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Agricultural Investments, Labor Productivity, and Rural Poverty Reduction: Gender Disparities in Togo

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policy analysis on growth and employment

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Abstract

Despite the crucial role of agriculture in economic development, the impact of investments in this sector remains little known, and information that could inform policy and encourage further investments for rural poverty reduction is scarce. We assess the impact of agricultural investments on labor productivity and poverty reduction in rural areas in Togo by analyses of data collected from 4,543 households in four townships via a Community-Based Monitoring System approach. Through descriptive statistics and econometric modelling of agricultural households, we examine such issues as gender disparities, educational levels, water and sanitation, insurance, and income. We find that public investments in health education and telecommunication infrastructure improve farmers' productivity and reduce the number of farmers below the poverty line, as do farmers' investments in inputs. We note an estimated farm-income gap between men and women of 44.1%, and suggest that increased public and private investments in education, health, safe drinking water, and irrigation infrastructure, as well as improvements in the equitable distribution of endowments such as land would equalize opportunities for disadvantaged or excluded groups and reduce the income gap between men and women.

JEL:H31; I32; J16; O16; Q14

Keywords: Household, Poverty, Gender, Investment, Agricultural Finance

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APP	Accelerated Poverty Profiling
CAADP	Comprehensive Africa Agriculture Development Programme
GDP	Gross Domestic Product
PNIASA	National Agricultural Investment and Food Security Plan
SMIG	Interprofessional Guaranteed Minimum Wage

Executive summary

Poverty reduction in Togo remains a major challenge, despite substantial progress. The result is that the efforts of Togo's government have not yet met expectations, especially for rural and mainly agricultural populations, which remain the poorest. Of the 531,068 rural households counted during the fourth National Census of Agriculture in 2011, 95.8% were agricultural, against 4.2% non-agricultural Agriculturally active is defined as « every person aged fifteen years and over involved in an agricultural activity, either on a full time or part time basis. » In addition, the agricultural sector contributes about 38% to real GDP against 23% and 36%, respectively, for the secondary and tertiary sectors, and it employs 40.7% of the total labor force.

Despite this significant contribution to the country's economic growth, an analysis of poverty by socioeconomic group showed that, in 2015, poverty was higher among households headed by independent farmers, an incidence of 72.6%. If investment choices and agricultural policies were implemented appropriately, the producers of the agricultural sector, given their contribution to the GDP, would be among the main beneficiaries of improved economic performance. Indeed, the impact of agriculture on poverty reduction is the result of the interaction of several effects. First, because many poor households have a marginal attachment to agricultural employment, the direct effect of growth in the agricultural sector is improvement in the income of employees in that sector. Second, the active participation of the poor in agricultural would depend upon the benefits they derived from growth in that sector, though this would remain a question of the type of agriculture practiced, the kinds of agricultural investments made, the availability of incentives for participation in agriculture, the distribution of agricultural income, and structure of farm-property rights.

Increases in farm productivity can come from improvement of techniques and greater deployment of such inputs as agricultural chemicals as well as the use of improved seed varieties and other new agricultural technologies. Moreover, growth in agricultural productivity is correlated with R&D, education, workforce health, transportation infrastructure, pricing policies, etc... In 2011, the Government of Togo adopted the National Agricultural Investment and Food Security Plan, to support farmers, particularly the most vulnerable. Despite this substantial progress, agriculture in Togo continues to face enormous constraints, including lack of infrastructure and agricultural equipment, access to credit, and governance. There also remains a disparity between men and women in terms of how much they benefit from investments in agriculture, their productivity at work and their overall living standards. Therefore, the main research question that arises is What gender disparities exist in agricultural investments and labor productivity and what is their effect on poverty reduction?

A team of local PEP researchers sought to assess the impact of agricultural investments on farming productivity and poverty reduction in rural areas, with the aim of informing new policies to improve the situation and ensure that both genders feel these benefits. The researchers gathered their information using the Community Based Monitoring System (CBMS) through which they surveyed

over 4,500 households in four townships in rural areas of Togo. Alongside this, a rider questionnaire was issued to collect additional data. The study aimed to assess how investment in agriculture had impacted on labor productivity and poverty reduction in rural areas and determine any disparities among male and female farm workers. The study analyzed the effects of agricultural investments on productivity of plots managed by women as compared with those managed by men. Furthermore, it also examined the gender wage gap in the agricultural sector.

The results of the analysis highlight the extreme poverty faced by those living in rural areas of Togo. The majority of farmers of both sexes have carry no insurance against natural disasters, and only 3.54% of farmers in the study area had access to credit (3.08% of women and 3.75% of men). The results showed that 75.60% of farmers had an average monthly income lower than the Interprofessional Guaranteed Minimum Wage (SMIG), and more of these were women (82.63%) than men (72.28%).

Men practice irrigation more than women on plots they own (about 4.43% of men farmers against 1.95% of women), which is explained by the cost of irrigation equipment. Access to inputs was difficult for farmers in Togo because of price and limitations on quantity set by the government. In the last two years, the fertilizer market has been liberalized and price has become the only barrier to the use of fertilizers (in fact, only 29.64% of farmers use fertilizers for their crops). We found, on average, that men farm areas equivalent in size to those of women, but the distribution of agricultural income by sex revealed that men have higher incomes.

Econometric estimates showed that public investment in infrastructure such as education, irrigation, telecommunications, health, drinking water, etc. improves farmers' productivity. In specific, having a secondary school less than 5 km away had a positive and significant impact on productivity, as did a higher level of education.

In our study area, access to safe drinking water and sanitary facilities had a negative effect on farmers' productivity, and the majority of farmers practiced open defecation. Mobile-phone use has improved agricultural productivity for all farmers as a whole, but, when a gender analysis was run separately, mobile-phone use was shown to improve productivity only for men.

Irrigation has a positive and significant effect on farmers' agricultural productivity, as does insurance against natural disasters and access to electricity. This was not the case, however, in terms of total productivity. Irrigation, access to electricity, household size, and carrying insurance against natural disasters do not, however, significantly influence labor productivity.

Considering the heterogeneity of productivity, a quantile regression showed that the irrigation variable had a positive and significant effect solely on the productivity of 1st- and 2nd-quantile farmers, while electricity and the use of fertilizers improved agricultural productivity solely for 2nd- and 3rd-quantile farmers. The effect of agricultural credit on farmers' productivity in the 2nd and 3rd quantiles was significant and negative.

Productivity coefficients had negative signs for farmers of both sexes, but we can conclude

that increasing farmers' productivity contributes significantly to reducing farmers' poverty. Land productivity, conversely, reduces solely the probability of farmers being poor.

The estimated farm-income gap between men and women is 44.1%. The under-compensation of women in the agricultural sector contributed to this difference by -0.12% (-0.053/0.441), while favoritism towards men represented 60.1% (0.265/0.441) of this gap.

The findings from this study highlight the need for policies that improve infrastructure in farming and increase and encourage investment in the industry. Additionally, farmers need to have more access to credit and there needs to be increased public investment in education, health and providing access to clean water for farmers. Policies also need to be in place to promote equality and equalize opportunities for disadvantaged or excluded groups, such as women.

Policies and programs that could contribute to these aims include:

- Strengthen rural households' access mechanisms to agricultural credit, commercial credit and other inputs to increase their income and reduce poverty.
- Invest in infrastructure and improve the technical capacity of farmers to meet international standards so they can export their produce and increase their income.
- Put in place institutional innovations in the field of agricultural insurance (e.g insurance against drought risk or natural disasters) and encourage farmers to subscribe to them to reduce the risks for borrowers and lenders and unlock agricultural finance.
- Create favorable conditions and incentives in rural areas to provide rural people with better access to savings and credit facilities.
- Increase public investments and encourage private investment in education, health, drinking water and irrigation infrastructure.
- Educate and inform the agricultural industry about the contribution of women to food production and food security efforts, and facilitate the participation of women in further training in new agricultural technologies.
- Inform communities, especially parents, about the issues surrounding early marriage.

1 Introduction

1.1 Context of the study

Poverty reduction in Togo remains a major challenge, despite substantial progress. After a long period of sociopolitical crises, the resumption of international cooperation, investments in infrastructure, and the promotion of employment have led to a renewal of the country's economic growth. Indeed, growth in the Gross Domestic Product (hereafter, GDP) was estimated at 5.5% in 2014 and 5.7% in 2015, and was expected to reach 5.9% in 2016 (African Development Bank, 2015). This renewed growth has had a significant impact on poverty reduction: poverty fell from 61.7% in 2006 to 58.4% in 2011 and was estimated at 55.1% in 2015, though this poverty reduction has not, unfortunately, favored poor households sufficiently (Institut National de la Statistique et des Etudes Economiques et Démographiques, 2016a).

Poverty has persisted in rural areas as has a large disparity compared to urban areas: 68.9% in rural areas and 37.8% in urban areas in 2015 (Institut National de la Statistique et des Etudes Economiques et Démographiques, 2016a). In 2015, seven rural households out of ten practiced open defecation, while urban households had all but abandoned the practice (Institut National de la Statistique et des Etudes Economiques et Démographiques, 2016a). Moreover, in 2015 only 16.2% of rural households had access to electricity, compared to 90.3% and 76.9% of households in Lomé, the capital, and in other urban areas, respectively. Analysis by place of residence showed that more than seven out of ten rural households were poor (73.9%) (Institut National de la Statistique et des Etudes Economiques et Démographiques, 2016b). The result is that the efforts of Togo's government have not yet met expectations, especially for rural and mainly agricultural populations, which remain the poorest (United Nations Development Program, 2011).

Of the 531,068 rural households counted during the fourth National Census of Agriculture in 2011, 95.8% were agricultural, against 4.2% non-agricultural (Ministere de l'Agriculture, de l'Elevage et de la Peche, 2013b) Agriculturally active is defined as "every person aged fifteen (15) years and over involved in an agricultural activity, either on a full time or part time basis. Pupils, students and apprentices are excluded, even if their participation is significant and if they have their own field" (Ministere de l'Agriculture, de l'Elevage et de la Peche, 2013a).

In addition, the agricultural sector contributes about 38% to real GDP against 23% and 36%, respectively, for the secondary and tertiary sectors, and it employs 40.7% of the total labor force (Food and Agriculture Organization of the United Nations, 2012). Despite this significant contribution to the country's economic growth, an analysis of poverty by socioeconomic group showed that, in 2015, poverty was higher among households headed by independent farmers, an incidence of 72.6% (Institut National de la Statistique et des Etudes Economiques et Démographiques, 2016a). If investment choices and agricultural policies were implemented appropriately, the producers (exclusively rural) of the agricultural sector, given their contribution to the GDP, would be among the main beneficiaries of improved economic performance.

Indeed, the impact of agriculture on poverty reduction is the result of the interaction of several effects. First, because many poor households have a marginal attachment to agricultural employment, the direct effect of growth in the agricultural sector is improvement in the income of employees in that sector (Grewal, Grunfeld & Sheehan, 2012).

Second, the active participation of the poor in agricultural would depend upon the benefits they derived from growth in that sector (Grewal, Grunfeld & Sheehan, 2012), though this would

remain a question of the type of agriculture practiced, the kinds of agricultural investments made, the availability of incentives for participation in agriculture, the distribution of agricultural income, and structure of farm-property rights. Increases in farm productivity can come from improvement of techniques and greater deployment of such inputs as agricultural chemicals (Wang et al., 2015) as well as the use of improved seed varieties and other new agricultural technologies (Evenson & Gollin, 2003). Moreover, growth in agricultural productivity is correlated with R&D, education, workforce health, transportation infrastructure, pricing policies, etc. (Fuglie & Rada, 2013).

The Comprehensive Africa Agriculture Development Programme (CAADP) is at the center of efforts made by African governments, on the initiative of the African Union and the New Partnership for Africa's Development, to accelerate growth and reduce hunger in African countries. In 2005, implementation of the CAADP resulted in the regional agriculture policy of the Economic Community of West African States. In 2011, the Government of Togo adopted the National Agricultural Investment and Food Security Plan (PNIASA), to support farmers, particularly the most vulnerable. With the support of the Food and Agriculture Organization of the United Nations and the World Bank, PNIASA was intended to increase farm incomes and sustainably enhance the living conditions of rural people, particularly of such vulnerable populations as women and youth (Ministere de l'Agriculture, de l'Elevage et de la Peche, 2012).

The PNIASA involves three complementary projects: (i) Project to Support Agricultural Development, (ii) Agriculture Sector Support Project, and (ii) West Africa Agricultural Productivity Program in Togo. These projects have enabled the rehabilitation and enhancement of beneficiaries' production capacities by focusing on value chains, the establishment of a favorable institutional environment, and other measures (World Bank, 2014).

Despite this substantial progresses, agriculture in Togo continues to face enormous constraints, including lack of infrastructure and agricultural equipment, access to credit, and governance (World Bank, 2014). The vast majority of the rural population consists of small producers (Food and Agriculture Organization of the United Nations, 2011) who are poorly monetized, which results in low productivity and an inability to take advantage of market opportunities (national or international) to increase income or take advantage of services that could improve their living conditions. Togo's agricultural sector is globally characterized by low-input use (improved seeds), insufficiency and poor quality of rural infrastructure, rudimentary equipment, low organization of producers, low access to credit, small farms, land insecurity, etc. (Food and Agriculture Organization of the United Nations, 2011). In 93.8% of farm households, agricultural production fell because of drought or the irregularity of rains, the high rate of crop diseases (90.7%), or the destruction of crops by grazing and pasture animals (88.5%) (Institut National de la Statistique et des Etudes Economiques et Démographiques, 2016b). In 2008, the overall cost of agricultural damages caused by floods was about eleven billion CFA francs, 83.8% of which was for food production, 12.5% for cotton, and 3.7% for livestock and other production. A 2009 report by the International Food Policy Research Institute on agricultural performance in Togo found that halving the number of rural poor would require growth in the agricultural sector of 9.6% per year over a five-year period (Food and Agriculture Organization of the United Nations, 2011).

To analyze the effect of agricultural investments (R&D, education, health, sanitation, transportation infrastructure, access to credit, etc.) on agricultural productivity and rural poverty reduction, we sought to fill in gaps in information that would allow a diagnosis of the extent of rural poverty, determine its causes, formulate policies in favor of rural farm households, and

assess the impact of agricultural investments on rural poverty reduction.

In particular, this study was intended to promote evidence-based decision-making and enlighten policy-makers about the extent of disparities between men and women in agricultural investments, productivity, and livings standard. Notably, the rural population of Togo is made up predominantly of girls and women (51.2% of the rural population, 51.1% of the agricultural population, and 54.2% of the non-agricultural population; see Ministere de l'Agriculture, de l'Elevage et de la Peche, 2013b). Increasing women's access to land, credit, education, and technology can boost their productivity, thereby enhancing growth and social welfare and significantly reducing hunger and malnutrition (Food and Agriculture Organization of the United Nations, 2011). Conversely, the exclusion of women from access to and control over assets, whether land, technology, or credit potentially lowers growth (Rao et al. 2008; Kelkar, 2011)..

1.2 Research questions and objectives

The mains questions of the study are:

- What are the effects of agricultural investments on the farm productivity of men and women?
- What are the effects of farm productivity on rural poverty reduction by gender?
- What is the gender wage gap in Togo's agriculture sector?

To answer these questions, we establish the following objectives:

- Analyze the effects of agricultural investments on the productivity of plots managed by women with those managed by men;
- Seek to understand whether agricultural productivity reduces rural poverty by gender;
- Analyze the gender wage gap in the agricultural sector.

To attend our objectives we use agriculture Households Model: Theory of Household to examine such issues as gender disparities, educational levels, water and sanitation, insurance, and income

2 Literature review

According to Schultz, "Most of the people in the world are poor, so if we knew the economics of being poor, we would know much of the economics that really matters. Most of the world's poor people earn their living from agriculture, so if we knew the economics of agriculture, we would know much of the economics of being poor" (1980, 639). The agricultural sector provides, directly or indirectly, a means of subsistence for the largest part of the population in developing countries (and even more in rural areas, where poverty is much more pronounced). This issue has fueled a plethora of theoretical studies, many of which have focused on structural transformations of the economy in developing countries in which economic growth is based largely on agriculture. Improvement of the economic situation in the agricultural sector should contribute significantly to economic growth and, consequently, to poverty reduction (Zepeda, 2001). Gains in agricultural productivity can come from the increased use of inputs (land, labor, water, chemicals, physical capital, etc.) and from the improvement of production techniques (Chebbi & Lachaal, 2007). The extension of infrastructure can facilitate access to cheaper, better-quality intermediate products, which could considerably reduce the costs of production, increase farmers' productive efficiency, encourage the diffusion of new technologies and

techniques, lower marketing costs, and stimulate growth in productivity (Wang, 2015).

Moreover, the importance of agricultural growth, particularly through its effect on employment in the small-scale, rural non-agricultural sector, has also been demonstrated (Mellor, 1999), and the literature has identified several channels through which growth in agricultural productivity can contribute to poverty reduction: (i) production performance directly increases farmers' real income, (ii) creation of opportunities in other sectors, and (iii) drop in the price of agricultural products, among others (Schneider & Gugerty, 2011). Similarly, Bresciani and Valdés (2007) framed the relationship between productivity and poverty in terms of three pillars: the labor market, agricultural incomes, and the price of agricultural products. Notably, the improvement of agricultural production stimulates employment in both agricultural and non-agricultural sectors through the increase in real income of households.

Empirical studies on agricultural investments have tended to conclude that investment positively affects change in agricultural productivity (e.g., Hayami & Ruttan, 1970; Nguyen, 1979; Schneider & Gugerty, 2011). Fulginiti and Perrin (1998) examined the relationship between agricultural investments and productivity in eighteen developing countries between 1961 and 1985. Using a non-parametric method, they showed a positive relationship between investment and agricultural productivity. The same results were found by Zepeda (2001). In Latin America, López and Valdés (2000) showed, on the contrary, that such investments affect productivity only slightly.

Velazco (2001) used a Cobb-Douglas function of production to analyze the factors that influenced agricultural productivity in Peru over the 1950-1995 period, including the use of fertilizer, technological progress, and investment, and found that private and public investments contributed positively to the improvement of agricultural productivity. Chang and Zepeda (2001) analyzed the role of investments in Asian countries, both physical and human, on the improvement of agricultural productivity and reported that investment in human capital was the only path to improving agricultural productivity. Tripathi and Prasad (2008), conversely, showed that labor productivity alone was insufficient to improve agricultural productivity in India and suggested combining it with the productivity of capital and land.

Other studies, however, have explained the increase in agricultural productivity by investments in R&D (Griliches, 1957; Fischer, Byerlee & Edmeades, 2009; Fuglie & Rada, 2013; Gĩthĩnji, Konstantinidis & Barenberg, 2011). In this respect, Fan, Hazell, and Thorat (1999) analyzed the impact of investing in productivity and found that investments in road infrastructure and R&D had a significant and positive impact on agricultural productivity in India. Kiani (2008) analyzed the relationship between investments in R&D and agricultural productivity in Pakistan over the 1970-2004 period, concluding that investments in R&D played a very important role in the growth of agricultural productivity.

African countries have also been the focus of empirical studies on agriculture investment and labor productivity change. Kibaara et al. (2009) analyzed changes in agricultural productivity in Kenya, noting a marked improvement explained partly by investment efforts in the sector. Muzari (2014) noted that the evolution of investments in human capital and R&D was similar to growth in agricultural productivity in sub-Saharan Africa. Muzari then focused on measuring the impact investments had on agricultural productivity, especially in South Africa and Zimbabwe, and highlighted the potential benefits of investments in infrastructure, reinforcement of agricultural human capital, and R&D in improving agricultural productivity in these countries. Similar results were found in South Africa (Poonyth et al., 2001; Thirtle, Piesse & Gouse, 2005).

An additional large group of studies has explored the relationship between agriculture

productivity and poverty reduction. Gallup, Radelet, and Warner (1997) analyzed the effect of agricultural productivity on rural poverty and showed that an increase of 1% in agricultural productivity resulted in a 1.61% reduction in rural poverty. Taking India as a case study and using a general equilibrium model, Ravallion and Datt (1996) demonstrated that productivity in the agricultural sector is crucial key factor in poverty reduction. Other empirical studies (Timmer, 1995, for Kenya; and Thorbecke & Jung, 1996, for Indonesia, e.g.) reached similar conclusions. With a sample of twenty-five countries, Cervantes-Godoy and Dewbre (2010) found that agricultural productivity played a fundamental role in reducing poverty: more than 52% of poverty reduction in twelve of the twenty-five countries was driven by growth in agricultural productivity.

Christiaensen, Demery, and Kuhl (2010) showed that agricultural productivity positively affected the average income of farmers in rural areas, and Byerlee, Jackson & Diao (2005) tested the relationship between agricultural productivity and poverty in twelve developing countries, reporting that, in countries where agricultural productivity improved, the level of rural poverty decreased. Irz et al. (2001) have also shown that productivity generated more income for farmers and therefore contributed to poverty reduction: a 1% increase in agricultural productivity moved about 0.68% of the rural population above the poverty threshold and raised the Human Development Index by 0.12%.

Notably, however, growth in agricultural productivity can also cause poverty to rise. If the demand for agricultural products is very elastic, any increase in consumer income will result in an increase in the demand for agricultural products and, hence, in higher prices. Higher prices, in turn, aggravate rural poverty. Thus, Byerlee, Jackson, and Diao (2005) demonstrated that, in Asian countries, an increase in the price of agricultural products as a result of productivity gains increased rural poverty.

Similar results were highlighted by Datt and Ravallion (1998), though they showed that agricultural productivity generated jobs that ultimately reduced poverty. In this respect, Warr (2001) showed that productivity gains in the agricultural sector not only created jobs for unskilled workers, but also contributed to the reduction of rural poverty.

Conversely, Virmani (2007) found that in India, an increase of 1% in agricultural productivity reduced poverty by 0.45%. Over the period 1990-2001, Ravallion and Chen (2007) found that the contribution of agriculture to poverty reduction in China was 3.5 times higher than the contribution of the secondary sector or tertiary sectors (1% growth in the primary sector reduced poverty by 7.85% against 2.25% for the non-primary sector). These results were subsequently confirmed by Montalvo and Ravallion (2010). Over, De Janvry and Sadoulet (2010) demonstrated that rural poverty declined in East Asia over the 1993-2002 period because of gains in agricultural productivity, noting identical results in some developing countries in Sub-Saharan Africa but conflicting results in Latin America. Indeed, they found that productivity gains were driven by the capital factor in Latin America, which did not create opportunities for job creation and de facto reduction of poverty.

According to Rosegrant and Hazell, (2001), increasing farmers' and landless workers' incomes through economic growth is particularly effective in reducing poverty. Evidence shows that investment in agriculture is more effective in reducing poverty, particularly amongst the poorest people, than investment in non-agricultural sectors.

Women play an important role in the rural economy in developing countries. Specifically, the World Farmers Organisation (2013) has pointed out that smallholder farmers, managed mostly by rural women, account for a significant proportion of farm production (exactly 80%). Women's

productivity is lower than men's, mainly because their inputs and human capital are lower than men's (International Food Policy Research Institute, 1995).

Tiruneh et al. (2001) reported that women's productivity in Ethiopia was 35% lower than that of men because of their weak utilization of input and poor access to extension services. In the Zimbabwean context, Horrell and Krishnan (2007) showed that women's limited utilization of fertilizer, their lack of experience, and the inaccessibility of extension services were the factors that mainly explained their low level of productivity.

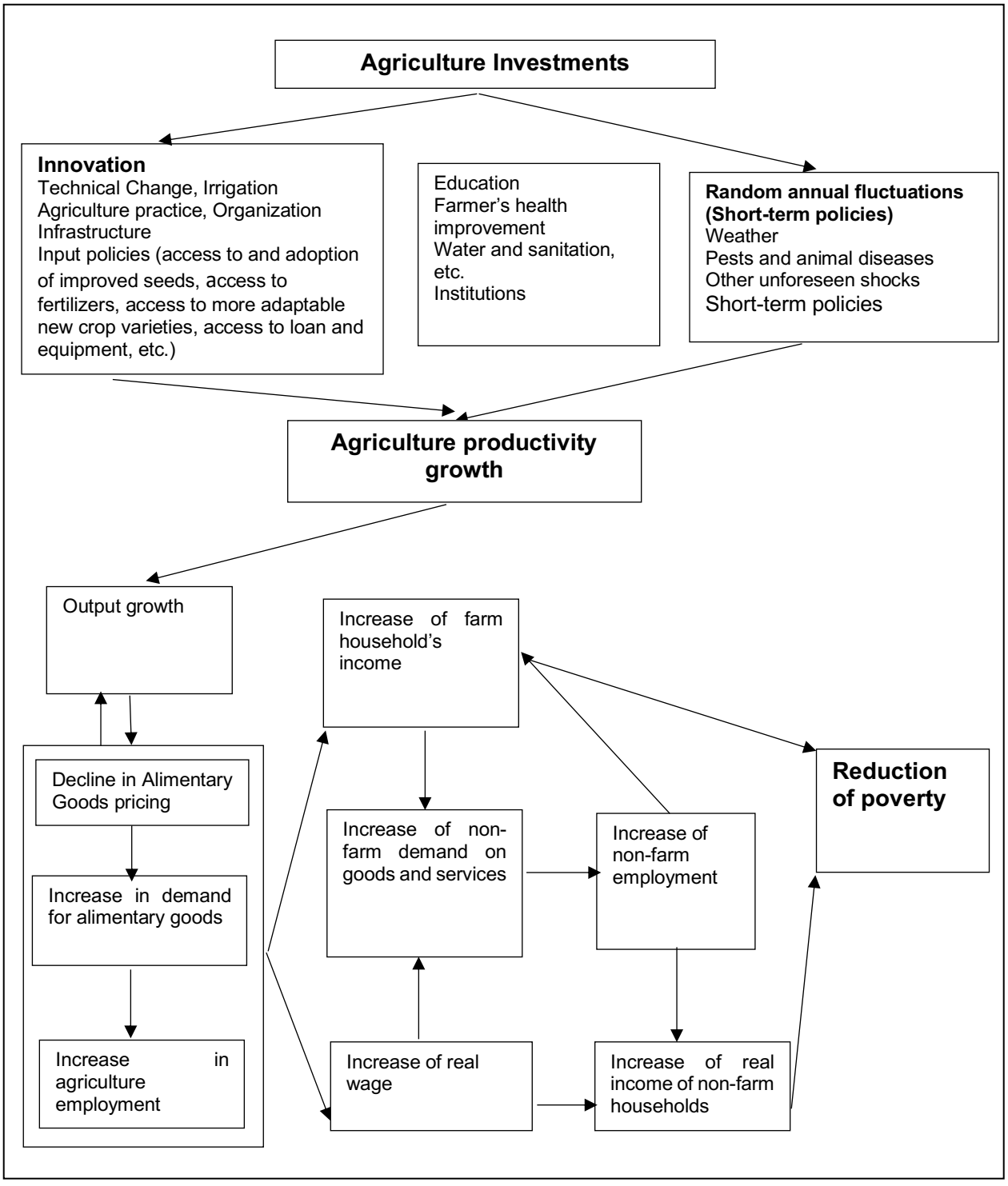
Mukasa and Salami (2016) found that reducing the gap in men's and women's productivity increased monthly consumption per adult in Nigeria, Tanzania, and Uganda, and noted that gender equality in the agricultural sector in Sub-Saharan Africa could be achieved only through a review of discriminatory land-ownership laws and an improvement in women's access to productive inputs (land, chemical fertilizer, improved seeds, and pesticides).

3 Methodology and data

3.1 Analytical Framework

We assessed the impacts of agricultural investments on labor productivity and rural poverty reduction, following a two-step hypothesis. As Figure 1 illustrates, the first part involved an empirical estimate of the relationship between labor productivity and agricultural investments (in infrastructure, transport, credit, energy, health, education, and related infrastructure) and an analysis of the mechanism by which agricultural investments positive affect workers' productivity. Furthermore, an increase in agricultural productivity should lead to an increase in production and, therefore, a decrease in food prices. Given that the majority of rural households in Togo are engaged in smallholder, staple-crop farming, greater productivity could have an important impact on rural poverty reduction in two ways: by increasing the income of poor farmers (Minten & Barrett, 2008) and by generating non-farm employment through spillover effects (Eswaran et al., 1983; Ravallion, 2009). Thus, our second hypothesis was that agricultural productivity has a significant impact on poverty reduction apart from the advantages of growth.

Figure 1: ***Transmission Channels: Agricultural Investment-Productivity-Poverty Reduction***



Agriculture supported by increased investment will result in a significant increase in the share of agricultural products processed into differentiated products with high added value. Some research has shown a potential macroeconomic relationship between agricultural investment and agricultural productivity (Chen, Restuccia & Santaeulàlia-Llopis, 2017). This means that an indefinite increase in the level of long-term investment cannot be expected to produce a

continuous expansion of economic activities.

For the rural poor to benefit from agricultural growth:

- land and access to natural resources must be more equitably distributed;
- publicly financed agricultural research must focus on the problems faced by poor family farmers and small scale producers as well as those faced by larger, more commercially oriented farms;
- new technologies must be suitable and profitable for all farm sizes;
- input, credit, and product markets must ensure that all farms have access to the necessary, modern farm inputs and receive similar prices for their products;
- the rural labor force must be able to migrate to find employment in agriculture or to diversify into rural non-farm activities; and
- policies must not discriminate against agriculture in general or family farmers in particular (Rosegrant & Hazell, 2001).

By implementing inclusive economic and social policies, the public sector has an important role in ensuring such conditions. Through public investment, countries provide public goods such as agricultural research and extension, infrastructure and services, and regulation and incentives for the sustainable management of natural resources and for the protection of land rights. Public investment should also support policies to guarantee health, education, and social protection for the rural population, including for the poorest of the poor.

Usually, public investment through non market services and infrastructure or public goods can create conditions that stimulate rural households or agricultural managers to invest more in their farms. This improves well-being generally in the economy through the multiplier effect which may, in turn, lead to increased demand for food and other goods and services. In addition, more employment can be created for the rural poor, including those without access to land (Food and Agriculture Organization of the United Nations, 2014).

3.2 Effects of Agricultural Investments on the Farm Productivity of Women and Men

Agriculture Households Model: Theory of Household

In Togo, farm plots are distributed between men and women in the household; in a farming household, women generally have their own plots. Lundberg and Pollak (1993) argued that the mechanisms used to decide who does what for whom within a household are likely to be exceedingly complex. That is particularly so in households in which agricultural production is carried out simultaneously on many plots controlled by different household members.

Based on this information, we used an agriculture-households model developed by Udry (1996) to analyze gender issues in investments and agriculture production in the context in which agricultural production occurs on multiple plots controlled by different household members. Specifically, we analyzed the impact of public investments on farm productivity on the basis of the weak assumption that factors were allocated across these plots in an efficient manner (i.e., Pareto efficiency). Productivity has been shown to be substantially lower on plots controlled by women than on similar plots controlled by men (i.e., planted with the same crop, in the same year, in the same household; see Udry, 1996).

A necessary condition for the efficiency of the allocation in a household model is that factors of production are allocated efficiently to the various productive activities of the household.

Consider a household with two members (the model generalizes easily to N members and an economy with K private goods). The vector C_j denotes the consumption of these goods by member j, $j \in \{F, M\}$. Aggregate consumption of these goods within the household is $C = C_F + C_M$. The labor supply of person j is N_j and the public goods or service consumed within the household are denoted by Z.

The utility of member j is determined by the function $U_j(C_F, C_M, Z, N_F, N_M)$ and therefore may depend upon her own consumption and on the consumptions and utility levels of the other members of the household. The household engages in production of at least some goods on the plots controlled by the household.

Let i index the plots of the household, A^i be the area of plot i, and $P^k = \{i|$ plot i is planted to crop k$\}$. Then the production of goods k in the household is

$$Y^k = \sum_{i \epsilon P^k} G^k(N_F^i, N_M^i, A^i) \quad (1)$$

where N_F^i and N_M^i are women's and men's labor on plot i, and $G^k(.)$ is a concave production function.

If crop k is planted both on plots controlled by men and on those controlled by women within the household, then Equation 1 embodies the assumption that technology may vary across crops but men and women have access to the same technology $G^k(.)$ for producing crop k.

Public-goods production within the household is determined by:

$$Z = Z(N_F^z, N_M^z) \quad (2)$$

Let us acknowledge that there is no labor market in the Togo villages. (Nothing in this section hinges on this restriction, but it is a reasonable approximation of the environment; see Fafchamps, 1993.) In that case, we can have:

$$N_F = \sum_i N_F^i + N_F^z \quad (3)$$

and

$$N_M = \sum_i N_M^i + N_M^z \quad (4)$$

The price vector is p, so the budget constraint is:

$$p \cdot C \leq p \cdot Y \quad (5)$$

where $Y\ is\ (Y^1, Y^2, \ldots, Y^k)$. A Pareto-efficient allocation of resources within the household solves

$$\max_{C_j, N_j^i, P^k} U_F(\cdot) + \lambda U_M(\cdot) \quad (6)$$

subject to Equations 1-5, for some $\lambda > 0$.

Consider any good k produced on more than one plot in the household. Equation 6 is recursive. If N_{Fk} and N_{Mk} are the aggregate quantities of labor inputs by women and men on plots planted with crop k, then Equation 6 implies that the allocation of labor across these plots solves

as

$$\max_{N_F^i, N_M^i} \sum_{i \epsilon P^k} G^k(N_F^i, N_M^i, A^i) \quad (7)$$

subject to $\sum N_F^i = N_{Fk}$, $\sum N_M^i = N_{Mk}, N_F^i, N_M^i \geq 0$.

This result is the standard separation result in agricultural household models, where production decisions are independent of preferences, except that this pertains to the allocation of resources *within* rather than across households. If $G^k(N_F^i, N_M^i, A^i)$ is concave, increasing, and strictly increasing in A, then Equation 7 and $A^i = A^j$ imply that $G^k\left(N_F^i, N_M^i, A^i\right) = G^k(N_F^j, N_M^j, A^j)$.

This is the implication of productive efficiency in the household that forms the basis of this study: within the household, variations across plots in output and factor inputs are functions only of variation in plot characteristics. We can therefore define

$$Q^k\left(A^i\right) = \frac{G^k\left(N_F^i(A^i), N_M^i(A^i), A^i\right)}{A^i} \ \forall \ i \epsilon P^k \quad (8)$$

where $N_F^i\left(A^i\right)$ and $N_M^i\left(A^i\right)$ are labor inputs by women and men on plot i in the solution to (7), and $Q^k\left(A^i\right)$ is the productivity on plot i $(i \epsilon P^k)$ in the solution to (7), which depends upon the characteristics of plot i. Let $\bar{A}^k$ be the average area of plots planted to crop k. If A^i is permitted to vary across $i \epsilon P^k$, the first-order Taylor approximation from (8) is:

$$Q^k\left(A^i\right) - Q^k(\bar{A}) \approx \frac{\partial Q^k(\bar{A})}{\partial A} \cdot \left(A^i - \bar{A}\right) \forall \ i \epsilon P^k \quad (9)$$

The equation to be estimated, therefore, examines the deviation of plot productivity from the mean productivity as a function of the deviation of plot characteristics from mean plot characteristics within a group of plots planted with the same crop by the members of the same household in a given growing season.

If we generalize Equation 9 to accommodate multiple dimensions of plot characteristics and introduce notation to accommodate the existence of different households and investments realized in different localities of the study, we have

$$Q_{hci} = X_{hci}\beta + \gamma G_{hci} + \varepsilon_{hci} \quad (10)$$

where X_{hci} is a vector of characteristics of plot i planted with crop c by a member of household h (X_{hci} includes, variables relative to public investment that benefit households, household characteristics, the area of the plot, and other information); Q_{hci} is the productivity on that plot; G_{hci} is the gender of the individual who controls the plot; and ε_{hci} is an error term (possibly heteroskedastic and correlated within household-year groups) that summarizes the effects of unobserved plot quality variation and plot-specific production shocks on yields.

Conditional on plot size (and, of course, land quality), is productivity equal on plots planted with the same crop in the same year but controlled by different members of a household? It should be noted that, in the absence of labor and land markets, Equation 10 imposes no restrictions on relative productivity on plots controlled by different households and, given credit and liquidity constraints, Equation 10 may not hold across plots controlled by the same household.

In households organized around a heterosexual couple, the man in always the head of household, and it is common for him and at least one of his wives to plant the same crop on different plots during the same period. An important characteristic of the organization of agricultural production in these villages is that decisions with respect to crop choice and the timing and quantities of inputs on different plots within the household are made by different individuals within the household.

The estimates focus, therefore, on productivity variations between plots managed by men and women, planted with the same crop, in the same household, in the same season. Productivity differences may be caused by differences in input intensity related to gender.

However, somewhat more household labor by women per hectare is devoted to plots controlled by men than to plots controlled by women. This model could show that a reallocation of the land, labor, fertilizer, and public investments by a household for the production of a specific crop in a given year could increase household production of that crop.

The different variables required to calculate the estimates shown in Equation 10 are presented and defined in the following section.

3.3 Effect of Farm Productivity on Rural Poverty Reduction, by Gender

Consistent with the findings of Datt and Ravallion (1998), Minten and Barrett (2008), and Eswaran et al. (2008), the labor productivity of rural farm households could affect their incomes (or wages) and prices.

Consider the indirect utility function of a rural household as: $V = V(p_j, y)$, where p_j is the price of farm output j, and y is income.

According to Minten and Barrett (2008) and Eswaran et al. (2008), the effect of a change in productivity on household welfare will depend upon the degree of integration of the areas where these households are located into major regional, national, or international markets, and, in particular, upon the tradability of farm output beyond the village, region, or country (Dzanku, 2015).

Denoting A, T, and L^f as land inputs, total stock of labor time, and household farm labor input, respectively, let household labor income, y, in $V = V(.)$ be decomposed into farm and nonfarm labor income:

$$y = p_j H * \Gamma(A, L^f, X|Z) + w(T - L^f) \tag{11}$$

where, where H is Hicks-neutral coefficient that captures the productivity of the technology, $\Gamma(.)$, used in the production agricultural output, $Q_j = H\Gamma(A, L^f, X|Z)$, X represents all other inputs used in the production process, Z designates agro-ecological characteristics that affect the types of crop a household can cultivate and maximum yields achievable, and w is the wage rate of the unskilled labor force. Suppose that the welfare of households is defined only by consumption of its own products and of goods purchased with income y. Totally differentiating Equation 11 and rearranging after dividing by the productivity coefficient yields:

$$\frac{dy}{dH} = \frac{p_j.Q_j}{H}[\varepsilon_{pj}, H] + \frac{p_j.Q_j}{H}[\varepsilon_{Qj}, H] - \frac{w.L^f}{H}[\varepsilon_{L^f}, H] + \frac{w}{H}[\varepsilon_w, H](T - L^f) \tag{12}$$

The effect of an increase in productivity on welfare depends upon the terms in the brackets: price elasticity in relation to technical change, production elasticity in relation to technical change, labor demand elasticity in relation to technical change, and wage elasticity in relation to technical change. These elasticities would affect household welfare regardless of whether the household was agricultural or non-agricultural, a seller, a buyer, self-sufficient, or a combination of these. For rural households with diversified subsistence economic activities, the determination of the effect of productivity on welfare is certainly not simple (Dzanku, 2015).

For a net seller of crop j, the effect of an increase in productivity on income depends upon the relative importance of the first two elasticities, all else being equal. Considering a decreasing aggregate demand curve, $(\varepsilon_{pj}, H) \prec 0$, and $(\varepsilon_{Qj}, H) \succ 0$; by definition, the welfare of a selling household increases if and only if $(\varepsilon_{pj}, H) \succ -(\varepsilon_{Qj}, H)$ all else being equal, (ε_{pj}, H) depends to a large extent on the level integration into regional, national and global markets.

An increase in productivity would have a different effect on the welfare of selling households depending on their location and the crops they produced. For buyers, the effect on prices should entail the benefits of total welfare (Deaton, 1997), all else being equal. With regard to the demand for farm labor, the supply of non-farm labor, and wages, the effect of prices still plays an important role. Demand for farm labor should increase as long as the value of the marginal product of labor is positive; it also depends upon the effect on prices. Thus, the demand for farm labor is expected to increase if the marginal product of the farm labor increases more rapidly than the decline in prices resulting from the increase in productivity. This could lead to the increase in non-agricultural wages followed by a decrease in the non-farm labor in agricultural households, all else being equal.

We estimate two models based on monetary index measures of poverty and household income considered as dependent variables.

In the first specification, a binary consumption poverty model is specified:

$$W_i^* = \beta_0 + \beta_1^{'} X_i + \beta_2 \ln yield_i + c_i + u_i, ; \; i = 1,2,\ldots,N \tag{13}$$

$W_i = 1$ if $W_i^* \succ 0$; $W_i = 0$ otherwise,

where W_i^* is the latent unobserved poverty level of household i; W_i is the poverty level which is observed only as a binary response and takes the value unity if a given household is below the defined poverty line, zero otherwise; the βs are unknown parameters; X_i is a vector of exogenous variables; $yield$ (in logarithms) is a partial measure of farm productivity; c_i is the time invariant household specific effect; and u_i is a random error term.

In the second specification, of the model that takes into account the mount of the income or consumption, we will use as dependent variable in the following model:

$$LogIncom_i = \gamma_0 + \gamma_j^{'} X_i + \gamma_k yield_i + u_i \;\; i = 1,2,\ldots,N \tag{14}$$

where the dependent variable, $Incom$, is the amount of household income; and the γs are unknown parameters to be estimated.

3.4 Discrimination Analysis: Gender Wage Gap

Estimation of labor-market discrimination by gender, age, and race began with the disaggregation of the wage gap by Blinder (1973) and Oaxaca (1973). The Oaxaca-Blinder method has been used to examine the assimilation of immigrants (LaLonde & Topel, 1992), school enrolment rates (Borooah & Iyer, 2005), health insurance coverage (Bustamante, et al., 2009), prevalence of smoking (Bauer & Sinning, 2008), or even local hunting-lease rates (Munn & Hussain, 2010). We applied the methods of disaggregation used by of Blinder (1973), Oaxaca (1973), and Neumark (1988).

Consider a simple unadjusted model of wage determination (Suh, 2010) such that:

$$\ln w_{it} = X_{it}\beta_{it} + \varepsilon_{it} \tag{15}$$

where w_{it} denotes the natural logarithm of weekly wages for an individual i at year t, X_{it} denotes a set of observed characteristics, β_{it} denotes the regression coefficients, and ε_{it} is a random error term.

To investigate the sources of gender differentials in detail, Suh (2010) estimated men's and women's wage functions separately such that:

$$\begin{aligned} \ln w_{it}^{m} &= X_{it}^{m}\beta_{it}^{m} + \varepsilon_{it}^{m} \\ \ln w_{it}^{f} &= X_{it}^{f}\beta_{it}^{f} + \varepsilon_{it}^{f} \end{aligned} \tag{16}$$

where m represents men and f is women. A simple log mean wage difference between men and women can be estimated by subtracting the second equation from the first equation so that:

$$\ln w_{it}^{m} - \ln w_{it}^{f} = X_{i}^{m}\beta_{t}^{m} - X_{i}^{f}\beta_{t}^{m} + \mu_{t} \tag{17}$$

where $\varepsilon_{it}^{m} - \varepsilon_{it}^{f} = \mu_{t}$.

Blinder (1973) and Oaxaca (1973) developed disaggregation approaches to partition the gender wage differential into components caused by two factors (Suh, 2010):

$$\ln w_{it}^{m} - \ln w_{it}^{f} = (X_{i}^{m} - X_{i}^{f})\beta_{t}^{m} + (\beta_{t}^{m} - \beta_{t}^{f})X_{t}^{f} + \mu_{t} \text{ (men as the reference group) or}$$

$$\ln w_{it}^{m} - \ln w_{it}^{f} = (X_{i}^{m} - X_{i}^{f})\beta_{t}^{f} + (\beta_{t}^{m} - \beta_{t}^{f})X_{t}^{m} + \mu_{t} \text{(women as the reference group)} \tag{18}.$$

The first term of the right hand side of Equation 19 captures how the wage differential between men and women changed in response to changes in the gap in characteristics between men and women. The first term is sometimes called "observed Xs" or "observed gender gap in characteristics." The second term measures the unexplained wage gap as a result of differences in

coefficients or returns. This term is considered to measure the level of "gender discrimination."

In order to overcome Blinder-Oaxaca index number problem, Neumark (1988) proposed a general disaggregation of the gender wage gap such that:

$$\ln w_{it}^{m} - \ln w_{it}^{f} = (X_i^m - X_i^f)\beta_t + (\beta_t^m - \beta_t)X_t^m + (\beta_t^f - \beta_t)X_t^f + \mu_t \quad (19)$$

where β_t is the non-discriminatory wage structure. The first term is the gender wage gap attributable to differences in characteristics. The second and the third terms capture the difference between the actual and pooled returns for men and women, respectively. He argued that, under discrimination, men are paid competitive wages but women are underpaid (Suh, 2010). If this is the case, the coefficient of men should be taken as the non-discriminatory wage structure (Suh, 2010). Conversely, if employers pay women competitive wages but pay men more, then the coefficient for women should be used as the non-discriminatory wage structure (Suh, 2010).

On the basis of estimates of wage (income) equations, the Oaxaca-Blinder method helps to decompose the average income differences between men and women in three effects:

(i) "endowment effects," which are the part of the differential resulting from differences in characteristic vectors of each group;
(ii) "coefficient effects" that correspond to differences in the outputs of these characteristics; and
(iii) "interaction effect," in which the segmentation hypothesis is verified when the second effect is statistically significant and positive, indicating that with similar characteristics, men receive a higher wage than women.

We used the R Package Oaxaca (Hlavac, 2014) to perform the Blinder-Oaxaca and Neumark disaggregations.

3.5 Definition of the Model's Variables

Agricultural productivity can be defined as production per unit of input (Yabi & Afari-Sefa, 2009). Thus, inputs can be labor, land, or capital. Total productivity with both inputs (crop area and labor) is the ratio of farmer's output to total crop area and labor factors used in farm production
The explanatory variables and their expected effects on farming labor productivity are presented in Table 16 (Annex). *The definition of Variables and their expected effects on poverty are presented in Table 17 (Annex).*
The data used in this study were obtained from the implementation of the community-based monitoring system (CBMS)amin census among agricultural households in the townships of Danyi and Tsévié. The collected data was conducted by CBMS-Togo team during January and February 2018. We adopted computer-assisted data recording, in particular through the CBMS Accelerated Poverty Profiling (APP) tool.
The mixed research method integrated the collection and analysis of quantitative and qualitative data using a household questionnaire, the agricultural (addendum) questionnaire, and the community questionnaire. The household questionnaire aimed to cover basic information on all

household members, such as demographics and education as well as household characteristics such as poverty and basic access to services (water, sanitation, housing, etc.). The addendum questionnaire covered additional information regarding agricultural investment, agricultural labor productivity, agricultural production, vulnerability of agricultural workers, and such gender-related issues as decision-making on plots of land. The community questionnaire provided additional information such as the presence in the region of educational institutions, industry, employment programs, and credit institutions.

Discussion points included such issues as the state of infrastructure, agricultural equipment, credit, governance, agricultural investment, organization of agricultural workers, land insecurity, working conditions and vulnerability, agricultural and non-farm income, non-agricultural activities, and health insurance.

The head of the household responded to the household questionnaire, and any household member who was identified as a farmer was automatically selected to complete the addendum questionnaire. The questionnaires were detailed enough to identify agricultural investments among men and women, so that investments in technologies, seeds, infrastructure, etc. would be gender-specific.

4 Application and results

We used data from agricultural households surveyed in the Danyi-Atigba-Elavagnon, Dalavé, and Gblainvié. The data were collected in 4,543 farm and non-farm households in seventy-seven villages in Danyi and Tsévié prefectures (Table 16). After cleaning, the analysis in this paper was based on 4,157 farmers. The distribution of villages and households surveyed by area is presente in table 1 (see below)

Table 1 : ***Distribution of Villages and Households Surveyed, by Area***

	Tsévié area		Danyi Area		Overall
	Dalavé	Gblainvié	Atigba	Elavagnon	
Total number of villages	19	13	19	26	77
Number of farmers	354	347	1681	1775	4157

Source of basic data: 2018 CBMS census in selected sites, Togo.

The majority of heads of agricultural households were between 35 and 60 years old, though 60.80% were between 36 and 60. Farmers aged 60 and over represented 15.95% of all farmers. Table 4 shows that about 75.44% of farmers had at least a primary-school education, though a significant gender gap was noted: more women farmers had no education (41.85%) than men farmers (15.10%). These results are consistent with those obtained nationwide, which showed that 67.2% of women farmers were illiterate compared to 41% of their male counterparts (Institut National de la Statistique et des Etudes Economiques et Démographiques, 2013). Most households were made up of between one and three persons (68.37%), followed by household consisting of four to six persons (28.70%), and households consisting of more than six persons (2.93%).

Table 2 : Distribution of Household Characteristics

		Women	Men	Total
Farmer's educational level	None	41.85	15.10	23.67
	Primary	39.97	31.96	34.53
	Secondary	18.18	51.63	40.91
	Higher	0.00	1.31	0.89
Farmer's age	15-35	22.30	23.69	23.24
	36-60	58.33	61.97	60.80
	Older than 60	19.37	14.34	15.95
Household size	1-3 persons	77.42	64.09	68.37
	4-6 persons	21.31	32.19	28.70
	More than 6	1.28	3.72	2.93

Source of basic data: 2018 CBMS census in selected sites, Togo.

Socioeconomic Characteristics of the Agricultural Households

Access to electricity remains a big challenge for agricultural households in rural areas in Togo. Only 36.32% of farmers have access to electricity (Table 5). This has improved over time (in 2015, only 14.1% of rural households had access to electricity; see Institut National de la Statistique et des Etudes Economiques et Démographiques (2016b). We also found that access to safe water and sanitation remained a major problem in rural areas: about 51.17% of rural household had no access to clean and safe water or sanitation (Table 3). Women had greater access to health care (56.41%) than men (45.25%).

Once the Government of Togo established the Agri PME program for the commercialization of fertilizer through an electronic purse system (a real-time program that allows farmers to know market conditions, the availability of fertilizer stock, and information on the agricultural sector such as location, cultivable area, select seeds, etc.), farmers began to deem it necessary to use a mobile phone (BAD, 2016). Our results showed that 69.11% of farmers used a mobile phone, but men farmers (72.66%) used them more than did women who were heads of household (61.59%). As Table 5 shows, most farmers were more than 5km from a market whether they could sell their agricultural products (34.93%).

Table 3 : Proportion of Farmers with Access to Public Services

variables	Definition		Women	Men	Total
EAU_SANIT	Access to drinking water and sanitation by the farmer	No	43.59	54.75	51.17
		Yes	56.41	45.25	48.83
ACC_SOINS	Access to health facilities in the case of the farmer	No	43.70	51.08	48.70
		Yes	56.30	48.92	51.30

Access to electricity	Household access to electricity	No	62.87	64.06	63.68
		Yes	37.13	35.94	36.32
Use of phone	Use of phone by head of household	No	38.41	27.34	30.89
		Yes	61.59	72.66	69.11
DIST_RESID_MARCH	Distance from the farmer's residence to the market in km	Less than 5km	67.37	63.99	65.07
		More than 5km	32.63	36.01	34.93
Distance between the place of residence and health facility	Distance between the place of residence and most-used health facility, in km	Less than 5km	80.5	77.02	78.13
		More than 5km	19.5	22.98	21.87

Source of basic data: 2018 CBMS census in selected sites, Togo.

4.1 Agricultural Indicators

The results presented in Table 6 show that farmers did not have health insurance in the study areas, likely because of their low incomes. Universal health coverage would require extending health insurance to these segments of the population.

Regarding insurance against natural disasters, the results revealed that the majority did not carry such insurance: 99.62% and 99.65% of women and men, respectively, did not (Table 4). These results showed that the challenges in developing agricultural insurance services need to be addressed in these study areas.

The results in Table 6 show that only 3.54% of farmers in the study area had received credit services: 3.08% and 3.75%, respectively, of women and men.

In Table 6, we report that about 75.60% of farmers had an average monthly income lower than the Interprofessional Guaranteed Minimum Wage (SMIG). Among them, more women (82.63%) than men (72.28%) had incomes lower than the SMIG. The results also show that about 17% of the farmers experienced an increase in income over the previous two crop years: 18.85% of men experienced and 13.01% of women.

Table 4 : *Agricultural Indicators*

Indicators	Women	Men	Total
Proportion of farmers (by gender) with an average monthly income below the guaranteed minimum wage	82.63	72.28	75.60
Proportion of farmers (by gender) who experienced an increase in their income over the previous two seasons	13.01	18.85	16.92
Proportion of farm workers who benefited from new agricultural practices, by gender	39.83	47.88	45.30
Proportion of farm that had health and accident insurance at work, by gender	0,00	0,00	0,00
Proportion of farm workers who had insurance against natural disasters, by gender	0.38	0.35	0.36
Proportion of farm workers who had received credit, by gender	3.08	3.75	3.54

Source of basic data: 2018 CBMS census in selected sites, Togo.

4.2 Agriculture Practices

Natural disasters have repercussions on yield, but they also affect the whole production chain. To minimize their consequences, new farming practices have been implemented to help farmers. According to our results, only 39.83% of women farmers used new farming practices against 47.88% of men (Table 6). Most of the agricultural population in the study areas still adopted traditional farming practices.

Table 7 shows that men practiced more irrigation than women on their farms: 4.43% of men farmers against 1.95% of women. The low proportion of agricultural households practicing irrigation is because the cost of irrigation equipment is more than most rural households can afford.

Fewer farming households used traditional seeds and, among them, women who owned plots had greater access to select seeds than men. About 16.62% of farmers used select seeds compared to 93.75% who use traditional seeds (Table 5) and, of the farmers who used select seeds, 86.57% were women. The use of improved seeds has increased significantly since 2012, at which point only 14.9% of farmers used them. Some farmers used both traditional and improved seed: 13.4% of these were women and 18.1% were men.

Until two years ago, access to inputs was difficult for Togolese farmers because of prices and limitations on quantity set by the government. Following later liberalization of the fertilizer market, price has become the only barrier to access to fertilizers, which explains why only 29.64% of farmers use fertilizers for their crops. The government fertilizer subsidy is insufficient considering the number of farmers who would use fertilizer if it were available. In addition, given the precarious living standards of most agricultural households, only 0.51% of farmers have adopted modern techniques to protect their animals against diseases.

Table 5 *: Agricultural Practices*

variable	definition		Women	Men	Total
IRRIGAT	Farmer has access to new irrigation techniques as well as conservation and agricultural practices	No	98.05	95.57	96.37
		Yes	1.95	4.43	3.63
SEM_AMEL	Use of improved seeds as an input during production	No	86.57	81.87	83.38
		Yes	13.43	18.13	16.62
SEM_TRAD	Use of traditional seeds as an input during production	No	6.68	6.06	6.25
		Yes	93.32	93.94	93.75
SEM_AMEL&TRAD	Use of improved and traditional seeds as an input during production	No	93.25	87.92	89.63
		Yes	6.75	12.08	10.37
APP_TECH	Technical support to the farmer in pest control and managing animal diseases	No.	99.85	99.33	99.49
		Yes	0.15	0.67	0.51
FERTILIZER	Use of fertilizer by farmers as an input during production	No	74.04	68.63	70.36
		Yes	25.96	31.37	29.64

Source of basic data: 2018 CBMS census in selected sites, Togo.

4.3 Crops and Productivity

Farm households in the study area practiced several types of farming, including legumes, cereals, tubers, cash crops, market gardening, and fruit trees. Apart from legumes, men who are heads of household used more land for crops than women.

Table 6 presents descriptive statistics that compare the land and labor-productivity (the production value per hectare and production value per unit of labor force used on each plot) of men and women who planted their plots with the same crop in the same year. The results reveal that in general, men's average labor productivity was higher than women's. On average, men achieve much higher land productivity than women for the same crops in the same crop year (the average productivity of all crops was USD $2,271.58[1] for men and USD $1,534.34 for women). Across the areas studied, men's farms averaged 4.97 hectares compared to 4.81 hectares for women heads of household.

Table 6 : Types of Crops by Sex According to Productivity, Labor Force, and Cultivated Area

variable		Man				Women			
		Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
cereals	**Total_pdty**	1964.52	2424.05	0	21062.5	1406.54	2229.16	0	21062.53
	Lab_pdty	**291.59**	**340.46**	**0**	**2350.7**	**205.56**	**266.21**	**0**	**1805.36**
	area	4.56	33.80	0	500.0	4.65	28.86	0	382.81
legumes	**Total_pdty**	2512.99	4381.71	0	30089.3	1732.97	2602.66	0	14202.16
	Lab_pdty	354.85	432.60	0	1880.6	226.30	287.50	0	1504.47
	area	2.10	12.67	0	93.8	10.92	68.30	0	437.5
tubers	**Total_pdty**	2235.92	2366.40	0	21062.5	1534.43	2385.22	0	36107.19
	Lab_pdty	366.02	371.11	0	2407.1	218.55	258.52	0	2256.699
	area	3.32	30.30	0	425.0	3.91	34.06	0	500
Cashcrop	**Total_pdty**	2548.46	3050.92	0	22567.0	1581.66	2163.16	0	14442.88
	Lab_pdty	376.69	353.53	0	2205.9	264.06	318.35	0	1805.36
	area	6.79	41.25	0	312.5	1.35	4.95	0	37.5
Market gardening	**Total_pdty**	3316.21	4622.27	0	30089.3	2072.23	3003.98	0	15044.66
	Lab_pdty	394.00	431.30	0	2256.7	227.93	250.13	0	940.29
	area	15.72	70.79	0	500.0	11.61	38.83	0	250
Fruit trees	**Total_pdty**	2587.23	2901.52	0	24071.5	1976.58	3445.20	0.07	21062.53
	Lab_pdty	450.09	443.34	0	2407.1	304.23	315.05	10.2	1372.83
	area	0.72	3.87	0	31.3	1.96	7.98	0	39.06
Total	**Total_pdty**	2271.58	2826.42	0	30089.3	1534.34	2396.66	0	36107.19
	Lab_pdty	343.24	370.58	0	2407.1	218.36	268.61	0	2256.70
	area	4.97	36.47	0	500.0	4.81	32.13	0	500

Total_pdty: Total productivity. Lab_pdty: Labor productivity. Source of basic data: 2018 CBMS census in selected sites, Togo.

[1] Average USD exchange rate (February 2020) = 531.95 FCFA for $1.00 USD

4.4 Econometric Results

4.4.1 Impact of Agricultural Investment on Farmers' Total Productivity

In order to achieve our first objective, an analysis of the effect of investments effect on rural farmers' productivity, we distinguished among total factor productivity, land productivity, and labor productivity. In addition, we distinguished public investments measured by the accessibility of rural populations to infrastructure in education, health, transportation, and telecommunications. Private investments were measured by the inputs used by farmers (fertilizer, select seeds, etc., e.g.) Thus, the tables present both public and private investment results on total land and labor productivity.

A Fisher's statistical analysis showed that the different model estimates for women, men, and both sexes were significant at the 1% threshold, as shown in Table 7. The results provided in the table reveal that the distance between secondary schools and residences (distance secondary school) positively and significantly influenced farmers' productivity at a 1% level of significance. In other words, the farther homes were from secondary schools, the higher was farmers' productivity. The same effects were observed when men and women were considered separately. This situation can be explained by the fact that that, because secondary schools are usually quite far from farmers' residences, their children do not attend secondary schools and instead devote themselves to agricultural activities, increasing the domestic labor force and, consequently, farmers' productivity.

The results in Table 7, however, also show that farmers' educational level had a positive and significant influence on agricultural productivity. Farmers with a higher educational level were the most productive, perhaps as a result of the skills that educated farmers acquired through access to information that allowed them to employ better agricultural-planning practices, to make better technical and allocation decisions, and to use inputs efficiently and effectively.

These results are consistent with those of Coelli and Battese (1996) and Bravo-Ureta and Pinheiro (1997), who found a positive correlation between agricultural productivity and educational levels. Ünal (2008) also showed that farmers with a high education had better access to knowledge and tools that improved productivity, and Adeoti (2009) confirmed this result by showing that educated farmers had higher productivity because education enhanced their ability to adapt to change, understand new practices and technologies, and face challenges. Moreover, considering the effect of men's and women's education on their respective productivity, we observed that being educated improved women's productivity (0.166) more than men's (0.069).

Because potable water is a major public-health issue, public investments should help ensure a safe supply of drinking water. In our study area, however, the results of our estimations showed that access to drinking water and sanitary facilities had a negative effect on farmers' productivity. This result, contrary to the expected sign, is in contrast to the findings of Platt (2012), who found that access to drinking water contributed positively to farmers' productivity. Indeed, given that almost 50% of the population in the study area had difficulty in access to potable water, it may be that the population devoted more time to fetching drinking water, a situation that has a negative impact on labor time and, in turn, on land productivity.

Our estimations revealed that mobile-phone use improved the agricultural productivity of all farmers, but a gender analysis showed that mobile-phone use improved the productivity of men alone. This result can be explained by the fact that farmers were more aware of agronomic practices and techniques through mobile telephony and the internet and had more information

regarding the prices of inputs and outputs. In addition, mobile-phone use was also an indicator of wealth. As a result, farmers who used a mobile phone had the financial capacity to invest more in farming and get better returns than those who did not.

In addition to public investments that influence agricultural productivity, private investments play an important role. In our study, irrigation practices had a positive and significant effect on farmers' agricultural productivity at a 1% level of significance, confirming the earlier findings of Dillon (2011), Huang et al. (2006), and Kemah and Thiruchelvam (2008), who indicated that irrigation was of paramount importance for agricultural production. Indeed, irrigation contributes to increased productivity by reducing losses caused by irregular seasons (Abro, Alemu & Hanjra, 2014, Hussain & Hanjra, 2003, 2004, Mateos et al., 2010). Our data, however, indicated that irrigation significantly affected only the productivity of men. Investments in improved seeds positively and significantly affected farmers' productivity, a particularly important result if it is true that traditional seeds are frequently no longer adapted to the variability in climate conditions that humanity now confronts.

Household size had a negative influence on agricultural productivity in our study area, which is not surprising given that most larger households had a higher number of children or inactive people who did not contribute to production. New farming techniques such as animal traction and the use of tractors have decreased the contributions of household members, which might also be a source of this negative effect Furthermore, expansion of crop area and labor has had a negative impact on farmers' productivity, which may be the result of a variation in output that is lower than the area increase. Low labor returns may also explain this negative effect.

The relationship between farm size and yield became a focal point of agrarian debates after the 1960s when Farm Management Surveys in India first established the empirical basis (Ünal, 2008). Since then, the evidence has been so widely observed by others in different countries that the inverse size-yield relationship is considered a "stylized fact" of agriculture in developing countries (Heltberg, 1998; Cornia, 1985, 1995; Okoye, Onyenweaku & Asumugha, 2007). Some argue that small-scale farms benefit farmers because they reduce the risk of drought, floods, pests, and other uncertainties that result from all farmland being in one place (Kaldjian, 2001). However, our results remain consistent with previous work: the more farm size increases, the greater the negative effect on farmers' productivity. The decline in productivity is more emphasized for women than for men.

Carrying insurance against natural disasters had a positive and significant effect on farmers' productivity, but the variable was significant (at a 1% level) only for men farmers. This result can be explained by the fact that men are most often the heads of households and usually monopolize insurance for the benefit of their farms rather than for those of women.

Table 7: ***Estimation of Agricultural Investment on Total Productivity***

Explanatory variables	Log(total productivity)					
	Women		Men		All	
	coef	t-stat	coef	t-stat	coef	t-stat
Agricultural investment						
Irrigation	0.347	(1.20)	0.416**	(2.57)	0.393***	(2.73)
Select seed	0.175	(1.07)	0.442***	(4.88)	0.385***	(4.72)
Use of fertilizer	0.180	(1.24)	-0.222**	(-2.09)	-0.082	(-0.95)
Community variables						
Distance to secondary school	0.483***	(3.36)	0.427***	(5.24)	0.464***	(6.56)
Distance to health center	-0.164	(-1.05)	-0.083	(-0.87)	-0.113	(-1.41)

Distance/time to market	**0.068**	**(0.48)**	**0.091**	**(1.11)**	**0.065**	**(0.92)**
Access to safe drinking water	**-0.363*** **	**(-3.10)**	**-0.588*** **	**(-7.12)**	**-0.534*** **	**(-7.84)**
Access to electricity	**0.173**	**(1.41)**	**0.148**	**(1.56)**	**0.150** **	**(1.97)**
Farmer characteristics						
Age	**-0.006**	**(-1.62)**	**-0.001**	**(-0.35)**	**-0.001**	**(-0.59)**
Household size	**-0.108*** **	**(-2.66)**	**-0.050** **	**(-2.08)**	**-0.062*** **	**(-2.86)**
Level of education	**0.129** **	**(2.49)**	**0.069***	**(1.75)**	**0.151*** **	**(5.07)**
Total workers	**-0.039** **	**(-2.49)**	**-0.059*** **	**(-14.00)**	**-0.053*** **	**(-7.91)**
Crop area	**-0.026*** **	**(-7.04)**	**-0.021*** **	**(-10.61)**	**-0.023*** **	**(-12.60)**
Disaster insurance	**-0.618**	**(-1.30)**	**0.982*** **	**(4.08)**	**0.508**	**(1.63)**
Access to credit	**-0.053**	**(-0.17)**	**-0.262**	**(-0.75)**	**-0.166**	**(-0.60)**
Use of mobile phone	**-0.050**	**(-0.42)**	**0.283*** **	**(3.19)**	**0.180** **	**(2.51)**
_cons	**13.291*** **	**(48.18)**	**13.413*** **	**(63.54)**	**13.185*** **	**(80.01)**
r2	**0.381**		**0.438**		**0.411**	
F	**14.283**		**36.278**		**36.806**	
P	**0.000**		**0.000**		**0.000**	
N	**1201**		**2630**		**3831**	

Source of basic data: 2018 CBMS census in selected sites, Togo.

4.4.2 Impact of Agricultural Investment on Farmers' Land and Labor Productivity

The results shown in Table 8 highlight the effects of public (community) and farmers' investments in land productivity in our study area. To this end, results analysis shows that public investments influence land productivity in similar to that of farmers' total productivity. However, we noted that access to electricity had a positive and significant influence on the land productivity of all farmers, but this was not the case for total productivity. Furthermore, access to insurance against natural disasters is beginning to have a significant and positive on land productivity for farmers of all sexes. The results of our estimations revealed that greater distance to health centers negatively and significantly affected land productivity because the remoteness of health centers means that those who are ill do not receive adequate treatment, negatively affecting the domestic workforce and farmers' productivity.

. Moreover, we observed a positive effect of labor force on land productivity. According to economic theory, an increase in the labor factor results in an increase in productivity. However, because agriculture is a labor-intensive activity in developing countries such as Togo, an increase in the labor force should increase the land productivity of farmers. Thus, the positive and significant effect of the labor force on the productivity of women's land only can be explained by the fact that women in rural areas use more community or paid labor than do men.

Distance and time to market had a positive and significant impact on farmers' productivity throughout the study area. Indeed, the farther away the market, the less farmers were likely to travel there, choosing to spend time on agricultural activities instead, thereby increasing land productivity.

Table 8: ***Estimation of the Impact of Agricultural Investment on Land Productivity***

Explanatory variables	**Log(land productivity)**					
	Women		**Men**		**All**	
	coef	**t-stat**	**coef**	**t-stat**	**coef**	**t-stat**
Agricultural investment						
Irrigation	**0.410**	**(1.54)**	**0.422*** **	**(2.93)**	**0.411*** **	**(3.24)**
Use of fertilizer	**0.301** **	**(2.22)**	**-0.141**	**(-1.42)**	**0.003**	**(0.04)**
Select seed	**0.162**	**(1.06)**	**0.351*** **	**(4.15)**	**0.313*** **	**(4.14)**

Community variables						
Distance to secondary school	**0.455*** **	**(3.31)**	**0.343*** **	**(4.95)**	**0.403*** **	**(6.39)**
Distance to health center	**-0.188**	**(-1.29)**	**-0.177** **	**(-2.02)**	**-0.184** **	**(-2.47)**
Distance/time to market	**0.228***	**(1.66)**	**0.206*** **	**(2.72)**	**0.192*** **	**(2.85)**
Access to drinking water	**-0.384*** **	**(-3.49)**	**-0.579*** **	**(-7.51)**	**-0.530*** **	**(-8.29)**
Access to electricity	**0.183**	**(1.59)**	**0.255*** **	**(2.83)**	**0.222*** **	**(3.08)**
Farmer characteristics						
Age	**-0.004**	**(-1.09)**	**0.000**	**(0.04)**	**0.000**	**(0.05)**
Household size	**-0.066***	**(-1.81)**	**-0.024**	**(-1.04)**	**-0.029**	**(-1.46)**
Level of education	**0.166*** **	**(3.40)**	**0.069***	**(1.86)**	**0.167*** **	**(6.01)**
Total worker	**0.013*** **	**(3.17)**	**0.006** **	**(2.49)**	**0.008*** **	**(4.39)**
Crop area	**-0.026*** **	**(-7.18)**	**-0.021*** **	**(-10.54)**	**-0.022*** **	**(-12.56)**
Disaster insurance	**0.779***	**(1.70)**	**1.006*** **	**(4.79)**	**0.888*** **	**(4.08)**
Access to credit	**0.061**	**(0.22)**	**-0.167**	**(-0.50)**	**-0.069**	**(-0.26)**
Use of mobile phone	**-0.147**	**(-1.27)**	**0.221*** **	**(2.60)**	**0.111**	**(1.60)**
_cons	**13.251*** **	**(50.98)**	**13.519*** **	**(70.79)**	**13.219*** **	**(86.10)**
r2	**0.365**		**0.330**		**0.338**	
F	**12.272**		**18.207**		**31.758**	
p	**0.000**		**0.000**		**0.000**	
N	**1201.000**		**2630.000**		**3831.000**	

Source of basic data: 2018 CBMS census in selected sites, Togo.

Table 9 presents the results of the labor-productivity estimation. Considering Fisher's statistics of the different models estimated, all were significant at a 1% level. The analysis revealed that, in general, the effects of public investments on land productivity through the establishment of basic infrastructure among farmers are similar on labor productivity.

Irrigation, access to electricity, household size, and insurance against natural disasters did not significantly influence labor productivity as was also the case for total and land productivity. In addition, the effect of distance between secondary school and farmers' places of residence on labor productivity was not significant for women. However, variables related to the total number of workers and the cultivated area had a negative impact on the farmer's labor productivity, similar to the results for total productivity.

Table 9: *Estimation of Agricultural Investment on Labor Productivity*

Explanatory variables	**Log(labor productivity)**					
	Women		**Men**		**All**	
	coef	**t-stat**	**coef**	**t-stat**	**coef**	**t-stat**
Agricultural investment						
Irrigation	**0.317**	**(1.39)**	**0.167**	**(1.40)**	**0.203***	**(1.85)**
Use of fertilizer	**0.268*** **	**(2.87)**	**0.113**	**(1.61)**	**0.166*** **	**(2.98)**
Selected seed	**0.042**	**(0.43)**	**0.352*** **	**(5.79)**	**0.286*** **	**(5.37)**
Community variables						
Distance to secondary school	**0.056**	**(0.50)**	**0.384*** **	**(5.66)**	**0.306*** **	**(5.20)**
Distance to health center	**-0.286*** **	**(-2.67)**	**-0.089**	**(-1.24)**	**-0.172*** **	**(-2.88)**
Access to drinking water	**-0.120**	**(-1.61)**	**-0.323*** **	**(-5.81)**	**-0.270*** **	**(-5.95)**
Distance/time to market	**0.050**	**(0.57)**	**0.072**	**(1.18)**	**0.059**	**(1.20)**
Access to electricity	**0.165** **	**(2.17)**	**-0.009**	**(-0.14)**	**0.036**	**(0.72)**
Farmer characteristics						
Age	**-0.000**	**(-0.07)**	**0.005** **	**(2.37)**	**0.004*** **	**(2.60)**
Household size	**-0.019**	**(-0.69)**	**0.019**	**(1.19)**	**0.015**	**(1.04)**
Level of education	**0.011**	**(0.32)**	**0.081*** **	**(2.94)**	**0.109*** **	**(5.36)**
Total worker	**-0.045*** **	**(-2.62)**	**-0.059*** **	**(-14.09)**	**-0.055*** **	**(-8.40)**
Area	**-0.003*** **	**(-2.77)**	**-0.003*** **	**(-3.70)**	**-0.003*** **	**(-4.62)**

Disaster insurance	**-0.287**	**(-0.76)**	**0.412***	**(1.73)**	**0.149**	**(0.64)**
Use of mobile phone	**0.200****	**(2.55)**	**0.327*****	**(5.52)**	**0.293*****	**(6.10)**
Access to credit	**0.018**	**(0.09)**	**-0.354**	**(-1.56)**	**-0.245**	**(-1.41)**
_cons	**11.221*****	**(59.75)**	**11.098*****	**(74.28)**	**11.004*****	**(96.35)**
r2	**0.233**		**0.400**		**0.345**	
F	**3.938**		**30.030**		**22.434**	
p	**0.000**		**0.000**		**0.000**	
N	**1297**		**2724**		**4021**	

4.4.3 Heterogeneity Analysis of Agricultural Investment Impact on Farmers' Productivity

Assuming that farmers do not have the same capacity, productive resources, or crop areas, their levels of investment should also be different. Thus, to analyze the effect of investments on farmers' agricultural productivity, we used a quantile regression. Table 10 presents the 25th, 50th, and 75th conditional quantile regressions. These estimates lead to inferences about marginal effects of all characteristics in the tails and in the central parts of the conditional-productivity distribution.

Distance to secondary schools and health centers had a positive and significant effect on the agricultural productivity of farmers' (men and women) in all three quantile groups. In addition, select seed use and farmers' educational levels had a positive and significant effect on agricultural productivity. Irrigation, conversely, had a positive and significant effect only on the productivity of 1st and 2nd quantile farmers. This result can be explained by the fact that low-productivity farmers often have small farms and are able to irrigation their crop areas and increase their productivity. That was not the case for large-area farmers in the 3rd quantile.

Access to electricity and the use of fertilizers only improved agricultural productivity for farmers in the 2nd and 3rd quantiles. This obvious result can be explained by the fact that 1st-quantile farmers, considered small producers, have low incomes to access inputs. Moreover, carrying natural-disaster insurance only improved the productivity of smallholders in the 1st quantile. This result is not surprising because, as in the case of low productivity, these farmers are clearly among the most vulnerable who benefit most from insurance subsidies or natural-disaster-insurance programs.

Agricultural credit had a significant and negative effect on farmers' productivity in the 2nd and 3rd quantiles because farmer's productivity levels determine access to agricultural credit, excluding 1st-quantile farmers. The negative effect can also be explained by the inadequate use of credit, delays in obtaining credit, and climate variability.

Table 10: *Quantile Regression of the Effects of Investment on Agricultural Productivity*

	Quantile (0.25)			Quantile (0.5)			Quantile (0.75)		
	Women	Men	All	Women	men	All	Women	men	all
Agricultural investment									
Irrigation	0.699***	0.429***	0.521***	0.642**	0.082	0.148**	-0.067	0.062	0.088
	(2.98)	(2.74)	(4.17)	(2.20)	(0.76)	(2.56)	(-0.50)	(0.45)	(0.68)
Use of fertilizer	0.084	0.003	0.056	0.333***	0.089**	0.166***	0.570***	0.168***	0.268***
	(0.56)	(0.04)	(0.73)	(6.69)	(2.10)	(3.73)	(6.13)	(3.73)	(5.66)
Select seed	0.036	0.258***	0.200***	-0.110	0.254***	0.231***	-0.151	0.213***	0.143***
	(0.38)	(5.36)	(3.68)	(-0.85)	(4.41)	(4.74)	(-1.49)	(3.79)	(2.97)
Community variables									
Distance to secondary school	0.627***	0.318***	0.420***	0.329***	0.246***	0.329***	0.068	0.170***	0.204***
	(4.44)	(6.84)	(6.23)	(4.83)	(4.93)	(6.79)	(0.54)	(3.05)	(3.57)
Distance to health center	-0.282*	-0.220***	-0.251***	-0.391***	-0.106*	-0.189***	-0.292**	-0.107*	-0.167***
	(-1.88)	(-3.19)	(-3.10)	(-4.21)	(-1.95)	(-3.86)	(-2.13)	(-1.82)	(-2.94)
Distance/time to market	0.402***	0.163***	0.207***	0.296***	0.034	0.084**	-0.093	0.155***	0.089*
	(3.86)	(3.02)	(3.13)	(3.56)	(0.74)	(1.97)	(-0.86)	(3.20)	(1.77)
Access to drinking water	-0.522***	-0.657***	-0.580***	-0.244***	-0.274***	-0.256***	-0.013	-0.099**	-0.043
	(-4.15)	(-8.29)	(-8.25)	(-3.30)	(-5.25)	(-6.04)	(-0.16)	(-2.15)	(-0.99)
Access to drinking water	0.175	0.121*	0.070	0.250***	0.002	0.085**	0.265***	0.167***	0.146***
	(1.37)	(1.77)	(1.09)	(3.57)	(0.04)	(2.21)	(3.01)	(3.56)	(3.46)
Farmer characteristics									
Age	-0.001	0.004**	0.003	0.002	0.003**	0.002*	-0.006**	0.003**	0.00
	(-0.12)	(2.08)	(1.63)	(0.69)	(2.25)	(1.76)	(-1.99)	(1.97)	(0.29)
Household size	-0.026	-0.020	-0.025	-0.026	0.017	0.008	-0.020	0.018	0.007
	(-0.69)	(-1.14)	(-1.47)	(-0.97)	(1.38)	(0.74)	(-0.73)	(1.32)	(0.54)
Level of education	0.226***	0.122***	0.278***	0.148***	0.053***	0.158***	0.065*	-0.014	0.061***
	(5.56)	(3.91)	(10.64)	(5.14)	(2.60)	(8.85)	(1.80)	(-0.59)	(3.21)
Total workers	-0.084***	-0.092***	-0.088***	-0.084***	-0.076***	-0.076***	-0.063***	-0.063***	-0.064***
	(-32.68)	(-22.87)	(-53.68)	(-14.82)	(-22.19)	(-21.76)	(-5.96)	(-23.41)	(-25.25)
Area	-0.048***	-0.038***	-0.042***	-0.033***	-0.024***	-0.025***	-0.022***	-0.019***	-0.020***
	(-2.77)	(-4.95)	(-5.62)	(-4.04)	(-5.95)	(-9.09)	(-7.10)	(-9.51)	(-13.96)
Disaster insurance	-0.472	0.731**	0.602***	0.632	0.325	0.231*	-0.241	0.342***	0.339
	(-1.13)	(2.07)	(2.58)	(0.29)	(1.54)	(1.90)	(-0.68)	(4.49)	(0.40)
Use of mobile phone	-0.152	0.129***	0.008	-0.272***	0.123***	0.029	-0.205**	0.098**	0.054
	(-1.50)	(2.62)	(0.15)	(-4.18)	(2.88)	(0.70)	(-2.40)	(2.26)	(1.20)
Access to credit	0.273	0.235*	0.135	0.005	-0.253***	-0.093*	0.007	-0.324***	-0.270***
	(0.76)	(1.71)	(0.81)	(0.05)	(-4.06)	(-1.85)	(0.02)	(-3.51)	(-4.70)
_cons	12.413***	12.936***	12.508***	13.272***	13.541***	13.278***	14.413***	14.044***	14.010***
	(47.32)	(97.91)	(95.03)	(88.56)	(129.76)	(138.91)	(63.45)	(119.03)	(131.29)
N	1201.000	2630.000	3831.000	1201.000	2630.000	3831.000	1201.000	2630.000	3831.000

4.4.4 Impact of Agricultural Productivity on Poverty Reduction

We tested the hypothesis that increased farm productivity would reduce rural poverty in our study localities, and the Model 2 estimates appear in Table 11. In a first estimate, we examined total productivity measured by land and labor factors and then considered land and labor productivity separately. Poverty was measured with a binary variable (1 if the farm household income was below the rural poverty line ($402.03 USD for Tsévié and $398.92 USD for Danyi) and 0 if not), as well as through a logarithm of farmers' income, which we considered a proxy to assess the effects of improved productivity on poverty reduction.

Considering the poverty measured with the binary variable, the results in Table 11 show that the productivity coefficients had negative signs for farmers of both sexes. This negative correlation means that improvements in productivity led to a reduction of poverty in the study areas.

An increase in agricultural productivity is likely to increase the demand for agricultural labor with a parallel increase in the area cultivated or in the intensity or frequency of cultivation (Irz et al., 2001). Thus, farmers' incomes would increase and lead to a reduction in the proportion of farmers with incomes below the poverty line. In addition, greater agricultural productivity can increase farmers' incomes and thus contribute directly and indirectly to poverty reduction. Similarly, Datt & Ravallion (1998) showed that an increase in agricultural productivity (defined as production per unit of land) contributed to poverty reduction in India. Their analysis of data from an Indian survey conducted between 1958 and 1994 showed that real incomes and higher agricultural yields reduced absolute poverty and that even the poorest benefitted from productivity gains. Their results were confirmed by De Janvry & Sadoulet (2010) and Ravallion (2009), who showed that improving agricultural productivity led to a reduction in rural poverty. With regard to a gender analysis, the results Table 11 show that increasing land productivity reduces poverty more for men than for women.

Table 11*: Estimation of Total Productivity Impact on Poverty*

Explanatory variables	Poverty (0 = not poor; 1 = poor)					
	Women		Men		All	
	coef	t-stat	coef	t-stat	coef	t-stat
Log (productivity)	-0.252***	(-5.38)	-0.165***	(-8.05)	-0.204***	(-10.82)
Farmer characteristics						
Age of farmer	0.006	(1.13)	-0.004	(-1.06)	-0.004	(-1.36)
Household size	-0.025	(-0.50)	0.006	(0.23)	-0.006	(-0.25)
Educational level						
Primary	-0.669***	(-4.68)	-0.189	(-1.38)	-0.501***	(-5.22)
Secondary	-0.664***	(-3.58)	-0.302**	(-2.29)	-0.709***	(-7.31)
High			0.162	(0.39)	-0.441	(-1.10)
Marital status						
Married	0.318	(1.11)	-0.208	(-1.40)	-0.068	(-0.52)
Divorced/window	0.567**	(1.97)	0.136	(0.75)	0.408***	(2.84)
Dependence Ratio	-0.149	(-1.12)	0.363***	(3.57)	0.205***	(2.58)
Migrant transfer	-0.655	(-1.08)	0.084	(0.13)	-0.240	(-0.58)
Total area	0.022	(1.29)	0.001	(0.63)	0.001	(0.64)
Agricultural investment						

Select seeds	-0.101	(-0.54)	-1.028***	(-7.54)	-0.685***	(-6.65)
Use of fertilizer	0.186	(1.24)	0.241**	(2.32)	0.239***	(2.85)
Practice of irrigation	1.262**	(2.25)	-0.046	(-0.18)	0.105	(0.51)
Community variables						
Use mobile phone	-0.159	(-1.16)	-0.665***	(-6.67)	-0.484***	(-6.03)
Distance from residence to market	0.154	(1.11)	-0.002	(-0.02)	0.067	(0.88)
Access to electricity	-0.033	(-0.24)	-0.111	(-1.10)	-0.079	(-1.00)
Natural-disaster insurance	0.905	(0.83)	1.261**	(2.04)	1.138**	(2.16)
_cons	3.340***	(4.43)	2.603***	(6.79)	3.287***	(9.96)
P (chi2)	0.000		0.000		0.000	
N	1194		2560		3754	

Source of basic data: 2018 CBMS census in selected sites, Togo.

Table 11 shows that a primary or secondary level of education contributed to reducing farmers' poverty. This result is obvious because better-educated, better-trained farmers are more able, all else being equal, to absorb modern technologies and to innovate, which should increase productivity, allow them to generate more income, and move them out of poverty. This result is consistent with the work of Coombs and Ahmed (1974) and Noor (1980), who showed that farmers were less likely to be poor if they were more educated. Our results showed that fertilizer use increased the probability that farmers' incomes would fall below the poverty threshold, though the result was not significant for women. On the other hand, irrigation practices increased the probability that women would become poor. These differing results on the use of inputs can be explained by the costs households incurred to use these factors, thereby reducing their net income.

In addition, investments in better farming techniques improve productivity and, therefore, reduce poverty. Studies have shown that the adoption of improved technologies can increase agricultural productivity, overcome poverty, and improve food security (Dontsop-Nguezet, et al., 2011). A primary or secondary education, the use of a mobile phone, and natural-disaster insurance led to a reduction in rural poverty.

Table 12 indicates that, by dissociating total land productivity and labor productivity, an increase in land productivity reduced solely the probability that farmers would be poor.

Table 12: *Estimation of the Impact of Land and Labor Productivity on Poverty*

Explanatory variables	Poverty (0 = not poor; 1 = poor)					
	Women		Men		All	
	coef	t-stat	coef	t-stat	coef	t-stat
Log (land productivity)	-0.376***	(-6.47)	-0.363***	(-9.23)	-0.390***	(-12.32)
Log (labor productivity)	-0.030	(-0.58)	-0.013	(-0.41)	-0.023	(-0.85)
Farmer characteristics						
Age of farmer	0.007	(1.23)	-0.004	(-0.90)	-0.002	(-0.76)
Household size	-0.019	(-0.38)	0.015	(0.52)	0.006	(0.23)
Educational level						
Primary	-0.593***	(-4.07)	-0.118	(-0.84)	-0.411***	(-4.19)
Secondary	-0.593***	(-3.21)	-0.226*	(-1.66)	-0.592***	(-5.96)
High	-	-	0.076	(0.17)	-0.448	(-1.00)
Marital status						
Married	0.265	(0.94)	-0.201	(-1.33)	-0.082	(-0.62)
Divorced/widowed	0.544*	(1.91)	0.094	(0.52)	0.349**	(2.42)
Dependence Ratio	-0.168	(-1.28)	0.371***	(3.60)	0.185**	(2.35)

Migrant transfer	-0.590	(-0.99)	0.524	(0.69)	-0.107	(-0.22)
Total area	0.008	(1.02)	-0.003***	(-3.05)	-0.003***	(-3.34)
Agricultural investment						
Select seeds	-0.133	(-0.71)	-1.035***	(-7.51)	-0.705***	(-6.79)
Use of fertilizer	0.326**	(2.13)	0.285***	(2.66)	0.327***	(3.80)
Practice of irrigation	1.299**	(2.34)	0.030	(0.11)	0.182	(0.85)
Community variables						
Access to electricity	-0.007	(-0.05)	-0.114	(-1.11)	-0.078	(-0.97)
Distance from residence to market	0.218	(1.53)	0.025	(0.26)	0.113	(1.43)
Use mobile phone	-0.214	(-1.54)	-0.659***	(-6.45)	-0.497***	(-6.07)
Natural-disaster insurance	1.604	(1.48)	1.386**	(2.43)	1.356***	(2.78)
_cons	5.389***	(5.52)	5.437***	(9.32)	5.997***	(12.31)
P (chi2)	0.000		0.000		0.000	
N	1194		2560		3754	

Table 13 shows the marginal effects of the logit regression. Raising total productivity by 1% increased farmers' chances of lifting themselves out of poverty by about 20%, and this probability was higher for women than for men. In terms of land productivity, women were still more likely to escape poverty than men. This result can be explained by the fact that, in addition to agriculture, women are engaged in other, parallel activities. Increased productivity increased their farm income which, when combined with income from other activities, can lift them over the poverty line.

Table 13: Marginal Effect of Productivity of Poverty

Explanatory variables	Poverty (0 = not poor; 1 = poor)					
	Women	Men	All	Women	Men	All
Log (productivity)	-	-	-	-0.252***	-0.165***	-0.204***
	-	-	-	(-5.38)	(-8.05)	(-10.82)
Log (land productivity)	-0.376***	-0.363***	-0.390***	-	-	-
	(-6.47)	(-9.23)	(-12.32)	-	-	-
Log (labor productivity)	-0.030	-0.013	-0.023	-	-	-
	(-0.58)	(-0.41)	(-0.85)	-	-	-
Farmer characteristics						
Age of farmer	0.007	-0.004	-0.002	0.006	-0.004	-0.004
	(1.23)	(-0.90)	(-0.76)	(1.13)	(-1.06)	(-1.36)
Household size	-0.019	0.015	0.006	-0.025	0.006	-0.006
	(-0.38)	(0.52)	(0.23)	(-0.50)	(0.23)	(-0.25)
Educational level						
Primary	-0.593***	-0.118	-0.411***	-0.669***	-0.189	-0.501***
	(-4.07)	(-0.84)	(-4.19)	(-4.68)	(-1.38)	(-5.22)
Secondary	-0.593***	-0.226*	-0.592***	-0.664***	-0.302**	-0.709***
	(-3.21)	(-1.66)	(-5.96)	(-3.58)	(-2.29)	(-7.31)
High		0.076	-0.448		0.162	-0.441
		(0.17)	(-1.00)		(0.39)	(-1.10)
Marital status						
Married	0.265	-0.201	-0.082	0.318	-0.208	-0.068
	(0.94)	(-1.33)	(-0.62)	(1.11)	(-1.40)	(-0.52)
Divorced/widowed	0.544*	0.094	0.349**	0.567**	0.136	0.408***
	(1.91)	(0.52)	(2.42)	(1.97)	(0.75)	(2.84)
Dependency Ratio	-0.168	0.371***	0.185**	-0.149	0.363***	0.205***
	(-1.28)	(3.60)	(2.35)	(-1.12)	(3.57)	(2.58)
Migrant transfer	-0.590	0.524	-0.107	-0.655	0.084	-0.240
	(-0.99)	(0.69)	(-0.22)	(-1.08)	(0.13)	(-0.58)

Total area	0.008	-0.003***	-0.003***	0.022	0.001	0.001
	(1.02)	(-3.05)	(-3.34)	(1.29)	(0.63)	(0.64)
Agricultural investment						
Select seeds	-0.133	-1.035***	-0.705***	-0.101	-1.028***	-0.685***
	(-0.71)	(-7.51)	(-6.79)	(-0.54)	(-7.54)	(-6.65)
Use of fertilizer	0.326**	0.285***	0.327***	0.186	0.241**	0.239***
	(2.13)	(2.66)	(3.80)	(1.24)	(2.32)	(2.85)
Practice of irrigation	1.299**	0.030	0.182	1.262**	-0.046	0.105
	(2.34)	(0.11)	(0.85)	(2.25)	(-0.18)	(0.51)
Community variables						
Access to electricity	-0.007	-0.114	-0.078	-0.033	-0.111	-0.079
	(-0.05)	(-1.11)	(-0.97)	(-0.24)	(-1.10)	(-1.00)
Distance from residence to market	0.218	0.025	0.113	0.154	-0.002	0.067
	(1.53)	(0.26)	(1.43)	(1.11)	(-0.02)	(0.88)
Use mobile phone	-0.214	-0.659***	-0.497***	-0.159	-0.665***	-0.484***
	(-1.54)	(-6.45)	(-6.07)	(-1.16)	(-6.67)	(-6.03)
Disaster assistance	1.604	1.386**	1.356***	0.905	1.261**	1.138**
	(1.48)	(2.43)	(2.78)	(0.83)	(2.04)	(2.16)
_cons	5.389***	5.437***	5.997***	3.340***	2.603***	3.287***
	(5.52)	(9.32)	(12.31)	(4.43)	(6.79)	(9.96)

Table 14 presents the assessment results of the impact of productivity on rural poverty reduction using farmers' incomes as a proxy. Fisher's statistics of the various models revealed that all models were significant at a 1% level.

Agricultural productivity variable had a positive and significant sign on farmers' incomes, a result that is consistent with the literature that has shown that increasing agricultural productivity leads to poverty reduction. According to Schultz (1964), Mellor (1995, 1996) and Gollin (2010), increased agricultural productivity leads to general equilibrium effects that further stimulate job creation and equitable growth and generate more dramatic wealth and stability benefits. For Gollin (2010), increased productivity led to increased income and agricultural profitability, leading to improved living conditions for farmers and poor rural populations. It also led to a reduction in food prices, which benefitted both rural and urban consumers, including farmers who were net food buyers.

Table 14 : Estimation of the Impact of Land and Labor Productivity on Farmers' Income

Explanatory variables	Log(income)					
	Women		Men		All	
	coef	t-stat	coef	t-stat	coef	t-stat
Log (productivity)	0.271***	(9.00)	0.235***	(9.58)	0.251***	(13.14)
Farmer characteristics						
Age of farmer	0.002	(0.61)	-0.004*	(-1.83)	0.000	(0.14)
Household size	0.053**	(2.29)	0.017	(0.92)	0.028**	(1.99)
Educational level						
Primary	0.266***	(3.68)	0.077	(1.15)	0.197***	(3.94)
Secondary	0.141	(1.38)	0.077	(1.22)	0.223***	(4.37)
High			0.244	(0.96)	0.476*	(1.92)

Marital status						
Married	-0.252*	(-1.81)	0.085	(1.36)	-0.017	(-0.29)
Divorced/widowed	-0.238*	(-1.73)	0.017	(0.23)	-0.121*	(-1.92)
Dependence Ratio	0.048	(0.81)	0.066	(1.35)	0.032	(0.85)
Migrant transfer	0.243	(0.74)	0.029	(0.10)	0.091	(0.40)
Total area	0.003***	(3.37)	0.002***	(3.23)	0.003***	(4.61)
Agricultural investment						
Select seeds	-0.076	(-0.67)	0.370***	(5.64)	0.240***	(4.12)
Use of fertilizer	-0.072	(-0.90)	-0.184***	(-3.30)	-0.153***	(-3.30)
Practice of irrigation	-0.250	(-1.15)	-0.323*	(-1.83)	-0.256*	(-1.74)
Community variables						
Access to electricity	0.112*	(1.67)	0.148***	(3.19)	0.117***	(3.04)
Use mobile phone	0.122*	(1.76)	0.353***	(6.96)	0.280***	(6.76)
Distance from residence to market	-0.096	(-1.45)	-0.112***	(-2.66)	-0.108***	(-3.03)
Disaster assistance	-0.176	(-0.24)	-1.192***	(-2.94)	-0.910**	(-2.52)
_cons	8.345***	(18.05)	9.063***	(25.20)	8.631***	(31.36)
r2	0.256		0.246		0.254	
F	7.752		12.546		20.670	
p	0.000		0.000		0.000	
N	1170		2515		3685	

Source of basic data: 2018 CBMS census in selected sites, Togo.

4.4.5 Gender Wage Gap in the Agricultural Sector

According to the empirical method of Oaxaca (1973) and Blinder (1973), it is difficult to systematically attribute any difference in income between men and women to discrimination against women. Indeed, considering only the African context, the hourly workload on farms is unequal between the two sexes, mostly because of housework or other activities such as trade, which mainly involve women in rural areas. Thus, it is possible that, for difficult labor such as agriculture, women's productivity may be lower. Certain other factors can also reduce the performance of women, including pregnancy, the time required to raise children, and expectations that they will prepare and serve food for their husbands and other farm workers, all of which can lower their incomes. In addition, women are typically given responsibility for work like sowing, spreading of fertilizer, and harvesting as well as such post-harvest work as winnowing, transportation, marketing, and, in some cases the processing of harvested products.

In our case, the Oaxaca (1973) and Blinder (1973) method required controlling, in a sample of farmers of both sexes, all the individual characteristics that gave rise to differences in agricultural income: access to land, use of agricultural inputs, level of education, etc., so as to isolate a residue that cannot be explained by these normal factors of income inequality. That, in turn, would help reveal sex discrimination. In other words, the objective was to assess the percentage of the average income gap between men and women farmers that could serve to quantify sex discrimination.

This disaggregation of the income gap had two parts. First, the differences in the returns of the characteristics weighted by the mean of women's characteristics; it was the unexplained part

of gender discrimination in income. Second, the quantification of differences as a result of individual characteristics weighted by men's returns, which would constitute the explained portion of variances in income by gender. The unexplained part was further broken down into two terms: the return in performance, weighted by men's structure, which represented men's advantage; and the yield gap as a result of being a woman, or women's disadvantage.

Table 15 presents the results of the estimates of the Oaxaca-Blinder model. Taking into account the labor force in our study area, the estimated gap between men's and women's farm income was 44.1%, which suggests that men's income is significantly higher than women's. The second part of the table presents the components of the aggregate decomposition of the income gap, which include the endowment effect, the structural advantage of men, and the structural disadvantage of women. Thus, according to the estimates in Table 17, 22.9% of the average farm-income gap between women and men is attributable to the endowment effect, for a relative contribution of 51.92% (0.229/0.441). Women's disadvantage that is, under-compensation in the agricultural sector as a result of being a woman—contributed to this difference by -0.12% (-0.053/0.441). On the other hand, the effect of men's advantage favoritism toward men represented 60.1% (0.265/0.441) of this gap. These indices suggest that income discrimination between men and women is ostensibly a result of discrimination against women farmers.

Discrimination against women can be explained by several sociological and economic factors that hamper women's access to land. Indeed, land is an important means of production in economic activities and is a main source of income in rural areas. The rights of access to land and to its use and control are accorded to women in rural areas by law in Togo. Yet various limitations to women's ability to own and control agricultural land not only hamper their ability to engage in economic activities but also significantly reduce the income they can derive from agricultural activities.

A study on land policies and women's access to land in Togo, conducted by Women in Law and Development in Africa (Women in Law & Development in Africa, 2009), revealed that only 20 women out of 130 heirs (or 15.2%) were heiresses and that the farmlands to which they had access were smaller than those inherited by men. Moreover, their inheritance was in most cases accompanied by restrictions on their rights (land could not be passed on to descendants, or conditions on sale were imposed) Patrilineal regime in Togo is the main reason for limitations on women's inheritance of land.

In addition, land transactions are very dynamic and give women access to land as a whole but, in the case of rented land, they do not prevent the exploitation of women given the lack of land titles and failure of owners to honor their commitments. Apart from inheritance, the only alternative for women to have a lasting control over their lands is to purchase them, but women often do not have the means to do so.

To carry out their agricultural activities, women have access to farmlands by usufruct (48.7% or 37 women) and by lease (76.5% or 85 women), both of which provide them with small farmlands of between less than 0.25 hectares and 2 hectares. They can use this land with a certain level of insecurity that does not allow them to adopt sustainable improvement techniques for their production. They are content with low yields despite the many requirements they must meet.

Table 15*: Oaxaca Disaggregation of Farmers' Income, by Sex*

A. Average gender differential	
Average productivity in men	12.366***

	(498.97)
Average productivity among women	11.925***
	(332.05)
The average difference in agricultural productivity by gender	0.441***
	(10.11)

B. aggregate disaggregation	**Endowment**		**Men: structural advantage**		**Women: structural disadvantage**	
	coef	**t-stat**	**coef**	**t-stat**	**coef**	**t-stat**
	0.229***	(5.58)	0.265***	(5.70)	-0.053	(-1.19)

C. detailed disaggregation	**Endowment**		**Men: structural advantage**		**Women: structural disadvantage**	
	coef	t-stat	coef	t-stat	coef	t-stat
Log (productivity)	0.126***	(5.19)	-0.458**	(-1.97)	-0.017*	(-1.85)
Farmer characteristics						
Age of farmer	-0.003	(-1.00)	-0.314*	(-1.94)	0.007	(1.46)
Household size	0.020**	(2.07)	-0.067	(-0.96)	-0.011	(-0.95)
Educational level	0.070***	(2.81)	-0.074	(-1.49)	-0.046	(-1.48)
Marital status	0.017	(0.75)	0.065	(0.61)	-0.018	(-0.61)
Dependence Ratio	-0.005	(-0.55)	0.013	(0.29)	-0.003	(-0.29)
Migrant transfer	0.004	(1.29)	0.002	(0.28)	-0.001	(-0.28)
Farm area	-0.002	(-0.35)	-0.007	(-0.96)	0.001	(0.33)
Agricultural investments						
Use of Select seeds	-0.004	(-0.93)	0.066***	(3.87)	0.019**	(2.55)
Use of fertilizer	-0.004	(-1.10)	-0.023	(-0.98)	-0.004	(-0.93)
Practice of irrigation	-0.005	(-0.93)	-0.002	(-0.40)	-0.002	(-0.40)
Community variables						
Access to electricity	-0.002	(-0.94)	0.013	(0.42)	-0.001	(-0.40)
Time/distance to market	0.003	(1.07)	-0.016	(-0.27)	0.001	(0.27)
Mobile phone	0.013*	(1.81)	0.139***	(2.63)	0.023**	(2.42)
Disaster assistance	-0.000	(-0.23)	-0.003	(-1.16)	-0.001	(-0.26)
Total	0.229***	(5.58)	0.932***	(2.81)	-0.053	(-1.19)

Source of basic data: 2018 CBMS census in selected sites, Togo.

4.4.6 Detailed Disaggregation

Section C of Table 15 highlights the results of the detailed disaggregation for all co-variables included in the analysis. Factors such as productivity, use of fertilizer, level of education, and use of mobile phones, however, contributed the most to explain discrimination against women.

Given the additive linearity property, it is possible to determine the contribution of each component to wage discrimination in the case of endowment, men's advantage, and women's disadvantage. The ratio of the effect of the different components on discrimination (and the overall gap) describes the importance of each factor: (i) farmer productivity represents 54.6% of the total endowment effect in absolute value (and 28.34% of the overall gender gap); (ii) level of education explains 30.56% (15.9%); and (iii) household size represents in absolute value 8.7% (4.5%). The components of men's structural advantage in farm income are (i) farmer age, (ii) use of select seeds, and (iii) mobile-phone use.

Most of these advantages for men (or disadvantages for women) may be the result of diminishing returns of some factors and lower wages for women farmers. It would be interesting to analyze them within a Pareto-efficiency framework within households, as did Udry (1996) and Akresh (2005).

4 Conclusions and policy implications

In order to improve the productivity of rural farmers and reduce their vulnerability, we make the following recommendations for decision-makers and stakeholders in the agricultural sector:

- Increase public or community investments and encourage farmers to invest in education, health, safe drinking water, and irrigation infrastructure;
- Integrate the roles of governments as regulators of agricultural commodities and of input prices to create an optimal legal and institutional environment for investment in service-delivery infrastructure that contributes to poverty reduction;
- Connect smallholders to dynamic new markets for high-value products that can increase their income and offer them an opportunity to reduce rural poverty more quickly;
- Invest in market infrastructure and improve the technical capacity of farmers to meet international standards so they can export their production and increase their incomes;
- Create favorable conditions and incentives in rural areas to provide better savings and credit facilities;
- Establish institutional innovations in agricultural insurance (index insurance against drought risk or natural disasters, e.g.) as private initiatives, and encourage farmers to subscribe to them to reduce risks to farmers' borrowers and lenders and unlock agricultural finance;
- Remove barriers to women by supporting and recognizing the contribution of women to food production and food security, and facilitate participation of women in training in new agricultural technologies to promote agricultural growth on a potentially massive scale; and
- Promote equity in the distribution of endowments by ensuring and providing rights to land through a new land code that equalizes opportunities for disadvantaged or excluded groups such as women and ethnic minorities.

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Annex

Table 16 : Definition of Variables and Their Expected Effects on Farm-Labor Productivity

Variables	Definition	Expected effects	Justification
Investment variables			
IRRIGAT	**Farmer practiced irrigation techniques (1 = yes, 0 = no)**	**+**	**An increase in agriculture productivity requires the expansion of irrigated areas (Audibert, 2010).**
dist_secd	**Distance to secondary school by the farmer. (1 = less than 5km; 0 = more than 5km)**		**The presence of a secondary school allows most of the population to achieve a secondary-educational level, which improves farmers' productivity (Weir, 1999).**
dist_healt_center	**Distance to health facilities in the case of illness by the farmer (1 = less than 5km; 0 = more than 5km)**	**+**	**The use of health facilities in the case of an illness during the rainy season significantly improves farm-labor productivity (Combary, 2016).**
mob_phone	**Possession of a mobile phone by the farmer (1 = yes; 0 = no)**	**+**	**Mobile-phone use significantly improves productivity in the agriculture sector (Jensen, 2007).**
acces_elect	**Access to electricity by the farmer (1 = yes; 0 = no)**	**+**	**Rural electrification generates positive employment spillovers in the agricultural sector and could spur broad local development through increased productivity spillovers. (Lewis & Severnini, 2017).**
EAU_SANIT	**Access to potable water and sanitation by the farmer (1 = yes; 0 = no)**	**+**	**Access to drinking water by households is a factor that positively contributes to farming productivity and development (Platt, 2012).**
CREDIT_AGRI	**Access to agricultural credits (1 = yes; 0 = no)**	**+**	**Access to agricultural credit increases productivity of farm households (Adesina & Djato, 1996; Diagne & Zeller, 2001).**
nat_dist_ins	**Benefit from insurance against natural disasters (1 = yes; 0 = no)**	**+**	**Insurance allows for more stable income streams and could thus be a way to protect groundnut producers' livelihoods, improve their access to**

			finance, and increase their productivity (Hess & Syroka, 2005).
Fertilizer	Use of fertilizers as an input during the production (1 = yes; 0 = no)		Application of chemical fertilizers significantly improving crop productivity (Yadav et al, 2000).
SEM_AMEL	Use of improved seeds as an input during the production (1 = yes, 0 = no)	+/-	The productivity of improved seeds compared to local ones was increased in some crops varieties and decreased among others (Briema, et al., 2013).
Socio-demographic variables			
AGE_CM	Age of farmer	+	Older heads of household carry out more sustainable farm practices with respect to seed source, soil fertility, crop management, pest and disease control, and weed control (Tankou, 2013).
TAILLE	Size of the household	+/-	Though family size is high in rural Nigeria, agricultural productivity is low, as is the income derived from it (Omideyi, 1988).
EDUC_CM	Educational level of farmer. Categorical variable: 0 = none, 1 = primary, 2 = secondary, 3 = higher	+	Education is one of crucial factors that positively affect farming productivity (Ziagonas, 1993).
Variables related to farm exploitation			
Dist_RESID_MARCH	Distance from the farmer's residence to the market in km (1 = less than 5km; 0 = more than 5km)	+	Distance to market and condition of road infrastructure play an important role in agriculture because they determine the mobility of inputs and products for agricultural production and marketing. (Kassali, 2006).
SUP_CULT	Farm size (in hectares)	+	A strong inverse relationship exists between farm size and land productivity (Byiringiro & Reardon, 1996).
JOUR_OUVR	Number of person-working days on the farm	+/-	The relationship between women's output and their working hours is non-linear: below an hour's threshold, output is proportional to hours; above an hour's threshold, output rises at a decreasing rate as hours increase (Pencavel, 2015).

Source of basic data: 2018 CBMS Census in selected sites, Togo.

Table 17 *: Definition of Variables and Their Expected Effects on Poverty*

Variables	Definitions	Expected effect	Justification
Productivity variables			
Agricultural total productivity	ratio of farmer output value to total crop area and labor factors used in farm production	-	Agricultural productivity increases household's income, which reduces the number of households below the poverty threshold (De Janvry & Sadoulet, 2010)
Land agricultural productivity	Farmer output value per crop area cultivated	-	Land agricultural productivity contribute to farmer poverty reduction (Irz et al., 2001; Datt & Ravallion, 1998)
Labor agricultural productivity	Farmer output value per labor engaged in production	-	Labor agricultural productivity negatively influences the level of Household poverty (Datt & Ravallion, 1998).
Characteristics of the household			
Level of education	Educational level of farmer (0 = None, 1 = primary, 2 = secondary, 3 = higher)	-	A negative association exists between the probability of a household being poor and the educational level of the head of household (Bilenkisi, Gungor & Tapsin, 2015).
Age	Age of the farmer	+/-	Poverty risk decreases as the age of the head of household increases (Bilenkisi, Gungor & Tapsin, 2015), but, beyond a certain threshold, it may increase the household's poverty.
Size	Size of household	+	Although family size is high in rural Nigeria, agricultural productivity is low, as is the income derived from it

			(Omideyi, 1988).
Mart_stat	**Farmer's marital status (0 = single, 1 = married, 2 = divorced/separated widowed)**	**+/-**	**Marriage has a large effect on reducing the risk of poverty. Unmarried individuals and single-parent families are more likely to live in poverty than their married counterparts (Blank, 1997; Furstenberg, 1990).**
Transfer of migrant	**Money transfer from migrant**	**+/-**	**Among households with migrants, there is no evidence that transfers are targeting households of lower income (Shaorshadze & Miyata, 2010).**
Ratio of dependency	**The dependency ratio is the ratio between number of members under 15 and over 64 to that of other members of the household**	**+**	**High Dependency Household Ratio is associated with lower per capita and household poverty (Hadley et al., 2011).**
Farm size	**Farmer cultivated area**	**+**	**A strong inverse relationship exists between farm size and land productivity (Byiringiro & Reardon, 1996).**
Sem select			
Fertilizer	**Use of fertilizer (1 = yes; 0 = no)**	**-**	**The use of fertilizer increases outputs and income, which reduces the number of households below the poverty threshold (Sarris, Savastano & Christiaensen, 2006).**
Infrastructure characteristics			
Access to electricity	**Farmer Household's access to electricity (1 = yes; 0 = no)**	**-**	**Modern sources of energy are required for the improvement of household living standards (Hussein & Leal Filho, 2012).**
Use of phone	**Use of phone by the farmer (1 = yes; 0 = no)**	**-**	**Extending telecommunications services into rural areas could alleviate poverty, encourage economic and social growth, and overcome a perceived "digital divide" (Bhavnani et al., 2008).**
Practice of irrigation	**Practice of irrigation by farmer (1 = yes; 0 = no)**	**-**	**An increase in agriculture productivity requires both an expansion of irrigated areas and the adoption of high-yield varieties (Audibert, 2010).**
dist_resid_march	**Distance between the place of residence and most-used health facility in km (1 = less than 5km; 0 = more than 5km)**	**-**	**The further away a health facility is, the more it can affect household productivity and increase the number of households below the poverty threshold (O'Donnell, 2007).**
nat_dist_ins	**Benefit from insurance against natural disasters (1 = yes; 0 = no)**	**+**	**The benefit from insurance against natural disasters improves farmer's productivity and contributes to poverty reduction in rural areas (Barnett, Barrett & Skes, 2008).**

Source of basic data: 2018 CBMS census in selected sites, Togo.