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Citrus supply response in Kyoga plains agricultural zone, Uganda

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ABSTRACT
Citrus is a high value crop with great potential in Uganda. Of the various types grown, orange fruits constitute the top most cash income earner among smallholders in Kyoga Plains Agricultural Zone in eastern Uganda. However, its supply has been characterized by low quantities thus limiting the smallholder benefits from opportunities offered by the increasing market demand. This study aimed to quantify the effect of socio-economic, institutional and infrastructural factors on citrus supply so as to provide a guide to strategic interventions and production planning. Based on cross-sectional data estimates of OLS model, findings showed that market access, institutional belonging, mobile phone/contact, investment and fertiliser affect citrus supply response. Institutional belonging, mobile phone and fertilizer elicited the highest magnitude of effect on supply response and as such could be prioritized for strategic interventions.

Key words: Citrus, market demand, oranges, Uganda

RÈSUMÈ
Les agrumes sont une culture de grande valeur avec un grand potentiel en Ouganda. Parmi les divers types cultivés, les fruits orange constituent la principale source de revenus en espèces parmi les petits exploitants de la zone agricole de la plaine du Lac Kyoga, dans l’est de l’Ouganda. Cependant, son offre a été caractérisée par de faibles quantités, limitant ainsi les petits exploitants des opportunités offertes par la demande croissante du marché. Cette étude visait à quantifier l’effet des facteurs socio-économiques, institutionnels et infrastructurels sur l’approvisionnement en agrumes afin de fournir un guide pour les interventions stratégiques et la planification de la production. Sur la base des estimations de données transversales du modèle des Moindres carrés Ordinaires (MCO), les résultats ont montré que l’accès au marché, l’appartenance institutionnelle, le téléphone portable / contact, l’investissement et les engrais affectent la réponse de l’offre d’agrumes. L’appartenance institutionnelle, le téléphone portable et les engrais ont suscité le plus grand effet sur la réponse de l’offre et, en tant que tels, pourraient être prioritaires pour les interventions stratégiques.

Mots clés: Agrumes, demande du marché, oranges, Ouganda

INTRODUCTION
Citrus is an important diversification crop grown in all parts of Uganda except Karamoja. The common types grown include the sweet orange, lemon, lime and tangerine. Sweet orange farming in particular is a priority enterprise among smallholders in Kyoga Plains Agricultural Zone in Eastern Uganda. Although countrywide production data is missing, it is evident that production has steadily risen (Kongai, 2017). For instance, in Teso sub-region alone, orange fruits output was expected

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to rise from 360,000 metric tons in 2011 to 826,000 metric tons in 2016 (UDC, 2012). The steady rise in production could be attributed to the development and promotional support accorded to the enterprise by the Government and other development partners (PMA, 2009; UDC, 2012; Kongai, 2017). In spite of this the crop's production is still characterised by low marketed quantities (Kongai, 2017), consequently smallholders fail to benefit from the opportunities offered by the expanding market. This study sought to determine and quantify the effect of socio-economic, institutional and infrastructural factors on citrus supply response in Kyoga Plains Agricultural Zone in Uganda. The supply response estimates can be used to deduce farmers' reaction to a number of factors in making planting and removal decisions (Kinney *et al.,* 1987). The estimates can also provide information on the impact of incentives and adopted policies on production (Mohammad *et al.,* 2007).

Supply response theory stipulates that the quantity of a commodity supplied directly relates to its price (Agarwal, 2008). When price increases the quantity supplied also increases implying that the quantity of a commodity supplied at a given time depends mainly on its price. Based on this theory, most agricultural development policies previously focused on price controls as the main stimulant to supply (Abrar *et al.,* 2002; Renting, 2013). However, non-price factors dominate farmers supply decisions (Mythili, 2006). Azam *et al*. (2012) argue that farmers' planting and marketing decisions are primarily governed by traditional behaviour and practices. On the other hand Arnold (2005) observed that agricultural supply response is affected by prices of relevant resources, technology, number of sellers, expectation of future prices, taxes, subsidies, weather and government restrictions. Studies assessing the effect of agro-ecology and technology on supply response also reported that agro-ecology and technology significantly affect supply response (Savadogo *et al.,* 1995; Abrar *et al.,* 2002). Limited irrigation, illiteracy, limited access to input and output markets, and high transaction costs have particularly been reported to lead to low supply response (Mythili, 2006). Besides, land quality, weather and infrastructure affect supply response (Abrar *et al.,* 2002). Women's participation in cash crop supply in particular has been found to depend on the prevailing farming systems (Evers and Waters, 2000). A study in Punjab, India showed that price, irrigation and rainfall affect crop supply (Mohammad *et al.,* 2007) while in Ethiopia female headed households responded to price incentives as strongly as male headed households, but the responsiveness varied according to type of crop and relative importance of the binding constraints (Suleiman, 2004). Lin and Dismukes (2007) similarly observed that animal traction and land access positively affect output, but land quality affected output supply among female headed households. Credit and technology have also been shown to generate a larger supply response than price and trade incentives such as changes in the level of import tariffs (Barrett, 2010). It is also argued that variables corresponding to expectations such as prices, revenues and profits need to be included in supply response modeling (Soontaranurak, 2011). Besides, agricultural supply is affected by past decisions which usually are a function of current and future expectations of economic circumstances (Soontaranurak, 2011).

Supply response measures the degree of change in production and/ or marketed quantities in response to change in some important variables (Kavinya and Phiri, 2014). It explains the behavioural changes of producers with respect to production, consumption and exchange decision of a product/products due to changes in economic incentives (Nkang *et al.,* 2007). Estimation of agricultural supply response has mainly been done using yield or area as dependent variables (Sadoulet and de Janvry, 1995; Bangura 2002). However, Rudaherwana *et al*. (2003) observed that farmers adjust price to desired output levels not acreage. So, the level of output can be changed without changes in acreage due to different degrees of crop husbandry care or weather variations. Besides, post-planting shifts in prices may induce shifts in harvesting as opposed to planting decisions. In spite of these observations, acreage (area) is still considered the most appropriate proxy for supply response estimation because acreage, unlike output, is not influenced by external shocks that occur after planting (Haile *et al.,* 2016). Therefore the objective of this study was to quantify the effect of socio-economic, institutional and infrastructural factors on citrus supply so as to provide a guide to strategic interventions and production planning.

MATERIALS AND METHODS

Time series, panel or cross sectional data has previously been used for estimation of supply response elasticities. The analytical approaches used varied according to the nature of variables, parameters of interest and/or availability of data. Generally, in Uganda, citrus production data is largely missing (Ekesi, 2011; Kongai, 2017). Consequently, this study estimated the effect of technical, socio-economic and environmental factors on citrus supply using cross sectional data. Ordinary least squares (OLS) estimation technique was used for parameter estimation. Drawing from (Woodridge, 2002) the estimated supply response function was specified as:

$$Y_i = f(It, Ib, A, Q, T\ Ix, S, P_{t-1}, M, E) \qquad \text{i}$$

Y_i refers to hectarage (dependent variable), It; information technology (mobile phone), S; gender, Ib; institutional belonging, Ix; investment costs, T, technology P_{t-1}; lagged price of oranges, Q; Output, M; market access, E; income source and A; age of household head (Table 3.2). Hectarage (Y) is a function of several variables in which case the estimated OLS model is specified as:

$$Y_i = \beta_0 + \sum_{i=1}^{I} \beta_i X_i + e_i \qquad \text{ii}$$

For simplicity, investment cost refers to price of orange plantlets, where in this case βo, hectarage allocation holding all other variables constant and βi, parameter (elasticity) estimates. The error term was assumed to follow a normal distribution and uncorrelated over time. The OLS model was adopted to account for the between district responses to the independent variables. Unlike other regression models, OLS can be run even if the data has some missing values, a limitation associated with the data used in this study.

Study area and sample. The study was carried out in Kyoga Plains Agricultural Zone, where citrus farming is a priority strategic enterprise (PMA, 2009; UDC, 2012, Kongai, 2017). The Zone has a flat terrain with isolated hills and shallow valleys. It experiences two rain seasons in a year. The main season runs from March to May with peak in April and second season from August to November with a peak in October/ November. The zone covers Kaberamaido, Soroti, Kumi, Pallisa, Kamuli, Kayunga, Iganga and parts of Tororo, Busia, Bugiri, Apac and Lira districts. Citrus production is intense in Bukedea, Kumi, Soroti, Katakwi, Amuria and Kaberamaido districts (PMA, 2009). So, the study was carried out in Kaberamaido, Kumi and Soroti districts.

The study sample was selected using multistage sampling design to ensure identification and selection of respondents with knowledge and experience in citrus production and marketing (Proctor *et al.,* 2009; Palinkas *et al.,* 2015). It involved purposive selection of the zone and districts in which citrus production was intense (PMA, 2009). The selected districts comprised of Soroti with 10 sub-counties, Kumi with 7 sub-counties and Kaberamaido with 9 sub-counties. The study considered the greater Soroti and Kumi districts which also covered the current Serere and Ngora districts, respectively. The sub-counties were randomly selected resulting in sampling of 12 sub-counties included in the study. The total number of households in the study area was 21,051 disaggregated as 6,000, 7,051 and 8,000 households in Kaberamaido, Kumi and Soroti districts, respectively. Respondent households were selected using a blend of random and Respondent Driven Sampling (RDS) criteria because generating sampling frames would yield strategic lists. RDS is a sampling approach that yields efficient and robust outcome in the sampling of hard-to-reach populations. It incorporates numerous theoretical assumptions borrowed from several disciplines thus reducing the numerous biases found in standard snowball sampling methods (Johnston and Sabin, 2010). RDS facilitated selection of citrus farmers with knowledge and experience in citrus farming as a business, while random sampling ensured inclusion of respondents from each of the target sub-counties and far to reach areas. Given that the population of citrus farming households in the study was 21,051 (PMA, 2009) and using the precision level of 0.05, a total of 446 households were included in the study.

The data collection procedure involved interviewing one adult (preferably the household head) per household. To ensure estimation of consistent and efficient model parameters, the data were subjected to various diagnostic tests. Box plots of orange fruits hectarage, seed cost, sales, output price, household size and age of household head were generated with the aim to understand the structure of the data and check for outliers. Results showed that apart from price and age of household head, other variables' approximated normal distributions (see Figure 1). Sales and size of household head had a few outliers, but

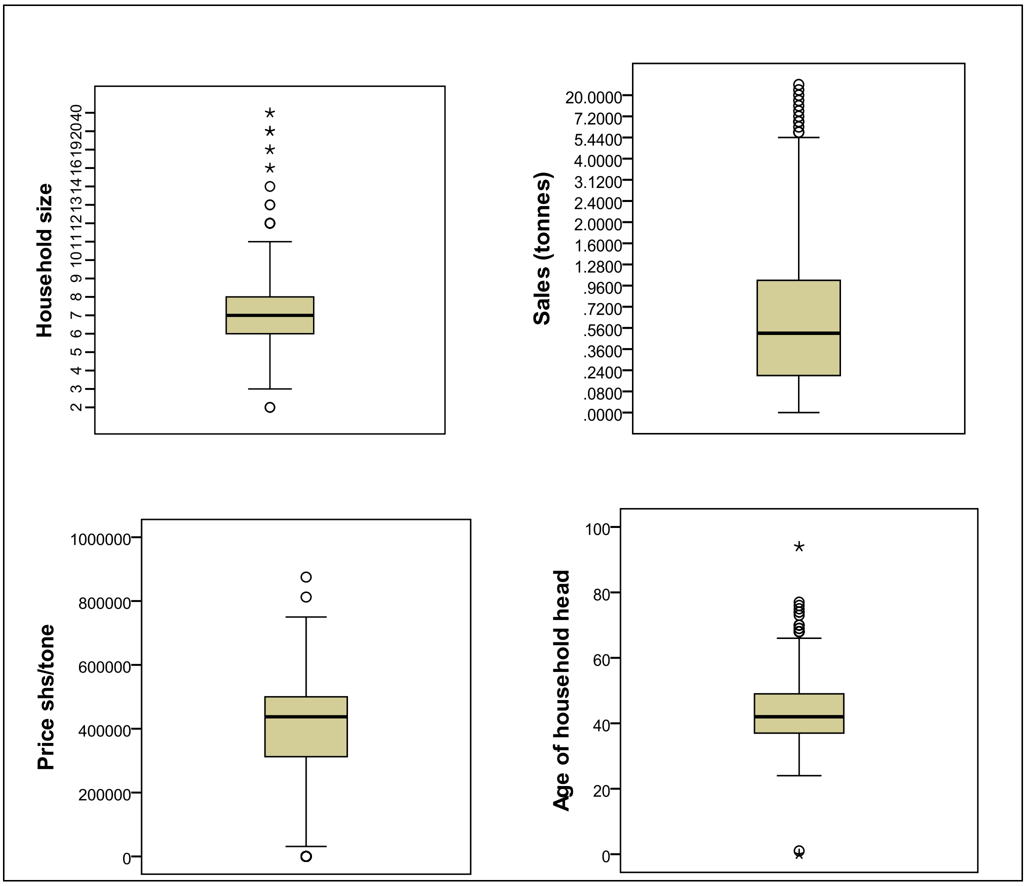

Figure 1. Box plots of household size, sales, price and age of household head

the medians were approximately located in the second quartile. The outliers were removed from the estimated model because the parameter estimates found to be more realistic compared to those with outliers.

Variables correlation coefficients were also generated and examined to obtain understanding of association amongst variables. Results showed that mobile phone, quantity of output, quantity of sales, total number of trees, fruiting trees, seed cost, cost of equipment, age of household head, output price, institutional belonging, household size, improved technology, fertiliser and market information had positive association with orange fruits hectarage. Gender of household head, farming, family labour and access to extension surprisingly had negative association with hectarage. The output variable was found to be highly correlated with total trees and fruiting trees so the two variables were dropped from the estimated model while seed cost was used to represented investment. Output price and age of household head data were transformed into natural logs with the aim to minimize the effect of data anomalies in estimation. The variance inflation factors (VIF) values after regression were examined, all values were found to be below the threshold of 10 thus minimising multicolinearity.

RESULTS AND DISCUSSION

Descriptive results showed that on average each household allocated 0.43 hectares of land to orange fruits farming. About 57, 23 and 20% of the households managed 100, 101 to 200 and over 200 orange trees respectively. Majority (60%) of the respondents used organic fertilizer to improve soil fertility in their orchards. The limited use of inorganic fertilizer could be attributed to limited access to or lack of agrochemicals as well as limited resources for inputs procurement. Similarly, a study in Kenya observed that limited market access constrained farmer's use of appropriate inputs (Kamara, 2004). Fertilizer prices have also been found to affect their use in smallholder production systems (Pandey *et al.,* 2012). Respondents unanimous indicated that they experienced pests and disease attack and about 70% of them used pesticides and fungicides for pests and disease management, but on irregular and indiscriminate basis (Table 1).

On comparing agrochemical usage across districts, Kumi farmers used more agrochemicals compared to their counterparts in Soroti and Kaberamaido districts. This could be because Kumi soils have been depleted and that farmers are aware that without improving the soil, they cannot expect good harvests. Overall, the citrus enterprise is a self-employment undertaking as majority (over 90%) of the respondents employed family labour for orchard management. Indeed, citrus farming in the area of study was done under basic farm management practices.

Supply response model estimates. OLS model estimates were generated using cross-sectional data. The model's statistical test of significance is the R^2. Based on the goodness of fit measured by adjusted R^2 the model explained 60% of the variation in orange fruits hectarage as shown by the value of the adjusted R^2(0.6008). Results showed that output, market access, mobile phone/contact, seed cost, institutional belonging, fertiliser and investment significantly affect citrus supply.

Table 1. Agrochemicals and irrigation technology usage in orange farming in Eastern Uganda

	Soroti		Kumi		Kaberamaido		Total	
	F	%	F	%	F	%	Used %	Did not use %
Pesticide and fungicide	172	38.6	175	39.2	79	17.7	95.5	4.5
Fertiliser	153	34.5	172	38.6	79	17.7	90.6	9.4
Inorganic fertilizer	28	6.3	72	16.1	36	8.1	30.5	69.5
Irrigation	14	3.1	7	1.6	0	0.0	4.7	95.3

Table 2. Estimates of orange fruits hectarage response

Variable	Coefficient	Standard Err	t-value	P-value
Output 2009 (Qt-1)	0.00003***	4.39e-6	6.97	0.000
Institutional belonging	0.04683*	0.02265	2.07	0.039
Gender	0.02501	0.03652	0.69	0.494
Household size	0.00634*	0.00373	1.70	0.090
Age of household head	0.00186*	0.00102	1.82	0.070
Output price (Pt-1)	0.00468	0.03353	0.14	0.889
Main income source (farming)	-0.02717	0.02717	-1.27	0.204
Extension advice	-0.00107	0.02233	-0.05	0.962
Fertiliser use	0.09262**	0.03688	2.51	0.012
Output 2010 (Qt)	-0.00001***	1.01e-6	13.49	0.000
Location (Kaberamaido)	0.01137	0.02720	0.42	0.676
Investment (seed cost)	1.08e-6*	5.83e-8	18.58	0.000
Pesticide use	0.05434	0.04611	1.18	0.239
Weeding frequency	0.00310	0.00830	0.37	0.709
Mobile phone	0.08037*	0.02057	3.91	0.000
Constant	-0.10851	0.21845	-0.50	0.620
Prob > F0.000				
R-squared	0.6157			
Adjusted R-squared	0.6008			

*** = p<0.01; ** = p<0.05; * = p<0.10

Non-price factors generally elicit the highest response to orange fruits hectarage. For example, possession of a mobile phone/contact leads to 0.08037 unit increase in orange fruits hectarage. This could be because mobile phones constitute main information dissemination tool in rural and remote areas that have some modern telephone connectivity. Bayes (2001) while sharing insights from a Grameen village phone initiative in Bangladesh observed that rapid and effective communication is necessary for building strong connections or networks. Mobile phones facilitate rapid communication when it comes to sourcing information for appropriate management of pests and diseases in the rural settings. Besides, mobile phones reduce the costs of information, communication and access (Aker, 2011; Urquieta and Alwang, 2012).

Market access proxied by quantity of output sold had a positive and significant effect on supply response. A unit increase in market access leads to a 0.00003 increase in orange fruits hectarage. Suleiman (2004), in a study assessing smallholder supply response in Ethiopia, similarly observed that access to market had a positive and significant effect on crop supply. This could be because market access facilitates access to inputs and thus enhances intensification and specialization (Kamara, 2004; Katungi *et al.*, 2011). It may also be because market access generally facilitates sourcing of resources for investment in production and provides avenues for farmer linkage and networking thus enhancing flow of information and other necessary production inputs.

Farm investments proxied by seed costs has a positive and highly significant effect on orange fruits hectarage. This could be because high-priced seed implied improved technology in terms of grafted or budded seedlings which farmers have been encouraged to grow because of the existing and potential markets. It may also be due to substitution effects where farmers want to override the effect of seed cost by increasing hectarage. An earlier study using district-level data from India to estimate crop supply response observed that farm investments are determined through a complex interactive process among farmers, government and intermediaries responding to the same factors (Binswanger *et al.,* 1993). This suggests that the observed effect could be attributed to the confounding effect of other factors, which this study did not take into account. The magnitude of effect, however, approximated to zero.

Belonging to a farmer institution was found to lead to 0.04683 units increase in land allocation to orange fruits. This implies that belonging to a farmer institution provides the opportunity for farmers to share knowledge and experiences, which improves on the decision makers' information base and ultimately reducing risk averse behaviour. Earlier works have demonstrated that belonging to institutions better positions smallholders to reduce transaction costs, obtain necessary market information, secure access to new technologies and tap into high value markets thus making them more competitive market actors (Markelova and Meinzen, 2009). Farmer institutions, especially cooperatives, popularize market participation by making farmers cross fertilise ideas, experiences and affords them with access to sources of information regarding credit facilities, knowledge and skills (Conway, 2005; Gani and Adeoti, 2011). Mangisoni (2006) argues that belonging to institutions provides smallholders the opportunity to pool resources and work together so as to realize economies of scale in procurement and supply. That can also provide the social capital which they require to be able to secure the much need support services such as credit for engaging in more stable relationships with their suppliers and buyers, which currently is the main limitation of citrus smallholder farmers in the study area (eastern Uganda). Fisher and Qaim (2012) in their study summed it up by recognizing the potential that farmer groups have in promoting smallholders commercialization in a gender equitable way.

Results also showed that use of fertilizer leads to 0.0926 units increase in hectarage allocation to orange fruits farming. Fertilizer use increases crop productivity which in turn improves on output profitability (Sheahan *et al*. 2014; Liverpool-Tasie, 2017). The consequent benefits from use of fertilizer therefore act as incentives to increased hectarage for citrus farming. Binswanger (1994) in an assessment of short-run price elasticities of supply in Sub-Saharan Africa similarly observed that fertilisers are among variable inputs whose quantities can be quickly adjusted to changing incentives.

Output was found to have a negative but significant effect on orange fruits hectarage. This could be because output data is subject to inaccuracies resulting from use of unstandardized measurements. Besides, farmers were grappling with orange fruits marketing problems. Nevertheless, studies elsewhere have shown that a positive relationship exists between hectarage and output (Akanni and Okeowo, 2002). In this study, Output price had a positive but none significant effect on hectarage. This also could be due to inaccuracies in pricing data caused by un-standardised measurements. Price data were based on polythene bag as a measurement standard, which greatly varied. For instance bags were filled to capacities ranging from 80 – 120 kilograms. The larger capacity bags popularly known as "egoropa" were at times filled to capacities ranging from 1 to 1 ½ ordinary bags. Generally, however, high output prices are expected to induce producers to increase hectarage allocation to production of the crop (Haile *et al.,* 2014).

CONCLUSION

This study demonstrated that market access, institutional belonging, mobile phone/contact, investment and fertiliser have significant effect on orange fruits hectarage. Among these, fertiliser, institutional belonging and mobile phone elicit the highest response. Strategic interventions, therefore could prioritize enhancing use of fertiliser, institutionalization of farmers groups and possession of mobile phones. This could be achieved by facilitating accessibility of subsidized fertilisers and mobile phones for farmers and facilitating establishment of functional farmer institutions.

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STATEMENT OF NO-CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this paper.

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