IMPACT OF AGRICULTURAL POLICY ON FOOD SECURITY: AN AGRICULTURAL SECTOR MODELLING APPROACH FOR BENIN[1]

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1. Introduction

In the last two decades, most of the African, Latin American and Asian countries have significantly changed their agricultural and food policies under various Structural Adjustment Programmes. These reforms responded to fundamental macroeconomic and financial disequilibria following inadequate economic policies and an unfavourable international environment by focusing on two groups of policies: (i) *Stabilisation,* also called macro-economic adjustment, which refers to immediate changes to key macro-economic parameters (e.g. devaluation of exchange rate, tighter monetary policies, reduction of budget deficit) aiming at achieving macro-economic stability in the short-term and (ii) S*tructural adjustment* proper, referring to fundamental changes to the way in which the economy operates. It involves market, trade, institutional and specific sectoral reform measures aimed at improving allocative efficiency and economic growth.

Benin started its first of a series of three structural adjustment programmes in 1989. The main components of the programmes were: reduction of the budget deficit, liberalisation of the economy, and other institutional reforms aimed at creating the conditions for sustainable growth. All these measures had a significant impact on the agricultural sector. For instance, a reduction in the budget deficit was to be achieved through a reduction of government expenditures. At the beginning of the first programme, about 40% of Government employees in the agricultural sector (mainly extension workers) were laid off. Also, expenditures on health, research, education and parastatals were cut back. While these reforms affected the farming sector indirectly, the most important change was the 100% devaluation of the CFA Franc (FCFA, the common currency of 15 West African countries), in January 1994. This

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devaluation meant a radical change in the farmers' economic environment. It led to a decrease in food production in rural areas and higher food prices which in turn adversely affected urban consumers and rural net buyers of food. Even though food production does not necessarily mean availability of food, these two aspects are closely connected in Africa (von BRAUN et al., 1999) and especially in Benin (MENSAH, 1998), where a short-term deterioration in food security may also lead to a long-term decline in per capita food production and employment. The Government's lay-off of thousands of civil servants, which increased the number of jobless people especially among young graduates and school-leavers, diminished income opportunities in urban areas, where unemployment is particularly severe (MENSAH, 1998).

A number of studies have analysed the impact of economic and agricultural reforms on farmers and rural and urban consumers' food security. DEATON (1989), BUDD (1993) and BARRET and DOROSH (1996) used non-parametric regression methods to estimate the instantaneous distributional implications of a food price change in Thailand, Côte-d'Ivoire and Madagascar, respectively. They examined the relationship between household income/expenditure, and the value of net sales as a proportion of income, food purchases and sales, inter alia. This methodology, however, ignores the partial equilibrium consequences of food prices on quantities demanded and supplied, as well as the general equilibrium consequences on employment patterns, wages, the prices of other factors and products, technological innovation, and other determinants of welfare. However, the advantages of studies using economy-wide models in terms of analytical completeness and intersectoral linkage effects must be weighed against the loss of detail in revealing inter- and intra-household relationships, distributional effects and determinants of household behaviour. Also, the uncertainties surrounding model parameters as well as the possible distortions caused by imposing substantial modelling requirements on the problem may be an important issue (BARRET and DOROSH, 1996). Studies using the latter approach, such as those of REARDON (1994), BOURGUIGNON et al (1991), de MELO and ROBINSON (1982), often conclude that the impact of adjustment on the rural poor will depend on the tradability of their output, while the impact on the urban poor in general is found to be negative. An approach located between the two mentioned above is the multi-market spatial-equilibrium model used by MINOT and GOLETTI (1998) to examine the effects of export liberalisation on regional rice prices and different household groups' welfare in Vietnam. Their results suggest that while liberalisation measures such as rice export liberalisation would raise food prices and

exacerbate regional inequality, they would also increase average real income and reduce the incidence and severity of poverty.

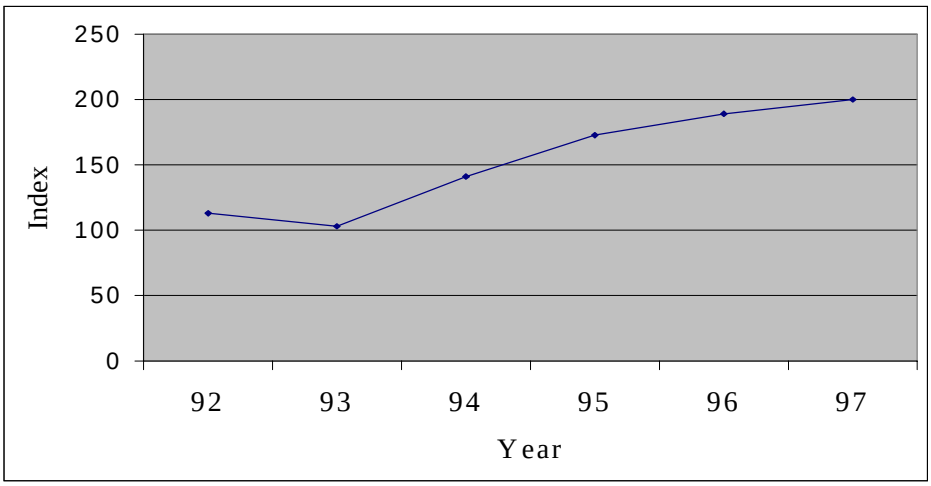
Since the beginning of the economic and agricultural reforms in 1989 in Benin, little attention has been given to their impact on food security at micro level. The existing evaluations concern mainly the description of macroeconomic parameters (for example, IMF and BENIN'S GOVERNMENT, 1998). In this article the focus is directed to the meso-economic impact on the agricultural sector of the reforms undertaken since 1989. The reasons for undertaking this type of analysis are as follows. First, Benin is a low-income country where the price of staple foods is an important determinant of the well-being of urban and rural populations. Second, there is a need for a better understanding of the limitations of both the first-order welfare effects estimation and the general equilibrium modelling. Third, there is a need to analyse the dynamic recursive character of farmers' decision-making as well as its impact on urban consumers' food security; this allows us to separate the direct effects of policies from those of other factors or events.

2. Impact of economic and agricultural reforms on food production in the Borgou region

Within the framework of the adjustment reforms the food sector has been largely liberalised, leading to strong price fluctuations. The cotton sector, on the other hand, because of its economic importance for the national economy, was liberalised only partially. A system of fixed, pre-announced cotton prices as the cornerstone of an active price policy for this crop has been maintained. The cotton price was increased three times after the devaluation: from 110 FCFA in 1993 to 140 FCFA in 1994, 175 FCFA in 1995 and 200 FCFA in 1996[2]. Cotton also benefits from well organised marketing and credit systems. Consequently, farmers reacted positively, increasing the share of cotton in the farming systems and reducing food production. As a result of these factors, foods prices increased considerably across the country. Figure 1 shows that the food price index doubled between 1993 and 1997 in Cotonou, the capital of Benin (INSAE, 1997).

[2]To insulate domestic farmers from decreasing trends in the international market, the Government fixed the cotton price for Benin farmers at 185 FCFA per kg in 2000.

Figure 1: Evolution of the food price index in Cotonou (1991 = 100).



The impact of the adjustment reforms on the agricultural sector is multifaceted and complex. The Borgou province, situated in the North of the country, is the main agricultural supply area in the country. It has been chosen as a representative region for the purpose of analysing the impact of the reforms on the agricultural sector. Besides being the main cotton producing area, it is also becoming the major food supplier to the Southern part of the country. The main food crops are maize (the most important), sorghum, yam, cassava, cowpea and groundnut. The agro-ecological conditions inside the Borgou Province clearly determine differences in farming systems, variations in yield levels, the management and potential regeneration of soil fertility as well as the nutritional pattern of the population (BRÜNTRUP, 1997). The Borgou, due to its agricultural weight, considerably influences national supply. The province is subdivided in three agro-ecological zones (the food crop-dominated zone in the South (AEZ 1), the cotton-dominated agro-ecological zone in the North (AEZ 3) and the mixed zone in the centre (AEZ 2)).

A survey was carried out in this area in 1997 to analyse cropping pattern changes following devaluation[3]. Results show that in all three AEZs cotton area expanded at the expense of food crop area. Even the farming systems in AEZ 1, entirely specialised in food production until 1993, responded positively to the cotton price increase (table 1).

[3] Another reason for choosing this area was the availability of a database covering the period April 1991 to August 1992 available at the University of Hohenheim and collected in the Borgou region (Brüntrup, 1997). This database has been used for comparison and reference purposes.

Table 1: Evolution of the cropping pattern in the Borgou region (% of total cropped area)

	1992	1993	1994	1995	1996	1997
Food crop-based zone (AEZ 1)						
Cotton	0	0	3	4	14	6
Food crops	100	100	97	96	86	94
Central zone (AEZ 2)						
Cotton	28	32	38	40	42	37
Food crops	72	68	62	60	58	53
Cotton-based zone (AEZ 3)						
Cotton	36	37	37	38	45	45
Food crops	64	63	63	62	55	55

Sources: 1993-97: Authors' survey; 1992: calculated from Brüntrup (1997).

These results are consistent with the trends reported by IGUE (1999) and MENSAH (1998), according to which all the staple foods experienced a pronounced negative national balance since 1995, the year of the cotton boom. Table 2 shows that the tradable surplus considerably decreased in the region between 1992 and 1997.

Table 2. Market share of food crops in % of gross production, 1992/1996

	Yam	Maize	Sorghum	Groundnuts	Cowpeas	Cassava	Rice
Food crop-based zone (AEZ 1)							
1992	30	76	30	100	28	7	
1996	19	53	25	100	13	10	
Central zone (AEZ 2)							
1992	7	25	9	78	54	11	
1996	8	16	9	68	52	9	
Cotton-based zone (AEZ 3)							
1992	32	11	3	55	54	17	58
1996	2	13	15	63	19	5	64

Sources: 1996: Authors' survey; 1992: calculated from Brüntrup (1997).

These trends show that the reforms have contributed to a decrease in food production area and marketing in the most important agricultural production area of the country. The question to be further analysed is how these changes have affected farmers' revenue and urban consumers' food security. A simulation model has been built to address this issue. The structure of the model used for the analysis of the differentiated impacts will be summarily described in the next section.

3. The MATA Model of the agricultural sector in Benin

The Multi-level Analysis Tool for the Agricultural sector (MATA) (GÉRARD et al., 1995; DEYBE and ROBILLIARD, 1997) is the modelling approach chosen here to simulate the impact of fundamental reforms in the agricultural sector. It is a recursive, partial equilibrium agricultural sector model developed to evaluate response trends in agricultural production and food consumption as a result of policy changes. The principal hypotheses of the model are:

- Farmers' decision-making process is based on price-"adaptive" expectations. Farmer surveys and the literature show that there is often a difference between the expected prices (on which production decisions are based and which determine the "actual" level of production) and the actual prices received after harvest, which depend on demand (determined by consumers' income and budgetary constraints, preferences, quality, etc.).
- Prices for agricultural non-tradables are endogenously determined in the economy as a result of total supply (net of rural self-consumption) and urban demand.
- Prices for agricultural tradables are exogenously determined by the international market while their supply/demand is not limited.

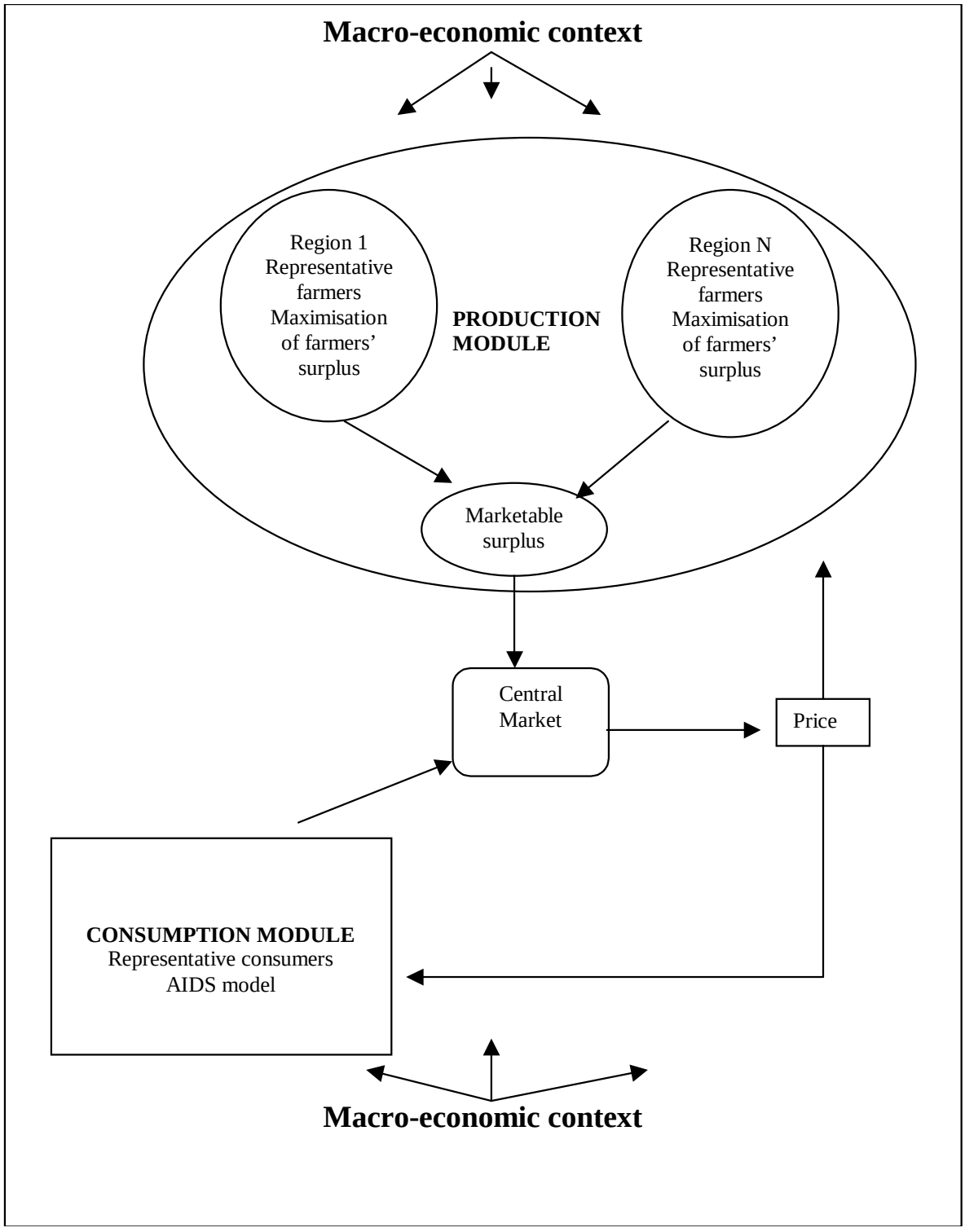
MATA is a combination of three inter-related modules: production, consumption and the macroeconomic context (figure 2).

The production module represents agricultural production; it contains a detailed description of the behaviour of each type of farmer/herder at the regional level. Land allocation, total production, consumption levels (by producers) and marketed surpluses are estimated. Physical, agronomic, socio-economic and institutional aspects of agricultural production are integrated into the representation of each region. A region is defined as a homogenous zone with respect to agro-ecological conditions, population and integration into the market and is represented through the modelling of representative farm-types, reproducing the main characteristics (opportunities and constraints) of the production units. Three periods within the year are considered to capture the seasonal characteristics and constraints affecting crops, livestock and consumption: sowing season, harvesting season and dry season.

A base level of rural consumption is secured through minimum household caloric intake constraints; consumption preferences are based on empirical studies, differentiated by type of farm and region. Risks related to the level of production and prices are considered using the «target MOTAD» method developed by TAUER (1983): several equations are introduced to

represent several scenarios, with a minimal revenue constraint from which revenues are allowed to deviate according to farmers' attitude to risk.

Figure 2: The structure of the model



The objectives considered at farm level are: income maximisation and food consumption sufficiency, but maximisation is done on joint surplus (aggregate farmers' surplus, which is

defined by production less consumption) at the regional level, subject to the constraint of household self-sufficiency, either satisfied by household production or purchases. Constraints are linked to farmers' and overall endowment of production factors: land, labour and cash availability.

By aggregating regional surpluses, national supply is calculated and is confronted with total urban demand in the market/consumption module.

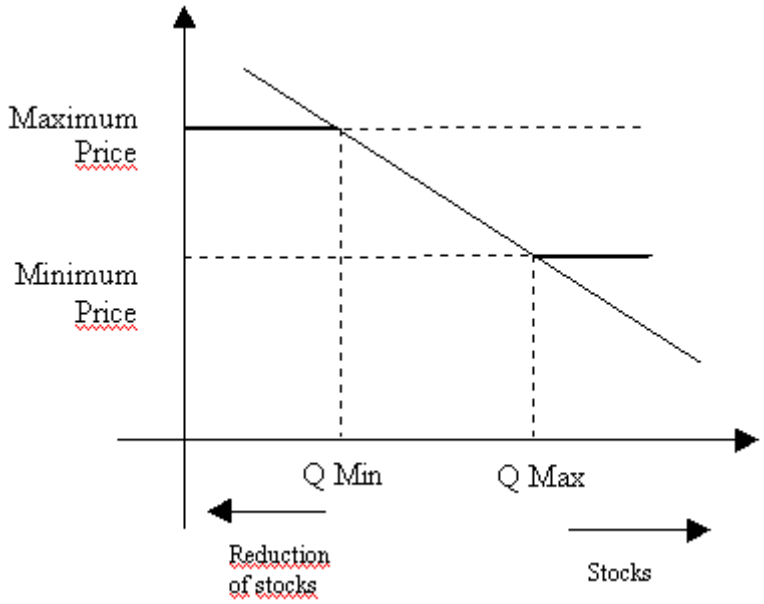
The market/consumption module describes consumers' behaviour. It focuses on the substitution process between local and imported products in urban consumption due to changes in revenues and prices. It represents the different commodity chains, especially the process of supply aggregation and price formation mechanisms. Consumer behaviour is represented by the linear form of the Almost Ideal Demand System (AIDS), which is constrained by the food expenditures of each household type and which considers price and income elasticities.

Following SURRY (1993), the market/consumption module has been calibrated using the Constant Difference of Elasticities (CDE) functional form developed by HANOCH (1975). The CDE is a globally well-behaved functional form that permits us to obtain the matrix of compensated price elasticities with only *a priori* knowledge of its direct diagonal elements[4].

The supply/demand equilibrium prices cannot move outside some price bands, as suggested by SADOULET and de JANVRY (1995) (figure 3). When the quantities arriving on the markets are too large to keep prices within the band, either the product is stocked by traders or farmers, or they find it more convenient to export the excess supply to locations with more attractive prices. In any case, the price can not go beyond the minimum and maximum price levels given by the band. The model specifies in the supply/demand equilibrium equation both the maximum (Q Max) and the minimum (Q Min) quantities which are made dependent on the national demand in each year. These maximum and minimum supplies ensure that prices remain within the band.

[4] Details on the methods can be read in SURRY (1993) and NODJIRIM (1998).

Figure 3: Influence of price bands on price determination



The context module describes the macroeconomic and institutional context affecting the global economy. It contains the parameters to be modified to simulate policies: exchange rate, population growth, credit conditions, some input and output prices, urban household revenue, etc.

The model was constructed to analyse and highlight the changes deriving from economic and agricultural reforms undertaken since 1989. Two scenarios were constructed: first, the continuation of the trend observed in 1989, with only the population growth as major change in the sector; and second, the changes which occurred in the agricultural sector as consequences of the adjustment reforms including input and output price modifications as well as changes in salaries, transportation costs, etc (see details in appendix 2).

The model was run for six years, from 1993 to 1998, to capture the most important measures including the devaluation of 1994. The country was divided into six homogeneous regions (BIAOU, 1995; AUBER; 1995; SENAHOUN et al., 1999a); in each of them a typology was defined using different databases (see appendix 1); three urban household types were distinguished according to their income level (HAEFLIGER et al., 1998).

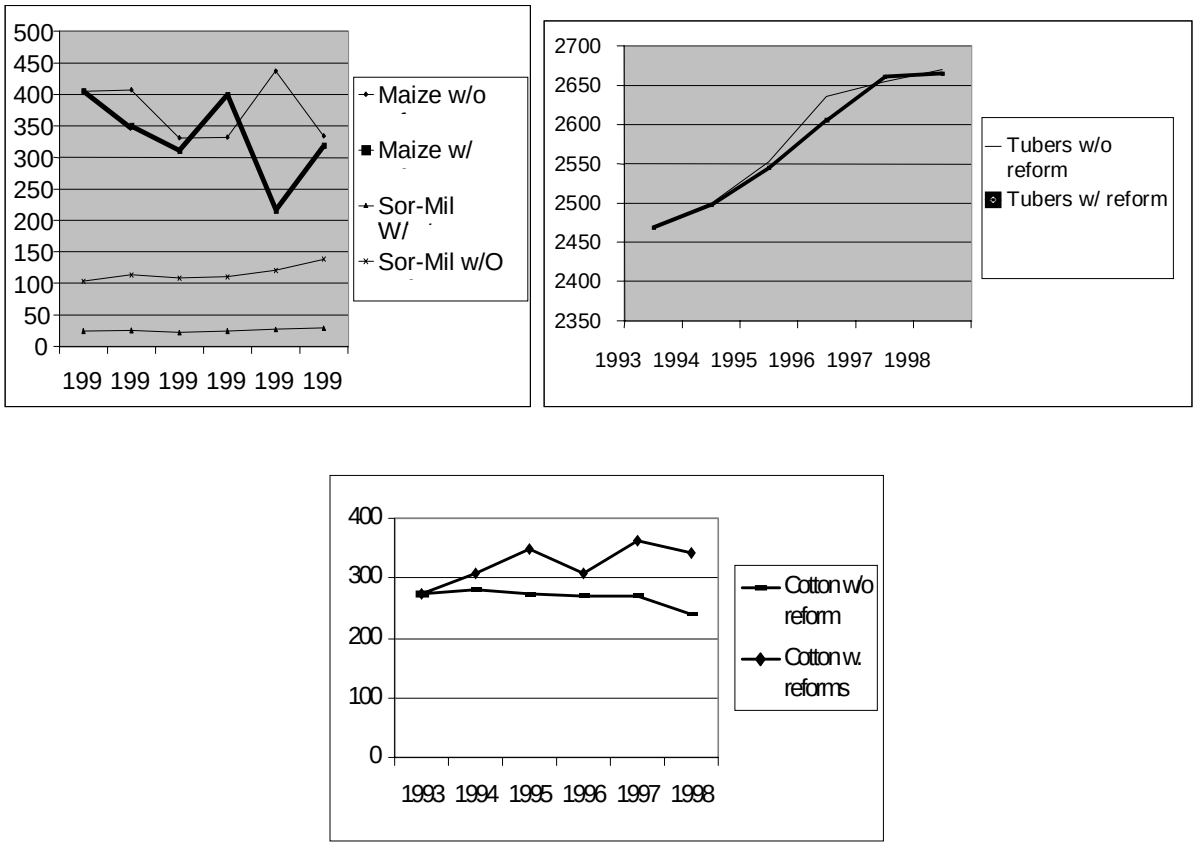
Several variables can be used to estimate the impact of the measures. Those selected to be the most relevant ones for the analysis of food security are food production and its consequences for rural income changes, changes in food composition at the rural level and the caloric intake of urban consumers.

The model was written in GAMS (General Algebraic Modelling System) and solved using the GAMS.MINOS solver.

4. Simulation results

The simulated food production scenarios confirm the trend observed for the Borgou region: while food and cotton production remain almost stable in the “no reform” scenario, cotton production increases by about 32% over the simulated period in the “reform” scenario (cotton area increased by about 51% over the same time period, implying a decreasing yield in the scenario). Food production “without reform” would have been higher than the one observed with the reforms (figure 4).

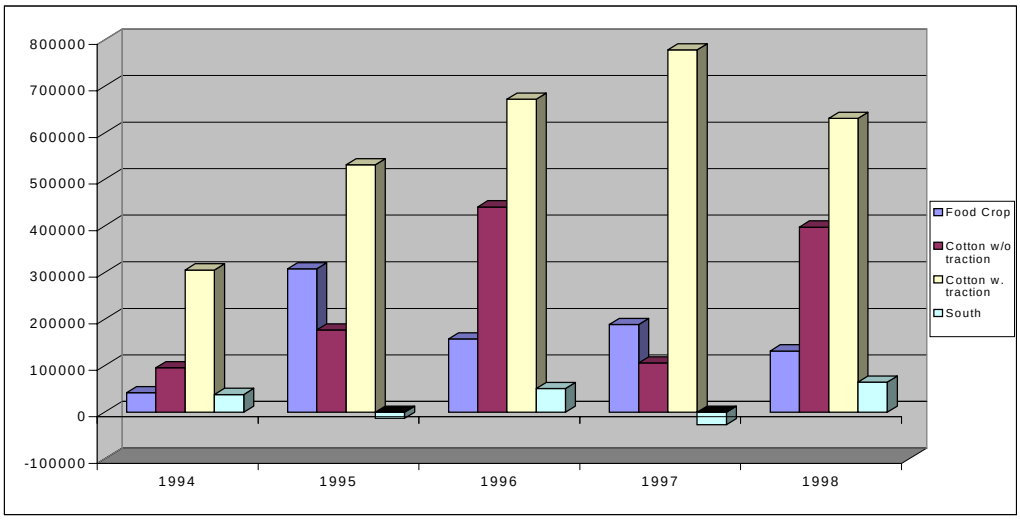
Figure 4: Simulation results: Crop production (in metric tons) in the no-reform and reform scenarios (national level).



The simulations show that the reforms improved nominal income for almost all types of farmers, especially cotton producers and among them particularly those with animal traction, whose differential to the "no reforms" situation increases persistently between 1993 and 1998

(figure 5). The response of food crop farmers is also positive, but slower and with stronger variability. The only farmers who are shown not to have benefited from this trend are the small farms in the Southern region, due to their extremely poor resource endowment (especially land and cash) and the ecological impossibility of growing cotton.

Figure 5: Simulation results: Income increase due to the reforms among different types of farmers (in FCFA)



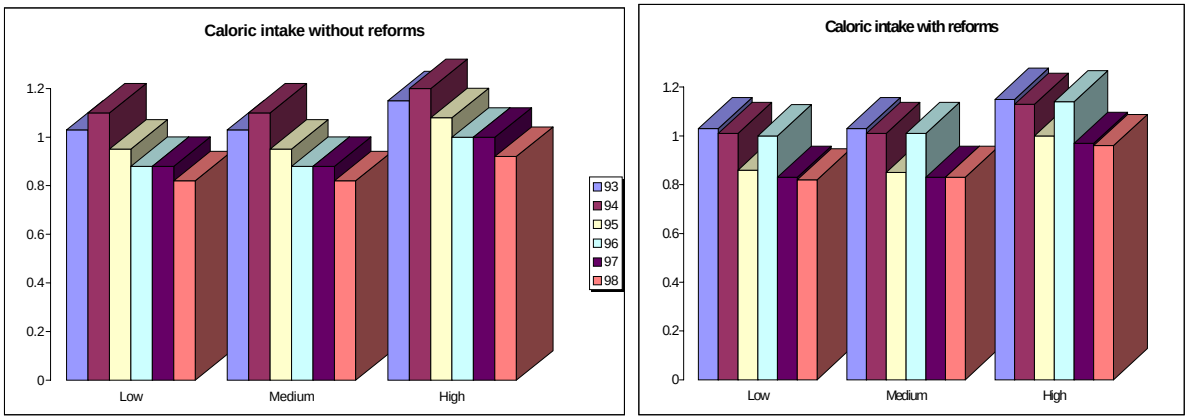
In the simulation, the consumption patterns changed with the reforms. The results differ among the regions according to their main production characteristics. In general, small farmers consume more tubers and maize. They decrease their consumption of rice (mostly of imported rice whose price increased strongly after the devaluation) and in some cases also of peanuts, thus reducing the nutritional value of their diet. Only in the centre region is rice consumption increasing; this is due to the influence of the higher income generated by cotton and peanuts, which is used for purchasing rice. However, in most cases the consumption patterns in the last year of the simulation revert to that of the base-run. This indicates that farmers initially responded to the high differential in prices by adapting their production patterns and afterwards, when the price differential declined, they resumed their previous consumption habits and to some extent their old production patterns.

Simulated food prices in the “reform” scenario are higher than the ones in the scenario “no reforms”, which is to be expected given the lower production and a partially inelastic demand. When the simulated prices are compared with the observed ones, the latter are about 30% higher. This large difference, which implies a higher than assumed level of demand, may represent the fact that the model does not take into consideration informal exports to

neighbouring countries (for which no data is available) or speculative behaviour on the part of traders. If these two factors were included in the model, the magnitude of the impacts would be larger.

Simulated caloric intake of urban consumers (in percent of FAO recommended caloric requirements) decreased for all consumer groups in the "without reform" scenario, which is logical given the increase in the population without a response in terms of food production. But the decline is even more pronounced in the scenario "with reforms", specially for low and medium-income households which, even if their demand is partially inelastic, were forced to decrease their level of consumption due to a real income decline (figure 6). The reforms may also have caused a stronger variation in consumption between years.

Figure 6: Simulated caloric intake of different urban households by income level (as a percentage of FAO recommend minimum, 1 = 100%).



The results show the high vulnerability of poor consumers: since their intake was very close to the FAO minimum requirements, any external shock in the form of higher food prices endangers their food security. The reforms may have increased their vulnerability: in most years, they consume less than 85% of their caloric requirements. However, urban consumers may have adapted their consumption behaviour towards lower quality products (i.e. broken rice instead of higher quality rice) which may have mitigated the negative impact on caloric intake but which is not captured by the model. Moreover, the study made the hypothesis of strong separability in consumer's budget allocation, and only food commodities are considered in the AIDS demand system. This implies that this specification does not allow us to capture shifts between other type of expenditures and food expenditures that probably took place in reality, and which can be expected to have occurred most probably at the high-

income consumers' level. Nevertheless, these figures indicate the negative trend in consumer welfare changes. Even if expenditure substitution among categories did take place, the overall level of income would not change, which implies a lower level of consumption of other goods with a consequent negative impact on welfare.

5. Conclusions

This paper discusses the outcome of the economic and agricultural adjustment reforms for agricultural production and urban food consumption in Benin and compares the results with the situation contrary to actual fact, i.e., what might have been had these reforms not taken place. Two main issues arise in analysing the impact of these reforms: 1. Has national GDP increased? 2. Who benefited and who lost out in this process? In this paper less attention has been given to the first question, although the increase in cotton production and exports would probably imply a positive impact. The main attention of this paper is focused on the second question. The results show that while the agricultural sector overall may have benefited from reforms, in particular farmers with the possibility of growing cotton, the social costs in terms of urban welfare decline may have been high, notably for low and medium-income groups. This confirms our observations during the survey in 1997 as well as studies by other authors in other countries (BARRETT and DOROSH , 1996; MINOT, 1998). This is not to say that Benin would have been better off not to reform its economic and agricultural policies. A no-reform scenario would have been untenable and financially infeasible. However, it should alert policymakers to the fact that the burden of reform is unevenly distributed. Those at the margin of survival are least able to carry additional burdens, and reform-induced changes may endanger their food security. To mitigate the negative effects of SAP on poor urban consumers, who are the main losers, the major instrument available to the Government is raising their incomes. It is more difficult and economically inefficient to manipulate or differentiate prices according to income groups. Employment promotion in urban areas, both through public employment or food for work programmes, and promotion of private sector development are vitally important measures which could be recommended to limit the social cost of adjustment for the poor. Particular emphasis should be placed on labour-intensive infrastructure programmes, income-generating microprojects, professional development, etc. (FAO, 1997; von BRAUN et al., 1998). Also, support for education and improving access to microcredit, particularly for women, have proven to be effective instruments to support low-income groups (ZELLER et al., 1997).

The simulation approach proved to be useful in analysing the different impacts on various groups concerned and in identifying those that need to be protected from adverse impacts of adjustment reforms.

References

AUBER, L. (1995): Prise en compte des effets à long terme de la dévaluation du franc CFA sur le secteur agricole et l'environnement. Le cas du Bénin. Mémoire d'Agronomie Générale Approfondie, ENSAR, Rennees, France.

BARETT, C.B.; DOROSH, P.A. (1996): Farmers' welfare and changing food prices: non-parametric evidence from rice in Madagascar. American Journal of Agricultural Economics 78, 656-669.

BIAOU, G. (1995): Impact de la dévaluation du franc CFA sur la production agricole et la sécurité alimentaire et propositions d'action. Systèmes de Production. Document de travail. FAO TCP/BEN/3452 (A).

BUDD, J.W. (1993): Changing food prices and rural welfare: a nonparametric examination of the Côte d'Ivoire. Economic Developement and Cultural Change, 41, 587-603.

BOURGUIGNON, F.; de MELO, J.; SUWA, A. (1991): Distributional effects of adjustment policies: simulations for archetype economies in Africa and Latin America. The World Bank Economic Review 5,339-366.

BRAUN (von), J.; TEKLU, T.; WEBB, P. (1999): Famine in Africa. Causes, responses and prevention. The Johns Hopkins University Press. Maryland.

BRUNTRUP, M. (1997): Agricultural Price policy and its impact on Production, Income, Employment and the Adoption of innovations. Peter Lang .

DEYBE, D.; ROBILLIARD, A.S. (1997): Dévaluation et consommation alimentaire en zone franc. Le cas du Burkina-Faso. Economie Rurale 244, 49-53.

DEATON, A. (1989): Rice prices and income distribution in Thailand: a non-parametric evidence. Economic Journal 99, 1-37.

FAO. (1997): Implications of economic policy for food security: a training manual. FAO, Rome.

GÉRARD, F.; BOUSSARD; J.M.; DEYBE, D. (1995): MATA: un outil d'analyse multi-niveaux pour le secteur agricole; Notes et documents CIRAD/URPA n° 51, Paris, France.

HAEFLIGER, H.; YERIMA, B.; RIEDRE, P. (1998): Après le cycle d'Uruguay: Conséquences pour le Bénin. Identification des opportunités dans le secteur agricole du Bénin. Working paper, EPFZ/LARES, Zurich/Cotonou.

HANOCH, G. (1975): Production and demand models with direct or indirect implicit additivity. Econometrica 43, 395-419.
IGUÉ, J. (1999): Le Bénin et la mondialisation de l'économie. Karthala, Paris.
de MELO, J.; ROBINSON, S. (1982): Trade, adjustment policies and income distribution in three archetypal developing economies. Journal of Development Economics 10, 67-92.
IMF and BENIN'S GOVERNMENT. (1998): Bénin: Enhanced structural adjustment facility; policy framework paper, 1998-2001. http://imf.org/.
INSAE (Institut National de la Statistique et de l'Analyse Economique). (1997): Indices des prix à la consommation: Les prix à la consommation en milieu urbain au Bénin, troisième trimestre 1997. INSAE, Cotonou.
MENSAH, M.C. (1998): Feeding more people and better in West Africa: the case of Benin. IFPRI Lecture Series N° 6. IFPRI, Washington D.C.
MINOT, N. (1998): Distributional and nutritional impact of devaluation in Rwanda. Economic Development and Cultural Change 46, 379-402.
MINOT, N.; GOLETTI, F.(1998): Export liberalization and household welfare: the case of rice in Vietnam. American Journal of Agricultural Economics 80, 738-749
NODJIRIM, D.B. (1998): Le modèle MATA et fonction de demande AIDS: une application à la consommation alimentaire des ménages urbains burkinabés. Mémoire de DEA, ENSA Rennes/CIRAD, France.
REARDON, T. (1994): Structural adjustment impacts on real incomes in Peru in the 1980s. In: Heidhues, F.; Knerr, B. (eds.). Food and agricultural policies under structural adjustment. Proceedings of an international symposium, 21-25 September 1992, Hohenheim, Germany, pp. 494-502.
SADOULET, E.; de JANVRY, A. (1995): Quantitative development policy analysis. The Johns Hopkins University Press, Baltimore and London.
SENAHOUN, J.; HEIDHUES, F.; DEYBE, D. (1999a): Structural adjustment and soil erosion, a bio-economic modelling approach for Northern Benin, Quarterly Journal of International Agriculture, 38, 245-262.
SENAHOUN, J.; HEIDHUES, F.; DEYBE, D. (1999b): Structural adjustment programs and soil erosion: A bio-economic modelling approach for Northern Benin. Research in Development Economics and Policy Discussion Paper 05/99. Stuttgart: Grauer Verlag.
SURRY, Y. (1993): "The constant difference of elasticities" function with applications to the EC animal feed sector. Journal of Agricultural Economics 44, 110-125.

TAUER, L.W. (1983): Target MOTAD. American Journal of Agricultural Economics, 65, 606-610.
ZELLER, M.; SCHRIEDER, G.; von BRAUN, J.; HEIDHUES, F. (1997): Rural finance for food security for the poor. Implications for research and policy. Food policy review 4, International Food Policy Research Institute, Washington D.C.

Appendix 1: Data

The study combines an empirical historical analysis of food crop production in the Borgou region of Benin with a model simulation. Surveys for the empirical analysis were carried out in the Borgou region for the following reasons:
- It is the most important agricultural region of Benin, comprising 50% of the national territory, 17% of the population, 60% of cotton production and more than 60% of the national supply of staple foods.
- It is also the province with the most advanced development of animal traction.
- This region, as the most important one in terms of food and cotton production, offers the opportunity to observe and to analyse the phenomenon of substitution within the farming system and the impact of policies on food security.
Brüntrup (1997) carried out a household survey from April 1991 to August 1992 in the Borgou region with 75 households randomly selected in three villages representing the three agro-ecological zones. The authors (Senahoun et al.1999a) carried out another survey from May to December 1997 with the same sample extended to 90 households.

Besides these data the following databases have been used for the calibration of the model:
- a primary data set collected in 1994 by the UNDP and the Ministry of Agriculture of Benin within the framework of a study on the living conditions of the rural populations in Benin (ECVR) and covering all Benin;
- a primary data set collected in 1994 by CIRAD for FAO and covering the whole country;
- a primary data set collected by Haefliger (1998) within the framework of a household budget and consumption survey carried out in the main cities of Benin;
- a secondary data set collected in different statistical offices in Benin.

Appendix 2: Scenarios:

	1993	1994	1995	1996	1997	1998
Scenario "without reforms"						
Cotton price (FCFA/kg)	100	100	100	100	100	100
Fertiliser price (FCFA/kg)	95	95	95	95	95	95
Farm labour Price	A	A	A	A	A	A
Imported food prices (CFA)	B	B	B	B	B	B
Transport cost (CFA)	C	C	C	C	C	C
Urban income	D	D	D	D	D	D
Rural population growth (%)	2,1	2,1	2,1	2,1	2,1	2,1
Urban population growth (%)	4,8	4,8	4,8	4,8	4,8	4,8
Scenario "Reforms"						
Cotton price (FCFA/kg)	100	140	175	200	200	200
Fertiliser price (FCFA/kg)	95	95	190	190	190	190
Farm labour Price	A	A*1,6	A*1,6	A*1,6	A*1,6	A*1,6
Imported food prices (CFA)	B	B* 2	B*2	B*2	B*2	B*2
Transport cost (CFA)	C	C*1,4	C*1,4	C*1,4	C*1,4	C*1,4
Urban income increase	D	D*1,02	D*1,02	D*1,02	D*1,02	D*1,02
Rural population growth (%)	2,1	2,1	2,1	2,1	2,1	2,1
Urban population growth (%)	4,8	4,8	4,8	4,8	4,8	4,8

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