

UNITED NATIONS
ECONOMIC
AND
SOCIAL COUNCIL



S2795

Distr.
LIMITED



E/CN.14/CAP/19
29 August 1967

Original: ENGLISH

ECONOMIC COMMISSION FOR AFRICA
Conference of African Planners
Second session
Addis Ababa, 4-15 December 1967

PLANNING FOR INNOVATION IN AFRICAN AGRICULTURE

M67-975

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The views expressed are those of the author and do not necessarily reflect those of the secretariat of the United Nations Economic Commission for Africa.

PLANNING FOR INNOVATION IN AFRICAN AGRICULTURE

If farmers in Africa are to grow more food and raw materials, they will generally have to adopt new techniques. Many economists believe that profits will provide the incentive to employ these improved methods. There seems to be a good deal of evidence to show that poor peasant producers are, in fact, often extremely responsive to opportunities for gain once they are convinced that such opportunities really do exist. The coffee growers in East Africa and the cacao farmers of West Africa are cases in point. Considerable evidence has come forward that Africans do respond to market conditions. They are anxious to maximize their monetary returns. They do follow profit, whatever dictates it may make. There are, of course, exceptions, but it seems that these remarks form an increasingly acceptable generalization. Gain, profit, call it what you will, constitutes a powerful incentive for change throughout many, if not most, parts of the underdeveloped world. The larger the profit is and the longer it can be sustained, the more likely is a hitherto poor agricultural beneficiary to work his way out of the vicious circle of poverty, ignorance, malnutrition and consequent low production. This, then, is the background against which planning in a mixed economy must be sketched.

We can define profits as equalling net rural product (gross rural product less depreciation allowances) minus payments to land, labour and capital. The rural economy is assumed to be taxless as well as free from net non-rural investment. The incentives for rural entrepreneurs to initiate an expansion in production will occur when this difference is expected to be positive. In equilibrium, factor costs will equal net rural income. There will then be no profits and no incentive to expand production. This equilibrium will only be disrupted if produce prices alter, or if some innovation in

production technique or product-type occurs. When equilibrium is disturbed by changes in market prices, any increases in revenue will be passed on to the factors of production in the form of rents or quasi-rents. But when innovation occurs, returns over and above factor costs will accrue to the innovator or entrepreneur in the form of profits.

Prior to an innovation, then, net rural income equals factor payments: i.e. the earnings of land labour and capital. Once an innovation is adopted, income rises above these factor costs and total profits occur in the rural economy equal to the difference between the two. The innovation will be adopted over an ever wider area and an ever-larger producing population until the added demand for land, labour and capital thus occasioned causes their cost, taken together, to rise up to the new income levels which can be earned. Profits disappear at this point and net rural income is once again in equilibrium; that is to say that there are no forces at work to cause further increases in production. Expansion associated with the innovation in question ceases and growth must wait upon further opportunities for the entrepreneurially inclined farmer to exercise his skill.

So it is that the magnitude and speed of rural growth associated with innovation can be conveniently discussed under the conditions governing the size of the additions to net rural product arising from an innovation as well as the increases in factor costs which are likewise likely to occur. Thus, criteria for indicative planning in African agriculture should emerge from an analysis of the determinants of net rural income and factor prices associated with any particular round of innovation.

I. THE DETERMINATION OF NET RURAL INCOME WITH INNOVATION

The more rapidly an innovation is adopted by the farming population, the larger the gain to each individual farmer, and the bigger the farming population able and willing to employ the new technique, the better will the innovation be from the point of view of society as a whole. This, then, gives us the first set of objectives which we must name in choosing the most advantageous types of innovation. The appropriate criteria for achieving these objectives are: (1) The size of the expected gains in value of output per unit of input with a new technique; (2) The size of what we shall call adoption ratio for the new technique, (3) The size of the potential innovating population, and (4) The price elasticity of demand for the product undergoing the innovation. If African Planners observe these criteria in the way which we will describe, increases in net rural product associated with an innovation will be maximized and/or the attainable gain will be accomplished in the shortest possible time.

1. The expected gains in output per unit of input with a new technique

This is the most obvious of all considerations governing the magnitude of net rural product growth arising from a particular innovation. Clearly, the more the new technique increases the value of the product of each unit of land, labour and/or capital, the more rapid and the more extensive will the increase in net rural product prove to be as innovation, demonstration and imitation take place.

2. The size of the "adoption ratio"

The process of innovation will run as follows in an underdeveloped rural area. Government agricultural extension agents or the salesmen of, say, a fertilizer company will succeed in persuading a group of farmers to adopt a new technique of production. If the new technique

shows added returns over and above added costs, the demonstration effect should take over. This, plus the continued efforts of extension agents or private salesmen,^{1/} will encourage other farmers to adopt the new technique. The demonstration effect as between one farmer and another will rapidly become the most important consideration in spreading the new technique. It will probably show some fairly clear arithmetic relationship from one period to another. If two farmers can be persuaded to use fertilizers successfully in the first period, then it may be that four imitating neighbours will appear in the next, eight in the next, sixteen in the succeeding period, and so on. This adoption ratio $\left(\frac{\text{numbers of farmers adopting the innovation in period } t + 1}{\text{number of farmers adopting the innovation in period } t} \right)$ may, of course, fluctuate if barriers to communication, such as a range of hills or a tribal boundary, interrupt the smooth process of demonstration and imitation. But the size of the adoption ratio will be an important factor in determining the speed at which a particular new technique or crop will spread. Therefore, agricultural planners in Africa should look into factors governing the size of the adoption ratio when it comes to frame their innovation policy.

Some considerations are more obvious in this respect than others. For instance, the size of the agricultural extension service, the extent of the facilities for the dissemination of market information, taken

^{1/} See William O. Jones, "Increasing Agricultural Productivity in Tropical Africa", in, E.F. Jackson (Ed.), Economic Development in Africa (Oxford: Basil Blackwell, 1965), p.39.

with the general level of education^{1/} and widespread opportunities for gaining experience, are all fairly clear-cut examples of factors affecting the size of the adoption ratio. But less manifest perhaps is the importance of risk when it comes to innovation among peasants who operate at close to the subsistence levels.

A farmer may feel that he and his family will starve or lose their land to creditors if a new technique fails; the possibility of loss will be given even greater weight in his decision than where failure would simply mean a temporary reduction in his standard of living. In these circumstances the rate of adoption of an innovation will be slow even where the probability of gain is very much greater than the probability of loss.^{2/} A government can increase the adoption ratio connected with a particular innovation by offering to underwrite whatever risk exists.

3. The size of the potential innovating population

Clearly, the farming population which is available to adopt a new method of production will eventually be exhausted. The added number of farmers using fertilizers, for example, cannot go on doubling or trebling in each succeeding period forever. There would not be sufficient farmers in any region or nation to allow this. Thus the size of the potential adopting population would place a limit on the magnitude of income expansion arising from a particular innovation. The pyrethrum grown in East Africa is a case in point. It can only be grown at certain very high altitudes and land suitable for its cultivation is always particularly scarce. Therefore, a government may be well advised

^{1/} It should be noted that it is often claimed that "formal" education induces contempt for agricultural pursuits or otherwise leaves traditional techniques of production unaffected [see, for example, Jones, op.cit., p.32; C.Davis Fogg, "Economic and Social Factors Affecting Smallholder Agriculture in Eastern Nigeria," Economic Development and Cultural Change, Vol. XIII, No. 3 April 1965, p. 288/

^{2/} The January-March 1964 issue of the Indian Journal of Agricultural Economics has a large number of articles devoted to this subject of risk.

to choose to concentrate extension service efforts on crops which may be grown over the widest possible area and/or by the largest possible population.

4. The price-elasticity of demand for the crop undergoing an innovation

Increased productivity with regard to a particular crop will ultimately cause its unit price to fall, although some innovations may be of the kind which improve product quality and thus initially increase the unit price, and so the rate at which rural income can grow. Nevertheless, the rate at which the value of the net rural product increases will eventually be arrested if this added produce so clutters up the market that prices fall quite sharply.

The market for any one product may be limited without heavy capital expenditure on roads, railways and other distribution facilities. In these circumstances, African planners may feel it wise to push innovations in crops which will face the perfectly elastic demand in the world market.^{1/} If this is done, price falls in a narrow market will not cut off income growth before the potential innovating population has been exhausted.^{2/} Although it must be remembered that many African countries export crops under favourable quotas granted by importing nations. If these quotas are exceeded, added production must be sold at what are generally much lower world-market prices.

^{1/}In an article on Central Africa R.E. Baldwin ("Export Technology and Development from a Subsistence Level," Economic Journal, Vol. LXXIII, No. 289, p.80) pointed out that "expansion in the export field requires only the development of marketing arrangements to send products out of (a) country instead of a complete marketing structure to reach the individual consumer".

^{2/}There is a growing body of evidence that farmers in developing countries are as responsive as Westerners to price changes when it comes to allocating acreage (see, for example, C. Davis Fogg, op.cit., p. 285). Thus it may be that African planners need not worry unduly about any ultimate declines in the value of the net rural product consequent upon innovation. They should simply try and encourage those crops with which as large a population or acreage as possible will benefit from the innovation before such price declines occur; i.e. crops with a highly elastic demand.

In summary, then, planning for innovation must be in accordance with the dictates of potential gain in rural income in each succeeding period, as well as the speed at which these gains can be realized. The magnitude of the increase in rural income associated with a particular innovation will depend heavily on the size of the innovating population as well as the elasticity of demand for the product involved. Speed of adoption will often be much increased by the elimination of risk of starvation or loss of land consequent upon the failure of a new technique, coupled, of course, with the intensity of the extension service effort itself. All this quite apart from the more obvious advantages of choosing an innovation which will show the highest gains per unit of land, labour or capital.

II DETERMINANTS OF RURAL FACTOR COSTS WITH INNOVATION

The net rural product associated with a particular innovation will go on increasing until factor costs once more rise to equal net rural product; i.e. until the profit incentive for further growth is eliminated. In any attempt to extract the most from an innovation, African planners should therefore try to moderate the rises in factor costs associated with it until net rural product has reached its highest attainable level. We must, then, also establish criteria for planned action when it comes to the effect of innovation on wages, rents, and interest.

1. Wages

Innovation may, of course, be labour-saving. Consolidation of land holdings or the replacement of the North African delu (water-drawing by counter-marching oxen) with the Persian Wheel (comparatively unattended oxen circling a well) would belong to this category. Then too, innovation may replace labour with capital, thus shifting the onus of moderating factor cost increase largely on to interest charges.

By and large, however, innovation, such as the use of fertilizer and insecticides, is going to require more labour when new elements are applied to crops, and more labour when a larger harvest is gathered in. But it is generally conceded that the African rural-work-force is fully employed, even in the more thickly populated countries, at certain seasons of the year. However, a rise in the cost of labour per unit of output need not be as great as a rise in the yearly or daily wage. The improved diets^{1/} and a better attitude towards the task in hand^{2/} associated

^{1/} See for example, Harvey Leibenstein, "Underemployment in Backward Economies," Journal of Political Economy, Vol. LXV, (April 1957), pp. 91-103.

^{2/} See, for example, John E. Moes, "Surplus Labour and the Wage Level - Implications for General Wage Theory," Indian Economic Review, Vol. 12 (Aug. 1959), pp. 109-27.

with the higher wages will see to that. Nevertheless, an almost complete inelasticity of labour supply at certain seasons of the year might cutoff particular innovations in their prime. Yet this should not be exaggerated as harvesting heavier ears of corn, for example, will be no greater task than gathering in their meagre, pre-fertilizer forerunners. In any event, these labour shortages at peak seasons may be over-emphasized as sowing and harvesting can often be carried on during longer periods than is currently the case.

But if inelasticities in peak-season labour supply to threaten to prove a problem, then African planners pressing for innovation should consider advocating the adoption of those new products and techniques which will spread the labour contribution more fully throughout the year; i.e. through diversification into crops with staggered harvests, off-peak planting and pruning of trees, and so forth. Again, however, it must be emphasized that increased demands for labour, even at peak periods, may often be left to take care of themselves. Upward pressures on wages can bring back, seasonally at least, some of those who have migrated to the towns in "excessive" numbers. Higher wages likewise stimulate the replacement of labour by capital, and we will try to show in the section on interest that such productive investments are unlikely to encounter rising interest rates in the long run.

2. Rents

The hiring price of privately held terrain in African countries is often unnecessarily high because of the lack of competition in land markets, by reason of neighbouring common ownership, and as a result of governmental failure to provide roads, etc. to open up new lands which cannot be reached by individual or small community effort. Thus, the threat of rising rents stands as one of the most often-cited curbs on innovation in underdeveloped countries. Why should a tenant farmer grow more when a landlord will take the lion's share in higher rents? It is simply not worth the effort or the risk, particularly if some of the concomittant capital improvement, such as irrigation ditches etc., will belong to the landlord.

So it is that the promulgation of action to increase the supply of land or to redistribute its ownership becomes important if an innovation is to run its full course. Greater competition in the hiring of land is everywhere required. Innovating tenants should be encouraged to move (i.e. through credit extension) where landlords attempt to raise rents above those in surrounding areas. Tenants should likewise be entitled to compensation for any capital improvements which they may have made.

But in many African countries the widespread provision of such encouragement, or the enforcement of such rules will often be beyond the powers of the planning authorities. This may also apply to the provision of private attributes to common land so as to increase the supply of terrain upon which individuals can make improvements, although this last is really a problem of making the members of African tribes see where their interests really lie, rather than benefitting one group-tenants, to the supposed disadvantage of another - landlords.

Where virgin land is plentiful, as it appears to be in equatorial Africa, the solution is relatively easy. Increases in rents in existing cultivated areas, which may be over-populated, can be held in check when innovation takes place if the State provides access roads, and, perhaps, some credit for the clearing and cultivation of hitherto unoccupied lands.^{1/} Then too, improvement in the road and rail system will tend to widen markets and so eliminate any monopolistic incentive which may exist to restrict land supply so as to maintain produce prices in hitherto isolated areas.

^{1/} Fogg, *op.cit.*, pp. 286 and 288, points to the importance of "risk" capital in the form of excess land to innovation which might endanger food supply.

Planned action with regard to rendering the supply of cultivable terrain more elastic, as well as land and produce markets more competitive, is therefore often an important adjunct to the encouragement of innovation. Outright land redistribution in favour of the individual cultivator can also solve a great many of these problems and it has often led to substantial innovation and increased production, as in Taiwan and Japan; although just as often perhaps the reverse has been true, as in Syria and Bolivia. At all events, land reform is almost always difficult to legislate and slow to be put in operation, although conditions are probably not as serious in this respect in Africa as they are elsewhere throughout the third world.

3. Interest Rates

Interest rates throughout Africa will be compounded of the pure cost of money, plus premia for administering the loan and the risk of failure to repay. Then too, in so far as the typical village money-lender is able to monopolize his market for loans, he may levy interest charges over and above these three costs of lending. This monopoly profit component of rural interest rates is usury. Such interest rates are, therefore, inevitably a good deal higher than those which obtain in developed countries, where the pure cost of hiring money is generally thought of as the only important element.^{1/}

It can be argued that the high rates of interest which currently obtain in underdeveloped rural areas can be expected to decline as productive innovation takes place. The pure cost of money will fall if an innovation spreads its use throughout the year, thus terminating the lost opportunities in year-round, non-rural loans. Then too,

^{1/} Planning for improved agricultural credit in Africa is discussed at length in two publications of the FAO. They are: Report on the Development Centre on Agricultural Credit for Africa, (1) Addis Ababa (Rome, 1963), and (2) Dakar (Rome, 1966).

innovation often costs little and produces much. Fertilizer may add four or five times its expense to the value of production^{1/} and it may be said that in such circumstances simple rural credit expansion will often be met by rapid increases in production. The added supply may be more than adequate to meet the multiplied demand which will follow the original increase in the amount of money in circulation arising from the financing of the innovation. This means that there need be no inflation with credit expansion, and, in consequence, there need be no premium within an interest rate for loss in the purchasing power of the means of repayment. Innovations which raise profits will probably result in increased rural savings,^{2/} which, in turn, may play their part in keeping the pure rural rate of interest down. Then too, the administrative component of rural interest rates will decline if innovation increases individual farmer demand for capital, as it may well do. If each loan is larger than before, less time need be spent on making it. If it results in added productivity, then the farmer will be more willing and able to repay and less effort will be spent on recovering the debt. Further, innovation which widens the margin between a farmer's subsistence needs and his production will also reduce the risk of lending to him and this premium on the rural interest rate can also be brought down. Once the premia for administration and risk are thus

1/ See Montague Yudelman, Africans on the Land (Cambridge, Mass.: Harvard University Press, 1964), p. 157.

2/ Baldwin, op.cit., pp. 84 and 85.

reduced, the farmer will tend to become eligible for institutional credit in the towns, and whatever monopoly profit the village moneylender may have been able to levy on the rural interest rate will thus begin to go.^{1/}

So it is that innovation will generally be accompanied by reductions in the long-run supply price for credit, although it may be necessary for extension agents to attach credit facilities to, say, the sale of fertilizer so as to ease any short-run inelasticities in loanable funds supply which may exist at the village level. Thus, eventual reductions in the interest cost component attached to any innovation can be expected to mitigate the effects of any concomittant increases in wages or rents, and so prevent profits as an incentive to further improvement from disappearing too rapidly.

^{1/} For evidence of the folly of trying to plan for the provision of rural credit in West and East Africa without first associating it with relatively uncomplicated technical innovation see: Consortium for the Study of Nigerian Rural Development, A Situation Report of Agricultural Credit in Nigeria (East Lansing: Michigan State University - 1 104 Agricultural Hall, June 1966), and Diana Hunt, "The Operation of the Progressive Farmer's Loans Scheme in Lango District," also "Some Aspects of Agricultural Credit in Uganda" (Kampala; Makerere University College, 1966).

SUMMARY AND CONCLUSIONS

Certain criteria for African planners emerge from this discussion. They arise from the fact that an administration which is attempting to persuade farmers to adopt new methods and types of production must pay due attention to the income effects of the innovation and its effect on factor prices.

On the income side we can say that the following considerations are important:

First, the planned innovation should be of the kind which raises output per unit of input (land, labour, capital) as much as possible.

Second, where there is a risk of starvation, loss of land-ownership or other serious hardship consequent upon the failure of the innovation, the government planners should consider underwriting this risk. If this is done, the rate of adoption of a particular new method of production may be much increased.

Third, planners must ask what is the size of the potential innovating population - is it limited by a particular scarcity in the type of terrain over which a new crop or method of production can be introduced? New techniques should normally first be pushed in those areas and with those crops where an innovating population is potentially as high as possible.

Fourth, planners must enquire into the elasticity of demand in the market for the crop undergoing innovation. The more elastic this is (i.e. the less price falls with increases in production), the greater will be the potential gain in rural income as output grows.

It was also shown that net rural income will go on growing consequent upon an innovation until rural factor costs (wages, rents and interest) increase to equal this income. Once these factor costs have risen to equal the net rural product, incentive for further adoption of an innovation arising from profit disappears. Thus, the more elastic factor prices are with respect to rises in net rural product the greater the potential gain from an innovation.

As far as labour is concerned the above means that African planners must consider encouraging the adoption of new techniques and the cultivation of new crops which do not make exhaustive demands on the workforce at peak seasons, and/or which tend to spread the demand for labour throughout the year. With rents, distinct efforts to increase competition in land markets, as well as to add to the supply of land itself, will often be an important concomitant of widespread innovation if tenants are not to fear that their profits will be appropriated by the rentier.

Interest rates may be expected to decline in the long run as income grows along with innovation. It costs less, particularly in terms of risk and administration charges, to lend to the relatively well-to-do. However, an increased demand for loanable funds may encounter some short-run inelasticities (limitations) in money supply at the village level, and governments should be at pains to see that rising interest rates do not appropriate all profits hitherto earned. Such elimination of profit might strangle growth before an innovation can begin to work its long-run downward influence on the rural interest rate.

The foregoing, therefore, represent the criteria for planned innovation policy in African rural areas. They have arisen from the analysis of the determinants of net rural product and factor prices which we have developed in this paper.

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