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The impact of water-pricing policy on the demand for water resources by farmers in Ghana

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ABSTRACT

Water scarcity has become a worldwide phenomenon as a result of climate change. For that reason most countries are adopting various measures to reduce the impact of water scarcity on their agricultural sector and Ghana is no exception. Ghana's agricultural sector is the backbone of the rural economy in the country. The agricultural sector employs about 90 percent of the rural population and contributes extensively to the GDP of the country. But, low productivity and inefficient water use have resulted in a significant threat to the livelihoods of the rural population. The paper used a programing model named MATA (Multi-Analysis Tool for the Agricultural Sector) to achieve the stated objectives. The main objective of the study was to find out the impact of water-pricing policy on the demand for water resources by the farmers in relation to their cropping activities and income. The results of the study indicated that water-pricing policy has a negative impact on the demand for water resources in Ghana. But this impact happens only when water prices are increased significantly. However, if water prices are high it has a negative impact on cropping activities, farmers' income, employment and crop varieties. Hence the study recommends that in order to at least reduce water wastage in the sector, it be proposed that a price (around 2 cedi/m^3) might be of significance in order to make farmers conscious of the scarcity of water resources, and to persuade them to adopt water saving technologies without affecting crop distribution. The study also recommends that water-pricing policy should not be used as a policy tool on its own but should be used together with other water saving policies in order to achieve the best results.

1. Introduction and problem statement

In Ghana, the agricultural sector is one of the most important sectors in the Ghanaian economy. This is mainly because the sector is a major contributor to the livelihood of the rural population. The sector employs about 80 percent of the rural population (MOFA, 2010) and contributes directly to food security and also to economic growth through its extensive contribution to foreign exchange earnings, employment in the formal and informal sectors and also serves as the key source of raw materials to the agro-based industry in the country. In the early 2000s the agriculture sector was the highest contributor to GDP, but its contribution to GDP has dwindled over the years, from 36 percent in 2005 through 35.4 percent in 2006, to 22.7 percent in 2012 (ISSER, 2013).

In Ghana the agricultural sector is characterized by two main season, the raining and dry seasons. During the raining season, farmers depend on rainfall for farming but during the dry season, farmers tend toward the use of irrigation for their farming practices. As observed by Faulkner et al. (2008) in the study of small irrigation reservoirs in the Upper East Region of Ghana, irrigation serves a vital role in the life of farmers since without the alternatives of irrigation, many farmers would be forced to travel from their homes to labor elsewhere especially during the dry season. Irrigated agriculture in Ghana is accountable for about 30 percent of agricultural production in the country. Within Ghana, water demand for irrigation in the year 2000 has been estimated as 652 million cubic meters per year (MCM), compared with 235 MCM for domestic use. With a total cultivated irrigated land area of 30,345 ha in 2012 (MOFA, 2012) irrigation is the dominant source of consumptive demand of water resources in the country.

With the current growth rate in the Ghanaian population with its consequent impact on the demand for the water resources as a result of urbanization, Ghana is becoming progressively scarce of water as future demand is coming close or even surpassing available supply of water resources. If care is not taken Ghana will soon be classified as a country with severe water stress if its population

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continues to grow at its current rate (3.3 percent) and water use efficiency is not increased effectively (Mualla and Salman, 2002).

In 1983, the country experienced severe drought that led to hunger and death of some of its populace. A study by Kasei (Kasei et al., 2009), has also projected future drought in the next ten years. This empirical evidence demonstrates the water scarcity potential in the country and of the vulnerability of irrigated agriculture to a reduction in water resources.

Efforts at addressing the potential water scarcity problem have focused on the supply side of water development. Water managers and planners have given high priorities to allocating, developing, and managing new water resources while demand management and improvement of patterns of water use has received less attention in Ghana. The growing concern among researchers and policy makers of the continuous global growing demand of water by agricultural sector (FAO, 1995) have however resulted in some analysts like Frederick (1993), Ahmed (2000) and Louw and Kassier (2002) embracing demand management as a mean to solve the current water crises. Water pricing is considered as one of the tools in the demand management approach (Reddy, 2009). Economists in the 1990s have emphasized the importance of treating water as an economic good (World Bank, 2003; Molle and Berkoff, 2007), and the waste of water as a result of underpricing.

Water pricing within irrigated agriculture as surmised by Molle and Berkoff (2007) can be used as a mechanism for cost-recovery; economic tool to elicit desirable crop or technological shift; and environment tool to promote sustainable ecological values. Judging the allocation of water from an economic perspective, the World Bank's Water Resource Management Policy Paper (World Bank, 1993), noted that the waste and inefficiencies within the irrigation sector has been as a result of the frequent failure to use pricing among other instruments to manage the demand and allocation of water. The introduction of pricing may therefore reduce water wastage and the inefficient use of water.

Though there is an increasing consensus on the potential benefits of water pricing, there are issues relating to the impact on labor. Berbel and Gomez-Limon (2000) in their paper on the impact of water pricing policy in Spain, noted that pricing of water causes a serious reduction in farm labor since farmers respond to price increases by reducing water consumption through changes in crop plans, introducing less profitable crops to substitute for higher value/higher, crops with high water demand.

Also another study by Gómez-Limón and Riesgo (2004) on irrigation water pricing, found that on the basis of their results, one might conclude that water pricing impacts differently on farmers in relation to their natural resource. The effects of irrigation water pricing thus vary significantly depending on the group of farmers. Nevertheless, some general conclusions can be outlined. One conclusion that is directly relevant to this study is that pricing irrigation water will lower farmers' incomes as a consequence of transfers of revenue to the State and changes in crop plans.

In view of the above possible impacts of pricing water, there is a need for a comprehensive water policy for Ghana's future water resources that will not only address the increases in agricultural water demand, but also reduce the inefficiencies in water use, as well as increase income and production within the agricultural sector. And that is what this study opts to do.

The main objective of the study is to estimate the economic, social and environmental impact of a water pricing policy in Ghana. This study being the first of its kind in the area of finding innovative policies provides decision makers with information on which policies are very efficient in water management and allocation, in the light of rampant water shortages and dropping water levels in Ghana. It also contributes to the ongoing debate with respect to sustainable agricultural development in the Sub-Saharan region.

2. Methodology

For this study the methodology used is a programing model. This model is recursive dynamic and a partial equilibrium sector model. The MATA model as it is known is a Multi-Level Analysis Tool for the Agricultural sector which takes into consideration price expectation and risk attitudes of farmers in agricultural decision making (Gérard, 1998). The MATA model is programed using GAMS computer language and utilizes non-linear optimization based on the numerical solver CONOPT3.

The original MATA model consists of three modules; the Consumption Module that describes the behavior of processors of agricultural products and the behavior of consumers, the Macroeconomic Module which describes the environment in which farmers, processors and consumers make decisions, and the Production Module which represents production decisions at the farm level. These modules virtually describe the flow of food from the farm gate to the consumers. In this study however, the MATA model has been improved by the addition of a fourth: The Water Simulation Module which is the value added to the original MATA model. In order to consider the impact of water demand on the agricultural sector in Ghana, water supply variables were considered and incorporated into the model as important constraint variables. The water simulation module was also incorporated as a result of recent climate change conditions affecting the agricultural sector in Ghana. The four modules described above are linked together. But for purposes of this particular study, the water demand module that simulates the demand for water by various production activities in the agricultural sector in the country will be the only part of the model that will be used.

In general the MATA Module has been found to be useful for analysing policy impact and can serve as a decision support system for policy makers, allowing for a multi-disciplinary approach to the problem of policy formulation since it integrates the knowledge of different disciplines involved in the agricultural sector. The module can be adapted to different contexts and situations (Deybe, 1998). In spite of its usefulness, Deybe also identified some limitations of the MATA Module, one of such is the fact that the use of this module requires large amount of data on the different production systems and farmers within a region of study.

2.1. The agricultural production module

First, for the production module, the study areas were zoned in order to define homogeneous areas in terms of socio-economic and agro-climatic environments. Following this zoning representative farm zones were derived based on their endowments of resources such as land, labor, capital and management. Each representative model farm simulates farmer management decisions based on a non-linear programing model. As a result of the vulnerability nature of agricultural production in the country, a high level of risk is associated with agricultural production. Therefore, overlooking risk-in any agricultural sector model often leads to results that bear little relation to the decision small and semi-subsistence farmers make in relation to the risk aversion behavior of the farmer.

For this study, a von Neumann–Morgenstern expected utility function is used to integrate risk into the model by combining income and risk aversion coefficient (De Frahan et al., 2007). It is assumed that each farmer chooses a set of activities that maximize the expected utility of Income, given the constraints that he/she faces, similar to the approach used by Erwidodo and Gérard (1997). Following Markowitz (1959), it is assumed that farmers' attitudes to risks are analyzed using the income mean-variance framework. The mean-variance framework assumes that the preferences of a farmer among various possible plans are based on expected income $E[R]$ and its associated variance $V[R]$.