organising the work of large numbers of labourers and the growing social unrest in the labour force. Many Latin American *latifundistas* (large landowners) would probably react by lowering the intensity of land use still further rather than by increasing their labour force.

This does not mean that measures should not be taken to raise the private cost of buying and using farm machinery so as to bring it nearer to the opportunity cost of capital. This would have important consequences for capital allocation in the economy, and in particular would free more resources for the supply of credit to the areas where mechanisation is not considered appropriate.

Provided adequate measures were taken at the same time to raise the level of production in the non-mechanised subsector, it would also reduce the tendency for the large mechanised farms to pre-empt most of the increase in market demand. It is sometimes argued that, because so much of the marketed food supply and the majority of agricultural exports come from the large-scale, relatively highly mechanised farms, government assistance should continue to concentrate on them. Although such a policy might possibly be justified in the case of certain specialised crops, and although it would make it easier to provide extension services, if applied at all generally it would preclude any possibility of increasing labour absorption in agriculture.

Probably the best approach to the implementation of selective mechanisation and agricultural employment planning is to aim at ensuring that as much as possible of the future production increase comes from the small farm, non-mechanised, subsector. In many Latin American countries this would imply changes in the present agrarian structure, so as to expand this subsector. Thus the mechanisation and employment issue provides yet another argument for land reform. At the same time, however, it would be essential to ensure that the co-operatives being set up under most systems of agrarian reform do not go all out for the economies of large-scale production and advanced labour-saving mechanisation.

There is abundant evidence that labour intensity is much greater on the smaller farms of Latin America. Concentrating on these farms would

in fact get round the problems of minimum wages and the opportunity costs of labour, for the attitude of the small farmer to the cost of his own and his family's labour is generally totally different from that of the large farmer to the cost of hired labour. The small farmer is also more ready to devote the necessary care to draught animals, although less able to spare land for feeding them. Where agricultural machinery is essential on small farms, it can be provided through various systems of joint use, including co-operatives, or through private or governmental contractors, and the latter should be able to ensure the necessary selectivity.

Lower production costs are often mentioned as being among the advantages of agricultural mechanisation, and such costs are certainly a major issue both as regards urban food supplies and exports. But it should be realised that the low private costs of mechanised production involve considerable subsidisation at the level of the economy as a whole. Production costs in the traditional subsector work out at much less if family labour is not valued at the cost of hired labour, and they can be lowered still further if measures are taken to reduce the cost of such inputs as fertilisers. There is also still ample scope for reducing consumer prices by means of marketing improvements. Thus it should be possible to obtain a sufficient part of the necessary production increase for most crops from the labour-intensive subsector, and at a low enough cost.

Finally, the need to lessen the heavy toil involved in so much agricultural work could well prove to be the Achilles' heel of policies designed to slow down mechanisation in order to retain more labour in agriculture. Even family farmers, who cannot set a very high price on their labour, are coming to value their leisure increasingly highly and to expect the burdens of their work to be lightened by some mechanisation. For the same reason those beneficiaries of land reform who were formerly hired labourers on farms with a fairly high level of mechanisation tend to want to continue working under the conditions to which they have become accustomed.

However, the need to wait longer for the full-scale application of science and technology for this purpose would probably be more readily acceptable if governments were to make much stronger efforts than at present to reduce the serious imbalance between the general amenities of urban and rural life. What are really needed are coherent employment policies that recognise all the implications (especially those concerned with social investments) of attempting to slow down rural-urban migration. Many of the difficulties would be greatly eased if governments were to work out with due care selective mechanisation policies in line with the priorities of economic and social development, and if they were then to make sure that such policies were widely known and understood.