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Cultivating Household Food Security through Resource – Use Efficiency among Cash Crop Farmers: Evidence from Tobacco Producers in Uganda

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Authors' contributions

This work was carried out in collaboration between all authors. Author DCM designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors KOO and FOO managed the analyses of the study. Author AJ managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Poverty, food insecurity and malnutrition cases have been reported among farmers who prioritize cash crops such as tobacco. This is as a result of inefficient allocation of farm resources to tobacco production, with little or no allocation to staple food crops. To increase food production among such farmers, researchers have recommended optimum allocation of farm resources between tobacco and staple food crops. This study therefore aimed at determining the resource use efficiency for tobacco – food crop production, the optimal farm plans and the factors affecting resource use efficiency for food crops production. Data Envelopment Analysis was used to assess the level of resource use efficiency and the optimal farm plans while Tobit model was used to determine the factors affecting resource use efficiency for the optimal farm plans. The results from data drawn from 200 tobacco farmers in Western Uganda depicted that farmers were 61% efficient in their resource allocation to tobacco and food crops. Results for the optimal allocation plans suggested that farmers should optimally allocate their resources to tobacco and food crops in order to achieve household food requirements. Household size, pesticides use, farm income and support from the tobacco contract companies had a positive association with resource use efficiency for food crop production while input prices, land size and gender had a negative relationship with resource use efficiency. In conclusion, farmers are inefficient in allocating their farm resources between tobacco and other food crops which has far-reaching implications for availability of household foods. The study therefore recommends that the governments of SSA should increase the training and extension services on the adoption of optimum resources for cash – food crop production as well as supporting the farmers through inputs subsidies so as to increase household food production.

Keywords: Resource-use efficiency, Tobacco, Food crops, Kiryandongo district, Uganda.

1. INTRODUCTION

The global demand for food continues to grow steadily due to the growing population. It is projected that global food production should increase by 60 - 70% by the year 2050 in order to meet an over 9 billion people's food demand [1]. From recent reports, it is projected that Sub – Saharan Africa will be highly vulnerable to food insecurity than other regions by the year 2050 [2]. Strikingly, SSA crop yields, especially staple foods are projected to decline by 17% by 2050 [3]. In east Africa, agricultural activities must produce more than nine times the current production in order to meet food demand by 2050. This implies that the governments of SSA need to strategize on how to improve agricultural production, especially on the staple foods which are highly essential for increasing household food security.

Sub – Saharan agricultural sector, which is expected to increase food production, is composed and cash and food crop production [4]. The two cropping systems are mainly driven by income generation and household food production respectively. However, there have been reported cases of poverty and catastrophic levels of food insecurity among farmers who prioritize cash crops over food crop production, such as tobacco producers. Evidently, tobacco production competes for the same farm resources with other farming activities including food crops such as maize, cassava, sweet potatoes, beans, rice, vegetable and groundnuts, among others [5,6]. The competition between tobacco and staple food crops results in over allocation of farm resources e.g. land, labour and capital to tobacco, as farmers are easily enticed with the income they receive [7]. Strikingly, WHO [8] argued that the high income earned from tobacco sale does not guarantee availability of sufficient food till the subsequent production season as majority of the farmers do not use their income to purchase food till the subsequent harvesting season. Moreover, relying on food purchase cannot guarantee food security. It has been argued that as much as farmers may be rational in choosing what to produce based on income maximization objectives, such farmers might not efficiently use resources at their disposal for farm planning so as to optimize output for both cash and the food crops [6]. As a result, there have been widespread shortages of food among tobacco producing households attributed to resource misallocation between tobacco and food crops [9]. For instance, research has shown that up to 72.2% of the tobacco farmers in Kenya tend lack enough food, a situation not any different in Uganda [9]. A recent study conducted by Mayer et al. [10] also indicated that tobacco production could be associated with food insecurity under unbalanced resources. In Kenya, Kibwage et al. [11] recommended crop diversification among tobacco producers as a result of low food production. Moreover, recent reports from World Bank Group [12] illustrated that more than 72% of tobacco producers in Indonesia were living under poverty. The international food policy research institute [IFPRI] also observed that many tobacco farmers in African countries including Uganda are poor and fall in the "alarming" and 'serious" categories of household food shortages, suggesting that tobacco production could be contributing to food insecurity [13]. Similarly, Mozeleski & Pandey [14] reported severe shortages of food crops among tobacco producers in Sub – Saharan Africa. Furthermore, Sreeramareddy & Ramakrishnareddy [15] reported that household food shortages were significantly higher among tobacco producers than non – tobacco producers, suggesting that tobacco could be contributing to food shortages as a result of resource misallocation. These were not in odds with the findings of Gomez [16], who reported that failure to balance farm resources between tobacco and food crops reduces the size of arable land allocated to food crops, which causes food shortage in SSA countries. As such, scholars like Rubhara et al. [7] recommended optimum allocation of farm resources among tobacco and the major food crops.

However, to increase food crops production among farmers who prioritize cash crops like tobacco, it is necessary to develop optimal resource allocation plans which would guarantee sufficient food crops for the farmers besides tobacco production. Such optimal plans would ensure that farmers have adequate major staple foods like maize, cassava, sweet potatoes as well as receiving some income from tobacco production. Moreover, the optimal plans would also ensure that farmers allocate their farm resources to both tobacco and staple food crops in such a way that they receive income from tobacco as well as producing sufficient foods for their households. This however requires understanding the farmers' level of farmers' efficiency relative to household food requirement (resource use efficiency), the optimal farm plans and factors affecting resource use efficiency. Existing studies such as have explained different types of efficiencies such as profit, technical, allocative and economic efficiencies but little work has been done on resource use efficiency, especially in relation to optimum resource allocation for household food production. To bridge the above gap in literature, the study focused on determining the resource use efficiency, its determinants and the optimal farm plans among tobacco - food crops so as to improve food production among tobacco producers in Uganda. The study considered the top three significant food crops in Uganda. These included maize, cassava and sweet potatoes [17] versus tobacco.

2. MATERIALS AND METHODS

2.1 Research Area

The study was conducted in western Uganda (Fig 1) in Kiryandongo district. The district has a population of 132,822 [18]. It is located in the Western part of Uganda with its headquarters located 220 Km away from Kampala, the capital city of Uganda [18]. It borders Nwoya, Oyam, Nakasongola, Masindi and Buliisa districts. Kiryandongo district has an average altitude of 1290 meters above sea level. This district covers an area of 3,621 square kilometres which is mostly arable land, 50% is set for agriculture while the rest is allocated to settlements. It has a total of 4 counties and 17 parishes. In terms of population, the district has approximately 132,822 people, which is majorly composed of females [18]. This district was purposively selected due to the fact that it has high numbers of tobacco farmers. Furthermore, 30% of the population live below the poverty line, which calls for allocation of farm resources to increase food production [18]. In addition, the district suffers land constrains due to the resettlement of refugees from South Sudan and Kenya [18]. The favorable climatic conditions and high rainfall especially in August make farming a major economic activity in this district [18]. Besides tobacco, other major cash crops grown include cotton and sunflower. On the other hand, the food crops grown include maize, cassava, sweet potatoes, beans and vegetables.

2.2 Sampling and Sample Size

The study used multistage sampling techniques. First, Kiryandongo and Kigumba sub-counties were purposively sampled based on the fact that these two sub-counties have the high numbers of tobacco farmers [18]. Secondly, In Kiryandongo sub-county, Kichwabugingo and Kyankende Parishes were purposively selected while in Kigumba sub-county; Kigumba I and Kiigya sub-counties were also purposively selected due to the high volumes of tobacco production in these two Parishes. Finally, eight villages were considered for data collection from these Parishes. The district agricultural officer helped us trace the farmers by availing us of the list of all tobacco farmers. A total of 200 farmers were considered for the study following a formula by Cochran [19], which is illustrated below.

$$n = \frac{Z^2P(1-P)}{e^2}$$

Where, n = Number of sampled farmers, Z= Z statistic at 95% confidence level, e = Error at 0.05 level and P = proportion which is 0.85 [18].

2.3 Preparation for Data Collection

In order to collect data smoothly from the farmers, we had to put all the ethical requirements in place. First, the study was presented to Gulu University Research Ethics Committee (GUREC) for approval. After a though analysis, some modifications were recommended by GUREC before its approval. We then thoroughly adjusted the work and got the approval from GUREC. We also obtained approval from Kiryandongo district Chief Administrative Office (CAO) to collect data from the farmers. Secondly, we hired and trained the enumerators on data collection so that they would understand the study's objectives, practice how to ask questions and be familiar with all the study questions. This was followed by pretesting the tool for clarity, relevance and reliability.

2.4 Actual Data Collection

Primary data were collected from the 200 sampled farmers using the semi – structured questionnaire. Face to face interviews were used during data collection between the research assistants and the farmers. They asked the study questions in the local language understood by the farmers and recorded their responses. The tool was developed in such a way that it captured all the variables needed for the study objectives. Specifically, the tool was structured into three sections, with the first section majoring on the socio – demographic characteristics of the

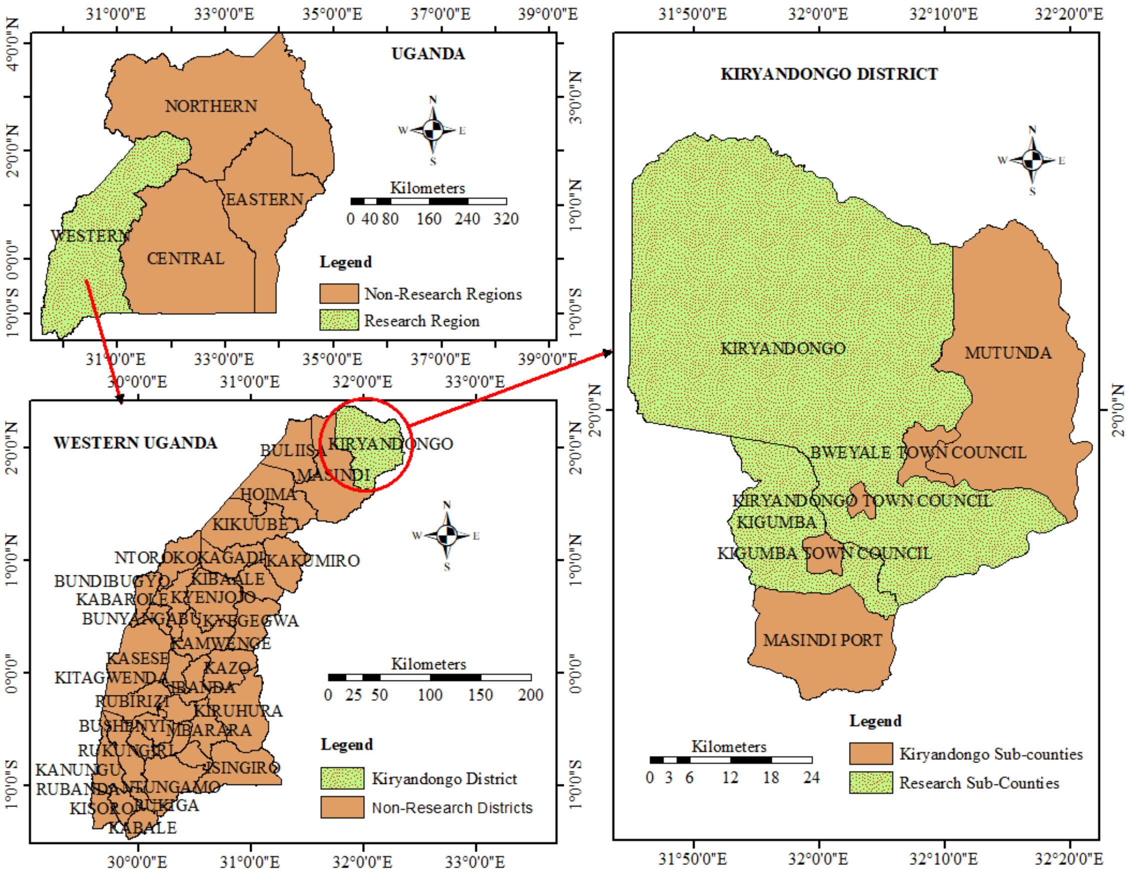

Fig. 1. Research area

farmers. The second section had variables on resource use efficiency and farm allocation plans. The last section of the questionnaire captured variables in household food requirements and household food consumption. Prior to data collection, we obtained verbal informed consent from the farmers. They voluntarily consented to participating in the study. This was as a result of elaborating to them how they would benefit from the study. Similarly, all ethical considerations were adequately followed during data collection. Data collection began on 1st December and was completed on 15th December 2022, making a total of 15 days.

2.5 Data Analysis

2.5.1 Data envelopment analysis

Data Envelopment Analysis (DEA), developed by Cooper et al. [20], has been widely used in agricultural studies to measure efficiency of farmers [21-26]. From literature, the method can also be used to measure resource use efficiency and the optimal farm plans, under given output requirement [27]. This can be seen in the study by Heidari et al. [28] who employed DEA to determine the resource use efficiency level as well as the optimal farm plans among poultry farmers; Kouriati et al. [29] recently applied DEA to determine the optimal levels of factors of production in Greece. As such the study modelled DEA in such a way that it considered farm inputs and relative output, which is the minimum household food requirement. The DEA was modelled to determine the level of farmers' efficiency in terms of resource allocation, relative to the minimum household food requirement for each food crop. This was followed by determining the optimum resource allocation plans which guarantees minimum household food requirement. The study considered DEA due to its ability to determine both the resource use efficiency and the optimal farm plans which guarantee sufficient food for the households till the subsequent harvesting season [29]. The cash crop used in the study was tobacco while the food crops included maize, cassava and sweet potatoes. The farm resources included land, labour and capital. An input-oriented variable returns to scale DEA is specified below;

$$\begin{aligned}
&\text{Min}_{\theta,\lambda} \quad \theta \\
&\text{Subject to} \quad -y_i + Y\lambda \geq 0 \\
&\theta x_i - X\lambda \geq 0 \\
&N1' = 1 \\
&\lambda = 0 \\
&\text{where } i = 1, 2, 2, 3 \ldots \ldots i
\end{aligned}$$

Where; $N1'$ = convexity constant, λ = N × 1 constant vector, X = input, Y = output, y_i = output vector, x_i = input vector. The inputs included land, labour and capital while the outputs included harvested quantities for tobacco, maize, cassava and sweet potatoes. The efficiency scores were represented as θ.

2.6 Tobit Model

After determining the level of resource use efficiency, Tobit regression model was then used to explore the factors affecting resource use efficiency. This was done using Stata version 14 software. Tobin model, developed by Tobin (1958), has the ability to determine the relationship between censored dependent variable and set of independent variables [30]. The resource use efficiency scores from the DEA were regressed as the dependent variable on Tobit regression model to determine the sign and magnitude of the factors influencing the resource use efficiency. The model has been successfully used in the studies conducted by Ahmad et al. [22]; Danso-Abbeam et al. [30]; Dube [31]; Hakim et al. [32]; Namome [6]; Ogundeji et al. [33]; Vu et al. [34], among others. Tobit model is specified as.

$$\begin{aligned}
&Y_i = \beta X_i + \varepsilon_i \\
&Y_i = Y_i^* \text{ if } Y_i^* > 0 \\
&Y_i = 0, \text{if } Y^* \leq 0 \\
&Y^* = \beta_0 + \beta_1(X_1) + \varepsilon_1
\end{aligned}$$

Where.

Y_i^* = Dependent variable, β_0 = Coefficient of intercept, β_1 = Regression coefficients, X_i = Explanatory variables in Table 1 while ε_i = Error term

3. RESULTS AND DISCUSSION

3.1 Socio-Demographic Profiles of the Farmers

Table 2 presents socio – demographic profiles of the farmers in the study area. The results show that the average age of the farmers was 40.73 years. The farmers in Kigumba sub-county were older than the Kiryandongo sub-county farmers by 0.64 years, however the difference was not statistically significant. The average number of years spent in school was 6.28 years. There was a statistically significant difference (P<0.1) between the years spent in school by the farmers in these two sub-counties. Farmers in Kigumba sub-county spent 1.22 years more than their counterparts in Kiryandongo sub-county. On average, the farming experience was 17.4 years. Farmers in Kigumba sub-county had 19.80 years of farming while their fellows in Kiryandongo sub-county had been engaged in farming for 15 years. The difference in their farming experience was statistically significant at 5% level of significance. There was no statistical difference between the distances to the nearest market, however, farmers in Kigumba were located near the markets than their counterparts in Kiryandongo sub-county. The average land size was 4.30 acres. There was statistically significant difference ($P<0.05$) between the agricultural land size in these two sub-counties. Farmers in Kiryandongo had significantly more land than their fellows in Kigumba.

Table 1. Explanatory variables

Variables	Measurement	Sign expectation
Age of the farmer	No. of years	+
Farmers' gender	1-Female, 0-otherwise	±
Secondary education	No. of years spent	+
Post-secondary education	Years spent in school	+
Land size	Acres	+
Sub-county of residence	1-Kigumba, 0- otherwise	±
Company support	1-Yes, o-otherwise	±
Household size	No. of people	±
Extension	1-Peer farmer, 0-otherwise	+
Pesticides usage	1-use, 0- otherwise	+
Farm income	In UGX	+
Source of labor	1-Hired, 0-otherwise	+
Input prices	Ugandan shillings	-

Table 2. Socio-demographic profiles of the farmers

Variables	Overall N=200 Mean	Kigumba N=100 Mean	Kiryandongo N=100 Mean	Mean difference (Absolute)	P-value
Continuous variables					
Age of the HH (Years)	40.73	40.41	41.05	0.64	0.730
Education (Years)	6.28	6.89	5.67	1.22	0.060*
Farming experience (Years)	17.40	19.80	15.00	4.80	0.006***
Household size (Number)	7.48	7.73	7.23	0.50	0.300
Market distance (Km)	3.04	3.01	3.08	0.06	0.790
Agricultural land size (Acres)	4.30	4.01	4.59	0.58	0.007***
Land allocated to tobacco (Acres)	2.13	2.07	2.18	0.11	0.460
Land allocated to maize (Acres)	1.17	0.95	1.37	0.42	0.000***
Land allocated to cassava (Acres)	0.56	0.47	0.52	0.04	0.355
Land allocated to sweet P (Acres)	0.44	0.36	0.39	0.02	0.500
Categorical variables	**Proportion**	**Proportion**	**Proportion**	**Difference**	**P - Value**
Farmer is Married (1-Yes)	0.81	0.91	0.72	0.19	0.000***
Farmer is Male (1-Yes)	0.76	0.86	0.67	0.19	0.001***
Access to extension (1-Yes)	0.88	0.83	0.88	0.05	0.310
Access to credit (1-Yes)	0.73	0.66	0.81	0.15	0.016**
Group member (1-Yes)	0.81	0.84	0.78	0.06	0.279
Farmer grows maize (1-Yes)	1.00	1.00	1.00	0.00	0.453
Farmer grows cassava (1-Yes)	0.88	0.84	0.92	0.08	0.110
Farmer grows s. potato (1-Yes)	0.87	0.84	0.88	0.04	0.235
Maize food shortage (1-Yes)	0.68	0.64	0.72	0.08	0.125
Cassava food shortage (1-Yes)	0.80	0.78	0.82	0.04	0.412
Sweet potato shortage (1-Yes)	0.79	0.74	0.84	0.10	0.245

, ** & * show significance at 10%, 5% and 1% respectively*

The average land allocated to tobacco farming was 2.13 acres. Farmers in Kiryandongo sub-county allocated more lands to tobacco than those in Kigumba, however, there was no statistical difference in their land allocations to tobacco. In the case of maize, there was a statistically significant (P<0.001) difference in the land allocations. Farmers in Kigumba allocated 0.95 acres of land while farmers in Kiryandongo allocated 1.37 acres of land to maize farming. Farmers in Kiryandongo allocated more lands to cassava (0.52 acres) than those in Kigumba (0.47 acres), there was no statistically significant difference in the land allocations to cassava. There was also no significant difference between the lands allocated to sweet potatoes in these sub-counties. However, Kiryandongo tobacco farmers allocated 0.39 acres while the farmers in Kigumba allocated 0.36 acres to sweet potatoes.

The results further indicate that 81.5% of the respondents were married. There was a statistically significance difference in marital status between the two sub – counties at 5% level of significance. On average, 76.5% of the farmers were males. The difference in gender was also statistically significant at 1%. Further, the results indicate that 88.5% of the farmers had access to extension services. On average, 81% of the farmers belonged to different agricultural groups. There was no statistically difference in group membership in the two sub-counties. In terms of food crop production, all the all the farmers produced maize since it was their staple food. However, only 88% and 87% of the farmers produced cassava. In terms of household food shortages, the majority of the farmers experienced shortages of maize, cassava and sweet potatoes in their households.

3.2 Resource Use Efficiency for the Optimal Farm Plans

Results presented in Table 3 show that tobacco farmers were not using resources efficiently for dual production of tobacco as a cash crop and the food crops. Strikingly, up to 37.5% of farmers were operating at the level below 50% of the economic optimum depicting a possible over-allocation of production resources to one crop at the expense of others. The results further indicate that only 21.5% of the farmers were able to achieve 90% and above of the resource use efficiency for tobacco-food crop production mix. The least farmer was only able to achieve 5% while the most efficient farmer achieved 100% resource use efficiency relative to food requirement. The mean efficiency stood at 61% of the optimal farm plan suggesting that up to 39% resource use efficiency for joint production of tobacco and food crop was lost. The results from the comparison of resource use efficiency level across the two sub - counties showed that farmers in Kiryandongo sub – county were more efficient than their counterparts in Kigumba sub – county.

When farmers allocate their resources efficiently such that they have adequate food as well as getting income from tobacco, they would score full efficiency [35]. However, from the findings of previous studies, this has not been the case [36,37]. Indeed, the results from this study confirmed that farmers were not efficiently allocating their resources. The majority of the farmers scored less than 50% efficiency in balancing their resources among tobacco and food crops to guarantee adequate food. This was attributed to overallocation of land, labour and capital to tobacco production at the expense of staple food crops. Moreover, some farmers allocated their resources to tobacco and ended up producing only two crops; tobacco and one of the food crops yet they needed these food crops for consumption. As a result, the majority of them experienced shortages of maize, cassava and sweet potatoes. This was the major cause of resource imbalance among the farmers. Similar findings were reported by Rubhara et al. [7] who found out that farmers were apportioning their farm resources in excess to tobacco compared to food crops in Cameroon. In addition, Hussain et al. [38] reported that farmers allocated 80% of their land to tobacco while the rest 20% was allocated to food crops leading to resource use inefficiencies and food insecurity in Bangladesh. Other studies which have found resource use inefficiencies among farmers include Kostlivý & Fuksová [36]; Ngango & Kim [39]; Raheli et al. [40]; Shanmugam & Venkataramani [41]; Sherzod et al. [42] and Tipi et al. [43].

Table 3. Distribution of resource use efficiency scores per sub-county

Range	Kiryandongo (N=100)	Kigumba (N=100)	Pooled (N =200)	Percentage (%)	Cumulative percentage (%)
≤ 0.50	40	35	75	37.50	37.50
0.51 – 0.60	10	14	24	12.00	49.50
0.61 – 0.70	20	16	36	18.00	67.50
0.71 – 0.80	7	4	11	5.50	73.00
0.81 – 0.90	3	8	11	5.50	78.50
≥ 0.90	23	20	43	21.50	100.00
Other statistics			**Efficiency**		
Min	0.20	0.05	0.05		
Mean	0.63	0.59	0.61		
Max	1.00	1.00	1.00		

3.3 Optimal Allocation of Farm Resources

Results on optimal allocation of farm resources (Table 4) revealed that farmers were over allocating land, labour and capital resources to tobacco production at the expense of food crops. First, farmers' actual land allocation to tobacco production exceeded the optimal allocation plan by 17.8%. A similar pattern of results was also observed for labour and capital at 11.30% and 10.2% respectively. Turning to resource allocation to food crops, cassava had the highest land deficit standing at 30.0% off the optimal allocation plan while its labour and capital allocation had a deficit of 25.0% and 41.5% respectively. Notably, sweet potatoes and maize resources were also in less quantities. Sweet potatoes had a land deficit of 21.41% while maize land deficit stood at 8.38%. A similar pattern was also observed in labour and capital allocation for maize and sweet potatoes.

On food crops resource allocation plans, maize also had resource deficit, even though it was a staple food for all the farmers. However, the results indicate that they allocated less resources to maize production than the optimal farm plans. Due to the resource deficit, the majority of the farmers (68%) experienced shortages of maize at some periods of the year. However, the optimal resource allocation plans suggest that they need to increase land, labour and capital allocation to maize by 9%, 13% and 66% respectively. The increment of these farm resources to maize production would cater for the additional food required by the household. Besides getting income from tobacco, the optimal resource allocation plans would ensure that farmers produce sufficient maize to consume till the subsequent harvesting season. A study conducted in Uganda by Igwe et al. [44], indicated that failure to optimize farm resources would lead to reduction in food crops production.

Similarly, cassava was grown by the majority of the farmers (88%). This implies that many smallholder farmers depend on cassava as a source of their food. However, the results indicate that it was the crop with the highest resource deficit. As a result, the optimal resource allocation plans suggest that farmers should increase their land, labour and capital by 30%, 25% and 42% respectively. When they adopt the optimal resource allocation plans, they are most likely to increase cassava quantities harvested by 46%. The increase in the quantity harvested meets the minimum household consumption requirement, implying that the optimal farm plans guarantee sufficient food for the farmers. This is in line with the findings by Hamba & Nuwamanya [45] who found out that cassava shortages in Northern Uganda was caused by poor farming skills including resource misallocation.

This study found out that the majority of the farmers (87%) were engaged in sweet potatoes production. However, due to poor resource allocation, 78% of the farmers experience its shortages. This was also attributed to over-allocation of land, labour and capital to tobacco. From the results, the optimum allocation plans suggest that they need to increase the land, labour and capital allocated to sweet potatoes by 21%, 37% and 51% respectively. Similarly, the optimal resource allocation plans would guarantee sufficient quantities of sweet potatoes to the farmers till the subsequent harvesting season. This conforms to the findings by Epeju & Rukundo [46] who found out that there were sweet potatoes shortages in Kiryandongo and Teso districts in Uganda, attributed to resource misallocation among cash and food crops.

3.4 Optimal Output Versus Household Food Requirement

The results show that cassava presents the most economic gains, standing at 46.3%, if farmers adopt the optimal resource use plan (Table 5). For sweet potatoes and maize, the optimal resource use plan would result in economic gains of 22.7% and 7.7% respectively. Lastly, the optimal resource use plan yields only 18.0% of the overall income loss in tobacco. The value gained from producing the additional food crops would be more than the foregone income from reduced tobacco acreage. Therefore, adoption of the optimal farm plans is a way of increasing food availability among tobacco farmers. It would ensure that farmers have sufficient food as well as income from tobacco to cater for other financial obligations, hence reducing poverty and food insecurity.

3.5 Factors Affecting Resource Use Efficiency

Based on the model fit, the results (Table 6) showed that the model was significant at 1%. The pseudo-R squared valued of 0.26 also met the acceptable range according to Mbachu et al. [47]. The log likelihood value of -58.81 also confirmed the fitness of the model. Similarly, the test of correlation between the independent variables (VIF) shown a mean VIF of 0.89, with minimum and maximum values ranging from more than 1 and less than 10 respectively, which showed that there was no multicollinearity among the independent variables [48]. The study therefore proceeded to present the results from the model.

The results from Tobit regression on the factors affecting resource use efficiency are presented in Table 6. The study found that different socio-economic had different effects on resource use efficiency. The negative relationship between gender of the farmer and resource use efficiency depicted less chances for female farmers of allocating farm resources for optimal dual purpose of tobacco and food crops' output. Furthermore, female farmers are mostly not the heads of the households and so they may not make decisions on which crop to grow and how to allocate farm resources between tobacco and food crops. This conforms to the findings reported by Mwaura & Adong [49] that belonging to female gender among farmers was negatively associated with resource allocation efficiency for banana, beans, cassava, sweet potato, maize and coffee crop enterprises in Uganda.

The negative effect of land size on resource use efficiency can be explained by the fact that farmers are tempted to allocate more land to tobacco production given its lucrativeness in the study area. It implies that resource use efficiency for cash – food crop production declines as more land is committed to tobacco farming at the expense of other food crops. This is because the more land the farmer allocates to tobacco, the more income he receives. Related findings were also reported in the study by Adjimoti [50], who found out that land size had a negative influence on the resource use efficiency between food and cash crops in Benin. It is also similar to the findings by Geta et al. [51], who found that land size has a negative relationship with resource use efficiency among Ethiopian farmers. In contrary, Amodu et al. [52] reported a positive influence of farm size on resource use efficiency in food crop production among smallholder farmers in Nigeria.

The positive association between household size and resource use efficiency may be due to the fact that families with many household members require more food than those with few members. Therefore, the requirement for food increases with the household size. As a result, households with many members need additional food which is obtained through allocating resources to food crops production to meet the household food requirement. Therefore, farmers with many household members are most likely to allocate their resources to food crops as a way of obtaining food to feed their families. In addition, family members are sources of farm labour; those with many family members are able to provide enough labour in their farms than the families with few members. This is similar to the findings by Adjimoti [50], who found a positive relationship between resource use efficiency and household size. Furthermore, it also conforms to the findings by Asefa [53] who found out that household size positively influenced resource use efficiency among wheat farmers.

The results further revealed that resource use efficiency was positively influenced by pesticides usage among the farmers. This may be attributed to the fact that farmers who had pesticides for the food crops were able to allocate their farm resources optimally among tobacco and the food crops since they were sure of reduced losses from pests and diseases. Among the chemicals

Table 4. Optimal allocation of factors of production

	Land (Acres)			Labor (Hours)			Capital (UGX)		
Crops	**Current Plan**	**Optimal Plan**	**Percentage Change**	**Current Plan**	**Optimal Plan**	**Percentage Change**	**Current Plan**	**Optimal Plan**	**Percentage Change**
Tobacco	2.13	1.75	-17.83	79.14	70.20	-11.30	971,998.00	872,445.80	-10.24
Maize	1.17	1.27	+8.38	45.64	51.67	+13.21	109,920.10	182,397.10	+65.94
Cassava	0.56	0.73	+29.50	46.35	57.96	+25.05	31,013.25	43,868.45	+41.45
Sweet Potato	0.44	0.54	+21.41	37.98	51.88	+36.60	27,654.75	41,874.80	+51.42

Table 5. Optimal output versus household food requirement

Crops	Current Quantity (Kg)	Optimal Quantity (Kg)	Gained/Lost Quantity (Kg)	Percentage (%) Gain/ Loss	Minimum household food requirement(kg)
Tobacco	1,141.00	936.50	-204.52 (Lost)	17.97(Loss)	----
Maize	716.38	771.50	55.12 (Gained)	7.69 (Gain)	748.50
Cassava	421.38	616.33	194.50(Gained)	46.26(Gain)	602.12
Sweet P.	410.42	503.70	93.28 (Gained)	22.73(Gain)	502.10

Table 6. Tobit regression results for the factors affecting resource use efficiency

Variables	Coefficient	Std error	Marginal effects
Farmer's gender (Female)	-0.165***	0.048	-0.053***
Total agricultural land size	-0.181***	0.061	-0.158***
Sub-county of residence	0.023	0.042	0.028
Household size	0.084*	0.045	0.068*
Pesticide's use	0.079**	0.037	0.082**
Farm income	0.067**	0.028	0.060**
Secondary education	-0.049	0.052	-0.06
Post-secondary Education	0.041	0.075	0.059
Source of labor (Hired)	0.061	0.111	0.067
Peer farmer extension	-0.052	0.041	0.058
Farmer's age	0.036	0.071	0.053
Company support	0.100**	0.044	0.089**
Input prices	-0.109**	0.042	-0.098**
Constant	1.134*	0.701	--
Pseudo R^2	0.2637		
Log likelihood	-58.817		
Prob>Chi^2	0.000		
N	200		
Mean VIF	0.89		
*,**,***	10, 1 and 5% SLs		

the farmers used to kill the fall army worm in maize include Cypermethrin, Thiamethoxam and Lambda-Cyhalothrin pesticides. Farmers also needed pesticides to grow cassava to its maturity to curb the spread of pests and disease. The pesticides used in cassava production included Dimenthoate, used to kill cassava mealybug (*Phenacoccus Manihoti*) pests, Cypermethrin, Lambola and Lindane, which are used to kill the cassava green mite (*Mononychellus Tanajoa*).

The positive influence of support from contract companies on resource use efficiency was attributed to the fact that farmers received farm inputs from the contract companies. These inputs included tobacco seeds, pesticides and fertilizers for tobacco production. The farmers used a portion of these fertilizers and pesticides to produce maize, cassava and sweet potatoes. As a result, the more support the farmers received, the more they allocate their resources to produce food crops A similar finding was reported by Namome [6], who reported that the support from the tobacco companies in West Nile Uganda had a positive influence on the efficiency. Additionally, according to a study done by Hossain [54], 65% of the farmers were receiving support from tobacco companies in Bangladesh, the support was in terms of seeds, fertilizers, access to market and access to extension services, among others.

Similarly, the positive influence of farm income on resource use efficiency may be due to the fact that if the food crops also perform well and yield more income than farmers would allocate their resources to food crops. This is because they are driven by income maximization but not food production. They would therefore allocate their resources to any crop, whether cash or food crop provided that it yields high income. A study done by Namome [6] confirmed that farm income had a positive association with resource use efficiency among banana, beans, cassava, sweet potatoes, maize and coffee crop enterprises.

There was a negative and statistically significant relationship between the input prices and resource use efficiency. The inputs considered included seeds, fertilizers, the cost of renting the land, cassava planting stakes, sweet potatoes planting vines and the cost of hiring labour for farm activities. The negative influence of input prices on resource use efficiency could be because farmers would allocate most of their resources to tobacco if the input prices increased. For instance, if the prices of cassava planting stakes, maize seeds, sweet potatoes vines and fertilizers increases, farmers would use their finances to purchase tobacco inputs instead of the food crops inputs due to the high income from tobacco. However, this would result in resource use inefficiencies. This result is in agreement with the findings by Science (2018) who found out that the input prices negatively influenced rice-livestock integrated farming system. Additionally, Briner & Finger [55] observed a negative association between input prices and resource use efficiency in Swiss dairy production system [56-59].

4. CONCLUSION AND RECOMMENDATION

Under the prevailing conditions at the time of the study, the findings of this study showed that tobacco farmers were inefficient in allocating their farm resources for tobacco and food crops to guarantee sufficient food among the households. Specifically, they allocated excess resources to tobacco at the expense of food crops. Notably, farmers allocated excess land, labour and capital resources for tobacco while only able to provide inadequate levels of the same resources for food crops, depicting resource wastage and thus a risk of food shortages at household level. However, the results from the optimal resource allocation plans suggests that farmers need to increase the land allocation to food crops while reducing the land allocated to tobacco so as to increase the quantities of the food crops (maize, cassava and sweet potato) among their households. Based on the results from Data Envelopment Analysis, this study concluded that tobacco farmers are inefficient in allocating farm resources namely land, labour and capital between tobacco and food crops production and thus they risk shortages of food crops in their households. The results from Tobit regression model showed that out of the 13 hypothesized factors, 7 of them presented themselves as significant factors having positive and negative significant effect on resource use efficiency. Specifically, farmers' gender, total farm size and input prices presented themselves as the factors having negative effect on resource use efficiency for the optimal farm plans. On the other hand, household size, use of pesticides, farm income and support from the contract companies in terms of farm inputs had a positive association with resource use efficiency for the optimal farm plans. This study therefore concluded that farmers' gender, total farm size, household size, use of pesticides, farm income, support from tobacco contract companies and input prices are the main factors affecting resource use efficiency for the optimal farm plans among tobacco growing households in Uganda.

4.1 Policy Recommendations

a. This study found out that farmers were allocating excess of their resources to tobacco, leading to food shortages among the smallholder farmers. In order to increase household food production, this study recommends that extension workers should train farmers and encourage them to adopt optimal farm plans. This allocation would ensure that they receive income from tobacco to cater for other financial obligations and still have sufficient food for their families.

b. The inverse relationship between input prices and resource use efficiency suggests that farmers have limited inputs to be balanced to these crops. Therefore, this study recommends that the ministry of agriculture, animal industry and fisheries should subsidize inputs such as seeds, pesticides and fertilizers so that farmers can access them easily to help produce the food crops.

c. Similarly, female farmers were found to be less efficient in allocating their resources than male farmers. Therefore, this study recommends that, the extension workers should empower and train women on resource efficiency so that they can increase their efficiency levels for dual tobacco and food crops production.

d. More training by extension officers targeting optimum use of farm resources in order to increase household food production is strongly recommended.

CONSENT

As per international standards or university standards, farmers written consent has been collected and preserved by the author(s). (verbally).

ETHICAL APPROVAL

As per international standards or university standards written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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