# PRODUCTIVE EFFICIENCY IN WATER USAGE: AN ANALYSIS OF DIFFERENCES AMONG FARM TYPES AND SIZES IN GEORGIA

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REFERENCE: *Proceedings of the 2009 Georgia Water Resources Conference*, held April 27–29, 2009, at the University of Georgia

**Abstract.** Water management in agriculture received much attention from researchers and managers, but the factors affecting variability in the productive efficiency of water usage among farmers has been historically neglected. It is important that these factors be analyzed in order to evaluate the effectiveness of future policies. The research presented in this paper considers eight voluntary or mandated quantity- and price-rationing policy alternatives targeting the reduction of water usage among farmers in Georgia. Using a contingent behavior survey, differences in intra-agriculture water usage are analyzed along two dimensions: farm type and farm size. It is hypothesized that additional productive efficiency with water is accounted for in alternative agricultural practices, such as organic and conservation tillage, compared to conventional agricultural practices, and that increasing farm size also yields improved water productivity and irrigation efficiency.

## INTRODUCTION

Because of the recent drought in Georgia, policy makers have increased the push for improved water management. Many options have been discussed though few have attained statewide consensus. In developing a plan, it is crucial to understand current water use patterns of the economy at large, individuals' behavior towards the use of water, and to what policy incentives a given population will alter behavior to a more efficient solution. Because of limited irrigation water monitoring, agricultural water use is perhaps the least understood.

Large and small farms often have different objectives and motivations when engaging in farming, and therefore their observance of water productivity is disparate when appropriate pricing and other policies are in place. In terms of water usage measured on the basis of average number of hours irrigated per acre, large farms are more efficient while small farms tend to be less efficient (Skaggs and Samani, 2005). Organic farms typically are categorized within the small farm classification but emphasize a management methodology of sustainability. Relatively little is known on the degree to which water use on organic farms is efficient in practice. In turn, farm level policies must respond to the different objectives of the identified farm characteristics.

## BACKGROUND

Economists widely accept that financial incentives, whether it be water trading opportunities or increased water rates, are an effective means of reducing water consumption in agriculture (Schoengold, et al., 2006). Conversely, other studies have shown that there is no significant demand response to modest price changes, indicative of an inelastic demand, largely a result of those water delivery systems that are highly subsidized (Garrido, 2001, Jones, 2003). In most cases, this subsidization rises when the price of water increases and mitigates the change of the real price of water. Georgia's farmers face a cost of water that includes no component of the inherent scarcity of water. By using pumping costs as a proxy for the price of water in Georgia, Gonzalez-Alvarez et al. (2006) found farmers decrease water use by 2.4 acre inches per $50 increase in pumping costs based on a mean pumping cost estimate of $21.54. Multiple authors have shown that the effect of an increase in the price of water on the adoption of water conserving irrigation technologies by farmers is positive (Caswell and Zilberman, 1985, Caswell and Zilberman, 1986, Hayami, et al., 1985, Kanazawa, 1992).

On the issue of policy-lead water management in agriculture, a number of demand-side policy options exist. Broadly defined, these policies are price-rationing policies, quantity-rationing policies that set maximum quantities individuals and firms may extract, and demand-shifting policies that come in a variety of different structures (Griffin, 2006). There are fewer opportunities to increase the supply of water as the existence of ground water reservoirs are known (though not fully quantified) and the damming of rivers to create surface reservoirs has been plagued with unintended environmental consequences and high costs. While responses to these policies can be modeled according to economic theory (Weinberg, 2002), the presence of significant differences between firms with respect to their characteristics raises concern in regard to the accuracy of broadly modeled scenarios on specific groups of water users. For example, these models fail to explain how differences in a farm's business structure, such as family farm or corporation, effect policy responses.

One study that assessed this concern over intra-agriculture water use variability, found, through interviews and a comparison of hours irrigated per irrigation event, that the smallest farms lacked interest in improving their current, inefficient irrigation systems or methods in New Mexico (Skaggs and Samani, 2005). The findings were attributed to the prevailing characteristic of small farms--residential/ lifestyle/ retirement agriculture environment in which profit is not a discernable motivation for farming--such that irrigating is viewed as a cost of living/recreation as opposed to an operational business expense as realized by larger, commercial farms.

Norman et al. review that the factors which are external and internal to the farm, and influence farmers' practices relating to water management, are not well understood, particularly at the smallholder irrigation level within the context of agricultural development (Norman, et al., 2008). ). In both developed and developing countries, it was found that farm level allocation of labor between agriculture and other economic pursuits is correlated with irrigation efficiency; there exists a negative relationship between off-farm income and irrigation efficiency (Abernethy, et al., 2000, Skaggs and Samani, 2005).

## METHODS

This study uses researcher collected survey data on organic farms, conventional farms, and other farms practicing alternative agricultural techniques in order to investigate differences in water use decisions between farmers with different agricultural methods. Approximately 500 total farms were surveyed, across the state, with conservation tillage[1] and organic[2] farms accounting for more than half of the total sample. Each survey participant was asked questions concerning farm demographics, production information, and water usage decisions. Using this information, a Tobit model was developed to estimate the causal effect of farm type (*FARMTYPEDUM = 1* for conventional) and farm size (*SIZE*) hours irrigated per acre as in equation A:

**A.**

$$HOURS_i = \beta_0 + \beta_1 X + \beta_3 FARMTYPEDUM_i + \beta_3 SIZE_i + \varepsilon_i$$

In addition, the survey asked each farmer surveyed to rank eight policy options in order of preference, and then respond to a series of questions regarding the impact of a particular policy on irrigation, production output, crop selection and management decisions should it be enacted. A short description was included for each of the eight policies: (1) quota, (2) one day a week watering ban, (3) one week a month watering ban, (4) water pump monitoring, (5) subsidy for improving irrigation efficiency, (6) regional 80% irrigation efficiency requirement, (7) water pricing, and (8) water market. These results were similarly analyzed to determine the effect of a particular policy on hours irrigated per acre and production output (*Q*) as represented in equations B and C:

**B.**

$$[(HOURS]_i - HOURS_{i_p}) = \beta_0 + \beta_1 X + \beta_2 FARMTYPEDUM_i + \beta_3 SIZE_i + \varepsilon_i$$

**C.**

$$[(Q]_i - Q_{i_p}) = \beta_0 + \beta_1 X + \beta_2 FARMTYPEDUM_i + \beta_3 SIZE_i + \beta_4 [(HOURS]_i - HOURS_{i_p}) + \varepsilon_i$$

## DISCUSSION

Previous research has found significant statistical differences between large and small farms with regard to water use decisions because of farm-level characteristics, but this research has not explored what, if any, of the variance in water usage can be attributed to differences in agricultural methods. Because of this gap in knowledge related to the factors which are external and internal to the farm and the subsequent effect of these factors on water management practices, this research will seek to quantify the internal factors' effect on water usage. This information is important if future policy to be effective in addressing water usage productive inefficiencies.

The importance of the research presented here is clear given the recent pattern of drought in Georgia. The results are particularly relevant for policy makers interested in regulating agricultural water use. For more academic audiences, research pertaining to alternative farms, particularly organic farms, is extremely limited due to data availability, and this study serves as an important step in moving the body of literature forward by economically analyzing water use decisions of this group. GIS will allow for the collection of climatic and edaphic factors specific to each farm. More generally, a careful analysis of differences among conventional farms will also serve to develop a better understanding of the external and internal factors affecting water efficiency.

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[1] Conservation tillage n=179

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