The Sustainable Tree Crops Program (STCP)

Phase II Program Document

The Analysis of Policies, Productivity and Agricultural Transformation in the Cocoa-Producing Rural Economies of West Africa

Technical Report
Executive Summary

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EXECUTIVE SUMMARY

Introduction

An analytical model of cocoa and the other major commodities produced in the cocoa belt of West Africa is developed for analyzing predicted impacts of public and private investments targeting the cocoa and food sectors in Cote d'Ivoire, Ghana, Nigeria, and Cameroon. One of the defining characteristics of the agricultural transformation process is a downward trend in the real price of agricultural commodities coupled with an increasing trend in their production and a reduction in the number of producers. Recognizing the crucial role of agricultural productivity in the rural transformation process, the African Union has proposed a Comprehensive Africa Agricultural Development Program (CAADP) as part of its New Partnership for Africa's Development (NEPAD) initiative. The CAADP has as its objective, 6 percent annual growth in agricultural productivity by 2015 (FAO 2002).

A multi-market model of the principal agricultural markets of the cocoa belt evaluates potential investments in productivity-enhancing technical and institutional change in both production and marketing. Commodity models of related markets are an essential tool for applied welfare analysis in the agricultural sector. The outcomes evaluated by the model are changes in agricultural income and producer welfare (as measured by producer surplus). The analysis looks to inform policy makers and development agencies on the feasibility of strategies for the cocoa belt that are in line with the CAADP of the African Union.

The model is used to estimate the predicted effect of an intervention on equilibrium quantities of demand and supply, price, farm incomes and producer surplus. To capture the interdependencies in production and consumption between these commodities and cocoa, the model includes cross price elasticities of demand and supply which cause all variables to adjust when the system is perturbed.

The efficiency enhancing innovations and investments examined include:

1. the widespread adoption of integrated crop and pest management practices for cocoa,
2. diffusion of improved planting material for cassava, plantains and yams as well as cocoa, oil palms and rubber clones,
3. the increased use of fertilizers on full sun production systems
4. improvements in the marketing efficiency of both cocoa and food crops, and
5. public and private investments in roads and market infrastructure.

The reductions in the cost of production associated with the adoption of new innovations lead in turn to lower prices forcing many smaller and marginal producers who are unable to compete to exit the sector. Several interventions designed to respond to the labor redundancy and negative price effects caused by on-farm productivity growth are simulated. These include:

1. the conversion of no-shade cocoa production systems to shaded cocoa agroforestry,
2. the redeployment of marginal cocoa land and labor to export-elastic commodities such as rubber and horticultural crops, and
3. the promotion of increased cocoa consumption in emerging markets (China and West Africa)

An Overview of the West African Cocoa Belt and Rural Transformation

The cocoa belt of West Africa is vitally important for urban and rural food provision. While cocoa and other export crops are important because of their capacity to generate foreign exchange, the growth in urban markets fueled by urban population growth in excess of 5 percent over the last several decades has led to a situation where commercial food production is now of significant and growing economic dimension in these rural economies. The larger urban agglomerations in West Africa are generally found in the humid zone and proximity to these large centers is leading to the increasing commercialization of staple food crops such as plantains, cassava and yams.

Production and farmgate price estimates from national ministries and FAOSTAT reveal that yam rather than cocoa is the most important agricultural commodity in the Cote d'Ivoire, Ghana and Nigerian cocoa belts. In terms of total value, non-cocoa agricultural commodities were estimated to account for more than 76%, 89% and 92% of total agricultural income in the cocoa belts of Cote d'Ivoire, Ghana, and Nigeria respectively. With the largest share of agricultural income generated from staple food production, any strategy targeting overall productivity growth of 6 percent must consider growth in the food sector and the yam, plantain and cassava sub-sectors in particular. It should be noted that a substantial portion of the staple foods produced in the cocoa belt are consumed on-farm and do not enter commercial circuits. As food markets further evolve in rural areas as part of the agricultural transformation process, we should expect to see increasing specialization in food and cash crop production with a growing reliance on food markets (rather than own production) to meet rural household food demands.

West African cocoa production has been in an expansionary phase over the last several decades. The cocoa producing portions of the humid forest agro-ecology in Cameroon, Nigeria, Ghana and Cote d'Ivoire now account for over 2 million tons of cocoa which represents 70% of world supplies. Cocoa production raises over $2 billion in foreign exchange for the sub-region, and taxation of the sector generates significant government revenues in Côte d'Ivoire and to a lesser extent Ghana. With average country yields between 200 and 400 kg per ha, approximately 7 million ha of land is currently in cocoa production, farmed by approximately 2 million households. Over the last 10 years, West African cocoa output has increased annually by 70,000 t on average.

The global cocoa market is characterized structurally by a relatively inelastic demand and supply. As a result of this and the large global market share of West African cocoa producers, policies, weather and civil strife in the region all affect global cocoa prices. The structure of the cocoa market is typical of agricultural commodities, but the lack of consumer benefit for export commodities presents a dilemma for government policy makers. Investment in productivity-enhancing technical change, given an inelastic demand, causes price to decline proportionally more, offsetting the gains in output achieved. Some might ask why innovate if the net result will be lower prices and benefits for consumers in rich countries. Producers who wish to remain in the business really have no choice, if they do not adopt cost reducing new innovations and their neighbors (i.e. competitors) do then when these new supplies cause prices to fall they find that their redundant technology is no longer profitable and they will ultimately be forced to leave the industry. If they do adopt, the increase in their production is offset by a decline in prices although typically and depending on whether they are early or late adopters, there is a substantial increase in their scale of operation and average incomes increase. The real beneficiaries of technical change and

innovation on the production side are the innovators and early innovation adopters. The growth in farm size as measured by increased output more than offsets the decline in price for the early adopters. As the scale of farming increases, economies are generated in both production and marketing and countries or regions experiencing rapid productivity growth tend to see an increase in global market share. Trade theory holds that there are significant costs to countries that do not adopt new technology because they suffer the low price and no increase in output.

West Africa's experience with palm oil is instructive and highlights the importance of research and extension in maintaining competitiveness. Palm oil has emerged in the last 40 years as the most important edible oil traded in global markets. In 1960, West Africa produced nearly all of the traded supply. Beginning in the 1960s, Malaysia and Indonesia through investment in research developed the varieties and production systems that led to their preeminent position in today's market. Meanwhile West Africa has become a net importer of edible oils. New technologies while leading to lower prices result in expanded production for those countries that aggressively pursue technical innovation while the producers who are on the cutting edge of the technology adoption process grow in size and efficiency. Sustaining productivity growth and the research institutions driving it, is essential for maintaining competitiveness and market share in today's globalizing world markets.

In order to maintain the West African share in cocoa at its current level (assuming trends continue) the four countries considered in this analysis must produce an additional 47,000 t of cocoa every year. Almost all of the West African expansion in the last 10 years has been achieved by an extension of the area in cultivation, which grew by 2.7% p.a. (whereas yield growth was not significantly different from zero at only 0.45% p.a.). This extensive expansion of cocoa production comes at increasing environmental cost as the secondary tropical forests of West Africa, which are the preferred type of land for cocoa farming, are becoming increasingly scarce. Future expansion of the West African cocoa sector must depend on the intensification of existing farms and the cocoa agro-reforestation of fallow lands.

Perennial crop production in West Africa is essentially of two scales—1) small family-based enterprises most typically of cocoa and coffee which range in size from under a hectare to over 40 ha for the largest smallholders, and 2) large-scale industrial plantations of bananas, oil palm, and rubber. The focus of this analysis is exclusively on the former typology of producer.

Distributional issues are central to the process of agricultural transformation and should be taken into consideration directly. The STCP baseline surveys of cocoa producing households indicate that the producers occupying the largest quartile (25%) of the household cocoa output distribution had costs of production that were four times lower and yields nearly four times greater than the smallest quartile on average. The largest 50% of producers are estimated to account for 85% of total West African production.

Economic losses are often incurred among the cocoa farmers of West Africa. If family labor used in cocoa production is assigned an opportunity cost, 44 percent of the more than 4,000 producers interviewed during the 2001 STCP baseline survey were estimated to be making economic losses at the time of the survey. Most of these tended to be smaller farmers with low yields. While targeting production innovations to larger producers is likely to lead to the greatest efficiency gains, reductions in cocoa price will eventually force the smaller, less

efficient producers out of the sub-sector. Explicit strategies for facilitating the transition of the poorer, less efficient cocoa producers to new productive endeavors are required.

Model Results

The model simulations assume that the regional cocoa market and related markets are in equilibrium. The cocoa market is modeled at the regional level while all the non-cocoa markets are considered at the national level. There are 13 non-cocoa markets in the current version of the model. There are three aggregate food sectors for Nigeria, Cameroon and Ghana (which will be disaggregated in the next version) and 10 commodity sectors (coffee, cassava, maize, pineapple, plantain, yam, rice, banana, oil palm and rubber) in Côte d'Ivoire. At the initial equilibrium, total producer revenue from cocoa is $1.49 billion and output is 2.28 million t whereas non-cocoa output had a value in excess of $8.6 billion. Shifts in demand and supply are expressed as percentages of the initial equilibrium quantity in each model.

Integrated crop and pest management

The first model simulation considers the widespread implementation of integrated crop and pest management (ICPM) by farmers following farmer field school and associated training approaches. We assume that 30,000 farmers with a mean baseline output of 1,753 kg per producer are trained in each of the project years. The number of farmers trained in the four countries is proportional to their average production for the last three years. The envisaged breakdown is 17,900 farmers in Côte d'Ivoire, 7,500 in Ghana, 2,100 in Cameroon and 2,500 in Nigeria in each of the next five years. The average output per producer is above the population mean of 1,454 kg as we expect lower participation of smaller producers as a result of self-selection. Assume that productivity is increased by 20 percent; although yields from the actual ICPM plots in the FFS are consistently about 50% greater than the farmer control, the results in farmers' fields are less substantial because of partial adoption of the set of innovations.

Given the assumptions, output from the 30,000 participants trained annually in the four countries would increase output by 10,500 tons annually, equivalent to a 0.46% increase in regional cocoa supply. Under this scenario, the weighted farm-gate price of cocoa would decline by $5.45 per ton and total regional output would increase by 2,900 t. Overall, total cocoa revenues decline by $10.5 million. Non-cocoa production increases by 3,000 t as non-participating farmers shift resources out of cocoa production and into non-cocoa alternatives in response to lower prices. The cocoa income of the 30,000 farmers trained increased by 18.9 % or $6.5 million. Under the given assumptions, to attain a 6 % productivity growth rate in the cocoa sector only through FFS extension would require training 391,000 cocoa farmers annually under the assumptions made.

Diffusion of improved planting materials

Most farmers in West Africa lack access to improved planting materials, including cocoa and improved food crops. Results from field research suggest that productivity gains of 50 percent are possible among the farmers who have fully adopted cocoa hybrids. We assume that yield gains of 50 percent accrue to households utilizing improved seed garden hybrid materials and that they replant 3 % of their existing hectarage annually. This implies that a total of 191 trees are replaced every year by the typical participant. Assume that fifteen

propagation centers for hybrid seed are strategically located in the most densely populated regions of the cocoa belt and each center services 10,000 cocoa producing households by distributing 70,000 hybrid pods to producers annually for replanting 1,590 ha of cocoa per center or a total of 24,000 ha replanted on an annual basis. Yields are increased by 50% from an average of 330 kg to 495 kg per ha resulting in an additional output of 3,900 tons per year for the sector as a whole, equivalent to a 0.18% rightward shift of the cocoa supply function.

The nine centers in Côte d'Ivoire also supply improved planting materials for other tree crops (hybrid oil palms and rubber clones) and vegetatively propagated yams, plantains and cassava and are included in the model under an assumption of 50% yield increases relative to local farmer varieties. In Cote d'Ivoire each of the centers distributes yam minisetts for planting 4000 ha, cassava sticks for planting 5000 ha, and plantain suckers for planting 5000 ha. Oil palm (both pre-germinated seed and seedlings) and rubber clones sufficient for the planting of 1,000 ha would also be produced and distributed by each center. Under these assumptions, productivity growth ranges from 0.17% for cocoa to nearly 10% for oil palm. In Ghana, Nigeria and Cameroon the aggregate food supply is assumed to be shifted by 2 percent as a result of increased farmer access to, and adoption of higher yielding varieties of yams, cassava, and plantains.

Qualitatively, the impact of improved planting materials on production is the same for all commodities—it is increased, however because of inelastic demand, total revenues decline in all cases with the exception of rubber which is characterized in our model by a relatively elastic demand. Cocoa production was increased by 3,000 tons while non-cocoa production is projected to increase by about 750,000 tons. Overall cocoa revenue declines by about $14 million and non cocoa revenue declines by about $131 million. While these results seem to suggest that productivity growth has deleterious effects in both the cocoa and non cocoa sectors, it is important to remember that those farmers who successfully adopt improved variety usually reap financial gains. At the same time innovation in agriculture is driving the transformation of the economy, freeing up labor resources, maintaining low cost food supplies, and generating capital savings for investment in other sections of the economy.

Fertilizer application in Ghana and Côte d'Ivoire

In general, fertilizer is most efficiently used in cocoa production systems with lower levels of shade. Indeed concern has been expressed in some circles about nutrient depletion of soils in full sun systems and the negative implications for the long term sustainability of such systems in the absence of fertilizer applications. Most of the no-shade or low shade cocoa systems in West Africa are to be found in Cote d'Ivoire and Ghana. The STCP baseline surveys conducted in 2001 and 2002 revealed that the majority of cocoa farmers did not apply fertilizers to their crops. Cote d'Ivoire was the only country where more than an insignificant proportion of farmers were using fertilizers and here only 168 of the 1122 cocoa farmers interviewed did so (equivalent to 13 percent).

The potential economic impact of expanding fertilizer use was analyzed by estimating a cross-sectional Cobb Douglas production function. The predicted mean output for the 1,018 producers who did not use fertilizer was 1,399 kgs. An output of 2,120 kg for these producers was re-estimated with the fertilizer variable set to the average expenditure among the 170 fertilizer users (equal to 111,000 FCFA) and the other inputs held at their mean levels. The 721 kg difference between the two predicted outputs is interpreted as the impact derived from fertilizer use.

Fertilizer users in Côte d'Ivoire as a group are significantly larger and use more labor, capital and insecticide per hectare than non-users. Producers in Côte d'Ivoire and elsewhere consistently cite a lack of production credit as their principal economic constraint. The lack of effective rural credit institutions in West Africa is a brake on intensification. The provision of fungicide credit by licensed cocoa buying agents in Nigeria and the Southwest Province of Cameroon offers a potential model for successfully extending and recovering rural production credit. We now model the impact of developing similar institutions and mechanisms in Côte d'Ivoire and Ghana for the provision of fertilizer credits.

We analyze the impact of developing tied credit schemes for fertilizers among the 26 marketing firms in Ghana and Côte d'Ivoire targeted for intervention on an annual basis. Eighteen firms are targeted for assistance in Cote d'Ivoire, and 8 firms in Ghana. We assume that each firm markets the cocoa of 1,000 farmers and is able to effectively administer tied credit schemes which give their clients the opportunity of purchasing fertilizers on credit against the future sale of their cocoa. If we assume that 50 percent of their clients choose to participate (this is approximately the proportion of cocoa producers accessing the tied credit supplied by buying agents in Nigeria and Southwest Cameroon), and that they apply the same amount and type of fertilizer used by growers in Cote d'Ivoire and assume their production function can be represented by our model, then we would predict a 721 kg increase in output per producer. If thirteen thousand of the 26,000 producers serviced by the 26 marketing firms were to participate and applied fertilizer at the same rate as the user group, West African cocoa tonnage would increase by 9,343 t which can be simulated by a 0.4% rightward shift in the supply function.

The results are qualitatively similar to the ICPM impacts. The increase in output causes cocoa prices to decline by about $5 per t on average while overall the aggregate regional supply of cocoa increases by about 2,600 tons. Across the cocoa belt such a policy would lead to a 0.2 percent decline in rural income with incomes declining by about $10 million.

Diversification of cocoa farms—Cocoa Agroforestry

Sustained innovation will lead to productivity growth and a declining cost structure which in a competitive market setting with inelastic demand will result in a declining price trend over time. If demand or supply shocks elsewhere do not occur, producers earning negative incomes will be required to quit the sector. We now consider several diversification strategies that seek to redeploy the resources of the marginal producers displaced from their livelihoods by the innovation process.

The conversion of no shade cocoa systems to cocoa agroforests in Ghana and Cote d'Ivoire, where these systems are the most common could prove useful in reducing poverty among the less efficient producers unable or unwilling to intensify cocoa production. In order for farmers to willingly adopt cocoa agroforestry, the returns from the secondary products must prove to be as remunerative as the cocoa production which is foregone when they are converted to shaded cocoa agroforests.

The target of this simulation is the annual conversion respectively of 20,000 ha of full sun cocoa in Cote d'Ivoire and Ghana to partial shade systems planted to either fast growing timber species (e.g. *Cordia* spp. and *Terminalia superba)* or fruit trees such as *Persea americana* and mangoes. The conversion from full sun to shaded agroforest reduces cocoa

productivity by 100 kg per ha, resulting in a reduction of 4,000 tons of cocoa annually. For the sake of exposition, assume that the average participant converts 2 ha and keeps 3 ha of full sun cocoa in production. This hypothetical producer with an average full sun yield of 350 kg per ha, sees total cocoa production decline by 200 kg to 1550 kg. Assume at the same time that the producer gains $200 per ha in annual income from the agroforestry component of the system.

The impacts of this modest leftward shift of the cocoa supply curve on producer incomes and surplus are positive. The higher cocoa price and the generation of $8 million in secondary products result in a $12.1 million overall increase in revenue. Although participants reduce their output by 4,000 tons in total, the positive, albeit modest response of non participants to a higher price incentive reduces the overall reduction in supply to approximately 1,000 tons. Positive cocoa income growth of $4 million results, but the 20,000 participants as structured in this simulation would forego $127 individually or $2.54 million in total cocoa revenues representing about 12 percent of their total cocoa income. We are assuming that the revenues would be replaced by $8 million in agroforestry product revenues. The profitable replacement of these revenues will be essential for the widespread adoption of such systems. Results from Cameroon where markets for agroforestry products are institutionally in place, suggest that the economic feasibility of the systems proposed for Ghana and Cote d'Ivoire will depend upon product demand and marketing costs.

Diversification of marginal cocoa farms—Rubber

Purposive targeting of marginal cocoa producers for diversification is an important option to explore. According to the STCP baseline surveys, the first and second quartiles of the cocoa household distribution of production are estimated to account for approximately 15 percent of total production and use approximately 1,840,000 ha of land in the process with an average yield of only 186 kg ha^{-1}. Assume that 200,000 of these marginal cocoa producers convert their cocoa to 368 000 ha of smallholder rubber (or some other high value commodity with an elastic demand) and that this rubber produced 750 kg per ha. This can be represented in our model by a 3 percent decline in the supply of cocoa and a 236 percent increase in the supply of rubber. Assume additionally that the remaining medium and large cocoa producers achieve 3 percent annual growth in cocoa productivity offsetting the decline in supply due to the conversion of cocoa lands. If this process were to continue for 5 years at the end of the period cocoa output and price would be virtually unchanged, however, the structure of the cocoa sector would have changed rather dramatically. The diversification of 1 million producers out of cocoa and the intensification of the remaining million would result in a doubling of output per producer and increase the average yield of the West African cocoa sector by 67% according to model simulations. We assume that all of this land is converted to rubber so that at the end of 5 years, 1.8 million hectares of marginal cocoa would have been replaced with high yielding clonal rubber.[1] The gross incomes of the former inefficient cocoa producers would nearly double from $223 in cocoa incomes to $412 in rubber income, while the remaining cocoa farmers would experience a 17% increase in income at the end of five years relative to their level at the start of the period.

[1] Rubber was chosen to illustrate the effect of diversifying into an export elastic commodity sector (The model assumes an elasticity of -10). Other examples might include pineapple, cut flowers, green beans etc. but could not be included because of a lack of data. For the sake of the argument, assume that the rubber sector is regional for this particular scenario.

Overall producer incomes and producer surplus change by only -0.4% while non cocoa income at the regional level increases by 2.5%. But as we have stated, much is going on beneath the surface as the sector sheds one million inefficient producers. Overall rural incomes would grow by 1.6 percent. However most significantly, a substantial number of cocoa farming households among the one million would have been lifted out of chronic poverty.

Collective marketing innovation

Just as production technology systems can be rendered more efficient through investment in the innovation process, marketing systems can be rendered more efficient through investment in human resources, marketing infrastructure and market information systems. In terms of our model, the impacts of such interventions can be reflected by a rightward shift in farm gate demand as marketing margins between agents in the supply chain are reduced.

Assisting farmers in the marketing of their cocoa through improved information flows, collective selling and bulking of product, development of quality controls and standards, and cooperative management principals has been shown to result in significant efficiency gains of 5 to 15 percent. These premiums represent a shift to the right of the farm gate derived demand facing producers for their agricultural products.

We analyze the impact of the strengthening of marketing services within 30 firms servicing a total of 30,000 producers of cocoa and food crops on an annual basis. Eighteen firms are assisted in Cote d'Ivoire, 8 firms in Ghana and 2 each in Nigeria and Cameroon. We assume that each firm markets 1,000 tons of cocoa and achieves a 10 percent reduction in marketing margins. We translate this into a shift of the demand curve for the cocoa belt by multiplying the total tonnage marketed by 10 percent and then dividing by the total tonnage marketed. We also assume that each firm diversifies and markets 1000 tons of food crops in addition to cocoa. As food crops in developing countries are beset by a host of market failures, we assume a 15 percent reduction in marketing margins to reflect the greater market failures in the food sector.

Although the shift in the cocoa demand curve was less than one-fifth of one percent there was a 0.35% increase in cocoa incomes. Overall, total farm incomes would grow by $10million with income gains shared equally between the cocoa and non-cocoa sectors with outputs increasing by two thousand tons, respectively. Of course the impact on affected cocoa producers would approach a ten percent increase in incomes. The diversification rationale lies in the underused capacity of marketing firms outside the peak cocoa harvest season. Although we do not consider explicitly the financial returns of diversified cocoa/food marketing enterprises, the additional marketing revenues are likely to increase the profitability of these market agents.

Investment in market infrastructure

Investment in rural roads, transport and warehousing capacity will certainly reduce marketing margins in rural West Africa. Recent empirical analysis of plantain marketing in Cameroon has found that the cost per kilometer of transport was 55% lower on paved all weather roads as compared to dirt and laterite roads. For the sake of our argument we assume that a reasonable sustained investment program in these areas by both the private and public sectors would result in a 3 percent per annum decrease in the cost of marketing. The impact of such a

reduction would be substantial, generating increases in cocoa incomes in excess of 8 percent and 4 percent for food commodities by increasing overall agricultural incomes by nearly $500 million.

Demand promotion in emerging markets

We now consider promotional campaigns to increase per capita consumption in emerging markets. The first markets we consider are the internal markets of the four producing countries. On the basis of ICCO consumption data reported by the Foreign Agricultural Service of the USDA, the weighted average per capita consumption of cocoa in the four countries is 61 g per annum which is equivalent to approximately 12,000 t. This represents about 0.5 % of regional production. Assume that promotional efforts and new product development result in a doubling of regional cocoa consumption to 122 g per capita. This would shift regional farm gate demand to the right by 8,400 t representing a shift of 0.37%. Overall agricultural income increases by about one-quarter of one percent. The second emerging market modeled is China where per capita consumption is only 16 g per annum. We assume that a multi-lateral agreement would be negotiated between Cameroon, Cote d'Ivoire, Nigeria, Ghana and the People's Republic of China to promote Chinese consumption of West African cocoa. If consumption increases by 16 g per capita, effective demand for cocoa would be increased by 21,060 tons on an annual basis, equivalent to a 0.65 percent increase in the regional demand for West African cocoa. Such an accord would increase cocoa revenues by nearly 2 percent.

A simulation of investments to achieve rural transformation

The final simulation presented considers the impact on incomes and producer surplus when marketing efficiency, intensification and crop diversification interventions discussed above are implemented jointly. The assumed impact on marketing efficiency and productivity are as follows:

1—a 3% decrease in marketing margins, equivalent to a 3% rightward shift in farm gate demand for all markets

2—conversion of 363,000 ha of low productivity cocoa to rubber production resulting in a 3% decrease in the supply of cocoa and a 236% increase in the supply of rubber

3—intensification of cocoa production on medium and larger farms resulting in a 3 percent horizontal shift to the right of the cocoa supply curve. The net impact on cocoa supply of the intensification and diversification interventions is to produce no change.

The results suggest that it may be possible to achieve rural transformation in the cocoa belt without a precipitous decline in overall farm income if productivity enhancing innovations for cocoa can be accompanied by the targeted diversification of marginal cocoa producers in conjunction with reductions in agricultural marketing costs. Overall farm income in the cocoa belt would increase by approximately 8 percent.

Concluding Remarks

A model of related markets for the cocoa belts of West Africa was developed to study the impacts of shifts in agricultural supplies induced by technical innovations as well as shifts in the farm gate demands of commodities due to reductions in marketing costs and promotional efforts in emerging markets. In general, increases in the productivity of most agricultural

commodities tended to reduce the farm income and producer surplus derived from those commodities. Such results are not surprising and similar findings characterize most agricultural sectors and are indeed a characteristic of the structural transformation process. Rapid productivity growth in agriculture is a sine qua non for the transformation of the rural sector. Eventually, overtime the inefficient and high cost producers are forced to exit the sector in question while the innovators and early adopters of new technology grow in size and increase their sales. In a liberal laissez-faire economy, the marginal producers would be left to their own devices. On the other hand, it is conceivable to imagine a pro-active policy whereby the more inefficient producers in the sector are identified and targeted for diversification. For instance, the STCP baseline surveys revealed that there were significant economies of scale associated with the size of cocoa output at the farm level. We exploited this knowledge to run a simulation in which the least efficient cocoa producers converted their cocoa farms to a more elastic alternative which for the sake of exposition was Ivoirian natural rubber. In practice, we would expect greater efficiencies to be generated if more diversification options were to be considered. Nonetheless, the model illustrates a mechanism for addressing some of the social costs of the structural transformation process. While the medium and large cocoa producers saw their incomes from cocoa increase by approximately 17 percent, the diversification out of cocoa and into rubber would have increased the average income of the less efficient cocoa farmers by 85 percent. Overall, the diversification only increased the income of the cocoa belt by approximately 2 percent. However, the potential impact on income appears to be substantial.

Model results indicate that the proposed innovation diffusion of the first three interventions considered would only result in about a one percent increase in productivity which is considerably less than the 6 percent growth advocated by the CAADP. It is clear from the analysis that the engagement of other actors will be required. Government actions are most critical; CAADP calls for significant increases in government spending on agriculture. Government must engage and commit to a process of innovation generation and diffusion. Governments, stakeholders and donor agencies need to agree to, and implement a common framework and strategy under the CAADP framework for the agricultural transformation of the cocoa belt. Investments in data collection for the monitoring and evaluation of agricultural performance need to accompany and inform the investment portfolio.

It is recommended that STCP continue with a collaborative modeling effort now underway in the four major cocoa producing countries. More elaboration of the food sectors in Ghana, Nigeria, and Cameroon is currently being developed by technical analysts. Once the basic model has been refined and adapted to the national policy context in each country, country round tables will be organized, bringing together the stakeholders in the sector to agree upon a consensus strategy. These roundtables should seek integration with the broader CAADP process.

STCP should endeavor to build human capacity and strengthen existing research institutions in the development of efficiency enhancing innovations that are the keys to rural development. Collaborative joint efforts and support for regional research networks are important tools in these efforts. As the results show, innovations in marketing systems can be essential to poverty reduction. New institutional arrangements for the development and diffusion of marketing innovations need to be considered. Finally, capacity for conducting policy research varies widely within the sub-region. To help build capacity in this area, a policy research network focused on supporting, monitoring and evaluating rural transformation in the cocoa belt should be organized and supported by STCP.