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Economy-Wide Impacts of Technological Change in the Agro-food Production and Processing Sectors in Sub-Saharan Africa[1]

by

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ABSTRACT

Processing of meat and crops accounts for a large share of manufacturing in Sub-Saharan Africa (SSA). The paper assesses empirically the impact of hypothesized productivity change in agro-food processing on growth, trade, employment, and input and output prices in SSA, using a 13 commodity, 7 region version of the Global Trade Analysis Project (GTAP) applied general equilibrium model with a 1995 database. Results are compared to impacts of factor-neutral and biased technical change in primary agricultural production--grains, non-grain crops, and livestock--overall and with respect to the agro-food sector itself. A given percentage increase in total factor productivity in primary agricultural production is shown by every criterion to have much greater favorable impacts than the same increase in any form of technical change in processing, even when consideration is given only to the welfare of people in the agro-food processing sector itself. Technological change in the non-grain high value agricultural sectors such as horticulture and livestock are second-best, but still powerful promoters of increased welfare. However, the paper is not able to assess the costs or likelihood of securing different kinds of technical change, and therefore comparisons are limited to the benefit side.

1. INTRODUCTION

Sub-Saharan Africa (SSA)-excluding South Africa-is the poorest region of the world, accounting for less than 2 percent of global GDP and more than 10 percent of the world's population (World Bank, 1997). Since agriculture accounts for 30 percent of GDP, 40 percent of exports, and 70 percent of employment in the region, technological improvements that simultaneously raise incomes of the rural poor and lower food prices have great scope for reducing the overall incidence of poverty. However, there is not yet a consensus as to the specific economic policies that will assist the rural sector.

While primary agricultural production is the big picture, we focus first on technical change in the agro-food processing sectors for two main reasons. First, it is hypothesized that agro-food processing industries are either existing or potential major sources of employment and income, thus providing access to food and other necessities to large groups of peoples, particularly the rural and urban poor. Second, it is argued that the development of agro-industry will help countries that are overly dependent on primary commodity exports to diversify their sources of value-added. The development of agro-food processing capacity will be essential to achieving growth and equity through diversification into high

value-to-bulk commodities (FAO 1997; Delgado and Siamwalla 1999; Goletti and Wolff 1999).

In low per capita income countries, processed food becomes more important over time relative to grain staples in the diet. Initially, marginal budget shares for meat, fruits and vegetables are much higher than those for other food items and also much higher than their own average budget shares, implying that the latter are growing over time (Delgado et al., 1998). Eventually, average budget shares for processed food such as meat, fruits and vegetables budget shares dominate other food items (Cranfield et al., 1998).

Our objective in this paper is to assess empirically the impact of hypothesized productivity change in the agro-food processing sectors (processed food crops and meats) on growth, trade, employment, and input and output prices in SSA. For comparison, we also assess the impacts of different types of technical change in primary agricultural production-- grains, non-grain crops, and livestock--on the agro-food sectors. Hicks-neutral technical change (augmenting the returns to all factors equally) is distinguished from factor-biased technical change in this regard.

The paper employs a multi-region Applied General Equilibrium (AGE) approach. A multi-region AGE model is a general, internally-consistent framework

convenient for analysis of policy options involving several regions and sectors. It is especially useful for the computation of welfare effects. Specifically, we use the Global Trade Analysis Project (GTAP) model and Version 4 of the data base (Hertel, 1997; McDougall et al.,1998). GTAP consists of a global database and an economic mode for performing simulation. The Version 4 data base represents economic conditions in 1995 and includes 50 commodities or sectors and 45 countries or regions. Africa is divided into five regions that permit a more disaggregated analysis than was previously possible (Hertel et. al. 1998).

2. AGRO-FOOD PROCESSING INDUSTRY AND ECONOMIC GROWTH

Agro-food processing involves the transformation of food products originating from agriculture and broadly defined to include crop, livestock and fisheries. It is part of the broader concept of agro-processing industries that range from simple preservation methods (such as sun drying) and operations closely related to harvesting, to the production by capital-intensive methods of such articles as textiles, pulp and paper (FAO, 1997). The food, beverage, and tobacco industries combined are the most important sub-sector involving agro-industrial components in both developed and developing countries. Figure 1, taken from FAO 1997, shows the share of agro-industry in the GDP of the developing countries. Food, beverage, and tobacco manufacturing account for about 3-4 percent of GDP in developing countries. Although the share of agro-food processing in GDP has been historically greater in Latin America and the Caribbean, it has tended to loose importance in contrast with other regions, including SSA, where it has tended to increase.

Expressed as a percentage of agricultural GDP, value-added in food, beverages and tobacco provides a broad indicator of the relative importance of agro-food processing compared to primary agriculture (Figure 2). Agro-food processing has been an important component of overall agro-food production in Latin America and the Caribbean during the 1970-1994 period, but has been

somewhat less important in relative terms in more recent years. In SSA as well as in all the other developing regions, processing of food has steadily gained importance relative to primary agricultural production, except for a sharp decline in 1992. Industrial processing of food, beverages, and tobacco typically employs about 10 percent of the total labor force found in manufacturing in the developed countries and around 20-30 percent in developing countries (FAO 1997).

Table 1 shows the share of agro-processing in total manufacturing with respect to employment and wages for selected countries. The highest shares of employment, of the order of 30-50 percent, are found in Africa. This is in large part explained by the poor development of the other manufacturing sectors, which also implies a large share of agriculture in African economies. Wages in the agro-processing sectors constitute a significant proportion of the total wages in African manufacturing. In the developed countries as a whole, manufacturing earnings substantially exceed earnings in agricultural processing, even though agricultural processing is numerically more important in developed countries than developing ones.

The development of agro-food processing industries can lead to capturing forward and backward production linkages with other sectors of the economy in SSA. Examples of backward linkages include manufacturing industries for meat conservation, machinery, and equipment, packaging materials and intermediate-

goods used in the processing. Examples of forward linkages include tanning operations, manufacture of footwear and other leather goods based on hides and skins.

Finally, investment in agro-processing plays a special double role in the small, commercializing, economies of SSA, where industrial production linkages involving agriculture on the whole are very weak. Processing not only adds value to agricultural commodities, but often makes them more tradable than they would be otherwise. Commercialization requires investment in processing of commodities to turn Africa's largely non-tradable rural economies into market-based economies (Goletti and Wolff, 1999). In addition improved processing of food in particular can help improve the elasticity of supply of those items that workers most want, and which are otherwise not always available, or are in limited supply, as wages increase. More formally, investment in processing in the African context can help improve the elasticity of supply of wages goods and, thus of non-tradables generally. Such improvements allow growth gains from increased exports to be converted more fully into further new employment and production, as opposed to inflation in food prices. It has been estimated that in SSA, these "consumption growth linkages" are, in a quantitative sense, at least nine times more important to growth than technical backwards production linkages (Delgado et al., 1998).

3. MODEL AGGREGATION, CLOSURE, AND EXPERIMENTAL DESIGN

Applied General Equilibrium (AGE) models provide a very general framework for analysis of productivity and trade-policy change. Research-induced technical change in agriculture can have economy-wide implications for employment and returns to factors of production, including the non-agricultural sector. Through output-market adjustments, technical change in agriculture affects the relative prices of agricultural and non-agricultural products, even if the latter are not directly affected by new technology. Induced changes in product markets lead to further changes in factor markets. Thus, agricultural productivity changes can affect foreign exchange earnings by affecting terms of trade between countries or regions; labor and land use in agricultural and non-agricultural production; and relative factor and product prices (Alston et al., 1995).

A multi-region AGE model provides an internally consistent framework for avoiding the pitfalls of under- or over-counting welfare effects in a multi-market setting, by avoiding partial equilibrium errors when evaluating the impact of technological change across multiple agricultural activities (Frisvold, 1997). Furthermore, the GTAP version used here embodies Constant Elasticity of Substitution (CES)–Constant Elasticity of Transformation (CET) assumptions about technology. This allows an exact and theoretically consistent measure of producer gains to research. Finally, AGE models specify the structure of primary

factor markets explicitly, permitting the direct examination of impacts of technology change on returns to owners of land, accounting for shifts in land and labor use and differential returns by type of sector (Hertel 1997).

Experiments in this paper are based on a thirteen-commodity, seven-region design using a full multi-region, general equilibrium closure. A multi-region specification allows easier consideration of the open economy effects of technical change. The thirteen commodity design allows for explicit examination of the transmission of effects of technological change among grains, non-grains, processed food, meat and dairy sectors of the economy. Grain outputs are intermediate inputs in both livestock and food production. Livestock is a major input to processed meat, dairy and other processed foods. Commodity and regional aggregations are shown in Table 2. Data used are from Version 4 of the standard database provided by the authors of the GTAP model (Hertel, 1997; McDougall et al., 1998). Different experiment runs are summarized below.

Experiment 1 (E1): Three percent unit cost reduction in both the processed food crop and meat product sectors, though labor-augmenting technology.

This experiment examines the impact of reducing the cost of production of processed food crop (E1A) and meat products (E1B) through unskilled labor-augmenting technical change (biased technical change). In fact, productivity change in processing industries under African conditions has primarily been

through labor augmentation (Connor 1988). In addition, unskilled labor constitutes a major share of total unit cost in the processed food and meat product sectors. The three percent unit cost reduction was implemented by increasing the efficiency of unskilled labor input while leaving unchanged the efficiency of other inputs (by shocking a labor augmentation parameter by 3 percent, divided by labor's cost share in the processed food and meat products sectors of the region). Since labor is a major constraint in SSA agriculture, improving its efficiency may be an appropriate strategy. We chose a 3 percent cost reduction because it is expected that meat and cereal consumption will grow by 3-3.5 percent over the next 20 years (Delgado et al., 1999).

Experiment 2 (E2): Three percent unit cost reduction in agro-processing of non-grain food crops and meat products through raw-material-saving technical change in processing technologies for non-grain food crops and animal products, respectively.

Experiment 2 assesses the impact of a biased technical change that increases the efficiency of converting non-grains (E2A) and animal products (E2B) into processed food. The GTAP database shows that non-grains constitute about 40 percent of processed food crops and that animal products contribute about 69 percent of value-added in meat production.

Experiment 3 (E3): Three percent unit cost-reduction in the meat and processed food sectors through cost-reducing technical change in provision of infrastructure services

This experiment serves to examine the impact of increasing the efficiency of provision of infrastructural services in the processed food (E3A) and meat products (E3B) sectors. Availability and efficient use of infrastructure (e.g. gas, water, construction, electricity, public administration, etc.) are major problems for many countries in sub-Saharan Africa. Thus, this experiment will enable us to examine how improving the efficiency of infrastructure service provision will impact on the agro-food industries.

Experiment 4 (E4): Three percent unit cost reduction through a factor-neutral, output-augmenting technical change in the processed food crop and meat products sectors.

This experiment examines the impact of reducing input requirements across the board on the production of processed food crops (E4A) and meat products (E4B). Comparison of results from this experiment with those from the other experiments can show if prices, sectoral employment, and returns to primary factors owners are sensitive to assumptions about the bias of technical change.

Experiment 5 (E5): One and one-half percent Hicks-neutral technical change in the primary production of grains, non-grain crops and animal products with no spillovers

Our last experiment consists of implementing separately a 1.5 percent neutral technical change in grains (E5A) non-grains (E5B), animal products (E5C) and, in combination, primary sector production (all three simultaneously) (E5D) in SSA. This shock reduces in neutral fashion the unit costs of production of raw grains, non-grain crops, and animal products, by uniformly reducing the input requirements associated with producing a given level of output. The 1.5 percent growth rate is much below the targeted growth rate of 4 percent in agriculture prescribed by the World Bank few years ago (World Bank, 1989). The shock is implemented in the GTAP model as a 1.5 percent increase in the output augmentation parameter for the grain, non-grains, and animal product sectors and the primary agricultural sector (i.e. the combined grains, non-grains and animal product sectors).

4. RESULTS

Tables 3 and 4 represent the results of Experiments 1-4 for the processed food crop and meat products sectors, respectively. A 3 percent unit cost reduction in the production of processed food crops (E1A) through labor-saving technology provokes an increase in domestic gains to $71.42 million. The same technological shock in the meat products sector (E1B) is associated with a domestic welfare gain of $4.32 million. SSA increases its overall exports of processed foods and meat products by 2.51 and 3.70 percent, respectively, as a result of the technological shock. However the labor-augmenting technical change reduces employment in the processed food and meat products sectors by 1.58 and 1.56 percent, respectively. Wage rates do not increase significantly. Output prices for the processed food and meat products fall by 0.62 and 0.89 percent only, while prices of other agricultural goods increase marginally or do not change. Thus the ratio of unskilled wage rates to food prices are not affected, implying not much impact on access to food by the rural and urban poor as a result of the shock. It seems that labor-using technology rather than labor-augmenting technological change may be the appropriate strategy for agro-food processing in SSA.

Non-grain augmenting technical change in the processed food sector (Table 3, E2A) increases exports of processed foods by 8.64 percent. Welfare gains for SSA are $291 million; about 95 percent of these gains are captured domestically. Employment generally increases in all sectors, except for non-grain crops, where it declined slightly, by 0.55 percent. Wage rates increased relative to the prices of all commodities, and particularly relative to the price of processed foods, which decline by 2.04 percent. Animal product-augmenting technical change in the meat products sector (Table 4, E2B) has similar effects, but the magnitudes are much smaller. Exports increase by 8.96 percent, but the domestic gain is only $10.95 million; nonetheless SSA captures about 80 percent of world gains. Employment in the meat product sector increases by 2.53 percent but decreases slightly in other sectors. Except for processed meat, whose price falls by 2.06 percent, the real wages of unskilled laborers are largely unaffected as a result of this type of technological change.

A three percent unit cost reduction from technical change in the provision of infrastructural services to the processed food crop sector (E3A) leads to welfare gains in SSA of $83.97 million (Table 3). Exports increase by 2.90 percent. Although returns to owners of factors of production, and particularly wage rates, increase proportionally more than the increase in price of foods, the increases are not high enough to have a significant effect on the purchasing power of unskilled labor. Technical change in the provision of infrastructural services to

the meat products sector (E3B) produces similar effects as in the case of foods from processed crops. However, at $3.63 million, the net welfare gains are the lowest of all experiments conducted (Table 4), reflecting in large part the small employment share of the processed meat sector.

Hicks-neutral output-augmenting technical change, embodied in a 3 percent unit cost reduction in the processed food crops sectors (E4A), leads to a significant increase in exports of processed foods, by 13.07 percent. The associated welfare gain is about $410.44 million; SSA captures 94 percent of the global gain. Employment increases overall, except in the non-grain and meat products sectors, where it declines by 0.14 and 0.07 percent, respectively. Prices of processed food crops fall by 3.01 percent, significantly increasing the ratio of wage rates to processed food crop prices. Although prices of other agricultural goods increase slightly, returns to factors of production and wage rates increase proportionally more, thereby enhancing the purchasing power of both producers and unskilled labor.

A three percent unit cost reduction embodied in an output-augmenting technical change in the meat products sector leads to similar results. However, the magnitudes are lower than in the case of processed food crops. The associated domestic welfare gain is $15.73 million, with SSA capturing 78 percent of the world gains. It is noteworthy that overall output-augmenting technical change in

the agro-food processing sector is associated with decreased exports of primary products such as grains, non-grain crops, and animal products, in favor of increased exports of the processed products where technological change occurred. This supports a strategy of diversifying the sources of exports from SSA to other regions of the world through promotion of technological in the processing sector.

Experiments E5A-E5D in Table 5 assess the separate and combined impact of a 1.5 percent output-augmenting technical changes in the primary production of grains, non-grain crops, and animal products. The results in Table 5 yield interesting insights about the role that primary agricultural sector still plays in the economy of SSA. A 1.5 percent growth rate in the combined primary agricultural sector (E5D) increases global welfare by $1.04 billion, with 91 percent ($945 million) of this welfare gain captured in SSA. Exports of all commodities increase, with the highest percentage increase occurring in the animal product sector (8.80 percent). Employment in the processed and meat product sectors increases, while it declines in the primary agricultural sector.

The importance of this insight should be stressed. Technological change in agricultural production is shown to be a prime mover in diversifying African economies out of agriculture, which is largely consistent with the patterns of diversification that have occurred across the continent since 1960 (Delgado

1995). Countries such as Ivory Coast, Zimbabwe and Kenya historically were the success stories in promoting technological change in agriculture and they were then the first to develop significant industrial plant. Technological change in agriculture moves labor out of agriculture in favor of the processing sector. Prices of all agricultural commodities fall from 0.32 and 1.165 percent. Wage rates of unskilled labor increase (0.50 percent) relative to a fall in the prices of agricultural commodities. The purchasing power of unskilled labor increases in the model, suggesting positive conditions for the enhancement of the food security status of large groups of people.

Applying the same technological shock separately for each of the primary agricultural sectors (grains, non-grain crops, and animal products), the non-grain sector yields the highest welfare. In this case, the domestic welfare grain is $545.01 million. Prices of non-grains and processed food decline by 1.28 and 0.18 percent, respectively, while prices of other commodities increase, but by less than the increase in wage rates. Returns to owners of factors of production increase. This is likely to have positive implications for poverty reduction, because the purchasing power of unskilled labor and agricultural producers increase.

A 1.5 percent growth rate from technical change in the grain sector leads to a domestic welfare gain of $281.23 million. Employment decreases in the grains

sector, and increases in the other agricultural sectors. However, the increase in the other sectors does not compensate for the decrease in the grain sector. Unlike in the case of the non-grains sector (E5B), returns to owners of factor of production decline and wage rates decline. Output prices decline as well, but not significantly enough to offset the decline in returns to owners of factors of production and wage rates.

With a 1.5 percent increase in the productivity of the animal product sector, welfare gains increase to about $115 million, with the SSA economies capturing 97percent of the global gains. Exports of animal products increase by 8.56 percent (Table 5, E5C). As expected, employment declines in the animal product sector, but increases in other sectors. Unskilled wage rates increase slightly, and return to land decline. The slight increase in unskilled wage rates compares favorably with the decline in output prices, thus raising the ratio of wage rates to food prices.

5. CONCLUSIONS

Agro-food processing offers opportunities to diversify their sources of value-added for many countries that are overly dependent on primary commodities. Agro-food processing sectors are also major sources income and employment, providing access to food and other necessities. Because the economy of SSA depends primarily on agriculture for employment and export earnings, we hypothesized that technical change that increases the productivity of agriculture and downstream activities such as processing has the potential to reduce the incidence of poverty. To address this issue, the paper focused on the impact of different kinds of technological change on the agro-food processing sectors in sub-Saharan Africa (excluding southern Africa). A thirteen-commodity, seven-region version of the GTAP model was used and the database reflects economic conditions in 1995 (Version 4). Experiments were also performed on primary sectors such as grains, non-grains and livestock, to permit comparison with the agro-processing sectors. The simulations generated the following conclusions:

(1) Even a small, one-shot increase in the productivity of crop and livestock production in Africa (1.5%) was seen to lead to large welfare gains for the region (of the order of U.S. $1 billion 1995), and to significant diversification of economies out of agriculture. This crucial point is often

(2) lost in more partial equilibrium work. Besides direct effects, the effects on exports and linkages with the domestic economies are major. Even from the narrow standpoint of the agro-processing industries themselves, a 1.5 percent cost reduction in the overall primary sectors appears superior to a 3 percent unit cost reduction from technical change in the agro-food processing industries themselves, according to a number of criteria: (a) domestic welfare improvement; (b) global welfare improvement; (c) domestic capture of welfare gains; and (d) raising the ratio of the wage rate to the price of food.

(3) Technological change in the production of non-grain crops (including fruits, vegetables, oil seeds, etc.) to produce processed food appears to be superior to other types of raw-material-saving technical change. Domestic welfare gains are three and four times higher than in the case of labor-augmenting and infrastructural services augmenting technical changes, respectively. The domestic capture of the gains is also higher (95 percent). Ratios of wage rates to prices also increase, suggesting potential benefits for the poor. Employment of unskilled labor increases overall. Labor-using rather than labor-augmenting technical change in the agro-food processing sectors is a more appropriate strategy.

(4) Within the processed meats sector, technical change in the primary production of animal products also yields the highest domestic welfare gains compared to other types of augmenting technical change. However,

the overall gains are modest compared to the processed food crops sector. The ratio of wage rates to the price of meat products increase but real wages are unaffected with respect to the prices of other agricultural products.

(5) Factor-neutral output-augmenting technical change in the agro-food processing sector yields much greater benefits for SSA economies than the different types of biased technological change examined. Exports of processed food and meat increase with significant positive impacts on welfare. The latter gains are higher than those obtained in other types of technical change. Also wage rates increase relative to prices of processed food and meat products and other agricultural goods, thus positively affecting the food security environment for unskilled labor.

(6) Technical change in the agro-food processing sectors decreases slightly the exports of other primary agricultural products in favor of the processed food and meat products thus diversifying the sources of exports. The increase in exports of processed food and meats more than offsets the reduction in exports of primary commodities with a positive welfare effect.

In sum, the story told here is a simple one of not-so-obvious linkages and unanticipated general equilibrium effects. It does not, however, match costs to benefits, as we have no way to compare the cost of one kind of technological change to another, or even to judge its feasibility. Nonetheless, the simulations

here do serve to demonstrate the value of AGE models to illustrate that the best route to development is not always to directly pursue the symptoms such as industrial development. On the contrary, success requires correctly identifying the engines of growth that are capable of having widespread and important effects on growth and poverty reduction in the aggregate. In SSA, this is basic agricultural productivity.

Table 1-Share of agro-processing employees[1] in total employees in manufacturing, and share of agro-processing wages in total wages in manufacturing in selected countries, 1992 (percent).

Countries	Agro-processing employees/ total employees in manufacturing	Wages in agro-processing/total wages in manufacturing
DEVELOPED		
United States	9.1	7.8
Finland	13.0	12.8
Germany	7.2	5.9
Canada	13.6	12.6
Sweden	9.8	8.8
TRANSITIONAL	11.7	13.4
Bulgaria	15.3	16.7
Croatia	12.5	10.8
Kyrgyzstan	11.2	19.6
Russian Federation[2]	18.7	23.7
Lithuania [3]	20.11	21.5
Hungary[3]		
	35.9	38.6
DEVELOPING	32.4	28.4
Africa :	26.1	36.9
Cameroon	59.3	55.6
Kenya	17.7	24.4
Botswana		
Senegal	22.8	12.0
Zimbabwe	20.2	14.5
Asia and the Pacific :	7.2	6.2
India	8.4	8.6
Indonesia	20.9	22.6
Korea, Rep.	20.5	20.3
Malaysia		
Philippines		
Sri Lanka	27.6	25.2
Latin America and the	33.0	12/5
Caribbean :	22.1	22.7
Argentina[2]	36.1	33.2
Brazil	20.9	17.6
Colombia	23.5	25.5
Ecuador		
Mexico		
Peru		

[1] Food, beverages and tobacco
[2] Data refer to 1993
[3] Data refer to 1994
Source : Adapted from FAO (1997)

Table 2-Regional and Commodity Aggregation

Regional Aggregation	Commodity Aggregation
1. North Africa and Middle East (NAFR_MEAST) Morocco Turkey Rest of North Africa Rest of Middle East 2. Southern Africa (SothernAfrica) South African Countries Union Rest of Southern Africa 3. Rest of Sub-Saharan Africa (RestSSA) 4. Asia (Asia) South and Southeast Asia 5. Western Hemisphere (Whemisph) North America Mexico Latin America and the Carribean 6. European Union (EU) 7. Rest of the World (ROW)	1. Grains Paddy rice Wheat Cereals , other grains 2. Non grains (Nongrains) Vegetables, fruits, nuts, oil seeds, sugar cane, soya bean, plant based fibers, other crops 3. Animal products (Animal Prod) Bovine cattle, sheep and goats, horses, and other animal products 4. Raw milk (Rawmilk) 5. Other livestock (OthLvstk) Wool, silk-worm cocoons 6. Natural Resource Industries (NatResInd) Forestry, coal, oil, gas, minerals 7. Processed food (Procfood) Veg.oils and fats,processed rice,sugar,other food products 8. Meat Product (Meatprod) 9. Dairy Products(Dairyprod) 10. Fishing 11. Beverages Beverages and tobbacco products 12. Manufactures (Mnfctrs) 13. Services

Table 3-Impact of a 3 percent cost reduction in the processed food sector coming from different types of technical change in the rest of sub-Saharan Africa on trade, output and factor prices, employment and welfare (percent).

	Type of Augmenting Technical change			
	E1A Labor in food processsing	E2A Non-grains in food processsing	E3A Services in food processsing	E4A Output of processed food
Trade (qxw)				
Grains	-0.17	-0.58	-0.30	-1.19
Non-grains	-0.20	-0.45	-0.35	-1.30
Animal products	-0.12	-0.34	-0.31	-1.13
Processed food	2.51	8.64	2.90	13.07
Meat products	-0.02	-0.44	-0.17	-0.82
Output prices (pm)				
Grains	0.05	0.17	0.09	0.36
Non-grains	0.05	0.11	0.09	0.33
Animal products	0.02	0.06	0.06	0.21
Processed food	-0.62	-2.04	-0.71	-3.01
Meat products	0	0.10	0.04	0.20
Factor prices (pfe)				
Land in grains	0.31	-0.37	0.33	0.48
Land in non-grains	0.31	-1.00	0.30	0.24
Land in animal production	0.29	-0.44	0.30	2.46
Wage rate(Unskilled labour)	0.05	0.24	0.09	0.42
Employment (qfe)				
Grains	0.07	0.23	0.07	0.16
Non-grains	0.06	-0.55	0.04	-0.14
Animal products	-1.58	0.15	0.05	0.13
Processed food	0	2.75	0.86	0.56
Meat products	0	0.11	-0.03	-0.07
Services	-0.01	0.20	-0.25	0.08
Welfare (EV)				
Domestic ($USm)	71.42	291.33	83.97	410.44
Total ($USm)	83.99	305.45	91.02	433.89
Domestic EV as % of total EV	85	95	92	94

Table 4-Impact of a 3 percent cost reduction in the meat product sector coming from different types of technical change in sub-Saharan Africa on trade, output and factor prices, employment and welfare (percent).

	Type of Augmenting Technical change			
	E1B Labor in meat processing	E2B Animal products in meat processing	E3B Services in meat processing	E4B Output of processed meats
Trade (qxw)				
Grains	-0.01	-0.03	-0.02	-0.05
Non-grains	-0.02	-0.03	-0.02	-0.06
Animal products	-0.03	0	-0.03	-0.05
Processed food	-0.01	-0.03	-0.01	-0.04
Meat products	3.70	8.96	3.60	13.75
Output prices (pm)				
Grains	0	0.01	0.01	0.02
Non-grains	0	0.01	0.01	0.01
Animal products	0	0	0.01	0.01
Processed food	0	0.01	0	0.01
Meat products	-0.89	-2.06	-0.85	-3.07
Factor prices (pfe)				
Land in grains	-1.06	-0.02	0.02	0.02
Land in non-grains	0.02	-0.03	0.01	0.01
Land in animal production	0.05	-0.07	0.05	0.04
Wage rate (Unskilled labor)	0	0.01	0.01	0.02
Employment (qfe)				
Grains	0	0	0	0
Non-grains	0	-0.01	0	-0.01
Animal products	0.04	-0.07	0.04	0.03
Processed food	0	0	0	-0.01
Meat products	-1.56	2.53	1.03	0.62
Services	0	-0.01	-0.01	0
Welfare (EV)				
Domestic ($Usm)	4.32	10.95	3.63	15.73
Total ($USm)	5.75	13.70	4.85	20.10
Domestic EV as % of total EV	75	80	75	78

Table 5-Impacts of a 1.5 percent output-augmenting technological change that reduces cost for producing grains, non-grains and animal products and the agricultural primary sectors on trade, output and factor prices, employment and welfare in sub-Saharan Africa (percent).

	E5A Grains	E5B Non-grains	E5C Animal products	E5D Primary sector
Trade (qxw)				
Grains	6.11	-1.29	0.05	4.75
Non-grains	0.26	4.90	0.04	5.21
Animal products	0.76	-0.53	8.56	8.80
Processed food	0.53	0.70	0.02	1.25
Meat products	0.22	-0.95	3.15	2.42
Output prices (pm)				
Grains	-1.80	0.37	-0.02	-1.48
Non-grains	-0.07	-1.28	-0.01	-1.37
Animal products	-0.14	0.08	-1.59	-1.65
Processed food	-0.13	-0.18	-0.01	-0.32
Meat products	-0.05	0.22	-0.76	-0.60
Factor prices (PFE)				
Land in grains	-1.78	0.40	-0.23	-1.65
Land in non-grains	-0.68	0.02	-0.26	-0.93
Land in animal production	-0.73	0.40	-1.15	-1.49
Wage rate(Unskilled labor)	-0.01	0.48	0.03	0.50
Employment (qfe)				
Grains	-1.21	0.20	0.03	-0.99
Non-grains	0.16	-0.27	0	-0.11
Animal products	0.10	0.20	-1.10	-0.79
Processed food	0.36	0.41	0.06	0.84
Meat products	0.26	-0.04	0.96	1.18
Welfare (EV)				
Domestic ($USm)	281.23	545.01	114.88	945.29
Total ($USm)	291.33	623.77	118.52	1037.84
Domestic EV as % of total EV	96	87	97	91

FIGURES

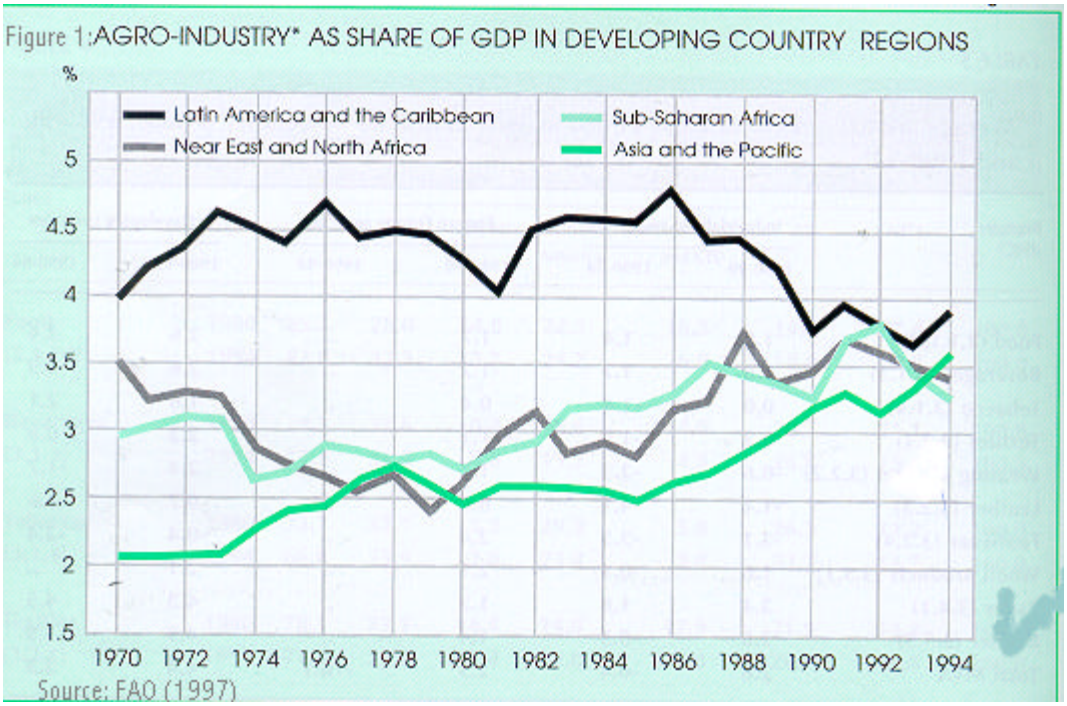
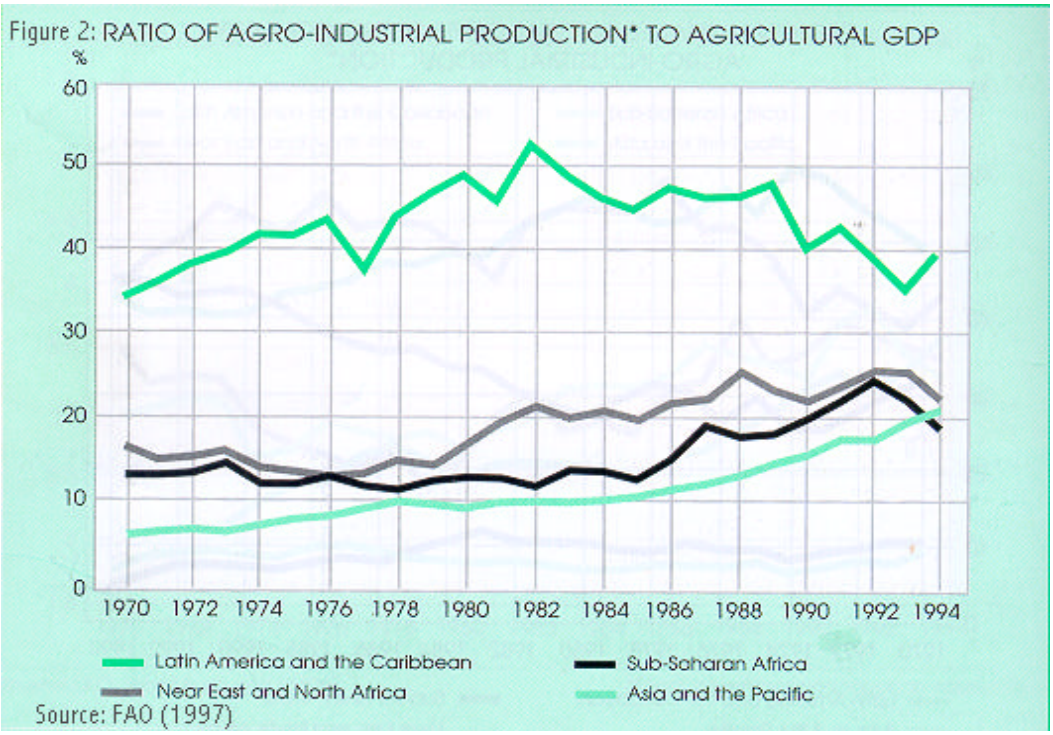


Figure 1:AGRO-INDUSTRY* AS SHARE OF GDP IN DEVELOPING COUNTRY REGIONS
%
Latin America and the Caribbean
Near East and North Africa
Sub-Saharan Africa
Asia and the Pacific
5
4.5
4
3.5
3
2.5
2
1.5
1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994
Source: FAO (1997)

Figure 2: RATIO OF AGRO-INDUSTRIAL PRODUCTION* TO AGRICULTURAL GDP



Source: FAO (1997)

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