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Technological Change and Income Distribution: The Case of a Semi-Open Less-Developed Economy

Beginning in the 1950s the economics literature has given emphasis to the importance of technological change for economic growth in general, and for the increase in factor productivity in agriculture in particular (Solow, 1957; Griliches, 1963; 1964). In addition, several studies have been performed with the objective of estimating the rate of return of public investments in agricultural research, mainly for specific crops (Griliches, 1957, 1958; Akino and Hayami, 1975; Ayer and Schuh, 1972). Also, Evenson (1968) estimated a marginal rate of return of 48 per cent in the case of public investment in agricultural research in the United States.

More recently, on the other hand, attention has been given to the distributive effects of technological change. Bieri, de Janvry and Schmitz (1972) had already called attention to the lack of theoretical and empirical efforts in this area, at the same time as the public sector was investing large sums in agricultural research. Afterwards we had, among other contributions, the ones by Akino and Hayami (1975) for the aspects of rice research in the economic development of Japan; by Scobie and Posada (1978), investigating the impact of technological change in the rice sector of Colombia in terms of income distribution for families of consumers and producers; finally, by Hayami and Herdt (1977), about the effects of such a change in subsistence agriculture.

The present paper is one addition to this more recent line of emphasis, that is, the distributive implications of technological innovations and concentrates itself on effects for low income food consumers in less developed countries. In the words of Singer and Ansari (1978, p. 47), 'even the ultimate objective of development is a great deal more than a mere increase in per capita income; questions relating to the use and distribution of this income are as important dimensions of development policies as its increase'. Our main reference focus will be an economy characterized as 'semi-open', in the context of Myint (1975, p. 332), that is, in which 'a large part of the domestic economy must remain insulated from the impact of foreign trade and comparative costs...'. In such a case, very likely to be a common one in less developed countries, we intend to show that a pattern of technological change concentrated on exportables can impair the growth of

domestic crops, alter relative prices of domestic-exportables and bring negative effects (real income) for low income consumers. Specific reference will be made to the large quick expansion of soybeans in Brazil, resulting from a process of technological change and the income distribution effects during 1967/79.

TECHNOLOGICAL CHANGE, RESOURCE USE AND PRICE EFFECTS

The central idea in this part of the paper is to show how important technological innovations can affect resource use among the subsectors of Myint's 'semi-open' economy. An important innovation is here supposed to have a great deal of significance with respect to individual crops and regions benefited and with occurrence during a relatively short time interval. This innovation would have the necessary conditions for altering the composition of output as the result of changes in the expected returns to farmers of the available options. A possible outcome is the one in which resources are transferred from other activities to the one being favoured by technological change during the period of diffusion of the new knowledge. If the total cultivated acreage could increase, incorporating new lands, this expansion could be predominantly orientated towards the crops favoured by the innovations.

It is possible, however, that such a result could not be generalized. Relevant factors are the type of technological innovation, market conditions and the possibility of substitution among factors. Here we want to discuss the effects of land saving innovations[3], the so-called bio-chemicals (Evenson, 1974; Hayami and Ruttan, 1971). These innovations usually come from the work of selection and varietal improvement, including a greater response to fertilizer application. Also, they result in larger yields, practically cause no change in the final product and reduce production costs (Kuznets, 1972).

With respect to market conditions, reference is here made to the product demand, through the parameters, price and income elasticities, as particularly important for a greater generality of the results, that is, technological innovations affecting crop mix in favour of the benefited products. The higher the value of the price elasticity of demand, the more likely is the occurrence of such a result. This conclusion can be obtained from Castro (1974) who worked, for analysing distributive questions, with a two-stage production function with four factors: land and land-saving capital (bio-chemicals) on one hand, and labour and labour-saving capital (machinery) on the other, with a high degree of substitution in each stage but with low substitution among the two stages. Working with constant prices for all four factors, Castro has shown that the demand for land would increase if $S_T\eta + S_L P > P_T$, where S corresponds to factor shares of the aggregate factors (land plus bio-chemicals; labour plus machinery), η to the price-elasticity of demand, P to the elasticity of substitution among the two subfunctions and P_T to the same parameter in the land subfunction (land and bio-chemicals)[4].

Now, if we introduce the case of a 'semi-open' economy, Myint's type, the picture described would become clearer. The literature is beginning to register such circumstances with more frequence. For instance, Abbott (1979) mentions the case in which selfsufficiency is a national policy and the government allows consumption to increase or to decline with the level of domestic production. In addition, Castro and Schuh (1977) indicate that the choice of products is important for the determination of beneficiaries from agricultural research, because of the different demand price-elasticities. In the following, we assume the agricultural sector with two subsectors: exportables and domestic products. The distinction is based in each market's functioning, that is, if it is open or closed to international transactions.

In an open economy, domestic prices are determined by the functions of supply and demand of exports, while in a closed economy the relevant functions are the internal ones. This last case is, usually, a consequence of the adopted commercial policy, through instruments like tariffs, import licensing and, in the extreme, import prohibitions. Also, if we assume a 'small country' case in international trade, the domestic price of an exported crop is determined by the international price, the exchange rate and the marketing costs. In such a special case, there is an influence from prices of exported crops to prices of domestic crops, but not the reverse.

With such a situation in mind, we can analyse the likely distributive implications for families of consumers, with a process of technological change biased, in a certain time period, towards one or more of the exportable crops. If we consider the case of land-saving bio-chemicals the individual marginal cost curves and the market supply curve would shift to the right. With a perfectly elastic export demand, the cultivated acreage with the crop in question would increase[5], with all these effects occurring with a constant product price. This is the particular case where all the direct benefits from technological change are appropriated by domestic producers[6], including increases in land prices, mainly considering the location-specific nature of research results (Perrin and Winkelman, 1976).

When total acreage is fixed, the change in the expected rate of return for the exportable crop benefited by innovations would cause the attraction of resources previously employed in the domestic subsector (possibly, also, from other exportables) and, consequently, the real prices of domestic crops would increase. This would continue until a new equilibrium relative price is attained, always assuming no change in the commercial policy which brought the domestic subsector into existence. In other words, the composition of output would be affected in favour of exportables. A second possibility is when total cultivated acreage can increase. In such a case, the process would tend to be directed towards the favoured crops, in addition to the previous effect in regions already under cultivation. In the case the innovations are specific to a certain agricultural region of the country, the unfavoured ones could show an increase in the production of domestic crops – by assumption, crops not benefited by technological innovations – partly compensating the production fall in the former region.

Furthermore, if the so-called domestic crops are formed by important foods, in terms of budget shares of low income families, the price increase following the change in the crop mix would be like a tax with regressive incidence. As a result, the unbalanced nature of the process of technological change among crops with different market characteristics, could bring a worsening of income distribution (from the expenditure side). For that, it is necessary that we maintain the assumption of no changes in commercial policy or, alternatively, that the international market, at least for certain commodities, is not a supplier able to complement domestic production.

EVIDENCE IN THE BRAZILIAN CASE

For quite some time Brazilian agriculture has been characterized by the existence of two subsectors, exportables and domestic crops, the first one being open and the second closed to international transactions[7]. Within the first group we have soybeans, oranges, sugar, tobacco, cocoa, coffee, peanuts and cotton, while the second one is formed by rice, edible beans, manioc, corn, potatoes and onions, most of them being important foods for low income families. In this part of the paper we intend to show that one of the main reasons for the tremendous growth in the production of soybeans from the early 1960s, was the development of technological innovations in Southern Brazil. In addition, such a growth was the causal factor for significant changes in the composition of output against domestic-food crops. Finally, we will attempt to show the effects of such changes on the index of food prices for families at different income levels.

However, it is important to point out at the beginning that technological innovation in soybeans was one of three factors favouring exportables in Brazil. The other two were (Homem de Melo, 1982): (a) The introduction, in 1968, of the system of exchange mini-devaluations, and (b) a favourable period of international prices, mainly during the first half of the 1970s. Consequently, the evidence of price effects to be later presented must be understood as the result of the above three forces, and not only from technological change in soybean production. We hope to show, however, that this last factor was of great importance for explaining the change in crop mix beginning in the second part of the 1960s.

Soybeans, in Brazil, represent the most recent example of a large expansion in area during a short time interval and with a limited geographic extension. In 1960 total soybean area was 177 thousand hectares, with 159 thousand in the state of Rio Grande do Sul. In 1980, on the other hand, the figures were 8,965 thousand and 3,988 thousand, respectively[8]. The increase in international prices started in 1971–72 and reached maximum levels in 1973 and 1974. In 1972 the total area was already at 2,292 thousand hectares. Certainly, the favourable period of international prices during the early 1970s made a positive contribution for that growth in area. However, that was not the factor at the origin of soybean expansion in Brazil, since during the 1960s those prices were practically constant in nominal terms. In

addition, it seems relevant to indicate that several commodities had price increases during parts of the 1970s, but none of them had an expansion in area comparable (or, even, near) to that of soybeans.

TABLE 1 *Time of introduction and adoption of new soybean varieties in Brazil and effects on yields*

Period	Average yield, Brazil (Kg/Ha)	New varieties
1960–		Amarela Comum, Abura, Pelicano, Mogiana.
1960–68	1,060	Hill, Hood, Majos, Bienville, Hampton.
1969–74	1,394	Bragg, Davis, Hardee, Santa Rosa, Delta, Campos Gerais, IAC–2, Viçosa, Mineira.
1975–80	1,541	IAS–4, IAS–5, Planalto, Prata, Perola, BR-1, Paraná, Bossier, Santana, São Luiz, IAC–4, UFV–1.
1980–	1,740	BR-2, BR-3, BR-4, Ivaí, Vila Rica, Unîão, Cobb, Lancer, CO-136, IAC-5, IAC-6, IAC-7, UFV-2, UFV-3, Cristalina, Dokko.

Source: Kaster and Bonato (1980), p. 421.

In Table 1 we show a summary of agronomic research in Brazil, in terms of new varieties, the time of introduction and the impact in actual yields. Two of those varieties – Santa Rosa and Hardee – were very important for the expansion of soybeans during the late 1960s and early seventies. The first one had its origin at Campinas Agronomic Institute, São Paulo, beginning with the introduction of American varieties and, later on, the development of lineage L–326 in 1958. In the mid–1960s it became commercially available in Rio Grande do Sul with the name of Santa Rosa. The variety Hardee, also of American origin, was studied and adapted at Campinas after 1965. Such facts also reveal the importance of international knowledge transfer for the process of technological change in Brazilian soybeans, mainly by making unnecessary a series of previous research work and leading, as in Guttman (1978), to a decline in research costs. Another related evidence of such importance is that from the 48 varieties recommended for planting in 1980, 26 had their origin in national programmes and 22 came from the United States, half of them in the form of lineages (Kaster and Bonato, 1980).

Several other agronomic aspects of the crop were emphasized over the years by the research centres: selection of Rhizobium's lineages, direct

planting, control of weeds, diseases and pests, density and planting time. The indications are that in the late 1970s, soybean research was one of the most developed in the country. For instance, according to Kaster and Bonato (1980), in recent years this research has been involved in developing production systems for other regions besides Southern Brazil, like East and Centre-West regions. In addition, 'the research is aiming at developing a technology specific for soybeans production in regions with latitudes below 15° S. The perspectives for obtaining varieties specifically adapted to lower latitudes, as well as for knowledge about crop management are excellent, and new in the world' (Kaster and Bonato, 1980, p. 432).

TABLE 2 *Annual percentage rates of growth of domestic production in Brazil, 1960–69, 1967–76 and 1970–79*

	Commodities	1960–69	1967–76	1970–79
1.	*Domestic*			
	Rice	3.20	2.47	1.46[a]
	Edible beans	5.37	–1.93	–1.90
	Manioc	6.05	–1.86	–2.09[a]
	Corn	4.74	3.55[a]	1.75
	Potatoes	4.34	1.34	3.73
	Onions	3.87	4.77	9.27
2.	*Exportables*			
	Soybeans	16.31	35.03	22.47
	Oranges	6.01	12.73	12.57
	Sugarcane	3.63	5.10	6.30
	Tobacco	5.30	–	6.16
	Cocoa	2.55	–	3.73
	Coffee	–7.10	–6.34[a]	–1.54[a]
	Peanuts	5.89	–6.80[a]	–12.06
	Cotton	1.51[a]	–1.99	–4.41

Source: Production data from FIBGE – Fundação Instituto Brasileiro de Geografia e Estatística.

[a]This letter indicates the coefficient is not significantly different from zero at the 5 per cent level.

In Table 2 we show the rates of growth of domestic production during 1960–69, 1967–76 and 1970–79 for fourteen crops, among exportables and domestic. When examining such data, we note that from the 1960s to the 1970s Brazilian agriculture experienced important changes: after a relatively uniform performance among crops during the 1960s, in the 1970s

the country had a substantial deterioration in the performance of domestic crops and a great expansion of certain exported ones, a process led by soybeans. The worst cases were manioc and edible beans, with large declines, while rice and corn had their production levels stagnated during the 1970s, at the same time population was growing at an annual rate of 2.47 per cent. When the first five domestic-food commodities of Table 2 were aggregated in terms of per caput caloric/proteic availability [9], the conclusion was an annual rate of decline, during 1967–79, of – 1.84 and – 2.09 per cent respectively (Homem de Melo, 1982a). Rice, corn and edible beans had their availabilities only slightly increased by imports over that period. These five domestic-food crops, in addition to cotton and pasture land, were the agricultural activities most affected by the substantial expansion of soybeans in Southern Brazil (Zockum, 1980).

Even when we consider other food products, like sugar, wheat, meat (beef, pork and poultry), eggs and milk, total per caput caloric/proteic availability declined during 1967–75 (annual rates of – 0.75 and – 0.76 per cent, respectively), with a small recovery during 1976–79. We also had a greater importance over time of wheat and sugar, the first one a traditional imported food which had a policy of price subsidies for consumers beginning in 1972 (Carvalho, 1981). During 1970–79, the growth rate of wheat availability was greater than that for domestic production, which indicates a more important role of imports. Without the policy of consumption subsidies and larger imports, the fall in caloric/proteic availability would have been even larger than that observed.

As a consequence of this unbalanced performance, in terms of domestic production and availability of food products, it seems relevant to investigate how different classes of family income were affected. To this end, we used the information from the family budget survey (ENDEF-FIBGE)[10] done in 1974–75 for the states of São Paulo, Rio de Janeiro, as well as South and Northeast regions (Homem de Melo, 1982a). Such data show important differences in consumption among expenditure classes[11] and regions. For instance, the share of rice and edible beans in total food expenditure varies between 21.1 and 27.9 per cent in the lowest income (expenditure class) and between 3.3 and 7.2 per cent in the highest one for the four regions[12]. Similar behaviour was observed for the shares of corn and its products, wheat and products (except in the Northeast), tubercle and roots (manioc, potatoes) and sugar. The contrary, however, occurs for meat and eggs/milk/cheese, that is, increasing shares as income rises. Also, a few important differences were observed in the Northeast: manioc is much more important in lower income classes, while wheat is more important for higher income classes.

These strong differences in consumption structures over income (expenditure) classes, as well as the distinct behaviour of physical availabilities, are good reasons for also expecting an uneven impact in terms of prices and real incomes for Brazilian families.This would occur through changes in market prices and consequent income effects, via each product's share in total food expenditure. After examining the behaviour of thirteen food items in São

Paulo during 1967–79, it was noticed that those with the largest increases were manioc, edible beans, beef, pork and corn (Homem de Melo, 1982a), three of them being domestic food[13], originating in the crop sector, and with greater relevance for lower income families.

As an attempt to verify the distributive effects of this situation, we estimated the increase of the food price index by income classes (based on ENDEF-FIBGE, 1974–75) for São Paulo, Rio de Janeiro, as well as South and Northeast regions. These indices were computed taking the shares (weights) of each product in total food expenditures for the two states and two regions of Brazil and the observed prices in São Paulo (Cost of Living Index). Excepting São Paulo, we are only approximating the situation faced by families over different income classes. It is expected, however, that the several prices vary mostly by reason of spatial distribution of production and consumption, without significantly affecting the rates of growth over time.

In Table 3 we show the estimated food price index only for the Northeast region. However, the direction of the change was the same in the two states and the other region analysed, that is, larger increases for the lower income families. In other words, these were the families mostly affected by the transformations which occurred in the composition of agricultural output, in response to technological innovations in soybeans and to changes in external variables (prices and exchange). The case of the Northeast region, however, was the most serious one and for that reason it is explicitly shown in Table 3. For instance, when we compare the lowest and highest income classes in terms of annual rates of growth of nominal food prices, we note that during 1967–79 they were 28.6 and 26.2 per cent respectively. Alternatively, a cumulated increase of 32.9 per cent more for the lowest income class. For São Paulo, Rio de Janeiro and South region the greater cumulated increase was 10.0, 12.7 and 8.7 per cent, respectively. For these different results among states and regions, we could mention two main reasons: (a) The greater importance of manioc and edible beans for lower income families in the Northeast as compared to other regions (26.7 against 2.4 per cent among the income extremes in that region, versus 14.2 against 1.4 per cent in the South). These two commodities were the ones with greater increases in prices during 1967–79. (b) The relatively small importance of wheat in the consumption habits of lower income families in the Northeast (4.2 against 10.0 per cent among the extremes in the Northeast, and 8.9 against 7.1 per cent in the South). We recall that, beginning in 1972, the Brazilian government subsidized wheat prices to all consumers, which in the Northeast had a regressive incidence. Results such as described, particularly those for the Northeast, can aggravate those obtained for nominal income distribution in Brazil with the census data of 1970 and 1980, in the sense of greater concentration of the real income distribution.

TABLE 3 *Indices of nominal food prices, expenditure classes, Northeast region, 1967/79 (1976 = 100)*

YEARS	<1.0	1.0–1.5	1.5–2.0	<2.0	2.0–2.5	2.5–3.0	3.0–3.5	2.0–3.5	3.5–5.0	5.0–7.0	>1.0
1967	100	100	100	100	100	100	100	100	100	100	100
1968	126	124	123	124	123	122	122	122	122	121	120
1969	160	155	152	155	151	150	150	150	148	148	147
1970	198	191	188	191	186	185	184	185	183	181	181
1971	153	143	237	242	233	231	230	231	228	225	223
1972	319	302	291	300	284	280	278	280	275	270	268
1973	430	407	389	402	380	373	370	374	365	359	356
1974	557	533	514	528	504	497	495	498	490	483	479
1975	766	721	688	712	669	659	649	658	640	624	606
1976	1,133	1,033	970	1,012	932	914	897	912	876	848	817
1977	1,546	1,401	1,317	1,383	1,270	1,242	1,222	1,242	1,195	1,156	1,124
1978	2,087	1,947	1,856	1,925	1,799	1,770	1,743	1,768	1,720	1,671	1,631
1979	3,311	3,081	2,917	3,038	2,820	2,775	2,729	2,770	2,686	2,609	2,542
Annual Rate	22.6	28.0	27.5	27.8	27.2	27.1	26.9	27.0	26.7	26.5	26.2

Source: Primary data from ENDEF-FIBGE (weights) and FIPE – Fundação Instituto de Pesquisas Econômicas (Prices in São Paulo).

CONCLUDING COMMENTS

This paper had the objective of investigating possible distributive implications of a pattern of technological innovations in a semi-open economy, that is, as composed by two subsectors in agriculture, exportables and the domestic one. The case we had most interest in was the one where the innovations were concentrated in crops of the exportables subsector during a certain time period. In such circumstances our conclusion was that the composition of output might change in favour of exportables. Without changes in commercial policy, prices of domestic crops would go up and if they are important foods for lower income families, real income distribution would be affected.

Attention was also given to the Brazilian case where a semi-open agricultural economy has long existed. In the domestic subsector important foods can be found, mainly in terms of budget shares for lower income families. We also gave particular attention to the technological innovations in soybeans, to its extraordinary expansion and to the transformations in the composition of output. Our final conclusion was that lower income families suffered the most from the behaviour of food prices during 1967–79. However, we also presented an important reservation: with the increase of certain international prices and modifications in the exchange rate policy, the results should not entirely be imputed to the unbalanced pattern of technological innovations, but to all factors together.

NOTES

[1]Before the work of Bieri, de Janvry and Schmitz (1972) in the distributive area, we emphasize the contributions of Johnston and Cownie (1969), Falcon (1970) and Schmitz and Seckler (1970), where the focus was in the factor markets.

[2]An extension of the case presented by Hayami and Herdt (1977) is given by Nguyen (1977), that is, an open economy where the market price is subject to a ceiling, via imports.

[3]In the case of neutral technological change, two factors and the usual hypotheses, the demand for land with the favoured crop would increase if the price-elasticity of the product's demand is greater than one (absolute value). See Pastore and Mendonça de Barros (1976) and Ivenson (1975) for the case of demand for labour.

[4]See, also, de Janvry (1977) for a similar production function in two stages and four inputs. De Janvry indicates that bio-chemicals are highly output increasing even with an inelastic land supply and a constant level of labour-saving capital, as long as the elasticity of labour supply is high.

[5]In Myints (1975) words: 'In peasant economies, not excepting densely populated countries like India, peasant producers have been generally observed to respond to relative price changes by flexibly reallocating resources between subsistence production and cash crops, including export crops'.

[6]Schuh (1976) mentions this point for analysing the conflict of interests among producers and consumers with respect to financing agricultural research.

[7]See Homem de Melo (1982 b) for details of this segmentation and for evidence about prices–domestic and international – in both segments. We have shown that, for domestic crops, internal prices have been above the international ones.

[8]In 1980, soybean exports were US$ 2.5 billions, about 12 per cent of total Brazilian exports. During the 1960s, the rate of growth of cultivated soybean area in Brazil was 16.3 per

cent annually and went up to 20.7 per cent in the 1970s.

[9]That is, domestic production minus exports plus imports. We did not consider use as seeds, losses and change in stocks, because of lack of data.

[10]National Survey of Family Expenses, Fundação Instituto Brasileiro de Geografia e Estatistica.

[11]They correspond to consumption expenditures plus taxes as well as labour and retirement/health contributions.

[12]The lowest and highest expenditure classes are not always coincident among regions.

[13]Even beef and pork meat are closer to the subsector of domestic products than of exportables. Some exports/imports were made during the 1970s, but in relatively small amounts when compared to domestic production.

[14]See Williamson (1977) for an analysis about wage goods and distributive inequality in the United States.

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DISCUSSION OPENING – J. VON AH

Professor Homem de Melo's paper deals with the problem 'Growth and Equity' as viewed from his Brazilian experience.

The agricultural subsector for export crops showed a spectacular increase in the total soybean acreage in the late 1970s. Improved new varieties met favourable price and demand conditions in the export markets. The agricultural subsector for domestic crops, however, was stagnating, even declining. While population still increased, food availability of traditional beans and manioc declined by 2 per cent per annum for low income groups. The situation was partly alleviated by Government subsidies on sugar, wheat and meats. Geographically, the north east of the country was especially badly affected and low-income families were hardest hit.

These findings seem to confirm Ruttan's general conclusions on effects of the so-called 'Green Revolution':[1]

- in areas of relative equality, its effect is strong in terms of productivity and equity.

- in areas with inequality (skewed distribution of land, prime land, wealth, power and so on) its effect is weak and increased the existing conditions of inequality.

In the case of this paper, *negative effects* are demonstrated on the nutritional status of people.

My comments will cover three areas of questions which appear to me important for judging possible effects of new technology on human nutrition. After all, equity of food distribution is an essential objective of *all* discussions on equity.

The first area covers questions of the data base and specifications, aggregations and disaggregations, namely:

- How meaningful is a national (or regional) average about nutrition in a large country like Brazil?
- Were the figures presented rural, farm, non-farm, family, local, male/female data?
- What is the share of subsistence food production without market exchange?
- Did the results present a trend or a cross-section of a fluctuation of good years/bad years? (A question I ask after reading yesterday's paper by Bhalla and Leiserson on 'Issues in the Measurement and Analysis of Income Distribution in Developing Countries: Some Comparative Perspectives'.[2])

A surprising quite recent publication was an article by Thomas T. Poleman, 'A reappraisal of the extent of World Hunger', in *Food Policy* of November 1981.[3] Poleman questions the basis of major surveys by FAO and the World Bank and USDA. He suggests that the real problem groups are mothers and small children.

How far did the Brazilian team worry about the above questions?

A second group of questions concerns theory and modelling. I have no arguments about the applicability of partial equilibrium analysis and Marshallian type approaches to the distribution of monetary costs and benefits of new technology between producers and consumers. My only question is whether the time and effort needed is available to formulate in urgent cases the relevant theoretical situation (I remind you of yesterday's papers by Hayami[4] and Just *et al.*[5]) for explaining what is happening and what policies should be initiated to solve problems of nutritional status.

Assuming the findings of de Melo on a deterioration of nutrition are correct, I have certain difficulties in blaming the soybeans for everything:

- What are the effects of overall price and trade policies of the Government?
- How about the Brazilian exchange rate policy which taxes in effect the agricultural sector?
- How about the growing of energy crops?
- Does the shared distribution of land have something to do with the problem at hand?

The paper presents more clear and straightforward conclusions on the relative position of areal productivity of soybeans versus other crops (for domestic *and* export use). In my opinion without improving the relative position of the traditional foods with soybeans in terms of better varieties and better prices, the process of product substitution will most likely persist.

There is a large task left for agricultural research of the biological type, and the designing of proper price policies.

Let me end with a third group of remarks. There is an enormous body of literature on the 'Green Revolution' which emphasizes strongly the negative effects, not the least, in forms of deteriorating equity. Our University of Friborg[6] has classified over 800 titles. My agronomist friends ask (with some resignation) 'Shouldn't it have taken place at all? What do you social scientists do with our good, successful work?'.

Without elaboration, it seems to me that scientists and biologists are expected to accomplish things that they simply cannot be expected to achieve. As a consequence I wish to put in a strong plea for a more intensive dialogue between agricultural economists and physical-biological scientists. With Schuh[7] I regret 'that there are social scientists who would have us throw the baby out with the bath water by abandoning technical change altogether, *rather than devise alternative policies to deal more directly with deleterious income-distribution consequences'*. – I add, naturally, that they have to be properly established first and identified as to their cause and nature.

I thank Professor de Melo for his stimulating paper. It would go beyond my competence to supplement the paper with suggestions for policy instruments; this task I leave, together with the author, to all of you.

REFERENCES

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[3]Poleman, Th.T., 'A Reappraisal of the Extent of World Hunger', *Food Policy,* November 1981, pp. 236–252.

[4]Hayami, Y., 'Growth and Equity, Is there a Trade-off', this volume pp. 109–19.

[5]Just, et al., 'Modelling Equity and Efficiency in Agricultural Production Systems', this volume pp. 120–37.

[6]Fleck, F., Bortis, H., and von Ah, J., *The positive and negative effects of the Green Revolution* – A Documentation, Fribourg, 1982.

[7]Schuh, G.E., 'Approaches to Basic Needs and to Equity that Distort Incentives in Agriculture', in Schultz, Th. W. (ed.), *Distortions of Agr. Incentives,* Indiana University Press, 1978.