



The Impact of Soil Degradation on Agricultural Production and Food Security in Burkina Faso

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Abstract

Based on a Computable General Equilibrium (CGE) model, the study examines the impact of land degradation on agricultural production and food security using three policy approaches: irrigation schemes, subsidies for agricultural inputs and equipment, and rural infrastructure development (roads and rural markets). These agricultural investment policies are funded through a combination of direct taxes and assistance from technical and financial partners. The results show that land degradation in Burkina Faso lowers Real Gross Domestic Product. Indeed, the agricultural policies that have been implemented have effectively

reversed the negative effects of land degradation on the agricultural sector. However, agricultural policies such as improving the rural road network, expanding irrigation capacities, and reducing costs of acquiring chemical fertilizers and farm equipment are cost-effective measures for farmers. The results show that in the face of production supply constraints emanating from the declining land productivity, the government could, in the short and medium term, focus on extending irrigation schemes and subsidizing agricultural inputs and equipment.

Introduction

Burkina Faso is a landlocked country in West Africa. There has been considerable growth in the economy over the last decade, with an average annual growth rate of more than 6% between 2000 and 2012 (FAO, 2014). Agriculture, livestock, forestry, and mining are the main economic activities. The agricultural sector employs more than 86.0% of the population and represents about 35.3% of the Gross Domestic Product (GDP) and accounts for more than 37.0% of national exports (Monitoring and Analyzing Food and Agriculture Policies - MAFAP, 2013). With nearly 77% of the population living in rural areas and dependent on agriculture for their livelihoods, agriculture plays a leading role in fostering economic growth and reducing poverty, and food insecurity in the country.

The proportion of the population living below the poverty line in Burkina Faso increased from 44.5% in 1994 to 40.1% in 2014, with a poverty incidence of around 47.5% in rural areas and 13.7% in urban areas for the year 2014 (INSD, 2017). Despite decline in poverty and increase in total agricultural production, existing data show that nearly 20% of households experience food insecurity (USAID, 2014). In addition, Burkina Faso is in a precarious situation, with a hunger index of 22.2, placing it the 65th nation among 78 countries (Garrido and Sanchez, 2015), but the dominance of agriculture has also decreased over the years with its contribution to GDP declining from 37% in 2008 to about 30% in 2015 (World Bank, 2018).

Most farmers in Burkina Faso are small-scale producers, with about 72% of farmers relying on less than 5 hectares of land (MAFAP, 2013). Cereal crop productivity is still very low, averaging only 1.14 t/ha between 2010 and 2015 (World Bank, 2019). In addition, only 15% of the country's agricultural land is irrigated, thus making agriculture largely susceptible to rainfall variability (Herrera and Ilboudo, 2012). The low agricultural productivity could be attributed to many factors, including land degradation, small farm size and low-technology use. Land degradation is mainly related to two broad categories of processes, one associated with climate change and the other linked to human activities, mainly change in land use (crop expansion, agricultural intensification, overgrazing and over-exploitation of timber plantations) (Rasmussen et al., 2014; Pimentel et al., 2004).

Recent empirical evidence shows that there is considerable uncertainty about the economic impact of land degradation (Nkonya et al., 2016). The cost of land degradation in West Africa is estimated at US\$ 18.9 billion (Nkonya et al. 2016). Thus, the loss of cereal yield induced by soil erosion is estimated between 5 and 20 million tons per year in Burkina Faso (ELD initiative and UNEP, 2015). More than two decades earlier, Lal, (1995) estimated the reduction in maize yield between 47.48 and 63% for a soil erosion of 5.1 and 20 centimetres in Ouagadougou, Burkina Faso. More recently, Niemeijer and Mazzucato (2002) find that soil erosion and degradation lead to a decrease in agricultural production of 0.5 to 1% in Burkina Faso. In addition, estimates of the direct effects of soil erosion using a biophysical model by Sartori et al., (2019), show a decline in agricultural production of 3,832 thousand tons in Burkina Faso. It is worth mentioning that land degradation affects 34% of cultivated land in Burkina Faso (Hien and CILSS, 2015).

Soil erosion is known to have severe consequences on populations (Panagos et al., 2018). At the international level, soil erosion is one of the main sources of land degradation according to Article 1 of the United Nations Convention on Combating Desertification of 2017. The Government of Burkina Faso, like other countries in the world, recognizes, in the face of continuing land degradation, the need for a stronger commitment to increase the performance of production systems, responding to food needs of her populations, improving farmers' incomes, and ensuring sustainable management of land, livestock and fishery resources. Since 2003, Burkina Faso has made efforts to promote agricultural development and reduce food insecurity by developing Rural Development Strategy (SDR), which was implemented in the period 2003-2010 through the Sub-Sector Action Plan and implemented in the period 2011-2015 by the National Rural Sector Programme (NRSP). The NRSP also considered the rural component in the Accelerated Growth and Sustainable Development Strategy (SCADD), the Comprehensive Africa Agriculture Development Programme (CAADP), the Agricultural Policy of the West African Economic and Monetary Union (WAEMU) and the Regional Agricultural Policy for West Africa. However, the implementation results of the SDR for the period 2003-2010 indicate that actions undertaken have been hampered by weak sector policies and insufficient budgetary programming instruments.

To address these situations, the SDR was reviewed in 2016 and includes four strategic pillars with specific objectives and action points that are translated into a National Rural Sector Programme (NRSP) for the period 2016-2020. The NRSP has a rural component within the National Plan for Economic and Social Development (PNDES). Within the implementation framework of the NRSP, three sector policies have been developed: agro-forestry-pastoral production sector policy; environment, water, and sanitation sector policy; and research and innovation sector policy that runs up to 2025.

The objective of the NRSP is to ensure food and nutritional security through sustainable development of a productive and resilient agro-forestry-pastoral, fisheries and wildlife sectors that are more market-oriented. Thus, the sector policy for agro-forestry-pastoral production for the period 2018-2027 is designed to sustainably increase agro-forestry-pastoral, fisheries and wildlife production and productivity. The specific objectives of the sector policies are: (i) increase production and productivity in the agricultural sector; (ii) improve food and nutritional security; (iii) increase irrigation production; (iv) improve producers' access to agricultural risk management tools; and (v) strengthen the livelihoods of vulnerable households. To achieve these objectives, the government intends to invest 10% of public expenditure in the agro-forestry-pastoral sector. Therefore, what would be the impact of loss of land productivity and agricultural investment options regarding agro-forestry-pastoral production policy on agricultural production and food security in Burkina Faso?

The overall objective of this study is to assess the impact of land productivity loss and subsequent policy interventions; that is, the agro-forestry-pastoral production policy, on agricultural production and food security in Burkina Faso. More specifically, this study first assesses the impact of land productivity loss and then the impact of public investments in irrigation, agricultural inputs and equipment and investments in rural infrastructure (roads and rural markets) on agricultural production and food security.

Considering that policies are designed to counteract the negative effects of land degradation, this paper combines both a soil degradation model and a Computable General Equilibrium (CGE) model. As this type of policy can generate significant general equilibrium effects, the CGE model is the most appropriate tool given that it is able to reconcile the complex general equilibrium effects of decline in agricultural productivity due to land degradation and agricultural investment policy of the government of Burkina Faso. CGE models are comprehensive tools capable of determining the correlations between economic activities and economic operators with given macroeconomic constraints. The analysis uses Burkina Faso's 2013 Social Accounting Matrix (SAM). This study contributes to and informs discussions on the impact of development policies in developing countries. In addition, to our knowledge, there is no study that fully captures these structural impacts of land productivity losses due to land degradation in Burkina Faso.

Agricultural policy and food security in Burkina Faso

Like most developing countries, majority of the population of Burkina Faso lives in rural areas and relies on subsistence farming. GDP per capita is one of the lowest in Africa and more than 40.1% of the population lives below the poverty line (INSD, 2017). Although the agricultural sector, which is key to overall economic performance

and poverty reduction, has grown in recent years, poverty and food security remain critical challenges for Burkina Faso's economic expansion. Agriculture remains largely characterized by low-inputs, and low-yield agricultural systems dependent on rainfall in which droughts periodically reverse performance gains with devastating effects on household food security.

Since the 1970s, food and nutrition security has been a major challenge in Burkina Faso. Drought seasons of 1970-1973, 1983-1984, 1991, 1994, 1998 and 2004 led to loss of livestock, loss of human life and prompted rural exodus. All these factors contributed to the severity of the famine. Recurrent drought has also led to further degradation of agricultural land. In fact, 34% of the production land is degraded, with a degradation progression that went sequentially from 113,000 ha/year between 1983 and 1992 to 360,000 ha/year between 1992 and 2000 to 469,000 ha/year between 2002 and 2013 (MAAH, 2018). In addition, the country's agriculture is characterized by small extensive family farms that occupy 70% of the cultivated areas and provides basic food for majority of the population. However, inflation in food prices has been high since 2008 and has affected access to food.

Famine susceptibility has continued due to inter-community conflicts and prolonged droughts in many parts of the country. Burkina Faso is gradually emerging from a difficult food situation caused by the 2011 drought, which affected 3.5 million people and forced the government to declare a state of national crisis in 2012 (WFP/FEWS-NET/Burkina Faso, 2014). Food prices have remained high since the 2008 food crisis and have contributed to keeping populations insecure in terms of food and subsequently putting them in a precarious situation (Kibora, 2014). As a result, Burkina Faso has become one of the main beneficiaries of international food aid.

Although the country has made progress in terms of food and nutritional security, food shortages continue to be a recurrent phenomenon. Thus, at the national level, 19% of households are food insecure, including 1% in a severe situation in 2014 (WFP/FEWS-NET/Burkina Faso, 2014). According to the 2015 SMART survey, the prevalence rate of undernourishment and stunted growth among children under five years of age are 21% and 30%, respectively, in 2015 (MOH, 2015) and the proportion of poor cereal-growing households in structurally deprived areas remains high at 56.6% for the same period. The economy loses about 7.7% of GDP each year because of long-term effects of malnutrition among children (FIAN Burkina Faso, 2016). Despite reduction in poverty rate over recent years, which fell from 46.1% in 2009 to 40.1% in 2014, the severity of poverty remains very high at 3.3% of the population (INSD, 2016).

For the purposes of sustainably increasing agricultural production and national food security, the Government of Burkina Faso has put in place Agro-forestry-Pastoral Production Sector Policy (PS-PASP, 2018-2027), which outlines three thematic areas of intervention, each with its own strategic objectives and investment plans.

These thematic areas of intervention are: (i) increasing agricultural production and productivity in a sustainable manner; (ii) improving competitiveness of agricultural commodity chains; and (iii) sustainable management of natural resources. The first strategic area is aimed at achieving a sustainable increase in agricultural productivity by providing subsidized agricultural inputs and equipment. Irrigation development is also a major priority of the government with a view to increasing agricultural production and productivity. Furthermore, improving competitiveness of agricultural products will help farmers move from subsistence farming to cash crop farming, mainly by improving rural market infrastructure, rural roads, and marketing systems.

To achieve the various thematic areas of intervention and strategic objectives requires efficient allocation of public resources and appropriate implementation of investments. Additionally, in recent years, the bulk of support to the agricultural sector has been directed towards agriculture-specific expenditures for the improvement of production, productivity, and food security. Table 1 shows the evolution of public expenditure on agriculture between 2008 and 2016. Data from Yameogo et al. (2017) indicate that agriculture-specific expenditure increased between 2008 and 2016, with a fluctuation between years (Table 1). Nevertheless, spending on agriculture has declined from its 2008 level. For the year 2013, Table 1 indicates that 67.2% of public support to agriculture goes to agriculture-specific expenditures (payments to employees in the agricultural sector and general support to agricultural sector) and 32.8% is directed to expenditures in promoting agriculture (such as rural infrastructure, health, or rural education). In 2013, development of rural infrastructure accounted for 85% of agricultural expenditure.

Table 1: Evolution of public expenditure (%) on agriculture between 2008-2016

	2008	2009	2010	2011	2012	2013	2014	2015	2016
Specific expenditures on agriculture	51.0	48.2	59.3	74.9	69.6	67.2	74.5	79.8	71.7
Payments to employees in the agricultural sector	60.9	57.7	47.4	42.7	57.3	64.8	56.2	61.5	60.1
General support to the sector	39.1	42.3	52.6	57.3	42.7	35.2	43.8	38.5	39.9
Spending on agriculture	49.0	51.8	40.7	25.1	30.4	32.8	25.5	20.2	28.3
Rural infrastructure	32.3	41.5	45.4	79.4	85.9	85.0	59.8	55.3	60.7
Other support to the rural sector	67.7	58.5	54.6	20.6	14.1	15.0	40.2	44.7	39.3

Source: Yameogo et al. (2017)

Specific expenditures on agriculture include payments to agricultural employees (including producers and consumers) and general support to the agricultural sector including agricultural research, technical assistance, training, extension services and agricultural infrastructure (irrigation, access roads, etc). For the year 2013, payments to agricultural employees represented 64.8% of specific agricultural expenditure, while

activities such as agricultural research, technical assistance, training, extension, and agricultural infrastructure consumed 35.2% of this expenditure heading. Producers receive payments in the form of input subsidies (seeds, fertilizers, agricultural capital, technical assistance, and extension services), which account for 85.1% of the total payment to staff in the agricultural sector.

There are two main sources of funding for public expenditure in the agricultural sector: donor aid and domestic resources. Donor aid is an important source of Burkina Faso's budget. In the last ten years, capital expenditure has been largely supported by external aid (loans and grants), accounting for 53% between 2006 and 2015 (Yaméogo et al., 2017). Between 2014 and 2015, donor-financed public expenditure was low at 12% and 18%, respectively. Between 2008 and 2013, external aid financed an average of 62% of public agricultural investment expenditure (Yaméogo et al., 2017). Moreover, between 2012 and 2015, external aid accounted for 25% of agriculture-specific expenditure and 40% of spending on agriculture. External aid is much more oriented towards spending on agriculture, particularly on rural education and rural infrastructure such as rural roads, rural energy, water, and sanitation, among others. The proportion of public spending on rural health covered by external aid rose from an average of 10% between 2006 and 2008 to 46% between 2012 and 2015 (Yaméogo et al., 2017). Expenditure on marketing and storage promotion is largely financed domestically.

Conclusion and policy implications

This study uses a Computable General Equilibrium (CGE) model to explore the potential impacts of soil degradation on agricultural production and food security by implementing three intervention options regarding agro-forestry-pastoral sector policy of the Government of Burkina Faso. Thus, four simulation scenarios were tested. The first scenario deals with the effects of reduction of land productivity. The last three scenarios deal with policy options to control soil erosion. The policy options relate to: (i) rural infrastructure development policy (roads); (ii) agricultural input and equipment subsidy policy; and (iii) irrigation extension development policy. The following conclusions can be drawn from the results:

In general, policies analyzed have shown significant impacts on food production, consumption, and security. The benefits are significantly greater for urban households, demonstrating the positive role that these policies can play on agricultural production and food security.

A comparison of agricultural policies shows that development of irrigation effectively resolves the problem of soil erosion through increased household production and consumption, followed by policy regarding subsidies for agricultural inputs and

equipment, and finally development of rural infrastructure (roads, markets, storage, and extension stores). This suggests that for Burkina Faso, where supply is limited, it is more effective in the short term to focus on agricultural production and on interventions aimed at subsidizing agricultural inputs and equipment to improve productivity and food security. In the medium term, focus on irrigation development and long-term focus on rural infrastructure development are essential aspects.

Regarding the sources of financing for required interventions, mobilization of internal and external resources for financing of agricultural policies gives better results, especially for rural infrastructure development policies and irrigation development, and we also note that the financing of these projects through mobilization of new funds via taxation could have favourable effects on production and food security. In summary, while input subsidies are a rapid and short-term instrument to achieve rapid agricultural growth and improved food security, the medium - to long-term solution to increase food security lies in further development of irrigation, as access to irrigation can also help reduce the risk of crop failure in times of climate change.

Finally, although these results provide insights into the adverse effects of land degradation on agriculture and the effects of agricultural policies, there are limitations to the study. Firstly, the methodology used does not fully address the uncertainty associated with land degradation. Second, alternative strategies for adaptation to land degradation exist, and the paper did not consider them despite their possibility that they could have beneficial effects on agriculture. Finally, it is not possible to determine the optimal way to finance agricultural policies.

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