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Ex-ante Analysis of the "National Investment Plan for Agriculture, Food and Nutritional Security" of Benin

Is the Envisaged Productivity Growth Pro-Poor?

Harald Grethe, Jonas Luckmann, Khalid Siddig, Thierry Kinkpe

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Harald Grethe, Jonas Luckmann, Khalid Siddig, Thierry Kinkpe

Abstract

This study conducts an ex-ante assessment of the effects of the agricultural productivity and production objectives under the national agricultural investment plan (PNIASAN) from 2017 to 2021 on different sectors and the economy of Benin as a whole. This study does not assess the effectiveness of the single policies implemented under the PNIASAN. It assumes instead that the targeted effects on productivity and land use will be achieved. A dynamic Computable General Equilibrium (CGE) model is used for the analysis, building on a comprehensive Social Accounting Matrix (SAM) which was developed based on an existing SAM and data collected from the Benin National Institute of Statistics and Economic Analysis (INSAE) and the Benin national Accounts. Two scenarios are analyzed: a Business As Usual (BAU) scenario, for which a continuation of historical growth rates for GDP, population, productivity, land and animal stocks, but no implementation of the PNIASAN is assumed, and a PNIASAN scenario, in which all the elements of the BAU scenario remain in force, but in addition, the PNIASAN is implemented.

Under the PNIASAN, the total agricultural production quantity is found to be 17% higher in 2021 and the average agricultural price level is found to be 15% lower compared to the BAU scenario. Due to lower agricultural and food prices, consumption of food is 11% higher, imports of agricultural products are 18% lower and exports of agricultural and food products are 129% higher. In 2021, GDP is 5% higher than under the BAU scenario. Looking at the distributional results, we find that all household groups experience welfare benefits, though to a different extent. Low-income households benefit more from the declined food prices in relative terms, as their food expenditure share is higher than for richer households. On the income side, all households except the poorest rural income quintile benefit, and the higher their income, the more households benefit in rural as well as in urban areas due to the composition of their factor income.

In conclusion, the productivity and land targets implied by the PNIASAN make the economy of Benin better off. Their achievement, however, is not automatically pro-poor: with respect to income, richer households benefit more than poorer households and the poorest rural households even experience an income loss, although they derive substantial welfare gains from the expenditure side as food prices decline resulting in a positive net welfare gain. This implies the need for an implementation of the measures specified in the plan that targets the poor as well as for complementary policies, if the government of Benin intends this plan or future plans on agricultural development to be pro-poor.

Key words: agricultural policy, agriculture, development, Benin, general equilibrium

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List of Abbreviations

BAU	Business as Usual
CAADP	Comprehensive Africa Agriculture Development Program
CFAF	West African CFA Franc
CES	Constant Elasticity of Substitution
CET	Constant Elasticity of Transformation
CFA	French Community of Africa
CGE	Computable General Equilibrium
ECOWAP	Economic Community of West Africa Agricultural Policy
EU	European Union
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (German Corporation for International Cooperation GmbH)
ha	hectare
IMF	International Monetary Fund
INSAE	Institut National de Statistiques et d'Analyse Economique (National Institute of Statistics and Economic Analysis)
kg	kilogramm
MAEP	Ministry of Agriculture, Husbandry and Fishing
PNIASAN	Plan National d'Investissements Agricoles et de Sécurité Alimentaire et Nutritionnelle
PSDSA	Plan Stratégique de Development du Secteur Agricole
PSRSA	Plan Stratégique de Relance du Secteur Agricole
RoW	Rest of the World
SAM	Social Accounting Matrix
t	Metric ton
US$	United States Dollar
WAEMU	West African Economic and Monetary Union

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1 Introduction

In accordance with the Comprehensive Africa Agriculture Development Programme (CAADP), the regional agricultural policy for West Africa (ECOWAP) as well as the Malabo Declaration from 2014, the government of Benin is implementing an investment plan (PNIASAN) from 2017 to 2021 to develop its agriculture. This study conducts an ex-ante assessment of the effects of the agricultural productivity and production objectives under this plan on different sectors and the economy of Benin as a whole. It does not assess the effectiveness of the single policies implemented under the plan, but assumes that the targeted effects on productivity and land use will be achieved.

1 INTRODUCTION

Since 2017, the government of Benin is implementing a new national investment plan for agriculture and food security (Plan National d'Investissements Agricoles et de Sécurité Alimentaire et Nutritionnelle, PNIASAN). This plan is the national realization of the Comprehensive Africa Agriculture Development Programme (CAADP). It is also aligned with the regional agricultural policy for West Africa (ECOWAP)[1] as well as with the Malabo Declaration from 2014, under which the African states commit themselves to increasing public investment in the agricultural sector to 10 % of the government budget, doubling productivity levels, and tripling intra-African trade in agricultural commodities and services by the year 2025. The overarching aim of the government with respect to the agricultural sector is that by 2025, the sector is competitive, resilient to climate change and creates wealth, jobs and meets the needs of the population in terms of food and nutrition security. The PNIASAN has a timeframe of 5 years (2017 – 2021) to achieve its objectives grouped into 5 categories:

- Improving productivity and production of priority agricultural commodities;
- Promoting and structuring the agricultural value chains of priority agricultural commodities;
- Reinforcing the resilience of vulnerable populations vis-à-vis climate change;
- Improving governance and information systems in agriculture as well as food and nutrition security;
- Developing accessible and suitable mechanisms for financing and insuring the various categories of actors involved in the agricultural sector.

To achieve these objectives, the PNIASAN foresees crop and animal productivity to strongly increase by 2021. Specifically, the production of maize, rice, pineapple, cotton, cashew, cassava, cattle, sheep and goat, pig, poultry, aquaculture, milk and eggs are given priority (MAEP, 2017). The plan targets these sectors but intends not to restrict the development of others.

1 *The CAADP and the ECOWAP aim at improving the food and nutritional security, the competitiveness and the modernization of the smallholders farms in the member countries (MAEP, 2017).*

Economy wide effects of the development of agriculture under the plan were not comprehensively assessed ex-ante when preparing the plan. Its implementation, however, can have important effects on the Beninese economy as a whole as well as the livelihoods of private households. For this reason, the "Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)" through its Agricultural Policy and Innovation Fund, aiming at promoting coherent and evidence-based policy decisions in the areas of agricultural and trade development in partner countries, in particular in Africa, initiated this study on the request of the Benin partner to fill this gap and assess ex-ante with economy-wide models the effect of the PNIASAN. Specifically, the objectives of this study are to:

1. Conduct an ex-ante assessment of the effects of the agricultural productivity and production objectives under the investment plan over time on different sectors and the economy of Benin as a whole.
2. Investigate to what extent these developments affect the trade potential of Benin.
3. Analyze the implications of the productivity and production objectives under the plan for food security in Benin.
4. Evaluate the welfare and distributive effects of the productivity and production targets under the plan as well as the effects on poverty.
5. Conduct sensitivity analyses with regard to crucial assumptions on the implementation and the effects of the plan.
6. Identify entry points to amend the current investment plan as well as suggestions for future investment plans in the agricultural sector.

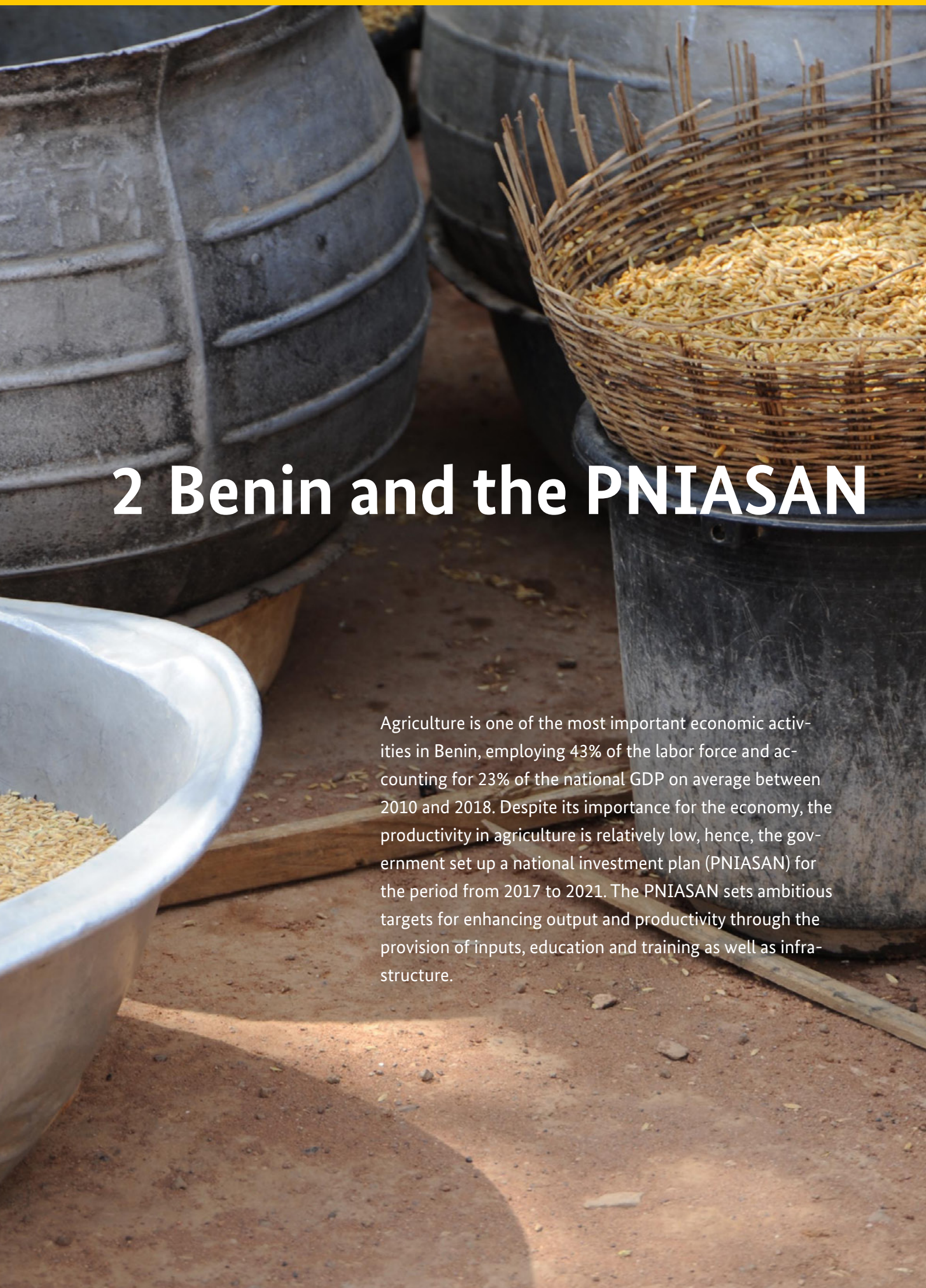
This study did not assess the effectiveness of the single policies implemented under the PNIASAN. It assumed, instead, that the production and productivity targets laid down in axis 1 of the PNIASAN will be achieved and their economy-wide effects are analyzed. Potential effects of policies specified in axes 2 to 5 are thus not considered, as long as they extend beyond reaching the productivity and production targets of axis 1.

Since the PNIASAN is a relatively long-term policy package, a dynamic Computable General Equilibrium (CGE) model was set up to analyze its effect. A comprehensive Social Accounting Matrix (SAM) was developed based on an existing SAM and data collected from the Benin National Institute of Statistics and Economic Analysis (INSAE), the Benin national Accounts, the World Economic Outlook Database, the United Nations World Population Prospects, etc.

This report[2] presents the study and its results. Apart from this introduction, this report presents four sections:

1. Benin and the PNIASAN, giving an overview on Benin, its economy and the PNIASAN;
2. Method, presenting an overview on the database, the simulation model and the scenarios simulated;
3. Results, showing first how agriculture and the economy as a whole are expected to develop without the plan (Business as Usual (BAU)) and second, the economy-wide effects of the achievement of the PNIASAN targets compared to the BAU scenario;
4. Conclusions, which summarize the most important results and derive policy implications.

2 *By the time this report was finalized, COVID-19 developed into a global pandemic with far-reaching economic consequences. This report was prepared on the basis of knowledge and data collected before the outbreak of COVID-19. Hence, the influence of the pandemic is not addressed in the analysis. This study assumes that the productivity and production objectives of the PNIASAN are achieved, and focuses on the economy-wide effects of achieving those objectives. The general direction and order of size of these effects as well as the subsequent policy recommendations would not differ when the pandemic would be taken into account in both the baseline and the scenario formulation.*



2 Benin and the PNIASAN

Agriculture is one of the most important economic activities in Benin, employing 43% of the labor force and accounting for 23% of the national GDP on average between 2010 and 2018. Despite its importance for the economy, the productivity in agriculture is relatively low, hence, the government set up a national investment plan (PNIASAN) for the period from 2017 to 2021. The PNIASAN sets ambitious targets for enhancing output and productivity through the provision of inputs, education and training as well as infrastructure.

2.1 Economy, agricultural sector and agricultural policies in Benin

Benin is a Least Developed Country with an average per capita GDP of US$ 901 in 2018 and stable economic growth of about 4.7% on average over the years 2010 to 2018 (World Bank, 2020a). Agriculture is an important economic activity in Benin. Between 2010 and 2018, it contributed on average for 23% of the national GDP (World Bank, 2020b) and employed about 43% of the labor (World Bank, 2020c). In terms of trade, agricultural and food products made up on average about 86% of total exports of Benin over that period (World Bank, 2019a). These figures show that the agricultural sector strongly contributes to the development of Benin.

Despite the importance of the agricultural sector in Benin, it is facing several challenges: farmers have limited access to agricultural inputs and mechanization. Farming is labor intensive with an average farm size of 1.7 ha (WFP, 2014). There is little water management and irrigation infrastructure. Accordingly, the productivity of agriculture is low. In addition, agricultural value chains are often poorly organized and the information and road infrastructure for access to markets is limited (MAEP, 2017). Finally, the overall share of expenditure on agriculture and food in the total public budget in Benin has traditionally been low. Table 1 shows the development of the budget allocated to the ministry of agriculture (MAEP) over the years 2011 to 2018. Between 2011 and 2014, the agricultural share of the MAEP budget in Benin's total public budget was around 5%. In 2015, this share increased to 8% and subsequently declined to 4.5% in 2018. In addition to the MAEP budget, some of the expenditures of other ministries also focus on the agricultural sector.

To improve the situation and allow the agricultural sector to contribute more to economic development, successive strategic plans have been developed: from 2011 to 2015, a strategic agricultural development plan (Plan Stratégique de Relance du Secteur Agricole (PSRSA) 2011-2015) has been implemented (MAEP, 2017). In this plan, thirteen agricultural activities were selected as highly important: maize, rice, cassava, vegetables, cotton, palm nut, yam, pineapple, cashew, meat, milk, eggs, fish and shrimp. At the end of the implementation period of this plan, the assessment showed that the development targets were not fully achieved (MAEP, 2017). The new policy plan (Plan Stratégique de Development du Secteur Agricole (PSDSA) 2017-2025) is again ambitious in terms of productivity targets. Based on the experiences from the implementation of the PSRSA, an investment plan was made for the first step of the PSDSA with the target year 2021 (Plan National d'Investissements Agricoles et de Sécurité Alimentaire et Nutritionnelle (PNIASAN) 2017 – 2021). The total cost of the PNIASAN is estimated at 1,570 Billion CFAF (2.7 Billion US$). The government is projected to fund 56% of this plan from the national budget and about 44% is expected to be contributed by the private sector (MAEP, 2017).

2.2 The PNIASAN with special focus on Axis 1

The PNIASAN involves five strategic axes (MAEP, 2017):

I. Improvement of productivity and production of plant, animal and fish products;
II. Promotion and fair structuring of value-added chains in agriculture;
III. Strengthening the resilience of farms to climate change and improving food and nutritional security for vulnerable households;
IV. Improvement of governance in agriculture and food; and
V. Establishment of accessible finance and insurance mechanisms in agriculture.

Table 1: Allocated total and MAEP budget of Benin in Billion current CFAF (2011-2015)

Year	2011	2012	2013	2014	2015	2016	2017	2018
Total national budget (Billion CFAF)	1,099	1,017	1,045	1,128	1,211	1,104	2,011	1,863
MAEP budget (Billion CFAF	53	50	57	60	73	74	106	84
Share of MAEP in total budget	4.8%	5.0%	5.5%	5.3%	8.0%	6.7%	5.3%	4.5%

Sources: MEF (2011, 2012, 2013, 2014) for 2011 until 2014; MAEP (2020) for 2015 to 2018.

Table 2: Budget of the PNIASAN in Billion CFAF (5 years)

Priority axis	Overall PNIASAN	Public financing		Private
		Ministry of Agri-culture (MAEP)	Other ministries	
A1 Productivity	1,058	291	132	636
A2 Value added chains	73	41	1	32
A3 Resilience	126	111	14	
A4 Governance	273	244	7	21
A5 Financing	39	38		
Total	1,570	726	154	689
Proportion	100%	46%	10%	44%

Source: MAEP (2017).

To realize its targets, the PNIASAN foresees an overall budget summarized in Table 2.

The share of the agricultural ministry includes the normal agricultural budget. It is estimated that the additional budget required by the ministry over the five-year period is at CFAF 95 to 199 Billion, depending on the utilization rate. Furthermore, other ministries are planned to contribute CFAF 154 Billion over the five-year implementation period. Finally, CFAF 689 Billion is expected to be provided from the private sector.
This study focusses on the analysis of the effects of targets formulated in Axis 1.

2.2.1 Content of Axis 1

Axis 1 of the PNIASAN is titled "improving the productivity and production of plant, animal and fish products in priority agricultural sectors". We analyze the economy-wide effects of the productivity and production targets specified in this axis.

Axis 1 first formulates sectoral targets for infrastructural developments by 2021. These targets include the number of dams, the rehabilitation of water reservoirs and irrigated area as well as roads, the installment of young entrepreneurs and the degree of mechanization.

Furthermore, specific targets are formulated for 13 priority sectors: 2021 versus a base period (2011-15 for crops; 2013-15 for animals). For all priority sectors, targets are formulated for yield per hectare/per animal and for total production. As production targets are typically higher, than yield targets, total agricultural area is obviously assumed to increase, which is not made explicit in the plan. Furthermore, there is an export target on pineapple and a processing target for cashew nuts.

No explicit targets are formulated for non-priority sectors. But the statement that "These sectors contribute to the national agricultural diversification for food and nutritional security. This fact justifies the support provided to support their development alongside the flagship sectors" (MAEP, 2017: 26) seems to suggest, that it is not planned or expected, that the production of non-priority crops should decline.

Assumptions are made on the actions required to reach these targets:

- Component 1.1: Enhanced availability and accessibility of quality seeds and seedlings;
- Component 1.2: Improving accessibility of other agricultural inputs;
- Component 1.3: Mechanization of agricultural activities adapted and accessible for men and women;
- Component 1.4: Improving access to professional knowledge and technological innovations for men and women;
- Component 1.5: Promotion of hydro-agricultural, pastoral and access infrastructure developments.

In short: in order to increase productivity, the PNIASAN focuses on the provision of inputs, education and training and infrastructure.

2.2.2 Ambition and consistency of the productivity and production targets of the PNIASAN

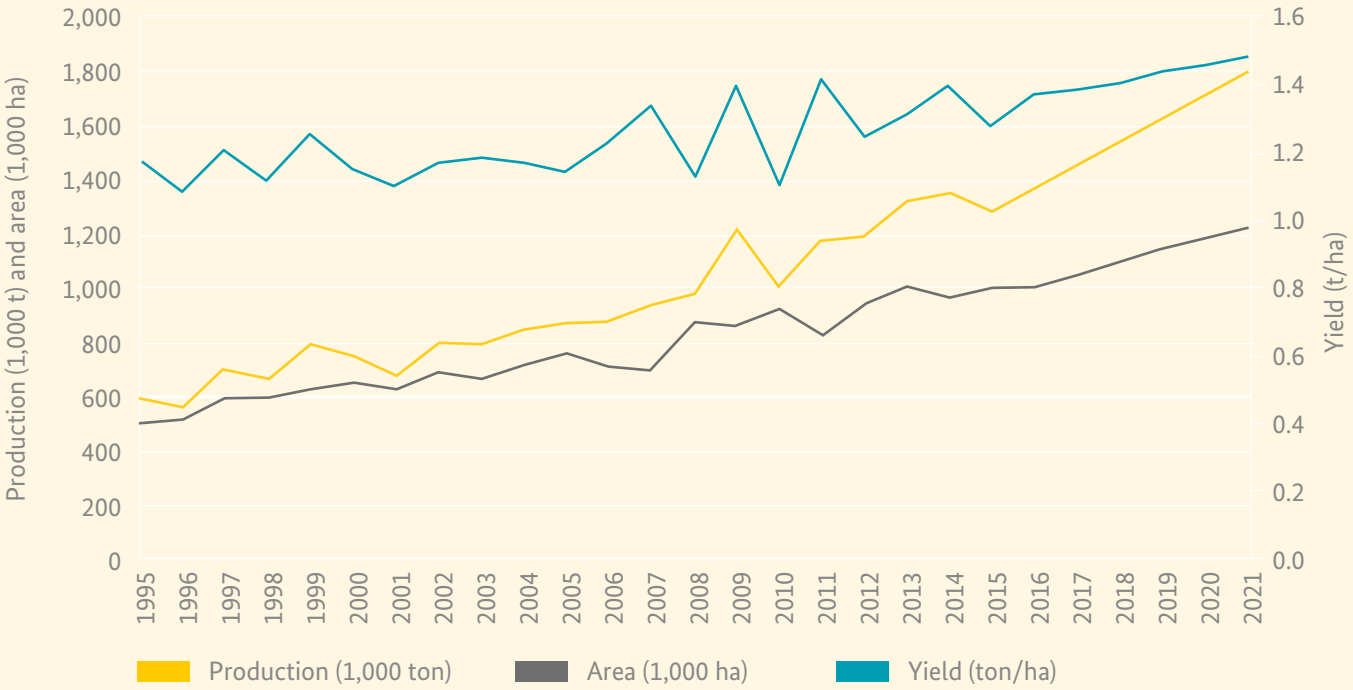
The PNIASAN is an ambitious plan. The overall budget of 1,570 Billion CFAF for 5 years is equivalent to about 140 US$ annually per hectare or to about 6% of the national GDP in 2015. If it would be fully funded by the public budget, it would account for about 16-28% of total public expenditure in the years 2016 to 2018 as specified in Table 1.

If one only looks at the additional budget required by the agricultural ministry, it would be equivalent to about 9-18 US$ per hectare annually or to about 0.4 to 0.8% of GDP. This would result in Benin getting closer to its 10% target of public spending on agriculture laid down in the Maputo and the Malabo declarations of the African Union (see Table 1). Looking at the total agricultural budget for the years 2016 to 2018 (Table 1), however, it must be noted that in none of these years the contribution of the ministry of agriculture envisaged in the PNIASAN (726 Billion CFAF/5 years = 145 Billion CFAF) was met.

Looking at the productivity and production targets, one also sees substantial ambition. Figure 1 shows the historical and projected maize yield (t/ha), production (1,000 t) and area (1,000 ha). This implies that the plan foresees maize yield increasing by 11% until the year 2021 relative to the average of 2011-15 and production increasing by 42%. In order to reach the production target with the given productivity increase, an implicit increase in land area of 28% by 2021 compared to the average of 2011-15 is required.

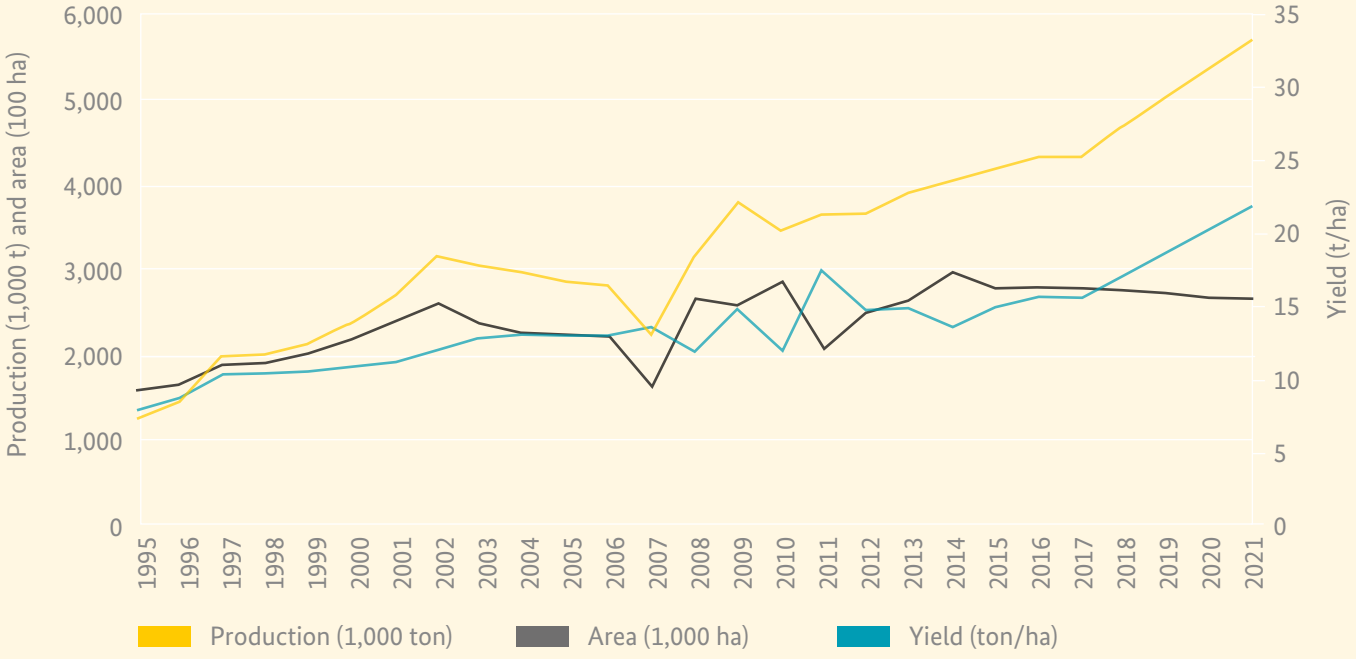
Figure 2 shows the historical and projected cassava yield (t/ha), production (1,000 t) and area (1,000 ha). The plan foresees cassava yield increasing by 44% until the year 2021 relative to the average of the years 2011-15 and production increasing by 46%. This implies that in 2021 Cassava is cropped on 2% more land compared to the average of 2011-15.

Figure 1: Historical and projected maize yield (t/ha), production (1,000 t) and area (1,000 ha)



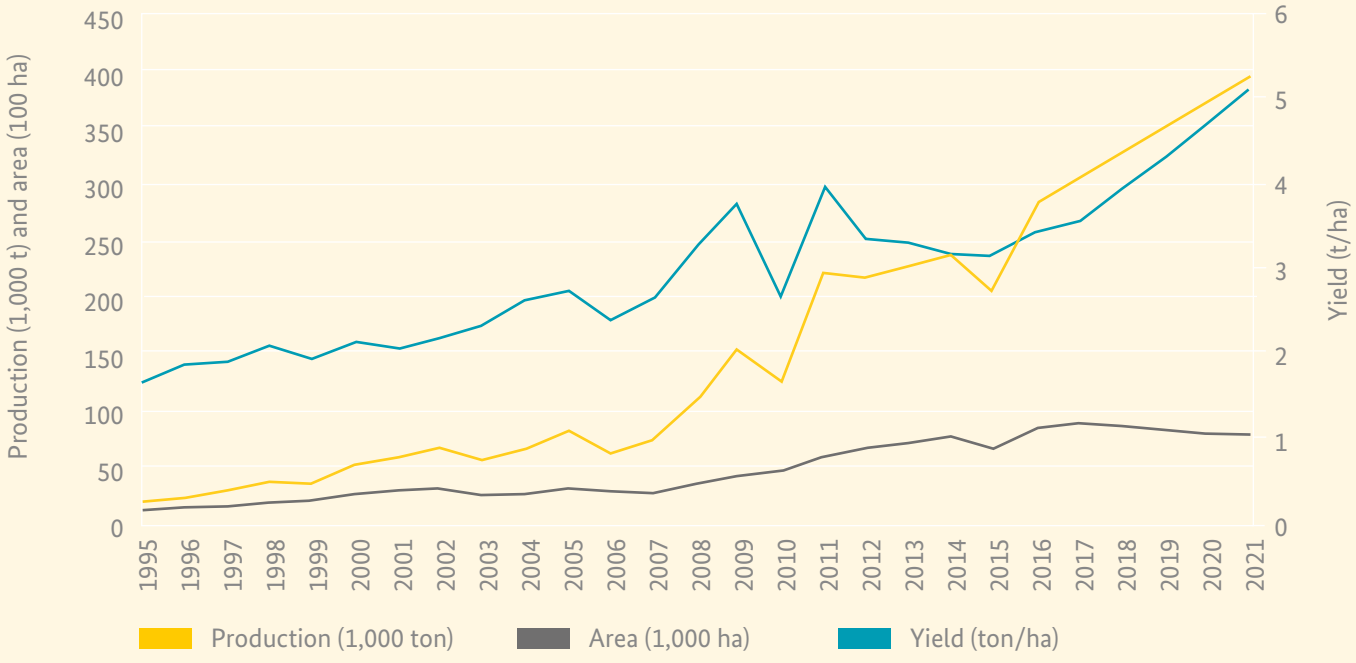
Source: Historical data for 1995–2017 from FAO (2019) and own projections for 2018-2021.

Figure 2: Historical and projected cassava yield (t/ha), production (1,000 t) & area (100 ha)



Source: Historical data for 1995–2017 from FAO (2019) and own projections for 2018-2021.

Figure 3: Historical and projected rice yield (t/ha), production (1,000 t) and area (1,000 ha)



Source: Historical data for 1995–2017 from FAO (2019) and own projections for 2018-2021.

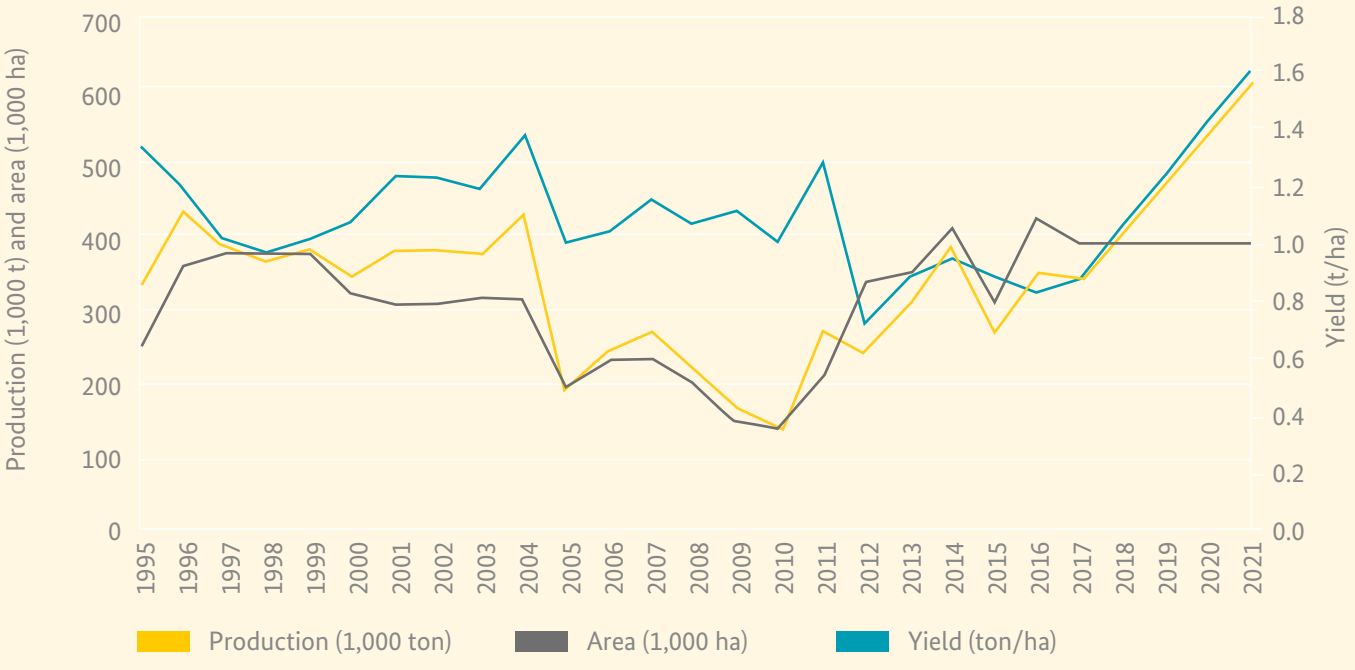
Figure 3 shows the historical and projected rice yield (t/ha), production (1,000 t) and area (1,000 ha). The plan foresees rice yield increasing by 51% until the year 2021 compared to the average of the years 2011-15 and production increasing by 78%. Implicitly, land area must increase by 20% by 2021 compared to the average of 2011-15.

Figure 4 shows the historical and projected cotton yield (t/ha), production (1,000 t) and area (1,000 ha). The plan foresees cotton yield increasing by 70% until 2021 relative to the average of the years 2011-15 and production increasing by 106%. This requires an implicit increase in land area of 21% by 2021, compared to the average of 2011-15.

For pineapple the results are presented in Figure 5, showing the historical and projected pineapple yield (t/ha), production (1,000 t) and area (1,000 ha). The plan foresees pineapple yield increasing by 35% and production increasing by 63% in 2011 relative to the average of the years 2011-15. This implies an increase in land area of 20% by 2021, compared to the average of 2011-15.

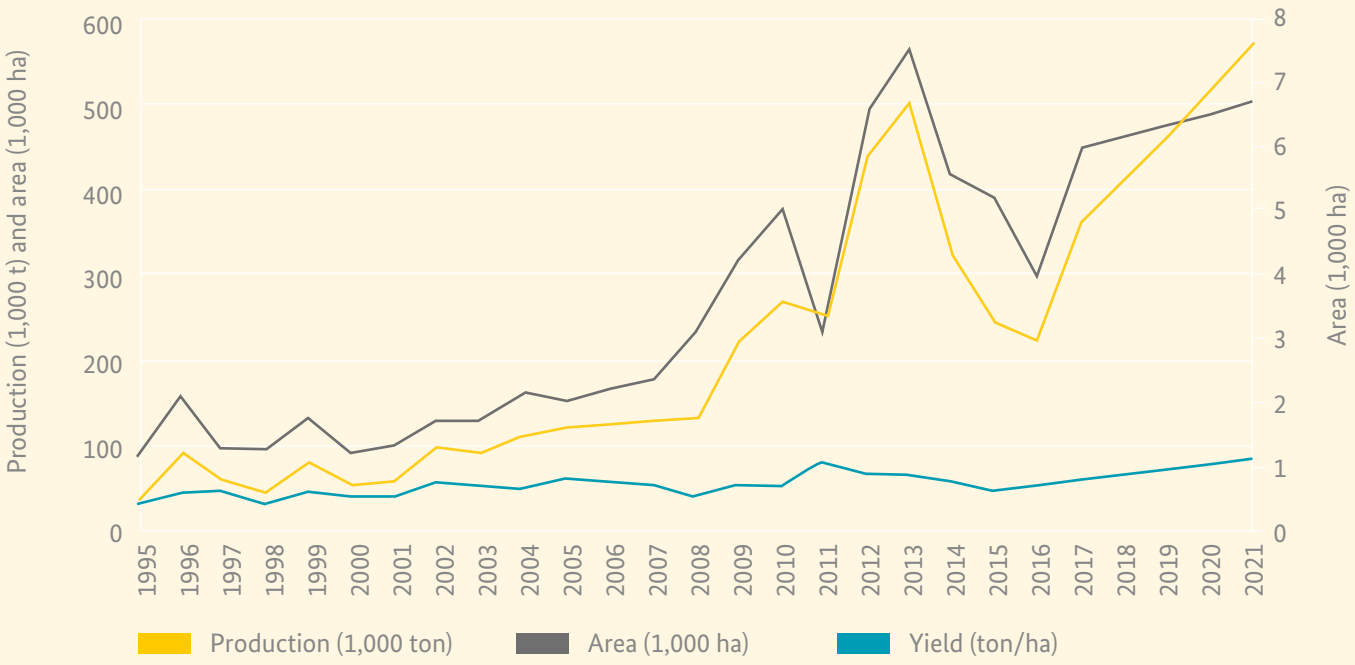
Finally, for cashew the results are presented in Figure 6, showing the historical and projected cashew yield (t/ha), production (1,000 t) and area (1,000 ha). The plan foresees cashew yield increasing by 85% relative to the average of the years 2011-15 and production increasing by 78%. This implies a decrease in land area planted to cashew of 3.7% by 2021, compared to the average of 2011-15.

Figure 4: Historical and projected cotton yield (t/ha), production (1,000 t) & area (1,000 ha)



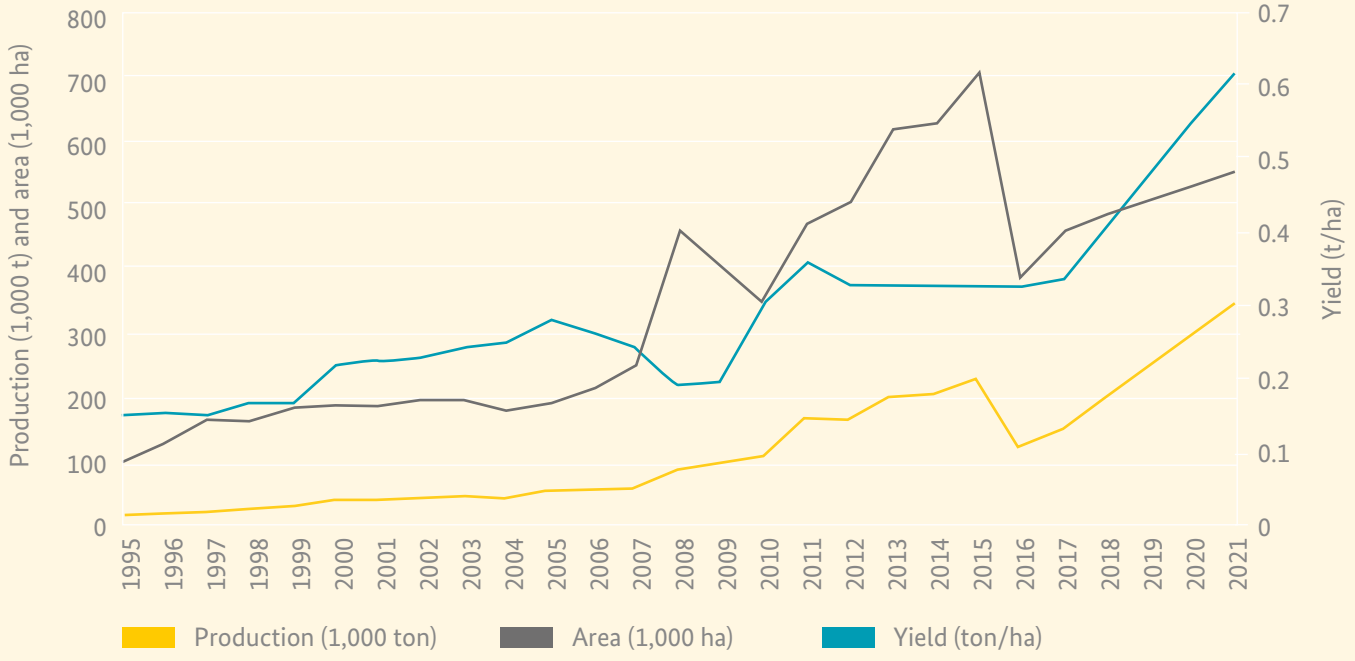
Source: Historical data for 1995–2017 from FAO (2019) and own projections for 2018-2021.

Figure 5: Historical & projected pineapple yield (t/ha), production (1,000 t) & area (1,000 ha)



Source: Historical data for 1995–2017 from FAO (2019) and own projections for 2018-2021.

Figure 6: Historical and projected cashew yield (t/ha), production (1,000 t) & area (1,000 ha)



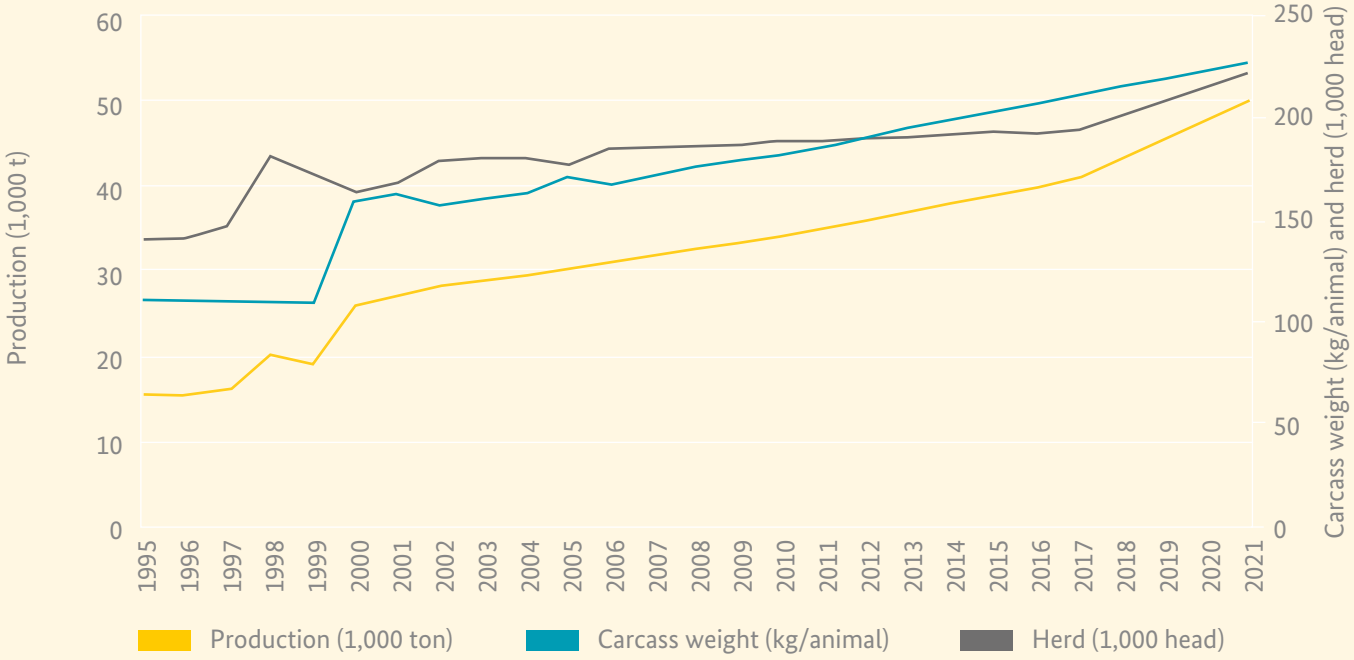
Source: Historical data for 1995–2017 from FAO (2019) and own projections for 2018-2021.

Table 3: Yield, production and implicit area growth rates under the PNIASAN and increase in arable land

	Yield (ton/ha)			Production (1,000 tons)			Implicit area (1,000 hectare)			
	2011-15	2021	%	2011-15	2021	%	2011-15	2021	%	+ha
Cotton	0.9	1.5	69.9	228.2	470.9	106.4	258.4	313.9	21.5	55.6
Pineapple	59.0	80.0	35.5	308.2	502.4	63.0	5.2	6.3	20.3	1.1
Rice	3.3	5.0	51.0	216.7	385.8	78.1	65.4	77.2	17.9	11.7
Cassava	13.9	20.0	43.6	3,624.9	5,297.4	46.1	260.2	264.9	1.8	4.7
Maize	1.3	1.5	11.4	1,265.5	1,800.9	42.3	939.5	1,200.6	27.8	261.1
Cashew	0.3	0.6	84.6	112.5	200.0	77.8	346.1	333.4	-3.7	-12.8
Tomato	7.4	9.0	21.1	288.9	361.1	25.0	38.9	40.1	3.2	1.2
Pepper	2.6	3.0	15.2	65.0	81.3	25.0	25.0	27.1	8.5	2.1
Potato	13.1	15.0	14.6	5.6	7.0	25.0	0.4	0.5	9.1	0.0
Onion	21.1	24.0	13.7	79.2	99.0	25.0	3.8	4.1	9.9	0.4
Okra	3.5	4.0	13.4	50.9	63.6	25.0	14.4	15.9	10.2	1.5
Leafy vege-tables	5.4	6.0	10.6	59.8	74.7	25.0	11.0	12.4	13.0	1.4
Sum							1,968.4	2,296.4		328.0

Source: MAEP (2017), FAOSTAT (2019), own calculations.

Figure 7: Historical and projected cattle/beef carcass weight (kg/animal), production (1,000 t) and herd (1,000 head)



Source: Historical data for 1995–2017 from FAO (2019) and own projections for 2018-2021.

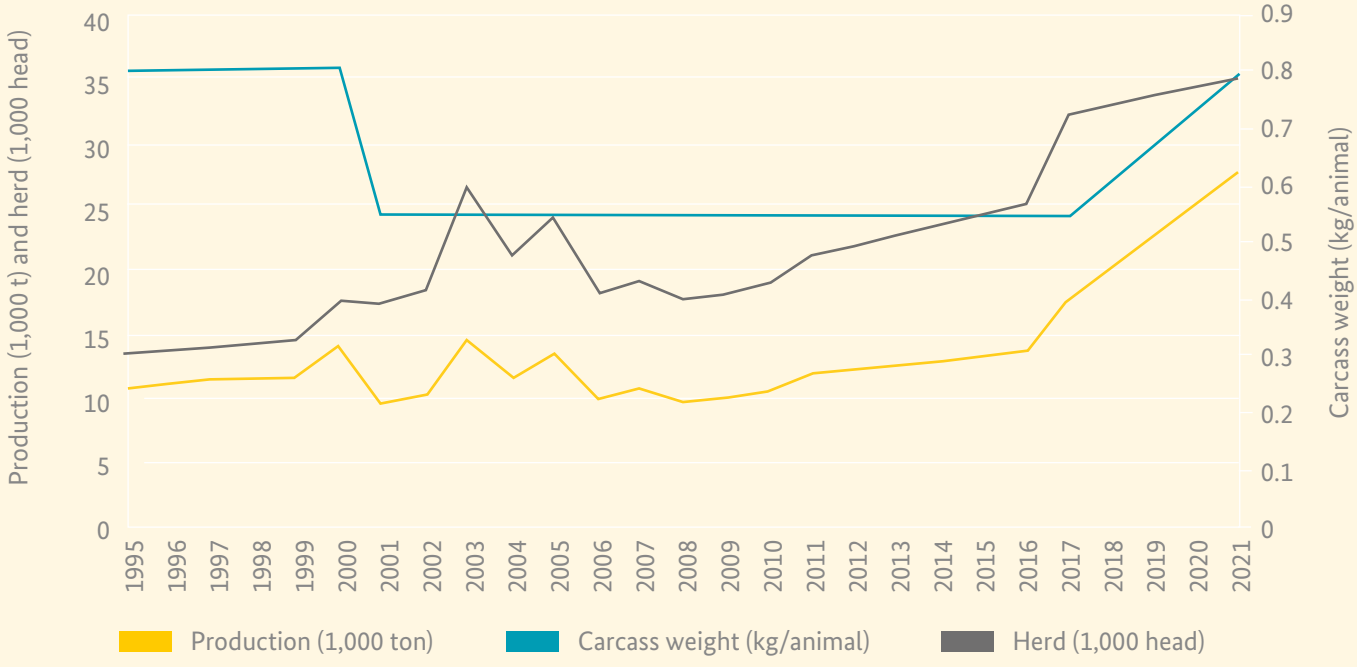
In conclusion, for individual crops the projections are ambitious, but not out of range of what may be feasible. However, as Table 3 shows, they imply an increase of about 330,000 hectares, which is equal to 16.7% of priori- ty crop area or 11.7% of current arable land in Benin. Should it be possible to increase the rate of multi-cropping, the required increase in arable land would be lower.

This raises the question as to where this land would come from, as only a development of 19,000 hectare is foreseen in the PNIASAN. As cutting into "non-priority crops" is not considered an option, new arable land would need to be developed or existing land reserves activated.

The PNIASAN not only sets yield and production targets for crops, but also for animal products. Figure 7 shows the targets against the historical development for cattle/beef as well as the derived implications for animal stocks. The results show the historical and projected carcass weight (kg/animal), production (1,000 t) and herd (1,000 head). The plan foresees carcass weight increasing by 14% in 2021 relative to the average of 2013-15 and production increasing by 32% in 2021. This implies an increase in herd size of 16% in 2021 by 2021, compared to the average of 2013-15.

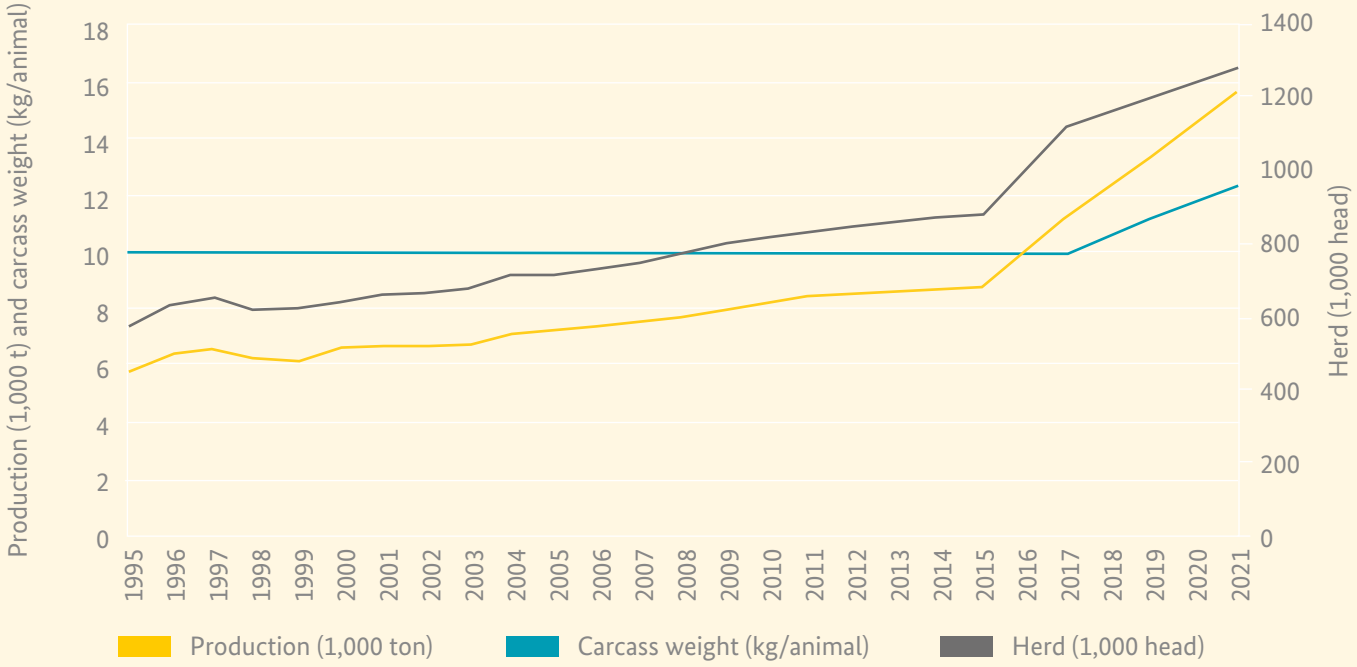
The historical and projected carcass weight (kg/animal), production (1,000 t) and herd (1,000 head) for poultry/poultry meat are presented in Figure 8. The plan foresees carcass weight increasing by 43% in 2021 relative to the average of the years 2013-15 and production increasing by 113%. This implies an increase in herd size of 49% by 2021, compared to the average of 2013-15.

Figure 8: Historical and projected poultry/poultry meat carcass weight (kg/animal), production (1,000 t) and herd (1,000 head)



Source: Historical data for 1995–2017 from FAO (2019) and own projections for 2018-2021.

Figure 9: Historical and projected sheep and goat meat carcass weight (kg/animal), production (1,000 t) and herd (1,000 head)



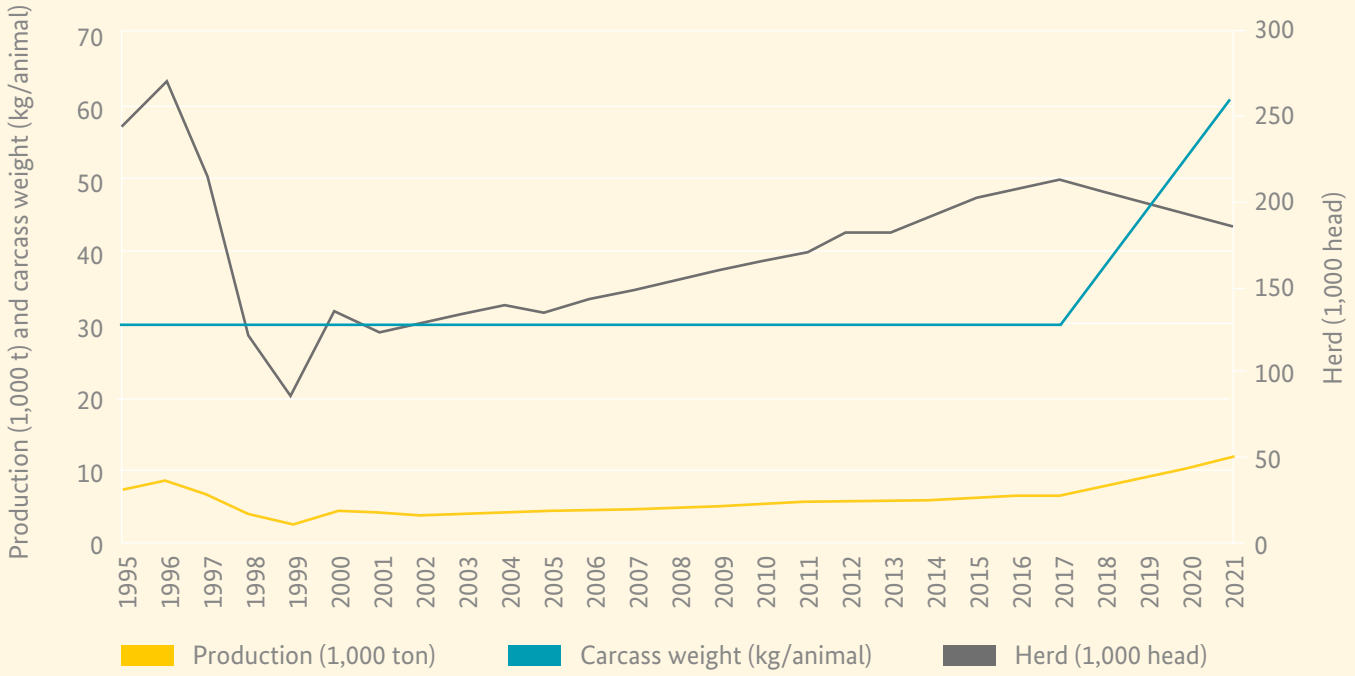
Source: Historical data for 1995–2017 from FAO (2019) and own projections for 2018-2021.

The historical and projected carcass weight (kg/animal), production (1,000 t) and herd (1,000 head) for sheep and goat meat are presented in Figure 9. The plan foresees carcass weight increasing by 22% in 2021 relative to the average of 2013-15 and production increasing by 78%. This implies an increase in herd size of 46% by 2021, compared to the average of 2013-15.

The historical and projected carcass weight (kg/animal), production (1,000 t) and herd (1,000 head) for pig/pork are presented in Figure 10. The plan foresees carcass weight increasing by 100% in 2021 relative to the average of 2013-15 and production increasing by 93%. This implies a decrease in herd size of 3% by 2021, compared to the average of 2013-15.

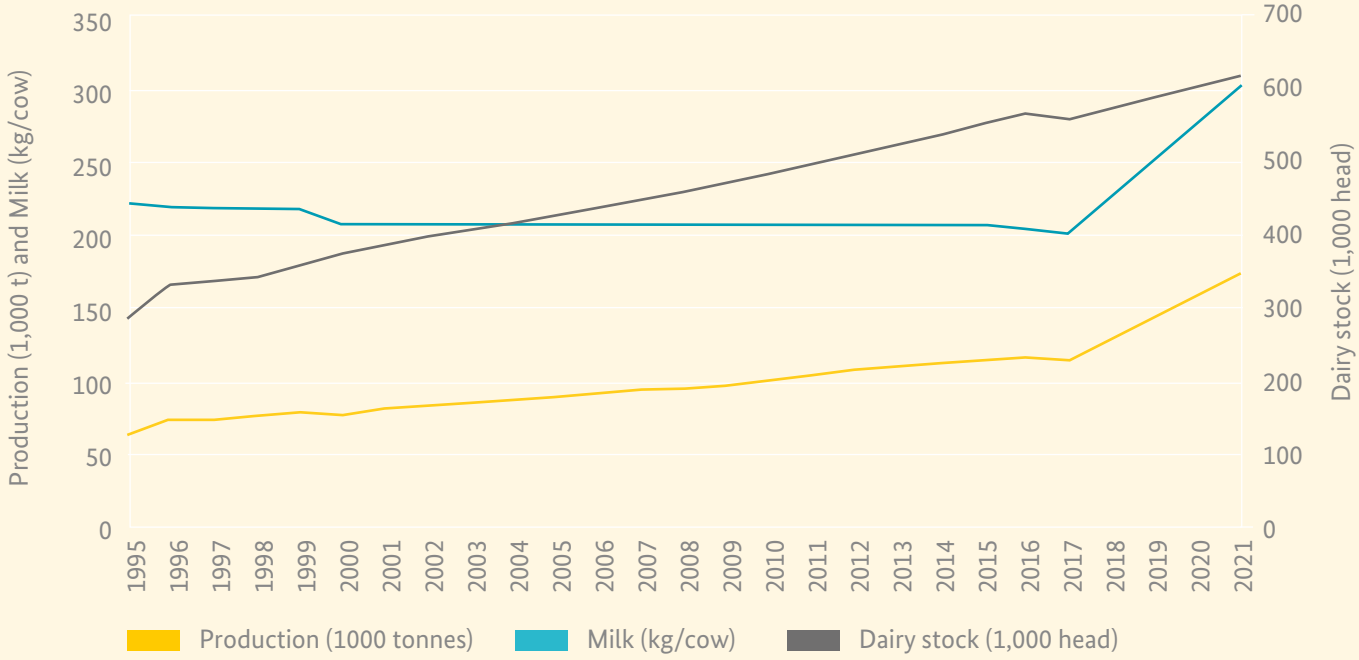
The historical and projected milk yield (kg/cow), production (1,000 t) and dairy stock (1,000 head) are presented in Figure 11. The plan foresees milk yield per cow increasing by 46% in 2021 relative to the average of 2012-15 and production increasing by 58%. This implies an increase in dairy stock of 16% by 2021, compared to the average of 2012-15.

Figure 10: Historical and projected pig/pork carcass weight (kg/animal), production (1,000 t) and herd (1,000 head)



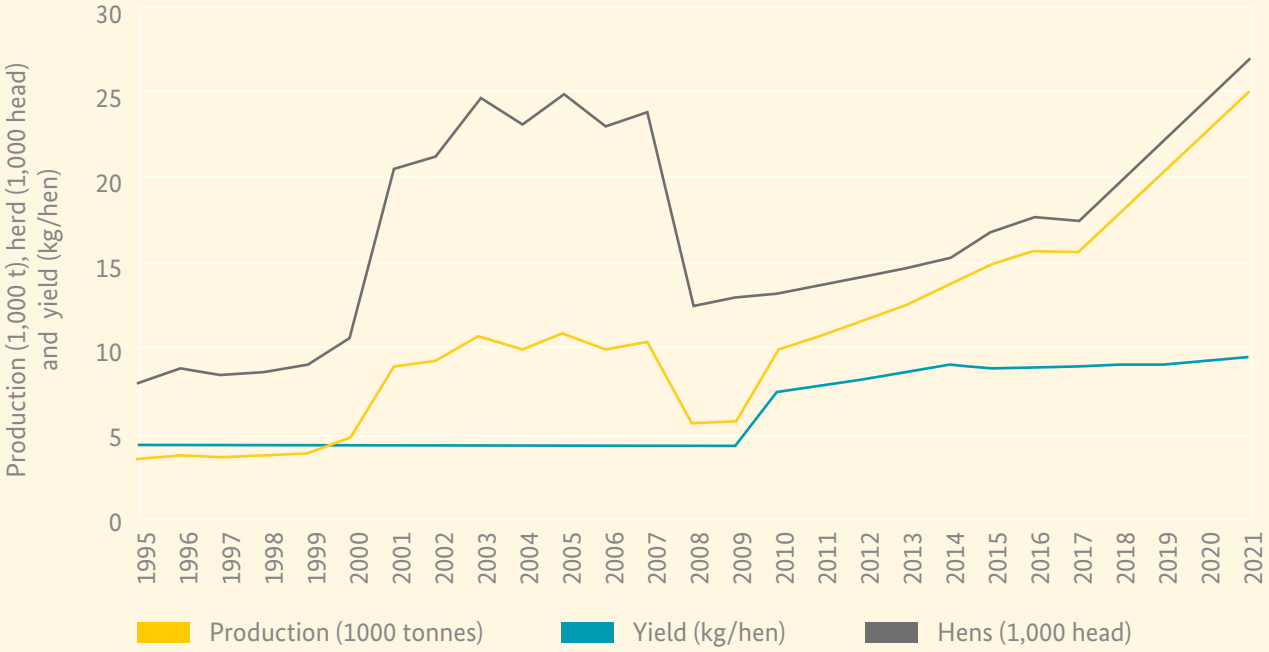
Source: Historical data for 1995–2017 from FAO (2019) and own projections for 2018-2021.

Figure 11: Historical and projected milk (kg/cow), production (1,000 t) and dairy stock (1,000 head)



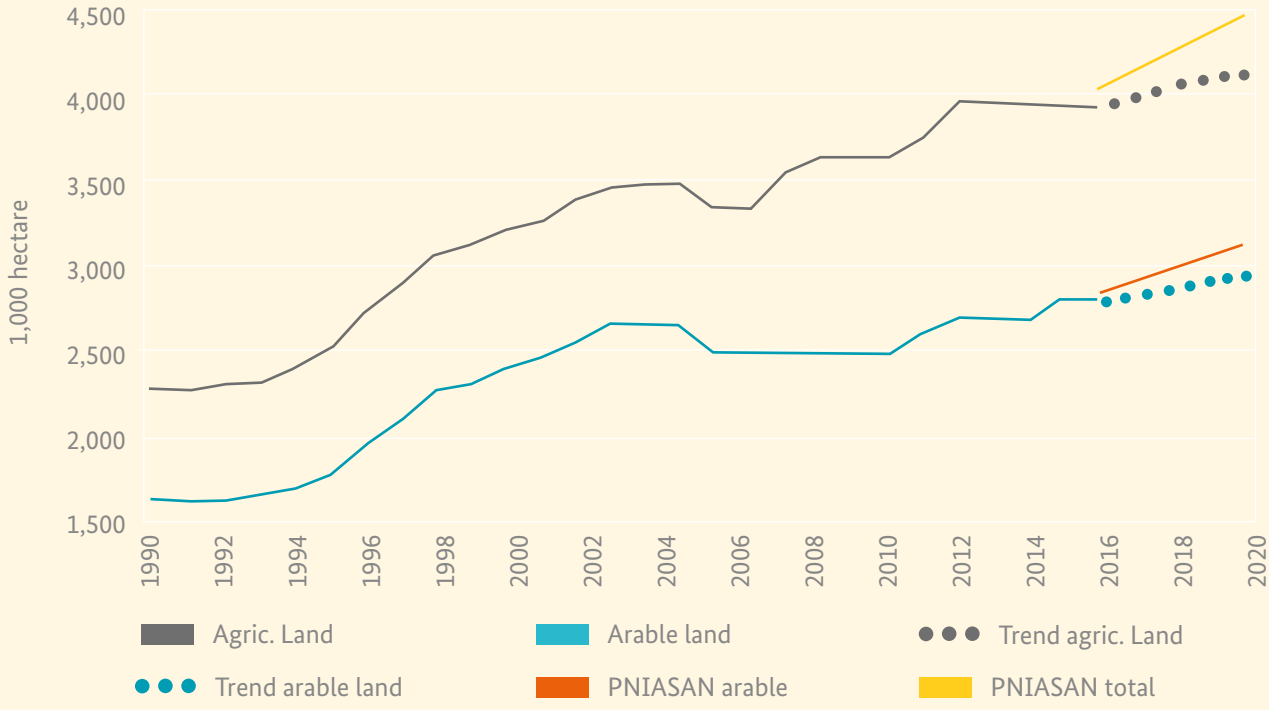
Source: Historical data for 1995–2017 from FAO (2019) and own projections for 2018-2021.

Figure 12: Historical and projected egg yield (kg/hen), production (1,000 t) and hen stock (1,000 head)



Source: Historical data for 1995–2017 from FAO (2019) and own projections for 2018-2021.

Figure 13: Historical development and trend of total agricultural and of arable land in Benin and land requirements under the PNIASAN



Source: Own calculations based on FAO (2019) and MAEP (2017).

Finally, Figure 12 presents the historical and projected egg yield (kg/hen), production (1,000 t) and hen stock (1,000 head). The plan foresees egg yield increasing by 8% in 2021 relative to the average of the years 2012-15 and production increasing by 91%. This implies an increase in hen stock of 77% by 2021, compared to the average of 2012-15.

In total, animal production is projected to increase by about 60% until 2021, which would imply an increase in total agricultural land of about 6%, as land allocated to animal production makes about 10% of total land demand in the 2015 SAM. This would be equivalent to 240,000 hectares. Even in case of improving feed efficiency by e.g. 10% over the implementation period of the plan and about 15% of additional feed demand being covered by imports, this would require substantially more land for the production of animal feed. We estimate this demand at 180,000 hectares or 4.5% of total agricultural area.

In total, the additional agricultural area demand for increases in crop and animal production is estimated at 12.4%. These projections are contrasted with historical development of agricultural land and a prolongation of the trend of the most recent ten years in Figure 13.

As Figure 13 shows, agricultural land in Benin has been increasing since long, but the growth rates would need to be substantially increased in order to meet the PNIASAN targets. Country experts and ministerial officials argued that such an increase would not be unrealistic. This would imply changes in land use e.g. from currently fallow land to pasture or cropland or from pasture to cropland. Part of the additional land demand may also be fulfilled by increased multi-cropping. Potential environmental implications of land use change, e.g. with respect to greenhouse gas emissions, are not analyzed in the paper and would need a thorough analysis. It should not be presumed, however, that conversion from fallow land to pasture or to crops necessarily implies an increase in greenhouse gas emissions, especially if indirect land use effects are accounted for.

The economy-wide effects of the productivity and production objectives as defined in the PNIASAN are ex-ante analyzed using a dynamic computable general equilibrium model. The model depicts all transactions within the Beninese economy over the simulation horizon from 2016 to 2030. A Business as usual (BAU) scenario is generated based on long-term forecasts of macroeconomic indicators, to which the implementation of the PNIASAN is compared. The PNIASAN scenario depicts the increases in productivity, production, and land use as foreseen in the plan as well as its financing. Sensitivity analyses assessing different funding options and a scenario without increasing agricultural area are also provided.

3 Method

3.1 Database

A 2015 SAM was provided by GIZ for this study. This SAM was produced by an external consultant and its use for this study was authorized by the local authorities (*Bureau d'Analyse et d'Investigation of the presidential office*). It is an updated version of the 2013 SAM produced by the Benin National Institute of Statistics and Economic Analysis (INSAE) with somewhat more disaggregation. Some aspects of the SAM such as the value-added shares of production factors (labor, capital and land) and the cost structure for agricultural activities were revised. For example, the shares of value added for capital and land were very high, 64% and 18%, respectively, leaving only 18% for the value-added share of labor. Furthermore, land accounted for a high share (53% on average) of the production cost of agricultural products.

Despite those drawbacks, this 2015 SAM was considered a better starting point than other SAMs produced for Benin which are either too old (2010 SAM by WAEMU), or too aggregated (2013 SAM by INSAE). To adapt the 2015 SAM to the realities of Benin, the following revisions have been implemented:

- The production structure in terms of intermediate consumption and total value added of agricultural activities was adjusted based on shares calculated from the Benin Economic Accounts of Agriculture (Adegbola et al., 2013a; 2013b). Only for cotton cropping the intermediate input consumption of the original SAM was maintained as the shares from the survey for cotton were found not to be realistic (too little input use).
- The distribution of factor income between labor, land and capital was adjusted based on shares from 2010 WAEMU SAM.
- As indicated in Table 6 in the Appendix, some sectors (activities and commodities) of the original SAM were aggregated, as they were not in the focus of this project and had a completely similar production/consumption structure in the original SAM, such that any shock would affect them similarly. Other commodities (e.g. rice husking, poultry slaughtering) were aggregated due to large re-export values in the original SAM.
- The maize cropping activity was split into two activities (local maize and improved maize) producing a homogenous maize commodity, using production data from Adegbola et al. (2013a, 2013b).
- A new cashew processing sector was split off the "other food" and "fruits and vegetable processing" sectors, in order to track the domestic processing of cashew nuts.
- Stock changes were zeroed out in order to avoid shifting of welfare effects into other periods (e.g. from selling commodities which have been produced in the previous year). The original SAM featured transactions of households and enterprises to stock-changes. These were shifted to (private) savings instead.[2] On the expenditure side the largest entry was the cotton commodity (-21.7 Billion CFAF). This value was added to the output of the cotton activity. The stock-changes account was eliminated. All other smaller values were simply deleted and resulting minor imbalances in commodity accounts were balanced later by using a SAM estimation procedure.
- The trade commodity in the original SAM, which was consumed by other commodities only, was converted into three trade margins (domestic, import and export margins). This was implemented in three steps. First, the export margin was split off the consumption of the trade commodity using the share of exports in total commodity value of all commodities. Second, the import margin was split off the remaining value using the share of the import value in domestic supply (domestic production + imports) of each commodity. The remaining value is the domestic margin. Third, a new trade commodity was added, which receives income from the three trade margins and which pays the existing trade activity.
- Land accounted for 61% of the total cost of the fishing activity in the original SAM. As fishing does not require any substantial amount of land, the land compensation of the fishing activity was shifted to capital, which resulted in a similar capital share as in the 2013 Ghana-SAM (http://www.ifpri.org/publication/2013-social-accounting-matrix-ghana).
- In order to be able to analyze distributional implications of the PNIASAN, urban and rural households were disaggregated into five income quintiles each.
  - Expenditure shares for these quintiles were calculated based on the raw data of the 2011 survey "Integrated Modular Survey on the Living Conditions of Households" (Enquête Modulaire Intégrée sur les Conditions de Vie des Ménages) provided by INSAE (2011).

[2] *1% of the enterprises' stock changes were added to public savings according to the original split of private and public savings in the enterprise-account.*

- Total income per quintile was also calculated based on the expenditure survey and information on income distribution by quintile from World Bank data.
- Land income to households was calculated using land data from INSAE (2011). First, these data were used to calculate the land income to each household group in 2011. Subsequently, the 2011 land income to each household group was updated to 2015 with the growth rate of agricultural GDP.

• After the described adjustments, the resulting SAM exhibited imbalances between income and expenditure in several accounts. An estimation algorithm based on the cross-entropy method (Robinson and McDonald, 2006) was used to produce a balanced final SAM. Thereby, additional National Accounts data were added in form of restrictions. Specifically, the SAM was estimated in order to reflect gross domestic product (GDP) at factor cost and market prices, net investment, total household and government consumption as well as total import and export values as reported in the National Accounts of Benin (BCEAO, 2019). Further, foreign investment was fixed to the level reported by World Bank (2019b).

3.2 Simulation model

We simulate the effects of the achievement of the PNIASAN targets with a dynamic Computable General Equilibrium (CGE) model. The CGE model is a mathematical depiction of the economy of Benin. It serves as a "laboratory" to analyze how the economy of Benin would react to certain exogenous changes, such as the implementation of new policies. The model we use in this study distinguishes 17 agricultural sectors (activities and commodities) in addition to mining, industrial and service sectors. A comprehensive presentation of the model structure and equations is provided in Diao and Thurlow (2012).

We model the economy of Benin as a market economy with flexible prices, in which consumers maximize their utility as far as their income allows and producers maximize their profits under given input and output prices. The economy of Benin is an open economy: all countries other than Benin are aggregated in one region that we refer to as 'the rest of the world' (RoW). The RoW is connected to Benin via exports and imports, remittances, and other public and private transfers as well as factor income to and from the RoW. The model assumes that the economy of Benin is small relative to the economy of the RoW, which implies that producers in Benin take the world market prices of all goods and service as they are without being able to influence them (small country assumption). We also assume that, constant returns-to-scale technologies prevail.

Producers' demand for primary factors of production is modelled using constant elasticity of substitution (CES) functions and that of intermediate inputs using Leontief functions. We assume that domestic production is differentiated between two destinations, domestic and foreign markets, and depict this by constant elasticity of transformation (CET) functions. For both intermediate demand by producers and final demand by institutions, the choice between imported and domestic goods and services is made according to the assumption of imperfect substitutability (CES).

There are four production factors in this model including two labor categories (skilled and unskilled), land and capital. For the two types of labor, we assume that they are fully employed and mobile across different sectors. The assumption of full employment is consistent with the observation that, while relatively few people have formal sector jobs, most working-age people engage in activities that contribute to GDP. Capital accumulation is modeled assuming a "putty-clay" formulation whereby new investments are allocated across sectors between periods in response to rate of return differentials, but once installed, capital remains immobile, i.e. it is fully employed, and activity-specific. Arable land is assumed to be fully employed by agricultural activities between which it can be shifted on an annual basis.[3]

Household income consists of returns to factors of production (supplied by households), enterprise income, remittances and government transfers. Part of households' disposable income is used to consume commodities and services, according to a Linear Expenditure System, while the rest is saved.

For the government, revenue sources include activity taxes, sales taxes, direct taxes charged on households, export and import taxes, returns from capital and

[3] *The model does not account for the fact that this is not the case for perennial crops such as cashew, palm tree and to some extent pineapple. Therefore, it would overestimate the short run supply response for these crops. In this study, however, only the medium term supply response (until 2021) is analyzed.*

transfers from the rest of the world such as development aid. This revenue is spent on transfers to households, enterprises and the rest of the world, purchases of commodities and savings. For the Business as Usual (BAU) scenario, we allow government savings to change while all tax rates are fixed.

In addition to the aforementioned assumption for public savings and revenues for the BAU scenario, we applied two alternative assumptions. In the core scenario analysing the PNIASAN (PNIASAN scenario), we assume that public savings and indirect tax rates are fixed exogenously, while the government account is balanced by multiplicative direct tax-rate changes for private households and enterprises. By exogenously increasing the government savings and consumption expenditure for education and other services, this setup allows that direct taxes fund the spending on the PNIASAN. As an alternative, which we implemented as a sensitivity analysis, we assume that public savings and all tax rates except sales tax rate are fixed exogenously, while the government account is balanced by uniform additive percentage sales tax-rate changes. This allows that sales taxes fund the spending on the PNIASAN without changing government savings.

For total investment in the economy, we apply a setting allowing the investments in the economy to be determined by the savings of domestic and foreign institutions (investment is savings-driven). This implies fixing the savings rates of households and enterprises and changing investments only through income changes, while allowing the share of investment in total absorption[4] to change. Foreign savings (external capital inflows) are assumed to be unaffected by domestic policy changes and hence fixed to the base year value. As Benin is a relatively small economy in the CFA franc currency union and its currency is pegged to the Euro, and not impacted by changes in the economy of Benin, the exchange rate is fixed as well, making it the numéraire, while allowing the consumer and producer price indices to adjust (van der Mensbrugghe 2013). For modelling the PNIASAN, we fix total investment as a share of total absorption and allow the domestic savings-rate to adjust accordingly (investment driven).

3.3 Definition of scenarios

We use the CGE model to compare two situations (scenarios), namely, a BAU and a PNIASAN scenario. For the BAU scenario, we assume a continuation of historical growth rates for GDP, population, productivity, land and animal stocks, but no implementation of the PNIASAN, while the PNIASAN scenario is a situation with all the elements of the BAU scenario, but in addition, we implement the PNIASAN over the period 2017-2021. In the following sub-sections, we provide more details on the two scenarios.

3.3.1 Description of the BAU scenario

The BAU scenario developed in this study is a hypothetical dynamic baseline path to 2030 that reflects development trends, policies, and priorities in the absence of the PNIASAN. It is important to note that this baseline does not forecast the future economy of Benin, but it rather provides a counterfactual – a reasonable trajectory for growth and structural change of the Beninese economy in the absence of the PNIASAN to be used as a basis for comparison with the PNIASAN scenario.

For the BAU scenario, we impose growth rates of the labor force, arable land and sectoral productivity exogenously based on data from different sources specified below. We also use projected data on remittances, foreign aid, government consumption, government savings and foreign and capital inflows. Annual GDP growth rates until 2024 are taken from the IMF's World Economic Outlook (2019). This resulted in an average annual GDP growth rate of 8.4% during 2018-2024. From 2025 to 2030, we applied the previous 6 years moving average growth rate resulting in an average growth for this period by 8.2%.

Population and labor force growth is based on UN (2019), while total factor productivity trends are set in conformity with GDP projections for agriculture, industry, and services sectors value added in World Bank (2019b). Data were available until 2018 and see the contribution to GDP in the period 2015-2018 at 25.2%, 23.1% and 51.6% for agriculture, industry and services, respectively.

4 *Absorption comprises total domestic final demand (private/public consumption and investment).*

In 2019, the BAU scenario assumes the moving average of the last four years (i.e. 2015-2018) contribution to the GDP by each sector, while in the subsequent years until 2030, a moving average of the previous four years is applied. This leads to average contributions of 25.2%, 23.3% and 51.4% for agriculture, industry and services, respectively during the period 2019 to 2030. For the BAU scenario we assume, based on historical trends, that the land available for agricultural activities grows annually by 1.1% for the entire simulation period. Annual growth rates on remittances, government consumption expenditure, growth domestic savings and foreign aid are obtained from the World Development Indicators of the World Bank (2019b) for the period between 2011 and 2017. We extended the period back to 2011 because the observed data fluctuate widely and this led to average growth rates for the BAU scenario during 2015-2017 of -2.0%, 4.7%, -8.3% and 7.8% for remittances, government expenditure, gross savings and foreign aid, respectively. For the period between 2018 and 2030, we applied a moving average of seven years. This led to average growth rates for the BAU scenario during 2018-2030 of 8.3%, 3.8%, 4.2% and 6.6% for remittances, government expenditure, gross savings and foreign aid, respectively.

3.3.2 Definition of the PNIASAN Scenario

This study does not assess, whether the targets set in the plan can be fulfilled with the measures and the budget foreseen, but instead analyses, what the potential impacts of the fulfillment of the targets on the overall economy of Benin would be. The following aspects of the PNIASAN are depicted in our model:

- Productivity changes for crops as envisaged in the PNIASAN, compared to productivity changes in the BAU scenario are implemented as increases in total factor productivity of the respective sectors.
- Production changes (including productivity as well as herd size growth) for animal products envisaged in the PNIASAN compared to productivity changes in the BAU scenario are implemented as increases in total factor productivity of the respective sectors.
- An increase of agricultural land implicit in the production targets in the PNIASAN, compared to an increase of agricultural land in the BAU scenario (BAU: 5.5%, PNIASAN: + 12.4% over the whole implementation period). It should be noted that the increase of agricultural land use in Benin is a controversial issue. Therefore, we also implement a sensitivity analysis, which excludes the raised increase of agricultural land use compared to the BAU scenario.
- An increase in the public budget for agriculture by 319 Billion 2015 CFAF. In order to keep other expenditures constant, we increase direct taxes for private households in relative terms such as to fund the additional expenditures. Direct taxes in Benin are mainly paid by the three upper income quintiles and their direct tax rates rise by 2.5 percentage points at maximum. As a sensitivity analysis, we also report welfare effects under two alternative funding options: 1) money collected through a sales tax, instead of an income tax and 2) 50% of the funding collected through a direct tax and 50% of the funding received as an international transfer.
- The total productivity and tax effects implemented as well as the resulting government revenue collected are summarized in Table 4 below. The total government revenue over the five years add up to 319 Billion 2015 CFAF.

Table 4: Productivity and tax changes under the PNIASAN compared to the BAU scenario

		%-point differences compared to BAU				
		2017	2018	2019	2020	2021
Productivity increase of crops	Local maize	1.5	1.5	1.5	1.5	1.5
	Improved maize	10.1	10.1	10.1	10.1	10.1
	Rice	8.4	8.4	8.4	8.4	8.4
	Cassava	4.4	4.4	4.4	4.4	4.4
	Yam	1.5	1.5	1.5	1.5	1.5
	Pineapple	8.9	8.9	8.9	8.9	8.9
	Fresh vegetables and spices	1.5	1.5	1.5	1.5	1.5
	Other food crops	1.5	1.5	1.5	1.5	1.5
	Cotton	10.9	10.9	10.9	10.9	10.9
	Cashew	3.1	3.1	3.1	3.1	3.1
	Palm nut	1.5	1.5	1.5	1.5	1.5
	Other crops for industry or export	1.5	1.5	1.5	1.5	1.5
Productivity increase of animal products	Beef, pork, sheep and goat, poultry	5.6	5.6	5.6	5.6	5.6
	Raw milk	6.6	6.6	6.6	6.6	6.6
	Eggs and other husbandry activities	10.7	10.7	10.7	10.7	10.7
Investment in fishing/aquaculture sector		27.0	27.0	27.0	27.0	27.0
Land supply		2.4	2.4	2.4	2.4	2.4
Household direct tax rate	Rural quintile 4	0.5	0.4	0.4	0.4	0.4
	Rural quintile 5	0.6	0.5	0.5	0.5	0.5
	Urban quintile 3	0.9	0.8	0.8	0.8	0.8
	Urban quintile 4	1.2	1.1	1.0	1.0	1.1
	Urban quintile 5	2.5	2.2	2.1	2.1	2.2
		Billion CFAF				
Additional government revenue from direct tax		53.7	53.7	60.4	69.5	81.3

Source: Own calculations.

3.4 Parametrization of the model for Benin

We provide the elasticities of trade, production and demand in Appendix Tables 7 to 9, respectively.

Achieving the productivity and production targets of the PNIASAN results in agricultural production being 17% higher and agricultural prices being 15% lower in 2021 compared to the BAU scenario. Due to lower agricultural and food prices, consumption of food is 11% higher, imports of agricultural products are lower and exports are substantially higher. In 2021, GDP is 5% higher than under the BAU scenario. Looking at the distributional results, we find that all household groups experience welfare benefits, though to a different extent. Low-income households benefit more from the declined food prices in relative terms, as their food expenditure share is higher than for richer households. On the income side, all households except the poorest rural income quintile benefit, and the higher their income, the more households benefit in rural as well as in urban areas due to the composition of their income.

4 Results

4.1 Business as Usual scenario

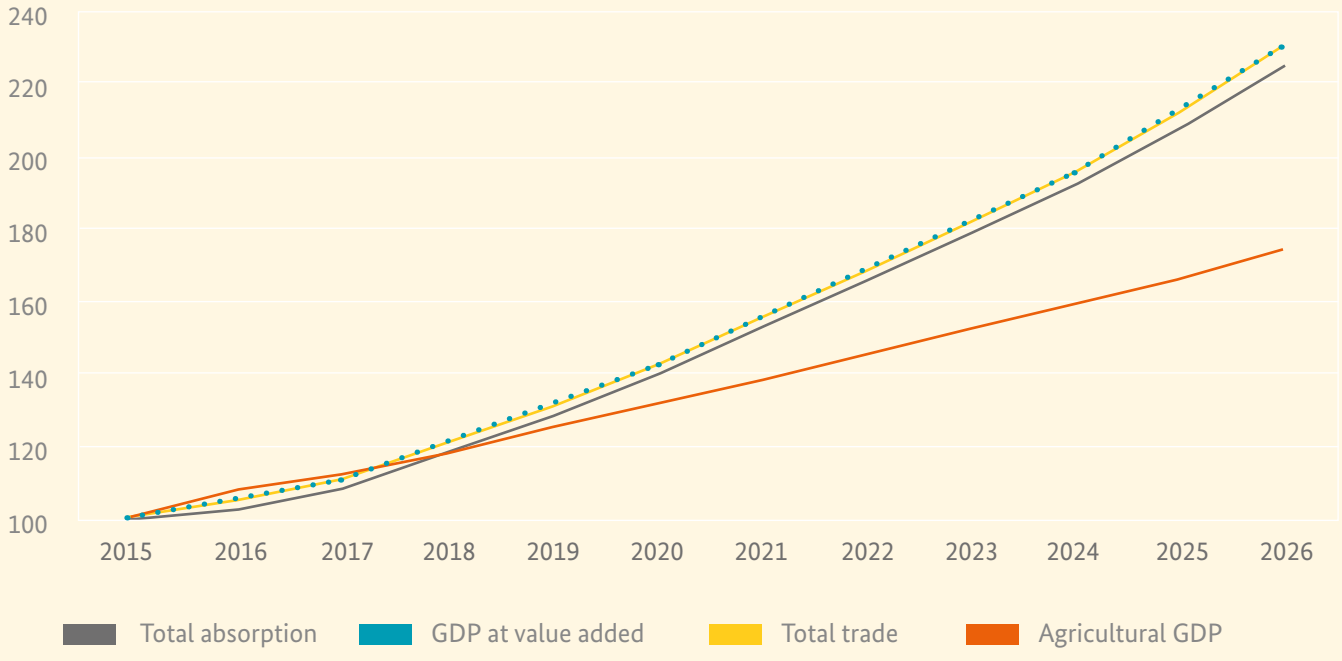
The economy of Benin develops favorably in the BAU scenario, which reflects the growth rates of GDP as well as other assumptions described for the BAU scenario above. Figure 14 shows these changes for the economy as a whole as well as for GDP in agriculture.

GDP, absorption and total trade all increase by about 55% by 2021 and more than double by 2026 compared to 2015. Agricultural GDP increases less than total GDP, indicating a declining share of agriculture in GDP, which is consistent with historical developments.

Looking at the development of the agricultural sector, Figure 15 shows that agricultural production in quantity terms is projected to increase by 37.6% until 2021 and by 78.6% until 2026. The increase in agricultural production value is somewhat higher, indicating that agricultural prices are increasing. Figure 15 also shows the increase in agricultural land over the projection horizon, which is considerably below the increase in production, indicating that most of the production increase comes from yield improvements instead of land extension.

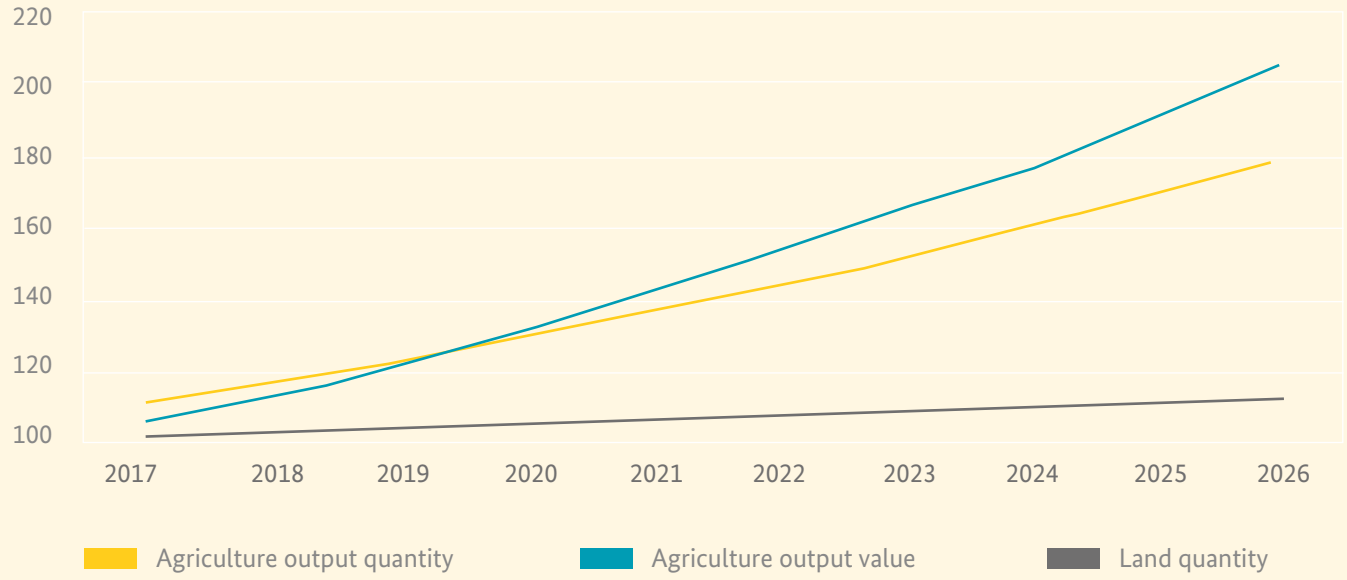
The development of agricultural imports and exports under the BAU scenario are depicted in Figure 16. Figure 16 shows that Benin is running into an increasing agricultural trade deficit under the BAU scenario.

Figure 14: Development of GDP, absorption and trade as well as agricultural GDP in the BAU Scenario (base period = 100)



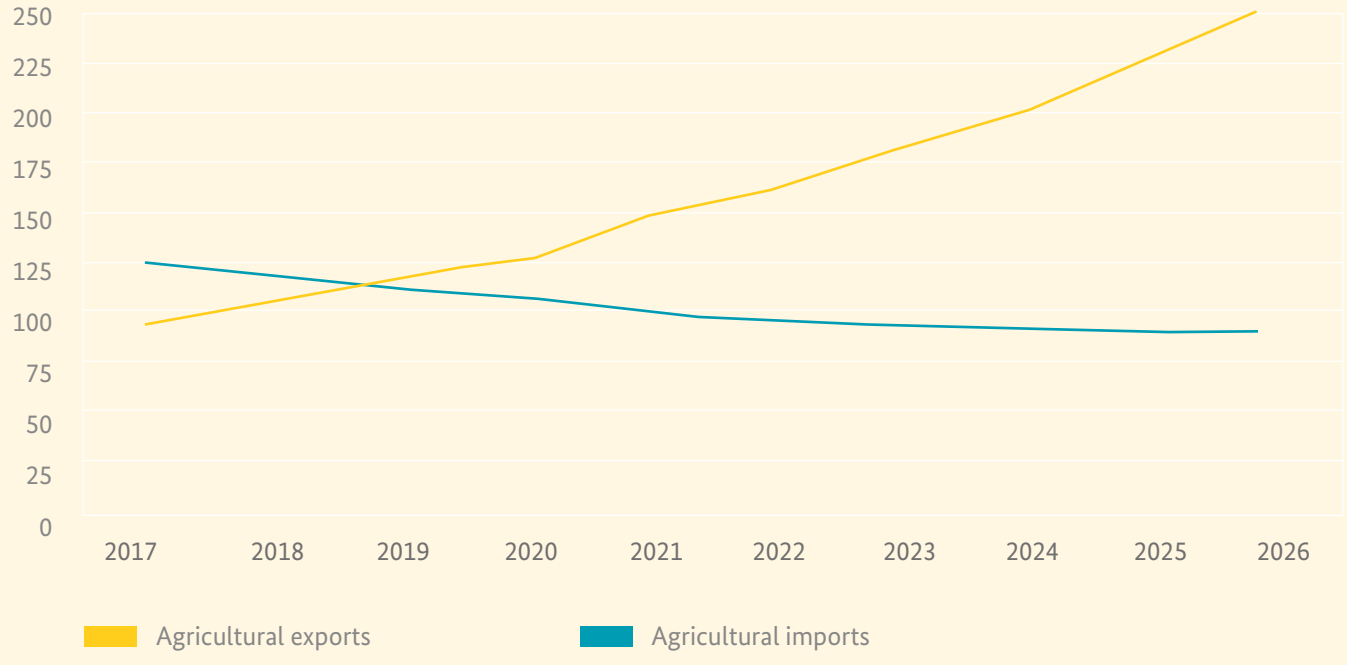
Source: Own calculations.

Figure 15: Development of agricultural production quantity and value as well as agricultural land use in the BAU scenario (base period = 100)



Source: Own calculations.

Figure 16: Development of agricultural imports and exports in the BAU scenario (base period = 100)



Source: Own calculations.

4.2 Results of the PNIASAN scenario

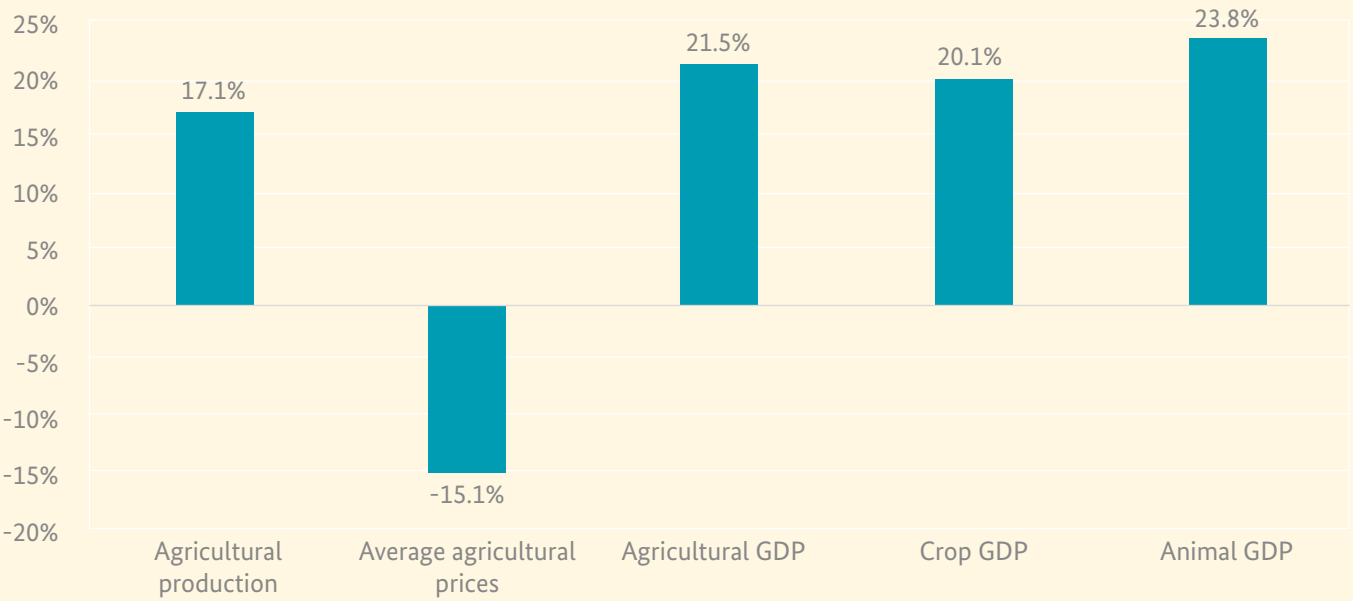
4.2.1 Agricultural production and prices

Under the PNIASAN, the productivity of production factors in agriculture as well as the endowment with production factors (land) increases. Therefore, total agricultural production quantity is 17% higher in 2021 under the PNIASAN. The average agricultural price level is 15% lower compared to the BAU scenario (Figure 17).

Looking at the agricultural sector in more detail, Figure 18 shows the changes in production as well as prices per agricultural product compared to the baseline (BAU).

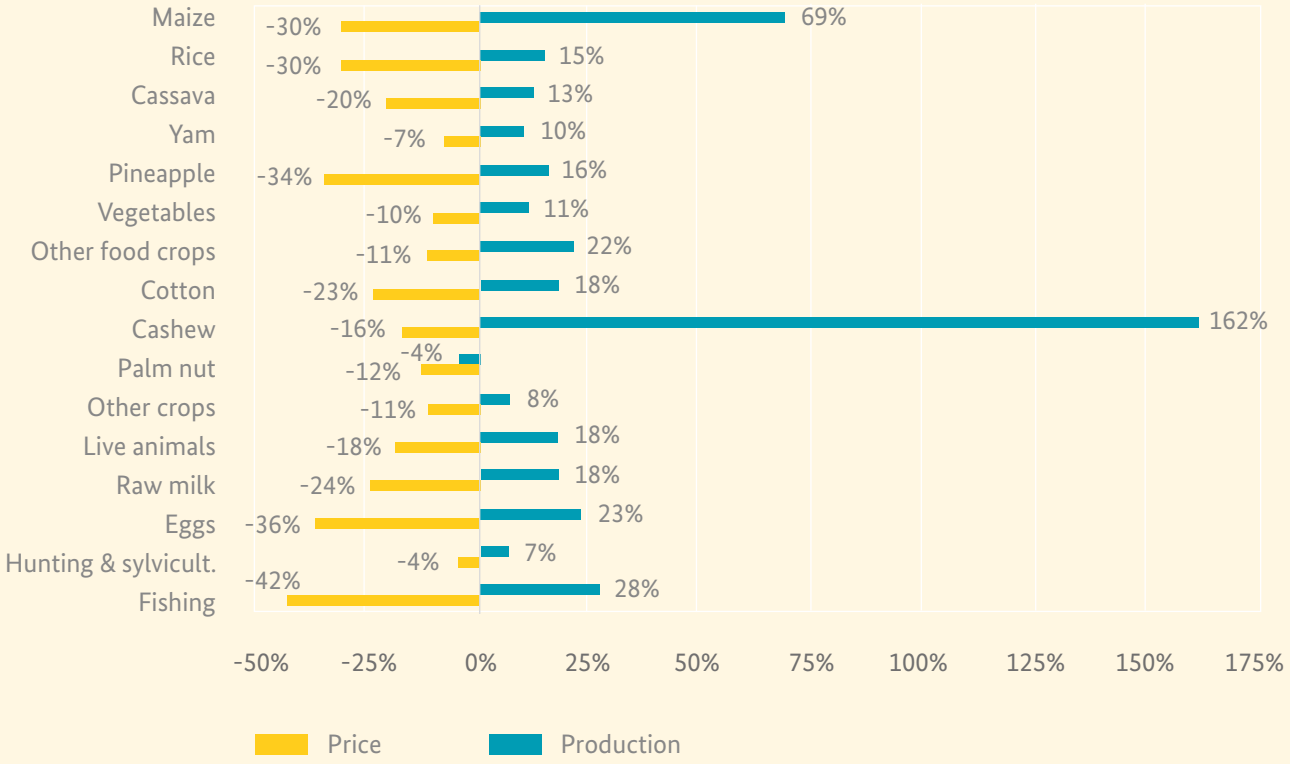
Production under the PNIASAN compared to the BAU scenario is especially higher for cashew (162%) and for maize (69%). This is the result of a wide range of drivers, among which productivity growth rates (Table 4), the increase in agricultural land and the model endogenous allocation of that land to different crops. Furthermore, the responsiveness of domestic demand as well as international demand and supply and the trade shares are important determinants, resulting in different price responses to productivity shocks. Cashew and maize are the two products with the highest export shares in total production (62% and 27%, respectively). This allows to increase production substantially without depressing domestic prices too much, especially in light of the high transformation elasticities between production for export and production for the domestic market (Annex Table 7). For some products, production increases are relatively small, accompanied by strongly decreasing prices. This is the case for pineapples and for rice and results from the fact that these products have very small export shares in the base situation, which does not allow for substantial additional exports under the simulations and thus increasing domestic supply is restricted by inelastic domestic demand, leading to falling prices.

Figure 17: Effects of the PNIASAN in 2021 on agricultural production, price level and GDP as well as crop and animal production GDP (at constant prices) compared to the BAU scenario in 2021 (in %)



Source: Own calculations.

Figure 18: Effects of the PNIASAN in 2021 on production quantities and prices of agricultural products compared to the BAU scenario (in %)



Source : Calculs des auteurs.

4.2.2 Consumption and trade

Due to lower agricultural and food prices, food consumption is 11% higher and exports of agricultural and food products are 129% higher than in the baseline (BAU). In addition, increasing domestic production leads to a substitution of imports and overall agricultural imports are 18% lower than in the BAU scenario. Table 5 shows the changes in consumption as well as export and import quantities for individual products compared to the baseline. Effects on exports are especially strong e.g. for pineapple, cashew and maize.

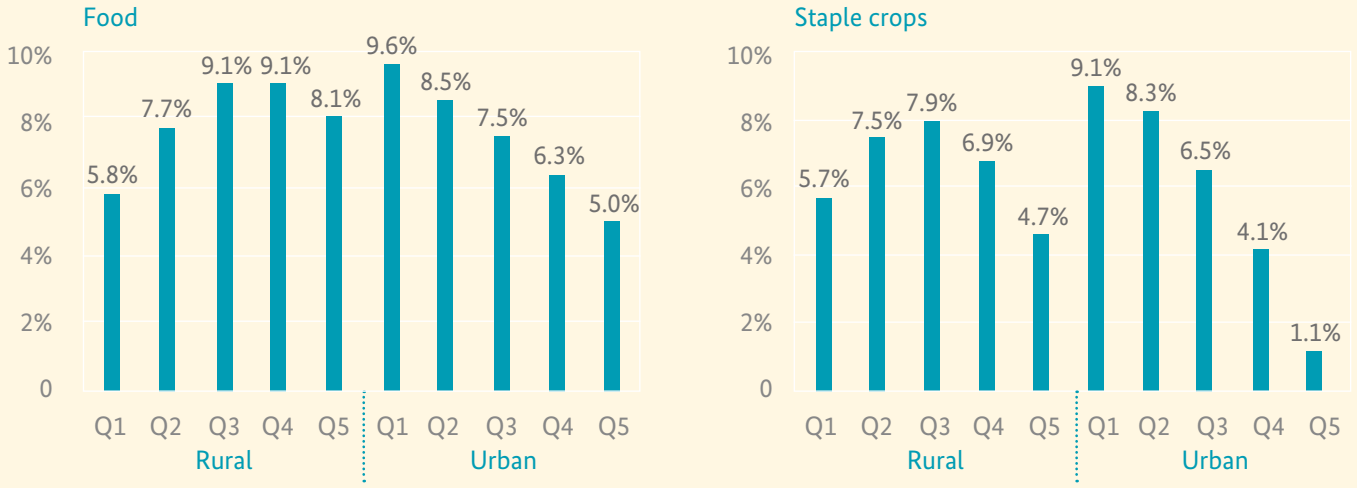
Table 5: Effects of the PNIASAN on consumption, export and import quantities of agricultural and food products compared to the BAU scenario (in %)

Products	Household consumption in 2021 relative to the BAU scenario (%)					
	Rural households					
	Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	All
Maize	7.09	9.10	9.30	8.06	5.47	7.99
Rice	17.69	19.48	18.93	16.32	11.13	16.88
Cassava	8.39	10.36	10.47	9.05	6.15	9.05
Yam	1.38	3.69	4.40	3.94	2.74	3.53
Pineapple	18.07	21.09	22.22	21.66	18.93	20.71
Fresh vegetables and spices	2.27	5.28	6.63	6.72	6.05	5.99
Other food crops for local consumption	2.86	5.56	6.75	6.77	5.98	5.95
Other food crops for export	1.62	4.38	5.62	5.70	5.08	4.80
Cashew	15.50	18.41	19.44	18.92	16.43	18.56
Palm nut	4.94	7.66	8.83	8.76	7.69	7.86
Other crops for industry or export	4.45	7.25	8.46	8.43	7.44	7.53
Live animals and poultry	14.13	18.19	19.25	17.78	14.01	17.15
Raw milk	19.40	22.39	22.91	21.25	17.02	20.90
Eggs and other husbandry activities	35.05	38.75	38.67	35.04	27.04	35.30
Hunting and sylviculture	2.21	5.46	6.73	6.51	5.38	5.62
Fishing products	45.47	50.33	51.00	47.70	39.31	47.42
All food	**12.70**	**13.90**	**14.56**	**13.45**	**10.47**	**13.18**
All agricultural products	**12.05**	**13.48**	**14.17**	**13.11**	**10.23**	**12.80**

Source: Own calculations.

Household consumption in 2021 relative to the BAU scenario (%)							Trade in 2021 relative to the BAU scenario (%)	
Urban households								
Quintile 1	Quintile 2	Quintile 3	Quintile 4	Quintile 5	All	Total	Export	Import
10.62	9.85	7.72	4.85	1.30	3.95	5.91	249.16	
22.39	20.18	16.07	10.29	2.79	8.74	13.45		
12.08	11.11	8.72	5.50	1.47	4.55	7.11		
4.37	4.48	3.50	2.19	0.59	1.84	2.80	48.06	
22.90	21.83	18.81	14.67	9.53	13.66	17.74	424.00	
5.82	6.22	5.37	4.18	2.78	3.76	5.01	40.46	-19.78
6.19	6.38	5.44	4.14	2.68	3.78	5.00	46.36	-20.46
4.91	5.24	4.48	3.42	2.23	3.15	4.09	58.99	-11.61
20.29	18.79	16.10	12.61	8.06	8.96	15.37	360.02	
8.49	8.46	7.21	5.56	3.56	5.14	6.89		
7.98	8.07	6.92	5.32	3.46	4.94	6.60	57.45	
19.69	19.49	16.96	13.17	8.17	12.01	14.88	143.06	
24.70	23.82	21.04	17.06	12.22	15.93	18.82		
41.93	39.83	34.45	26.53	16.11	23.80	30.18		
6.12	6.67	5.87	4.73	3.45	4.44	5.09	23.77	
53.17	51.85	46.77	38.45	25.67	35.70	42.49	276.13	-77.18
17.18	**15.17**	**12.87**	**9.67**	**5.60**	**8.70**	**11.22**	**129.41**	**-18.16**
16.49	**14.72**	**12.50**	**9.41**	**5.49**	**8.47**	**10.91**	**97.76**	**-17.71**

Figure 19: Effects of the PNIASAN on food and staple crop consumption per household quintile (% change compared to the baseline; Q1 = lowest, Q5 = highest income group)



Source: Own calculations.

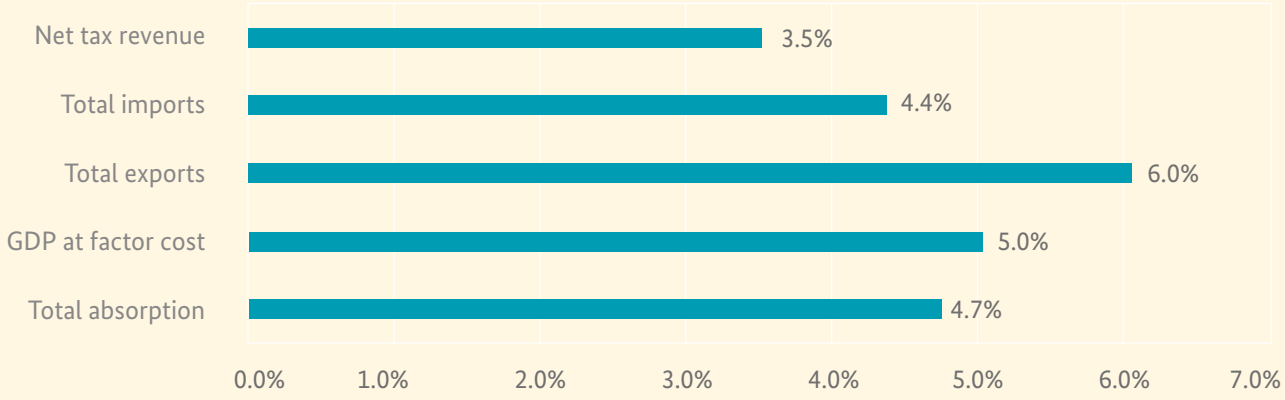
Figure 19 shows that globally, all household groups increase their total food, as well as their staple crop consumption under the PNIASAN relative to the BAU scenario. For urban households, the poorest quintile increases food consumption most (almost 10%) and the richest least (about 5%). The same pattern applies to urban household groups for staple crops consumption. This is due to poor households being more price responsive (prices are falling) and income responsive (income is increasing see below). For rural household groups, however, the middle-income quintile is the one which will increase its staple crop consumption most. This results from two opposing effects working in different directions: poor households are more price responsive, but at the same time, their income declines, while that for higher income rural household groups increases.

4.2.3 Macroeconomic effects

The developments in the agricultural sector caused by the productivity and land shocks have repercussions in the economy as a whole, as agriculture is a large sector in Benin (Figure 20).

- GDP and total absorption grow annually by about 1% more and in 2021, as a cumulative effect both measures are about 5% higher than under the BAU scenario.
- This stems from increasing productivity of production factors as well as an increasing factor stock (land). Furthermore, lower agricultural and food prices contribute to the purchasing power of consumers who spend more on consumption of other products and such generate multiplier effects throughout the economy.
- Total imports and total exports both increase by the same absolute amount, which is a consequence of the model closure chosen (see Section 3.2). There are, however, differences in percentage changes, as there is a trade deficit in the model base period (imports a larger in absolute terms than exports), which is assumed to stay constant.

Figure 20: Percentage change of selected macroeconomic indicators in 2021 under the PNIASAN compared to the BAU scenario



Source: Own calculations.

4.2.4 Welfare and distributional effects

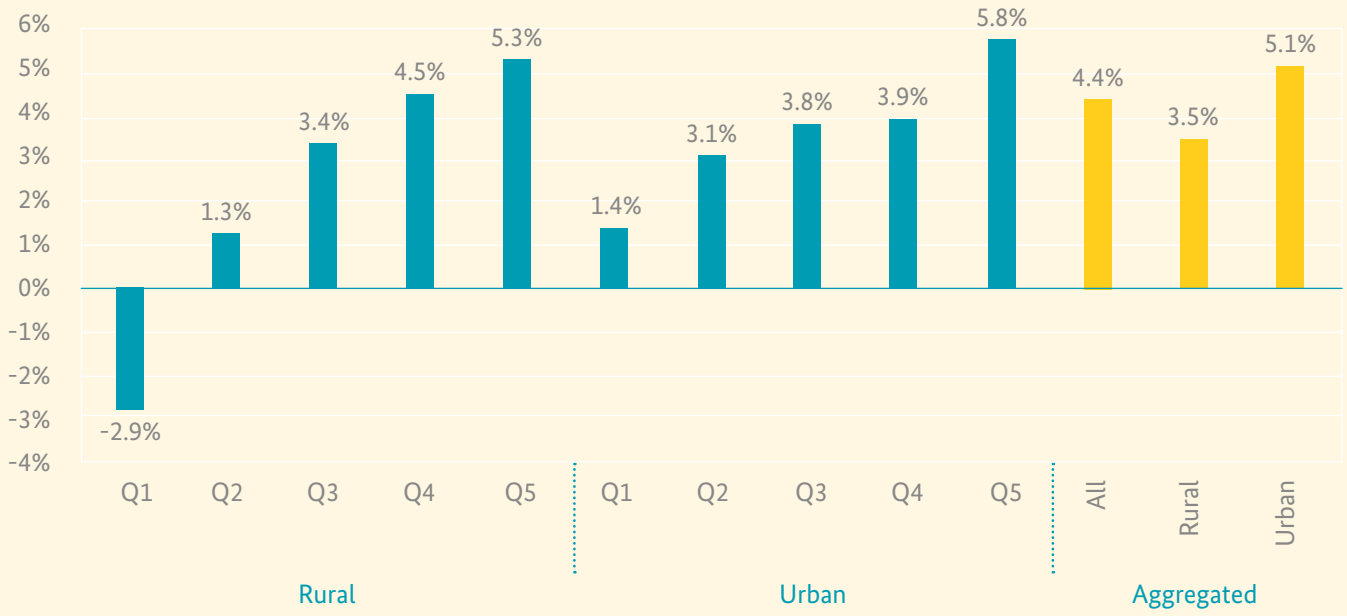
The PNIASAN affects private households directly in two ways: First, lower agricultural and food prices have an effect on the expenditure side of households and second, changes in prices for production factors as well as taxes raised to fund the PNIASAN affect private household income. Looking at the expenditure side, poorer households benefit more from the declined food prices in relative terms, as their food expenditure share is higher than for richer households. This is reflected by the relatively strong increases in food expenditures of poor households (Figure 19), despite their lower income increases (Figure 21).

On the income side, all households apart from the lowest rural income quintile benefit, but high-income households generally benefit more than low-income households (Figure 21). In addition, urban households benefit more proportionally than rural households.

This can be explained by the development of factor prices (Figure 22):

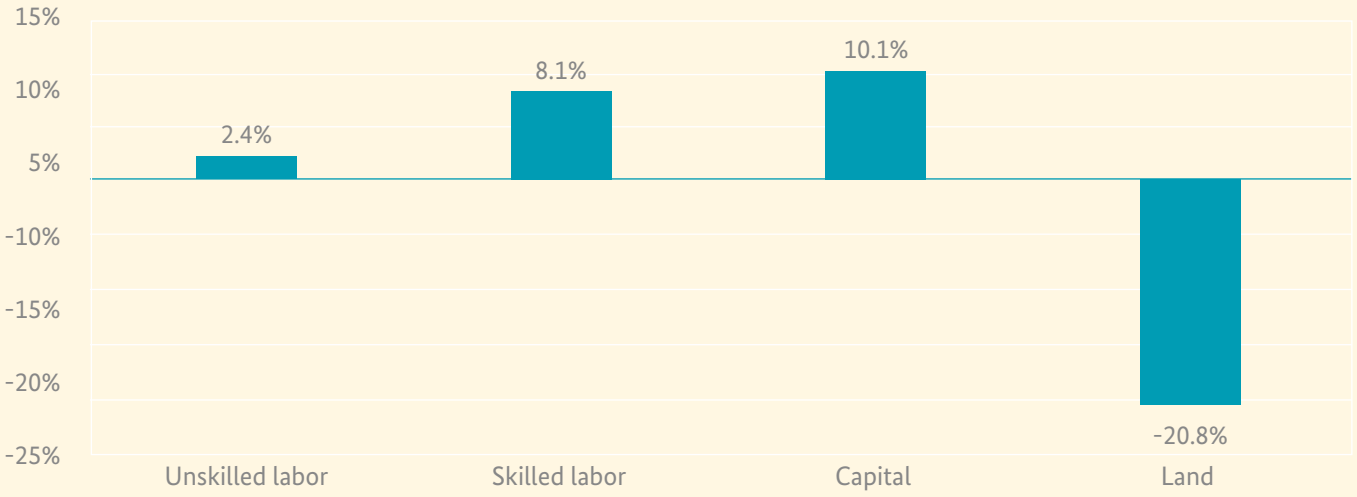
- The wage for skilled labor and capital rents increase the most, while the wage for unskilled labor increases to a lesser extent. Thus, richer households benefit more, as their share of income from skilled labor and capital is higher.
- The factor price for land (which can be interpreted as the rental rate) declines by almost 21%. Thus, income of most rural household groups increases less than income of urban households, as rural households have a higher income share from land. For all rural household groups on average, the share of land in total factor income is 11%, for the lowest rural income quintile it is 46% and for the highest income quintile it is 3% (see Section 3.1. for data sources).
- In conclusion, the negative income effect for the lowest rural income quintile is strongly driven by its high share of income from land and would not apply for landless rural households such as agricultural workers.

Figure 21: Household income effects of the PNIASAN in 2021 compared to the BAU scenario in 2021 in % (Q1 = poorest income group; Q5 = highest income group)



Source: Own calculations.

Figure 22: Development of factor prices under the PNIASAN compared to the BAU scenario (in %)



Source: Own calculations.

The development of factor prices may seem counter-intuitive at first sight. It follows, however, logically from the effect of the PNIASAN: by increasing the productivity of agriculture, factors which are overproportionally employed in agriculture become relatively less scarce: unskilled labor and land. Furthermore, land is getting even less scarce, as agricultural area expands. Therefore, the production factors, which are employed less than proportionally in agriculture, capital and skilled labor, are getting relatively scarcer and thus more expensive. The combination of the pro-poor welfare effects resulting from lower food prices and the non-pro-poor welfare effects resulting from changes in factor income combine in a way that all household groups experience substantial welfare gains which vary between 1.3% (lowest rural income quintile) and 5.4% (third and fourth rural income quintiles) of the 2021 BAU income. In total, private household welfare gains are about 3.8% of income under the BAU scenario in 2021. These overall effects are more positive in rural areas (4.8%) than urban areas (3.2%). However, welfare effects in 2021 are non-pro-poor in rural areas and pro-poor in urban areas. In rural areas, households have a higher share of their expenditures on food (including subsistence production) and thus benefit more from lower food prices. But as the poor are more negatively affected at their income side due to their relatively low income shares from capital and skilled labor and their high income shares from unskilled labor and land, they benefit less in total. For urban households, high-income households benefit less than low-income households due to their lower expenditure shares on food and due to the fact, that we assume the cost of the PNIASAN being covered to a large extent by direct taxes predominantly charged on high income households.

4.2.5 Effects up to 2030

Once, the additional productivity and area shocks are ended in 2021 and the tax rates as well as area and productivity growth rates return to their baseline levels, the positive effects on agriculture and the economy as a whole persist to a substantial degree. For example, while total GDP is about 5.0% higher under the PNIASAN scenario compared to the baseline in 2021, it is still 4.3% higher in the year 2030. Agricultural GDP in real terms (measured in constant input and output prices of the base period) remains at about 21% above the baseline level in 2021 as well as in 2030.

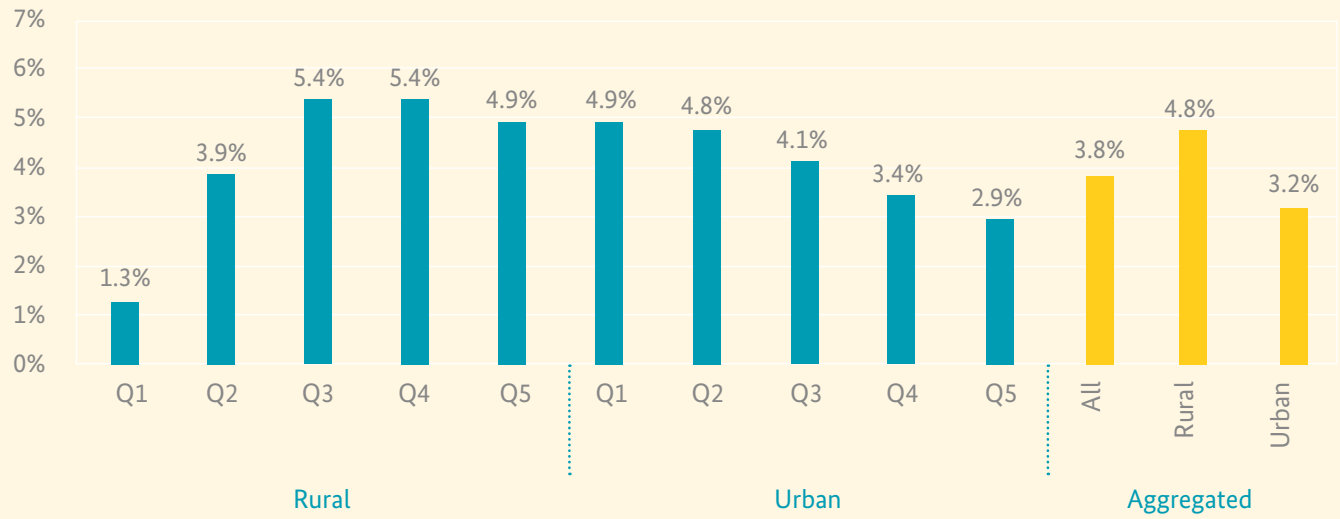
4.2.6 Sensitivity analyses

Alternative funding options

Figure 24 compares the welfare effects of the PNIASAN under different funding options. Under the sales tax scenario, the welfare gains of most households are slightly reduced compared to the income tax scenario (Standard). This stems from the fact that in the sales tax scenario, all households contribute to financing the PNIASAN. Thereby, a higher burden is put on poor households who spend a relatively higher share of their income on consumption instead of saving. An exemption are the urban quintiles 3, 4 and 5 who are paying the lion's share of income tax in the standard scenario and which in the sales-tax scenario contribute a relatively lower share to the total financing of the PNIASAN.

The funding of 50% of the PNIASAN by international donors has similar welfare implications as in the standard scenario for most household groups. Those households (rural quintiles 4 and 5 and urban quintiles 3-5) who are paying income tax are slightly better off, as their tax-burden is reduced and thus their disposable income increases.

Figure 23: Household welfare effects* of the PNIASAN in 2021 in % of the BAU income in 2021 (Q1 = lowest income group; Q5 = highest income group)



* Measured as equivalent variation in percent of baseline income in the year 2021.

Source: Own calculations.

No increase in land supply

Increasing agricultural land use in Benin is controversially discussed for at least two reasons:

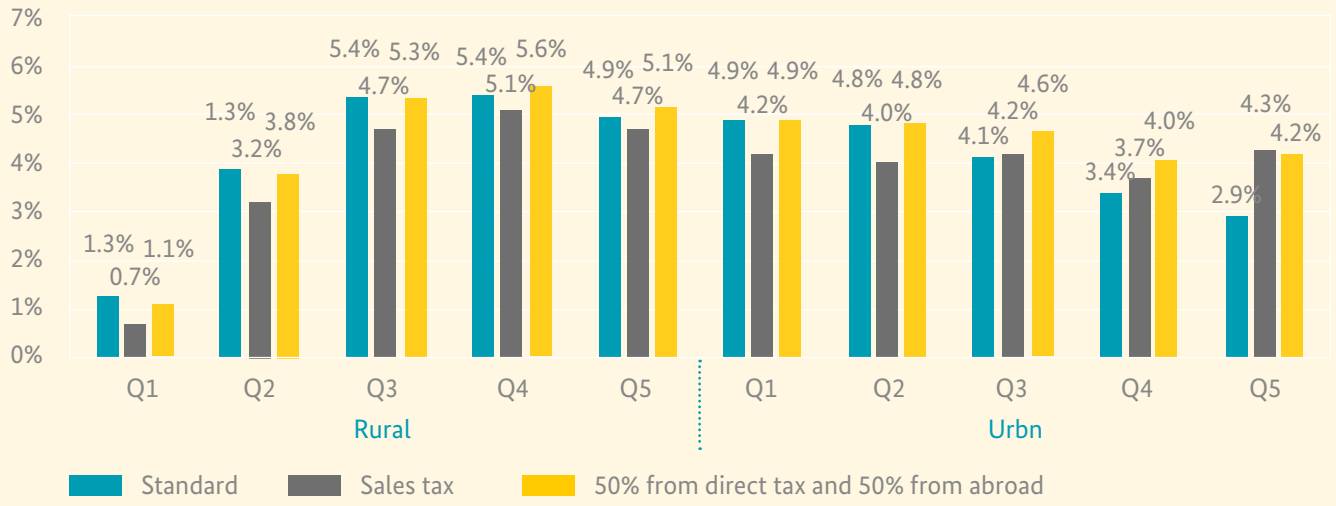
- Although land belongs to the state by law, individuals/families possess land property rights and they may not want to rent out or sell land, even if they do not use this land for farming. In such cases, options for the government to encourage land use are perceived as limited (providing incentives or expropriation).
- Environmental externalities may be caused by increasing land use.

Therefore, a sensitivity analysis was applied in order to assess the productivity effects envisaged under the PNIASAN without an increase in land supply. As expected, effects on agricultural production are slightly less in this case: Instead of 16.9%/17.4%/21.5%, domestic agricultural/crop/animal supply are only 12.9%/12.5%/19.3% higher compared to the baseline in 2021. Accordingly, also the welfare effects are substantially lower for most household groups.

Figure 25 shows the welfare effects of the productivity shocks per household group with (standard scenario) and without (sensitivity analysis) increasing land supply.

It can be seen that without an additional increase in land supply welfare effects for all households except for the rural poor (Q1) are less. This is because as less land is available, overall domestic production does not increase as much as in the standard scenario, which is why household income is not as high as in the core scenario. While income from production factors generally is lower compared to the standard setup, only income from land is declining less strong (-6.9% vs -11.1%), as land is a scarcer production factor if its supply is not increased so that the land rent drops only by 6.9% instead of 20.8%. Of all household groups, the poorest rural quintile derives the largest share of their income from land, which is why in case of less increasing land supply their income drops slightly less than under the standard scenario and the positive effect of reduced consumer prices dominates more.

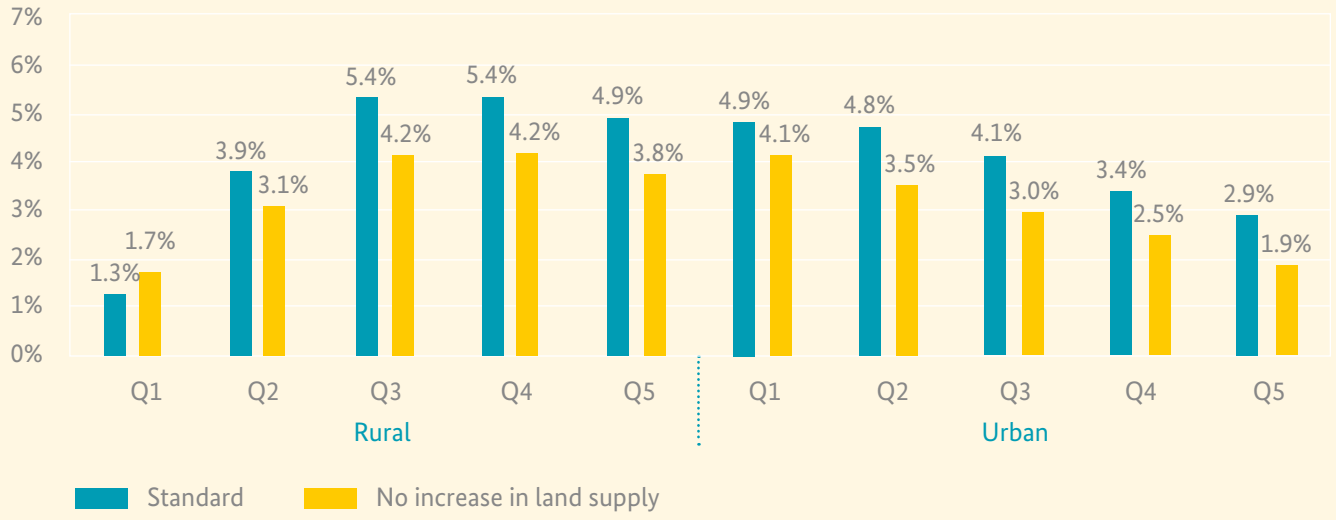
Figure 24: Household welfare effects* of the PNIASAN in 2021 in % of the BAU income in 2021 under three different funding options (Q1 = lowest income group; Q5 = highest income group)



* Measured as equivalent variation in percent of baseline income in the year 2021.

Source: Own calculations.

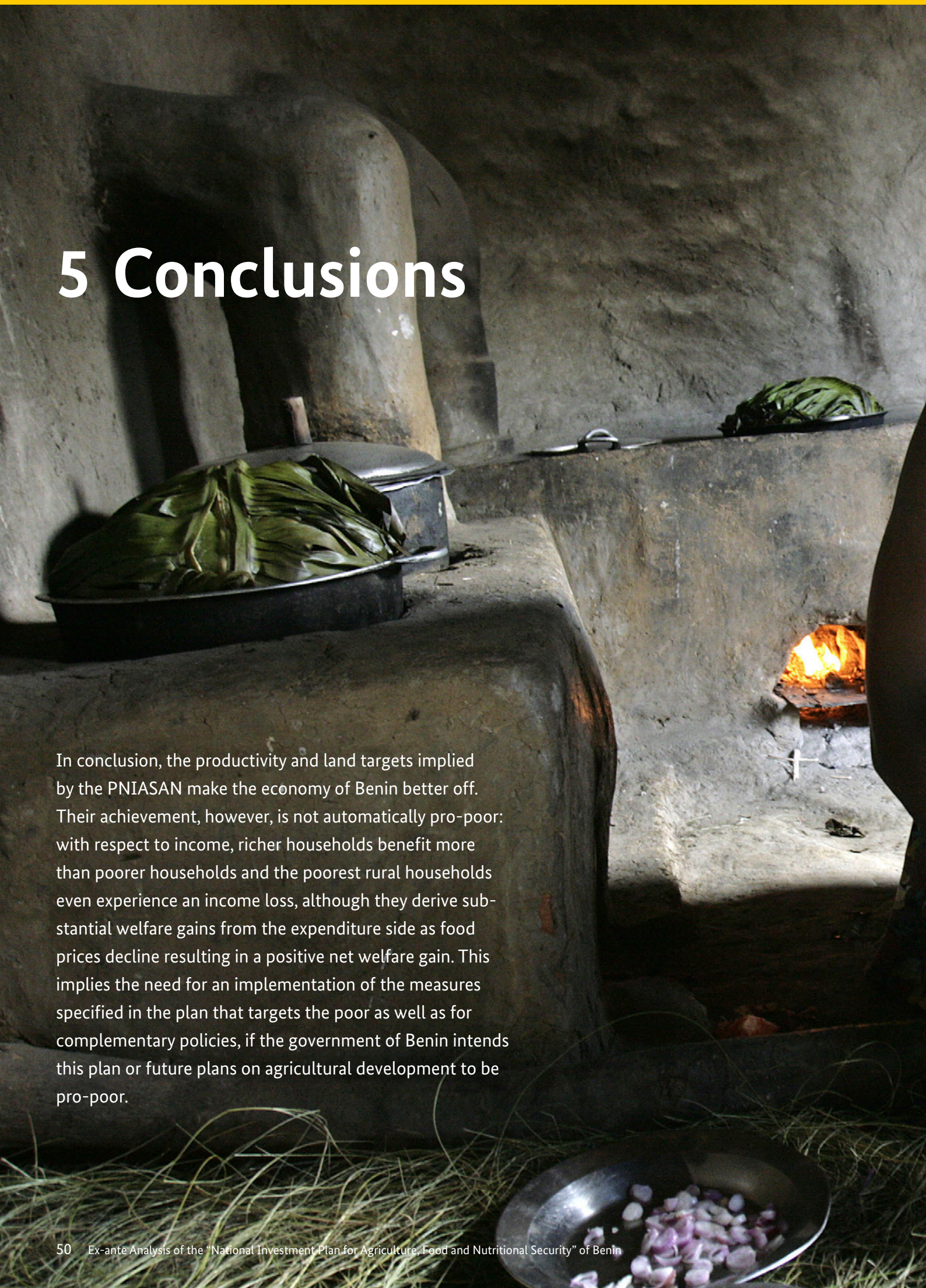
Figure 25: Household welfare effects* of the PNIASAN in 2021 in % of the BAU income in 2021 with and without increase in land supply (Q1 = lowest income group; Q5 = highest income group)



* Measured as equivalent variation in percent of baseline income in the year 2021.

Source: Own calculations.

5 Conclusions



In conclusion, the productivity and land targets implied by the PNIASAN make the economy of Benin better off. Their achievement, however, is not automatically pro-poor: with respect to income, richer households benefit more than poorer households and the poorest rural households even experience an income loss, although they derive substantial welfare gains from the expenditure side as food prices decline resulting in a positive net welfare gain. This implies the need for an implementation of the measures specified in the plan that targets the poor as well as for complementary policies, if the government of Benin intends this plan or future plans on agricultural development to be pro-poor.

5.1 On the PNIASAN

- The PNIASAN is an ambitious plan, targeting at high growth rates for crop and animal productivity and production.

- This study does not assess, whether the targets set in the plan can be fulfilled with the measures and the budget foreseen, but instead analyses, what the potential impacts of the fulfillment of the targets on the overall economy of Benin would be.

- Especially two aspects of the plan were not assessed critically for this study:
  - It is not clear, to what extent the share of 44% in the total budget foreseen to be paid by the private sector will be realized.
  - For some crops, the targets set regarding yields seem very high if contrasted with the yield developments of the last 15 years. This is the case e.g. for cotton and cashew. For animal production, the targets are far beyond the historical trend except for beef.

- For crops, the plan specifies targets for yield and production increases. The production growth rates are higher than the yield growth rates for all crops except for cashew.
  - This implies an increase in arable area by 330,000 hectares, equivalent to 11.7% of current arable land.

- The plan specifies an overall increase in animal production by 60%. Even in case of improving feed efficiency by e.g. 10% over the implementation period of the plan and about 15% of additional feed demand being covered by imports, this would require substantially more land for the production of animal feed. We estimate this demand at 4.5% of total agricultural area.

- In total, the additional agricultural area demand is estimated at 12.4% of the agricultural area in the year 2013. This would imply ambitious annual growth rates which are higher than those, historically observed.

- A thorough assessment is needed, of what the environmental effects of this extent of additional land use would be and what complementary measures would be needed, to not reduce the environmental sustainability of agricultural production in Benin.

5.2 On the data situation for the analysis with economy wide simulation models

- Economy wide simulation models need comprehensive databases, called Social Accounting Matrices (SAMs).

- The quality of the database in terms of correctness, comprehensiveness and degree of differentiation in various dimensions (products, households, production factors) to a large extent determines the options for, as well as the quality of simulation model analyses.

- Existing Social Accounting Matrices for Benin are not disaggregated enough (2013 INSAE SAM, 2015 SAM by an external consultant) to exploit the analytical potential of CGE models for Benin fully, especially with regard to household differentiation.

- Most of the data which would be needed to build a richer and recent Social Accounting Matrix is collected by INSAE and some of this data was used to disaggregate the 2015 SAM for the analysis in this project.

- The bottleneck for a better SAM is thus not the general data availability, but the resources available to analyze and process this data.

- It seems adequate, that the core work for the construction of a SAM takes place at INSAE, as this is the institution with the best knowledge on the data.
- INSAE is currently working on the compilation of a SAM for the year 2015.

- In order to support more in-depth impact analysis of agricultural as well as economic policies, it would be desirable, to strengthen INSAE in this field through capacity building as well as the provision of resources for a team within INSAE working on a SAM.

5.3 On the effects of the achievements of the productivity targets of the PNIASAN

5.3.1 How we analyze the effects of the productivity targets of the PNIASAN

- We simulate the effects of achieving the PNIASAN targets with a so-called Dynamic Computable General Equilibrium (CGE) model.

- The CGE model is a mathematical depiction of the economy of Benin: It serves as a "laboratory", allowing to analyze how the economy of Benin would react to certain exogenous changes, such as for example the implementation of new policies.

- We use the CGE model to compare two situations (scenarios):
  - A "Business as Usual" (BAU) situation, for which we assume a continuation of historical growth rates for GDP, population, productivity, land and animal stocks, but no implementation of the PNIASAN.
  - A situation with all the elements of the BAU scenario, but in addition the implementation of the PNIASAN over the period 2017-2021.

- The following elements of the PNIASAN are depicted in our model:
  - Productivity changes for crops as envisaged in the PNIASAN, compared to productivity changes in the BAU scenario are implemented as increases in total factor productivity of the respective sectors.
  - Production changes for animal products envisaged in the PNIASAN compared to productivity changes in the BAU scenario are implemented as increases in total factor productivity of the respective sectors.
  - An increase of agricultural land implicit in the production targets in the PNIASAN, compared to an increase of agricultural land under the BAU scenario (BAU: 5.5%, PNIASAN: + 12.4%).
  - An increase in the public budget for agriculture by 319 Billion 2015 CFAF. In order to keep other expenditures constant, we increase income taxes for private households in relative terms such as to fund the additional expenditures. Income taxes in Benin are mainly paid by the three upper urban income quintiles and their income tax rates rise by 3.3 percentage points at maximum.

5.3.2 The results of the productivity targets of the PNIASAN

- Under the PNIASAN, total agricultural production quantity is 17% higher in 2021 and the average agricultural price level is 15% lower compared to the BAU scenario.

- Due to lower agricultural and food prices, consumption of food is 11% higher, imports of agricultural products are 18% lower and exports of agricultural and food products are 129% higher.

- As a result, agricultural GDP in real terms (measured in constant input and output prices of the base period) is about 21% higher than under the BAU scenario.

- GDP grows annually by about 1% more, and as a cumulative effect in 2021, GDP is 5% higher than under the BAU scenario.

- Total absorption of private as well as public institutions is 4.7% higher in 2021 than under the BAU scenario and welfare of the population of Benin is about 4.4% higher than in the BAU scenario in 2021.

- These effects to a large extent persist in the longer run, beyond the phasing out of PNIASAN.

- Looking at the distributional results, we find that:
  - Poorer households benefit more from the declined food prices in relative terms, as their food expenditure share is higher than for richer households.
  - On the income side, all households except the poorest rural income quintile benefit, and the higher their income, the more households benefit in rural as well as in urban areas.

- This can be explained by the development of factor prices:
  - The wage for skilled labor and capital rents increase substantially, but the wage for unskilled labor increases only slightly. Thus, households with higher income benefit more, as their share of income from skilled labor and capital is higher.
  - The factor price for land (which can be interpreted as the rental rate) declines by 20.8%. Thus, income of most rural household groups increases less than income of urban households, as rural households have a higher income share from land.

- The development of factor prices may seem counter-intuitive at first sight. It follows, however, logically from the effect of the PNIASAN: Increasing agricultural productivity has the effect that the factors which are overproportionally employed in agriculture become relatively less scarce. These are unskilled labor and land. Furthermore, land is getting even less scarce, as agricultural area expands. Therefore, the production factors, which are employed less than proportionally in agriculture, capital and skilled labor, are getting relatively scarcer and thus more expensive.

- The combination of the pro-poor welfare effects resulting from lower food prices and the non-pro-poor welfare effects resulting from changes in factor income combine in a way that the resulting welfare effects are higher for rural households than for urban households (5.2% against 3.4%).

- All household groups experience substantial positive welfare effects, varying between 1.3% (lowest rural income quintile) and 6.1% (fourth rural income quintile) of the 2021 BAU income. Welfare effects in 2021 are non-pro-poor in rural area (driven by factor income) and pro-poor in urban areas (driven by food price effects and the funding of the PNIASAN through direct household taxes mainly paid by high income households).

5.4 On policy implications

- Increasing productivity in agriculture and enhancing land supply leads to lower agricultural and food prices. While this is desirable from a consumer perspective, it may be problematic for agricultural producers, especially if the negative price effects overcompensate the positive productivity effects. Such negative price effects would be buffered by increasing exports, which can be supported by investments in physical as well as informational infrastructure in order to enable agricultural supply from Benin to be processed as well as traded (market information systems, roads, reduced red tape). Especially the neighboring countries in West Africa could be targeted due to good accessibility, similar preferences and comparably low requirements in terms of standardization.

- The productivity and land targets implied by the PNIASAN make the economy of Benin better off. Their achievement, however, is not automatically pro-poor: with respect to income, richer households benefit more than poorer households and the poorest rural households even experience an income loss. Looking at total welfare, all households benefit, but in absolute terms, households with higher incomes benefit more.

- This implies the need for an implementation of the PNIASAN or any future plans such that they target the poor as well as for complementary policies, if the government of Benin intends this plan or future plans on agricultural development to be pro-poor.

- On targeting the funding of the PNIASAN or any future plans such as to be pro-poor:
  - The household groups with relatively high income benefit most from the PNIASAN in absolute terms. Therefore, it seems adequate to overproportionally involve them in funding the PNIASAN.
  - This is assumed in the PNIASAN scenario in this report, where the additional public expenditures for the PNIASAN are raised through income taxes, mainly paid by the three upper urban income quintiles.
  - But the income tax system in Benin is not yet well developed. Therefore:

- In the long run, the income tax system should be developed such that all income source and not just wage income be taxed.
- In the short run, other taxes which are mainly born by wealthy households such as real estate property taxes may instead/complementary be used.

- On targeting the measures of the PNIASAN and any future plans and complementary policies such as to be pro-poor:
  - The provision of public services should be explicitly targeted at agricultural smallholders:
  - Extension and training may especially be provided in regions and communities with a high share of smallholders and/or directly address smallholders.
  - Access to inputs (fertilizer, plant protection, machinery, animal feed) should be especially improved for agricultural smallholders.
  - Special programs may support smallholders through combined training on, and the provision of microfinance and subsidies for simple technologies such as fuel saving ovens, water containers for irrigation, water harvesting technologies and simple processing technology such as fruit and vegetable dryers.
  - The development of public market information systems which are accessible by simple means such as mobile phones could empower smallholders in their negotiating position when selling their products.
  - Public road infrastructure in remote areas has a strong potential to link farmers to markets for selling their products as well as purchasing inputs. It also improves access to medical care and schools.
  - Incentives may be provided to urban households, which hold property rights for an increasing share of agricultural land, to put their land to use and invest in agriculture and agricultural processing in a way that is labor intensive. This might provide employment opportunities for unskilled workers and hence reduce the negative income effects experienced by poor rural households, and it would stimulate the rural economy as a whole. Also, this would help to expand farmed area as foreseen in the PNIASAN without the need to exploit new land reserves.
  - This may be achieved for example through lower property taxes on agricultural land if put to use compared to unused land and other tax reliefs for stimulating investments in the rural economy.
  - Finally, the state may expropriate land owners.

- On the role of capacity building for the design of future development plans for agriculture.
  - The current plan has been developed without a comprehensive ex-ante assessment of the potential economy-wide effects. For the future, we recommend that the Government of Benin develops in-country capacity to conduct such analyses. Such investment may involve:
  - A two-year capacity building program for the national statistical office and the statistical division of the ministry which should result in the development of a sound SAM, adequate to address the economy-wide implications of agricultural development in Benin.
  - A two-year training program for selected staff members of the ministry of agriculture and potentially other government institutions to conduct such analyses independently. Ideally, such a program would be set up in collaboration with Universities in Benin to develop the capacity of the next generation of policymakers and policy analysts.

- On the importance of reflecting upon the funding of agricultural development plans.
  - The PNIASAN has been silent on how the government would finance its part of the plan.
  - For future plans, the question of how to finance the additional expenditures should be addressed more explicitly, as this will have important implications for the economy-wide effects of the plan.
  - The ministry of agriculture should work together with the ministry of finance to identify feasible options. Such options may include the variation of existing tax rates (income taxes, sales taxes and taxes on trade) as well as the reduction of government expenses for other objectives. A modelling team resulting from the capacity building recommended above may support this process by providing analyses regarding the implications of the different options.

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6 Appendix

Table 6: Account mapping between 2015 SAM provided by GIZ and final SAM

Original SAM from GIZ		Current SAM	
Long name	**Short name**	**Long name**	**Short name**
Activity maize	B01	Local maize Improved maize	almaize aimaize
Activity rice	B02	Rice	arice
Activity cassava	B03	Cassava	acassav
Activity yam	B04	Yam	ayam
Activity pineapple	B05	Pineapple	apineap
Activity vegetables and spices	B06	Fresh vegetables and spices	avegspi
Activity other food crop for local consumption Activity other food crop for export	B07 B08	Other food crops for local consumption or export	aofcrcx
Activity cotton	B09	Cotton	acotton
Activity cashew	B10	Cashew	acashe
Activity palm nut	B11	Palm nut	apalm
Activity other cash crop for industry or export	B12	Other crops for industry or export	aocrinx
Activity live animal and poultry	B13	Live animal and poultry	alivani
Activity raw milk	B14	Raw milk	armilk
Activity eggs and other husbandry products	B15	Eggs and other husbandry activities	aeggoth
Activity hunting Activity forestry	B16 B17	Hunting and sylviculture	ahunsyl
Activity fishery	B18	Fishing	afisch
Activity oil extraction	B19	Petrol mining	apetrom
Activity sand mining	B20	Sand mining	asandm
Activity other mining	B21	Other mining	aothm
Activity poultry slaughtering, processing and preservation of poultry meat Activity slaughtering, processing and preservation of meat and fish	B22 B23	Slaughtering, meat and fish processing	aslmfip
Activity oils and fats	B24	Oils and fats	aoilfat
Activity fruits and vegetables preservation	B25	Fruits and vegetables tin can	afrvegp
Activity beverages	B26	Beverages production	abevera
Activity rice husking Activity other food industry	B27 B28	Other food industry including rice husking cashew processing	aofooin acashp
Activity cotton ginning	B29	Cotton ginning	acotgin
Activity textiles and fibres	B30	Textiles and fibres	atexfib
Activity clothing and furs	B31	Clothing and furs	aclofur
Activity other clothing, leather and skins	B32	Other clothing, leather and skins	aoclols

Original SAM from GIZ		Current SAM	
Long name	**Short name**	**Long name**	**Short name**
Activity petrol refinery	B33	Electricity, water, other artisanal and modern industry	aelwoin
Activity electricity	B34		
Activity water	B35		
Activity other artisanal industries	B36		
Activity other modern industries	B37		
Activity construction	B38	Construction	aconstr
Activity trade	B39	Trade	atrade
Activity hotels and restaurants	B40	Hotels and restaurants	ahotres
Activity transport	B41	Transport and communication	atracom
Activity communication	B42		
Activity finance	B43	Finance	afinanc
Activity education	B44	Education, health and non-commercial services	aedhncs
Activity health	B45		
Activity non-commercial services	B46		
Activity other services	B47	Other services	aoservi
Commodity maize	P01	Maize	cmaize
Commodity rice	P02	Rice	crice
Commodity cassava	P03	Cassava	ccassav
Commodity yam	P04	Yam	cyam
Commodity pineapple	P05	Pineapple	cpineap
Commodity vegetables and spices	P06	Fresh vegetables and spices	cvegspi
Commodity other food crop for local consumption	P07	Other food crop for local consumption	cofcrc
Commodity other food crop for export	P08	Other food crop for export	cofcrx
Commodity cotton	P09	Cotton	ccotton
Commodity cashew	P10	Cashew	ccashe
Commodity palm nut	P11	Palm nut	cpalm
Commodity other cash crop for industry or export	P12	Other crop for industry or export	cocrinx
Commodity live animal and poultry	P13	Live animal and poultry	clivani
Commodity raw milk	P14	Raw milk	crmilk
Commodity eggs and other husbandry products	P15	Eggs and other husbandry activities	ceggoth
Commodity hunting products	P16	Hunting and sylviculture	chunsyl
Commodity forestry products	P17		
Commodity fish	P18	Fishing product	cfisch

Original SAM from GIZ		Current SAM	
Long name	**Short name**	**Long name**	**Short name**
Commodity oil	P19	Petrol mining	cpetrom
Commodity sand mining products	P20	Sand mining	csandm
Commodity other mining products	P21	Other mining	cothm
Commodity poultry meat and offal	P22	Poultry slaughtering, poultry meat processing and preservation of meat and fish	cslmfip
Commodity other meat and fish products	P23		
Commodity oils and fats	P24	Oils and fats	coilfat
Commodity processed fruits and vegetables	P25	Fruits and vegetables tin can	cfrvegp
Commodity beverages	P26	Beverages production	cbevera
Commodity husked rice	P27	Other food industry including rice husking	Cofooin
Commodity other food	P28	cashew processing	ccashp
Commodity cotton ginning products	P29	Cotton ginning	ccotgin
Commodity textiles and fibres	P30	Textiles and fibres	ctexfib
Commodity clothing and furs	P31	Clothing and furs	cclofur
Commodity other clothing, leather and skins	P32	Other clothing, leather and skins	coclols
Commodity petroleum products	P33	Electricity, water, refined petroleum and other artisanal and modern industry	celwoin
Commodity electricity	P34		
Commodity water	P35		
Commodity other artisanal industry products	P36		
Commodity other modern Industry products	P37		
Commodity construction	P38	Construction	cconstr
Commodity trade	P39	Trade	ctrade
		Margin domestic Trade	TRD
		Margin Exports	TRE
		Margin Imports	TRM
Commodity hotels and restaurants	P40	Hotels and restaurants	chotres
Commodity transport	P41	Transport and communication	ctracom
Commodity communication	P42		
Commodity finance	P43	Finance	cfinanc
Commodity education	P44	Education, health and non-commercial services	cedhncs
Commodity health	P45		
Commodity non-commercial services	P46		
Commodity other services	P47	Other services	coservi
Unskilled labour	F01	Unskilled labour	funskla

Original SAM from GIZ		Current SAM	
Long name	**Short name**	**Long name**	**Short name**
Skilled labour	F02	Skilled labour	fskilla
Capital	F03	Capital	fcapit
Land	F04	Land	fland
Enterprises	E00	Enterprises	ENT
Rural households	M01	Rural household quintile 1	hruraq1
		Rural household quintile 2	hruraq2
		Rural household quintile 3	hruraq3
		Rural household quintile 4	hruraq4
		Rural household quintile 5	hruraq5
Urban households	M02	Urban household quintile 1	hurbaq1
		Urban household quintile 2	hurbaq2
		Urban household quintile 3	hurbaq3
		Urban household quintile 4	hurbaq4
		Urban household quintile 5	hurbaq5
Government	G01	Government	GOVT
		Direct taxes	DIRTAX
Other production taxes net of subsidies	G02	Indirect taxes	INDTAX
VAT	G03	Value added taxes	VATTAX
Other commodity taxes net of subsidies	G04	Sales taxes	SALTAX
Customs duties on imports excluding VAT	G05	Import taxes	IMPTAX
Export taxes	G06	Export taxes	EXPTAX
Savings-investment private	I01	Savings-investment private	invpriv
Savings-investment public	I02	Savings-investment public	invpub
Savings stock change	I03		
Nigeria	W01	Rest of the World Nigeria	rownig
Rest of the World	W02	Other Rest of the World	rowoth
Total		Total	Total

Source: Authors.

Table 7: Trade Armington and transformation elasticities

List of commodities	Armington (CES)	Transformation (CET)
Maize	6.00	6.00
Rice	2.00	6.00
Cassava	4.00	4.00
Yam	4.00	6.00
Pineapple	4.00	4.00
Fresh vegetables and spices	4.00	4.00
Other food crop for local consumption	4.00	2.00
Other food crop for export	4.00	4.00
Cotton	4.00	4.00
Cashew	4.00	4.00
Palm nut	4.00	4.00
Other crop for industry or export	4.00	4.00
Live animal and poultry	4.00	4.00
Raw milk	4.00	2.00
Eggs and other husbandry activities	4.00	3.00
Hunting and sylviculture	4.00	4.00
Fishing product	4.00	2.00
Petrol mining	4.00	6.00
Sand mining	4.00	6.00
Other mining	4.00	6.00
Poultry slaughtering, poultry meat processing and preservation of meat and fish and tin can	4.00	2.00
Oils and fats	4.00	6.00
Cashew processing	4.00	10.00
Beverages production	4.00	4.00
Fruits and vegetables tin can	4.00	4.00
Other food industry including rice husking	4.00	6.00
Cotton ginning	2.00	4.00
Textiles and fibres	2.00	4.00
Clothing and furs	2.00	4.00
Other clothing, leather and skins	6.00	4.00
Electricity, water, refined petroleum and other artisanal and modern industry	4.00	4.00
Construction	4.00	4.00
Trade	2.00	2.00
Hotels and restaurants	4.00	4.00
Transport and communication	4.00	4.00
Finance	4.00	2.00
Education, health and non-commercial services	4.00	4.00
Other services	4.00	4.00

Source: Authors.

Table 8: Production elasticities on the top and second levels

List of production activities	Factor substitution	Aggregated value added and intermediate input substitution
Local maize	0.60	0.50
Improved maize	0.60	0.50
Rice	0.60	0.50
Cassava	0.60	0.50
Yam	0.60	0.50
Pineapple	0.60	0.50
Fresh vegetables and spices	0.60	0.50
Other food crop for local consumption or export	0.60	0.50
Cotton	0.60	0.50
Cashew	0.60	0.50
Palm nut	0.60	0.50
Other crop for industry or export	0.60	0.50
Live animal and poultry	0.60	0.50
Raw milk	0.60	0.50
Eggs and other husbandry activities	0.60	0.50
Hunting and sylviculture	0.60	0.50
Fishing	0.60	0.50
Petrol mining	0.60	0.50
Sand mining	0.60	0.50
Other mining	0.60	0.50
Slaughtering, meat and fish processing	0.60	0.50
Oils and fats	0.60	0.50
Fruits and vegetables tin can	0.60	0.50
Beverages production	0.60	0.50
Other food industry including rice husking	0.60	0.50
Cashew processing	0.60	0.50
Cotton ginning	0.60	0.50
Textiles and fibres	0.60	0.50
Clothing and furs	0.60	0.50
Other clothing, leather and skins	0.60	0.50
Electricity, water, other artisanal and modern industry	0.60	0.50
Construction	0.60	0.50
Trade	0.60	0.50
Hotels and restaurants	0.60	0.50
Transport and communication	0.60	0.50
Finance	0.60	0.50
Education, health and non-commercial services	0.60	0.50
Other services	0.60	0.50

Source: Authors.

Table 9: Income elasticities of demand

List of commodities	Rural Q1	Rural Q2	Rural Q3	Rural Q4	Rural Q5	Urban Q1	Urban Q2	Urban Q3	Urban Q4	Urban Q5
Maize	0.7	0.6	0.5	0.3	0.2	0.7	0.5	0.4	0.2	0.1
Rice	0.7	0.6	0.5	0.3	0.2	0.7	0.5	0.4	0.2	0.1
Cassava	0.7	0.6	0.5	0.3	0.2	0.7	0.5	0.4	0.2	0.1
Yam	0.7	0.6	0.5	0.3	0.2	0.7	0.5	0.4	0.2	0.1
Pineapple	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Fresh vegetables and spices	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Other food crop for local consumption	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Other food crop for export	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Cotton	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Cashew	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Palm nut	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Other crop for industry or export	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Live animal and poultry	1.4	1.2	1.0	0.7	0.5	1.4	1.1	0.9	0.6	0.3
Raw milk	1.0	0.9	0.7	0.6	0.4	1.0	0.8	0.7	0.5	0.3
Eggs and other husbandry activities	1.4	1.2	1.0	0.7	0.5	1.4	1.1	0.9	0.6	0.3
Hunting and sylviculture	1.0	0.9	0.7	0.6	0.4	1.0	0.8	0.7	0.5	0.3
Fishing product	1.4	1.2	1.0	0.7	0.5	1.4	1.1	0.9	0.6	0.3
Petrol mining	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Sand mining	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Other mining	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Poultry slaughtering, poultry meat processing and preservation of meat and fish and tin can	1.4	1.2	1.0	0.7	0.5	1.4	1.1	0.9	0.6	0.3

List of commodities	Rural Q1	Rural Q2	Rural Q3	Rural Q4	Rural Q5	Urban Q1	Urban Q2	Urban Q3	Urban Q4	Urban Q5
Oils and fats	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Cashew processing	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Beverages production	0.8	0.7	0.6	0.5	0.4	0.8	0.7	0.5	0.4	0.2
Fruits and vegetables tin can	1.4	1.5	1.5	1.6	1.6	1.4	1.5	1.6	1.7	1.8
Other food industry including rice husking	1.2	1.2	1.1	1.1	1.0	1.2	1.2	1.1	1.1	1.0
Cotton ginning	1.2	1.2	1.1	1.1	1.0	1.2	1.2	1.1	1.1	1.0
Textiles and fibres	1.4	1.5	1.5	1.6	1.6	1.4	1.5	1.6	1.7	1.8
Clothing and furs	1.4	1.5	1.5	1.6	1.6	1.4	1.5	1.6	1.7	1.8
Other clothing, leather and skins	1.4	1.5	1.5	1.6	1.6	1.4	1.5	1.6	1.7	1.8
Electricity, water, refined petroleum and other artisanal and modern industry	1.2	1.2	1.1	1.1	1.0	1.2	1.2	1.1	1.1	1.0
Construction	1.2	1.2	1.1	1.1	1.0	1.2	1.2	1.1	1.1	1.0
Trade	1.2	1.2	1.1	1.1	1.0	1.2	1.2	1.1	1.1	1.0
Hotels and restaurants	1.4	1.5	1.5	1.6	1.6	1.4	1.5	1.6	1.7	1.8
Transport and communication	1.4	1.5	1.5	1.6	1.6	1.4	1.5	1.6	1.7	1.8
Finance	1.4	1.5	1.5	1.6	1.6	1.4	1.5	1.6	1.7	1.8
Education, health and non-commercial services	1.4	1.5	1.5	1.6	1.6	1.4	1.5	1.6	1.7	1.8
Other services	1.4	1.5	1.5	1.6	1.6	1.4	1.5	1.6	1.7	1.8

Source: Authors.