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Resource use efficiency among small-scale farmers in selected areas of western Kenya

Kleinbauern in Westkenia und ihr effektiver Betriebsmitteleinsatz

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1 Introduction

Agriculture is the mainstay of Kenya's economy providing, as it does, the basis for the development of other sectors of the economy. Its contribution to the gross domestic product (GDP) in the last decade averaged about 30 per cent (KENYA, 1988). Agricultural products contribute about 70 per cent of the total exports and they are responsible for most of the country's foreign exchange earnings.

The bulk of Kenya's agricultural output however, is produced by small-scale farmers who dominate the dualistic farming communities of the country. With an average farm size of 2.3 hectares they account for over 60 per cent of the total farmed land. Apart from wheat and sisal which are produced on a large-scale, crops are mainly produced on small-farms. Food production figures also show that 90 per cent of the maize, over 60 per cent of the tea and about 80 per cent of the sugarcane are produced by small-scale farmers (LUGOGO, 1983).

The worrying problem however is that the actual yields of major food crops in Kenya are far below the potential yields. For example, while yields of up to 10 000 kg ha^{-1} of maize have been recorded from commercial fields and the research stations in recent times, good farmers within the area rarely obtain 6 000 kg ha^{-1} with poorer farmers often getting only 1 000-2 000 kg ha^{-1} (COOPER and LAW, 1978). It has further been noted that low yields on farmers' farms are due to poor husbandry and insufficient or lack of use of modern inputs and seldom due to environmental constraints. In other

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words, a substantial additional increase in output can be obtained from the existing hectarages by adopting a production technology package that makes optimum use of farm inputs.

This however, is not all. Kenya has a high population growth rate of about 3.5 per cent per annum and this has created an additional demand for food that is not currently met by the domestic production. As a result actual domestic output for basic food crops such as maize, beans and wheat fall below the targeted figures that the country need to attain self suficiency in food crop production (KENYA, 1989). The problem is aggravated by the fact that only 12 per cent of Kenya's land is of high agricultural potential with 75 per cent either arid or semi-arid and suitable only for nomadic pastoralism.

The challenge faced by the small farmers therefore lies in the efficient utilization of available resources in agricultural production. That is to say, there is a need for the small-scale farmers to efficiently allocate their farm inputs among the competing enterprises.

This study therefore focuses on the resource use efficiency of small-scale farmers in the western province of Kenya. This province was chosen for this study because it is a major food producing area in the country with a high population density. The relevant questions that this study seeks to answer are

1. What is the generally pattern of food crop production by small-scale farmers in western Kenya?
2. What inputs are used by these farmers in their production process?
3. To what extent are the inputs efficiently utilized; That is to say, do the farmers equate the value marginal product of each input to its marginal cost?
4. And finally what policy recommendations based on the findings of the study can be put forward to possibly increase the efficiency of resource use among the small-scale farmers in western Kenya.

The paper is arranged as follows. Section two of the paper deals with the metholodogy adopted in the study, while section three presents the results and discussion. Finally section four summarizes the major findings from the study and in addition highlights the relevant policy recommendations derived from the study.

2 Methodology

A multi-stage random sampling procedure was adopted in the study for the purpose of data collection (COCHRAN, 1977). The province was first divided into the various districts. There were four districts in the area during the period of study. The districts were then sub-divided into their respective divisions and by means of simple random sampling two divisions were chosen from each district for a total of eight divisions. Thereafter, the selected divisions were stratified into their locations. By means of simple random sampling again, two locations were selected for a total of 16 locations.

Similarly the selected locations were stratified into their various sub-locations[3]. One sub-location was then selected from each location. It was from these sublocations that 200 farm families were finally selected by means of the simple random sampling for the collection of primary data.

Data were collected, by means of a structured questionnaire, on socio-economic characteristics of the farmers as well as on the quantity and costs of inputs used in the production process. Input variables considered included fertilizer, seed, herbicide, labour (family and hired) and cost of hiring tractor.

The output variable was obtained by means of the yield plot approach. This consisted of marking out a portion of the farm and measuring the area so marked out. Farmers harvested the crops within the marked area in the presence of enumerators who weighed the output. With the output of the marked area known, the estimated total output of the entire farm was calculated.

The main analytical techniques employed in the study were the budgetary analysis and the production function model. Budgetary analysis involves the estimation of total cost and returns for the same production period. The aim was to arrive at a profit (loss) for the farmers as shown in the following identity (GITTINGER, 1982):

$$\pi = TR - TC \qquad (1)$$

$$\text{Where } TR = \sum_{i=1}^{n} P_i Y_i$$

$$TC = \sum_{i=1}^{n} C_i X_i$$

P_i is the output price of the crop enterprise, Y_i is the output quantity, C_i is the cost of an input used in the production of an output an X_i is the input quantity. π is the profit associated with the food crop enterprises engaged by the farmers.

The production function on the other hand gives the mathematical relationship between quantities of output and inputs used in the production process. (DILLON and HARDAKER, 1980). Mathematically, this relationship can be stated implicity as

$$Y = f(X_H X_L X_F X_P X_T, e)$$

Where Y = value of output in Kenya shillings[4]
X_H = land in hectare
X_L = labour (hired and family) in man days
X_P = quantity of pesticides in kg

[3] The sub-location is the smallest administrative unit in the area.

[4] The shilling (Ksh) is Kenya's unit of currency. As at 1990, Ksh 1.00 ≈ U.S $O.043.

X_S = lost of seeds in Kenya shillings
X_T = number of hours of hiring tractor
e = random error term.

On a prior expectation $\delta_y/\delta_{xi} > 0$, that is as the quantity of input increases, the value of output also increases, *ceteris paribus*.

Various functional forms of the model were specified and bases on the relative magnitude of R^2, the statistical significance of the regression coefficients, signs of regression coefficients and the relative freedom of equations from muiticollineanty problem, the Cobb-Douglas function was chosen for the purpose of further analysis (PINDYCK and RUBUNFELD, 1981). Thus the estimating equation is

$$LnY = Ln\beta_0 + \beta_H LnX_H + \beta_L LnX_L + \beta_F LnX_F + \beta_S LnX_S + \beta_T LnX_T \qquad (2)$$

where the X_S are as defined above.

From the estimated coefficients, the marginal value products (MVP) of the inputs were obtained at their geometric mean levels. These marginal value products were then used to compare with the marginal cost of each resource to see whether the farmers were economically efficient in the use of their scarce resources.

3 Results and discussion

Socio-economic characteristics of the respondents

Most often the socio economic characteristics of the farmers influence to a large extent their decisions making process with regards to their farming operation and production practices. It was against this background that the socio-economic characteristics of the respondents were studied and the results are presented below.

Age distribution of the farmers

From Tab. 1, it is seen that the majority of the farmers were between 31 and 50 years of age, representing a total of 70 per cent of the respondents. This therefore suggests that most of the food crops produced in the area are by farmers within this age bracket. The table also shows that the ageing farmers participated significantly in food production as they constituted 18 per cent of the respondents. Farmers aged between 21 and 30 years were comparatively less involved while the youth of less than 20 years of age were virtually absent in food crop production in the study area.

This finding suggests the possibility of rural-urban migration in the study area that leaves only the aged and a good percentage of the rural women in farming. In fact, the distribution of the respondents by sex indicated that only about 30 per cent were male.

Tab. 1: Age distribution of the respondents (n=200).

Age	Per cent respondents	Commutative frequency
21-30	12.0	12.0
31-40	24.0	36.0
41-50	31.0	67.0
51-60	20.0	87.0
>60	13.0	100.0
Total	100.0	—

Level of education

From the results of the study, 49.0 per cent of the farmers had only primary education while only 17.0 per cent went beyond secondary education. The result of this finding which is presented in Tab. 2 shows a high level of illiteracy among the farmers, a factor that may have affected their in ability to adopt modern agricultural technology.

Tab. 2: Level of education of the respondents (n=200).

Level of education	Per cent respondents	Cumulative frequency
No formal education	49.0	49.0
Primary school only	28.0	77.0
Secondary school	17.0	94.0
Others (higher education)	6.0	100.0
Total	100.0	—

Land ownership and tenancy in the study area

Ownership of land and the tenancy arrangement is another important socio-economic factor that determines farmers' access to cropping land and hence, their level of input consumption. The result of survey showed that the majority of the farmers (84 per cent) own their farms on individual basis. Tenant farmers constituted 10 per cent of the respondents while communal land ownership represented only 6 per cent. This finding shows that communal ownership of land is becoming rare in the study area.

Most of the farmers in the study area acquired their piece of land by inheritance. Renting and inheritance constituted 84 per cent of land acquisition type in the study area. Purchased land accounted for only 2.0 per cent as land is not usually sold in the

area. However, leasing as a method of land acquisition is not uncommon and it accounted for about 14.0 per cent during the period of study.

Farm sizes and average holdings

The size of the farms put under food crop production by the farmers was also studied and the results are presented in Tab. 3. The results revealed that about 51.0 per cent of the farmers cultivated farms of less than 2 hectares during the 1990 cropping season. During the same period the average farm size in the area was 2.02 hectares with less than 5.0 per cent owing more than 5 hectares of farm land.

Tab. 3: Distribution of the respondents by farm size (n=200).

Farm size (hectares)	Per cent respondents	Cumulative frequency
Below 0.5	17.5	17.5
0.5 to < 1.0	9.5	27.0
1.0 to < 1.5	12.5	39.5
1.5 to < 2.0	11.5	51.0
2.0 to < 2.5	13.5	64.5
2.5 to < 3.0	8.0	72.5
3.0 to < 3.5	6.0	78.5
3.5 to < 4.0	5.5	84.0
4.0 to < 4.5	6.0	90.0
4.5 to < 5.0	5.5	95.5
≥ 5.0	4.5	100.0
Total	100.0	—

Sources of credit to the farmers

It has long been established that capital formation is very slow among small-scale farmers and as a result capital is a big limiting factor in traditional agriculture (PENNY, 1981 and MBATA, 1991). It was on this basis that the sources of credit available to the farmers were examined. Most of the farmers rely heavily on personal savings as a source of cash for farming operations. However, this source usually proves inadequate hence farmers resortes to credit to augment their personal savings. Tab. 4 shows that about 18 per cent of the farmers depended solely on personal savings and did not borrow money to finance their farming operations. 21.0 per cent borrowed money from friends and relatives, 34.0 per cent borrowed from social or age group associations while 20.0 per cent borrowed from co-operative societies. Only 7.0 per cent obtained credit from agricultural Finance Co-operation (AFC).

Tab. 4: Sources of credit to farmers (n=200).

Source of credit	Per cent respondents	Cumulative frequency
None	18.0	18.0
Age group/social associations	34.0	52.0
Co-operative societies	20.0	72.0
Friends and relatives	21.0	93.0
Agricultural Finance Co-operation (AFC)	7.0	100.0
Total	100.0	—

Modern input utilization by the farmers

Most farmers used hybrid maize seeds in their farms. A few however, used local varieties which they claimed can do well with little or no fertilizer application. In the study area not all the farmers interviewed applied chemical fertilizer on their farms while some used farm yard manure in addition to chemical fertilizer. Fertilizer application however was limited to maize and cassava production as fertilizer was not used for crops like beans and beans based intercropping. Pesticide was spargely used despite the real need for this input as pest attacks were noticed on some farms during the study period.

Tab. 5 presents the average fertilizer and pesticide application rates for the 1990 cropping season. From the Tab. it is seen that the average levels of fertilizer and pesticide used by the farmers were below the agronomic recommended level in the

Tab. 5: Average application rates of fertilizer and pesticide for the farmers during the 1990 season.

Farm size	Fertilizer (kg ha^{-1})	Pesticide (kg ha^{-1})	Percentage of farmers using recommended level
Below 0.5	45.0	0.5	0.0
0.5 to < 1.0	69.7	0.6	0.0
1.0 to < 1.5	88.2	0.8	0.0
1.5 to < 2.0	98.2	0.8	3.5
2.0 to < 2.5	120.7	1.1	6.0
2.5 to < 3.0	133.6	1.3	2.0
3.0 to < 3.5	149.7	1.5	5.0
3.5 to < 4.0	150.1	1.9	3.5
4.0 to < 4.5	158.5	2.0	4.5
4.5 to < 5.0	178.4	2.3	3.5
≥ 5.0	183.8	2.8	3.0
% of farmers	89.0	79.0	31.0

study area. Farmers cultivating a very small land area, in particular do not use appreciable quantities of these farm inputs.

Insufficient farm capital was identified as the main reason responsible for farmers' inability to use the fertilizer and pesticide inputs at recommended levels though some farmers complained of high costs of modern inputs.

Farm labour supply in the study area

Human labour was supplied to all phases of production except for ploughing and harrowing which was mainly done by the ox-driven plough. Tab. 6 shows that a total of 241.2 man-days of labour were utilised in the cultivation of one hectare of land. Family labour was supplemented with hired labour and on the average about 59 per cent of the total labour supplied to the farm came from hired labour. This was due to the high demand for labour during peak farming periods when family labour proves to be inadequate and additional labour is needed if farm operations are to be carried out as required.

Tab. 6: Labour per hectare utilized by farmers in the study area.

Farming operation	Amount of labour per (man-days)	Percent of hired labour
Land clearing	71.6	65.8
Planting	42.7	23.5
Weeding	38.0	9.6
Fertilizer application	24.6	7.4
Harvesting	64.3	50.3
Total	241.2	31.3

Analysis of farm income and resource use efficiency

The underlying assumption in the farm income analysis is that profit from the farm depends on quantities of inputs and outputs and their unit cost and prices. Using the budgetary analysis, the farm profit was obtained for the farmers under study. Total costs and revenue were estimated as follows:

Total revenue in the study consisted of the revenue obtained from the sale of the main crops viz maize, beans, cassava, sweet potatoes and bananas considered in the study. Value was imputed for output not sold but consumed at home.

Total costs on the other hand consisted of both cash and non-cash expenses. Cash expenses included the expenditure on inputs like seeds, fertilizers, pesticides, tractor hiring and the money paid for hired labour. Non-cash expenses included imputed value for family labour, opportunity cost of capital, imputed value for family land using the

prevailing rent in the study area and the depreciation allowance for farm assets. Tab. 7 presents the results of the budgetary analysis. From the tab. it is seen that the farmers obtained an average net farm income of Kshs. 2,910.3 per hectare for the 1990 cropping season.

Tab. 7: Average costs and returns per hectare of small scale farmers in the study area, 1990.

Item	Quantity	Value/cost
Revenue		
Maize (kg ha^{-1})	1,840.0	4,919.9
Beans /kg ha^{-1})	2,100.6	10,503.0
Sweet Potatoes (kg ha^{-1})	10,048.6	15,400.8
Cooking bananas(kg ha^{-1})	3,960.0	15,840.0
Cassava (kg ha^{-1})	9,633.6	10,435.7
Gross value of output		11,419.95 *
Variable cost		
Labour (man-days)	241.2	3,618.0
Fertilizer (kg ha^{-1})	146.4	951.6
Pesticide (kg ha^{-1})	1.6	160.0
Seed (Kshs. ha^{-1})		650.0
Tractor hiring (Kshs)		600.0
Transportation		350.0
Total variable cost (Kshs. ha^{-1})		6,329.6
Imputed value for farmers' land (Kshs. ha^{-1})		1,000.0
Interest on capital (Kshs.)		759.6
Estimated depreciation		
Allowance on farm tools (Kshs)		420.4
Total cost (Kshs)		8,509.6
Net farm income (Kshs)		2,910.3

* Gross revenue is obtained by dividing the total revenue from all the farms (mixed and side) by the total number of hectares.

On the other hand the regression model was used to estimate the marginal influence of the included explanatory variable on the dependent variable (gross value of inputs). The regression was estimated in the double - logarithmic form and because of that one was added to all the variables to avoid zeros (MASSEL, 1967).The results of the regression analysis are given in Tab. 8.

The results of the regression analysis show that all the included explanatory variables except the tractor hiring variable came out with the expected signs. Statistically, 71 per cent of the included explanatory variable were significant at 1% or 5% level. The regression analysis yielded an R^2value of .87 indicating that about 87 per cent of the variation in the gross value of output is explained by the variables in the regression equation.

Tab. 8: Regression results of the double-logarithmic function (n=200).

Variable	Parameter	Extimate coefficients	Standards error	T-Values
Constant	$ß_O$	3.7340		
Farm land	$ß_H$	0.3639***	0.1362	2.671
Labour (man-days)	$ß_L$	0.2065***	0.1027	2.011
Fertilizer (kg)	$ß_F$	0.1832**	0.1453	1.261
Pesticide (kg)	$ß_P$	0.0253**	0.0156	1.622
Seeds (kgs)	$ß_S$	0.2310***	0.0873	2.646
Tractor hiring (hrs)	$ß_T$	-0.0106 [1]	0.1587	0.067
R^2		0.8666		
F-Ratio		9.7629***		
d.f = 193				

*** = Significant at 1%; ** = Significant at 5%;

[1] Although the sign is perverse, the coefficient itself is not statistically different from zero

To evaluate the economic efficiency of the farmers, the marginal physical products were computed from the regression coefficients since these coefficients are the elasticities in the double-logarithmic function (OLAYEMI, 1981). Thus, the marginal physical product is obtained using the relationship.

$$MPP_{Xi} = ß\ Y/X_i$$

Where X_i and Y are the geometric mean levels of the inputs and output variable respectively and ß is the elasticity. However, in this particular study, the dependent variable was expressed in monetary terms and therefore the derivative of the value of output (y) with respect to each of the variable inputs give the MVP for that input.

Tab. 9: Marginal value product for the variable inputs.

Variable	Elasticity	Geometric mean values	MVP	MC
Farm land	0.3630	2.02	2052.19	1000.00
Labour	0.2065	487.22	14.29	15.00
Fertilizer	0.1832	245.70	14.29	6.50
Pesticide	0.0253	3.52	180.58	100.00
Seed	0.2310	1313.00	4.06	1.00 [1]

[1] When an input is measured in monetary terms, its marginal cost is equivalent to Kshs. 1.00.

Tab. 9 shows the marginal value product for the inputs with their corresponding marginal costs. From the results of Tab. 9 the following inferences can be drawn on the efficiency of resource use of the farmers in the study area. The farmers underutilised the land, fertilizer pesticide and seed variables as the MVP for these inputs were higher than their marginal costs. The marginal value products were found to be Kshs.

2,05.19, Kshs. 514.29, Kshs. 180.58 and Kshs. 4.06 and marginal cost were Kshs. 1,000, Kshs. 6.50, Kshs. 100.00 and Kshs. 4.06 for land fertilizer, pesticide and seed respectively.

Labour input was on the other hand, found to be over utilized. An additional man-day of labour valued at Kshs. 15.00 yielded only Kshs. 9.70 in incremental revenue. This finding is consistent with earlier results obtained by OLAYEMI (1974) where he found excessive utilization of farm labour in swamp rice production among traditionally small-scale farmers in Nigeria.

Generally, the farmers underutilized the more modern types of inputs-fertilizers, pesticides and improved seeds. In order to attain economic optimum therefore, the farmers should increase the level of use of these inputs. Their increased use would, however, imply large farm sizes as the average size of farm in the study area was also found to be below optimum.

4 Policy recommendations and conclusion

The need for the small-scale farmers in Western Kenya to increase their use of modern farm inputs derives directly from the findings of this study. The results of the study of input use at the farm level and the regressions analysis results indicated that fertilizers pesticides and seed inputs were used at suboptimal levels from both the agronomic and economic points of view. However, the increased use of these inputs will obviously necessitate higher investments of capital that the farmers may not be able to afford. It is therefore, suggested that a more generous policy towards credit provision to small-scale farmers in the area be adopted. In fact, it was discovered that only about 7.0 per cent of the respondents got credit from the AFC, the major agricultural lending institution in the country.

On the other hand, the farmers should reduce their use of farm labour (family and hired) since this input was excessively utilized. It therefore does appear that the farmers are substituting farm labour for modern farm inputs, a situation that has led to the inefficient utilization of all the inputs. This simply means that any policy that seeks to promote the consumption of more modern inputs will inevitably free excess farm labour which could now be directed to other sectors of the economy.

In conclusion, this study has shown that the present pattern of food crop production in western Kenya is still economically inefficient. This calls for the reallocation of the existing inputs given the current prices of output and costs of factor of production. A particular effort is needed to provide more credit to the farmers as an incentive to increase their level of modern farm inputs usage if they are to attain technical and economic efficiency in food crop production.

5 Summary

Food crops production by small-scale farmers who dominate the agricultural sector in Kenya is characterised by low actual yields compared to what is technically and economically feasible.

This study investigates the production pattern of the small-scale farmers in Western Kenya with the view to estimate the level of their resource use efficiency. To capture the specific objectives of the study, both budgetary and production function analyses were used to estimate the net farm income, the marginal influence of the productive inputs and, hence, the profit maximising ability of the farmers.

The results indicate that the farmers in the study area obtained an average net farm income of Kshs. 2,910.3; an indication that food crop production is a profitable enterprise in the area. However, it was observed that the farmers underutilized modern types of inputs (fertilizer, pesticides and improved seeds) but overutilized farm labour. To attain economic efficiency therefore, it is recommended that the farmers increase their use of modern farm input but decrease the use of labour up to the point where the marginal value product of each input is equal to its marginal cost.

6 Zusammenfassung

Kleinbauern, die die Landwirtschaft Kenias prägen, haben in der Nahrungsmittelerzeugung niedrige Erträge verglichen mit dem was technisch und ökonomisch möglich ist. Diese Studie untersucht die Produktionsformen der Kleinbauern in Westkenia im Hinblick auf den effektiven Betriebsmitteleinsatz.

Um das Nettobetriebseinkommen, die Möglichkeit der Gewinnmaximierung und den Einfluß der Produktionsfaktoren zu schätzen wurden betriebswirtschaftliche Funktionsanalysen genutzt, sowohl im Ökonomie- als auch im Produktionsbereich.

Die Ergebnisse zeigen, daß die Bauern in der untersuchten Region ein durchschnittliches Nettobetriebseinkommen von 2.910,3 Kshs. (1990) hatten, ein Indikator für eine gewinnbringende Nahrungsmittelerzeugung.

Es wurde festgestellt, daß die Bauern neuere, moderne und kapitalintensive Betriebsmittel wie Dünger, Pflanzenschutzmittel und verbessertes Saatgut wenig einsetzen, dafür aber einen hohen Arbeitseinsatz haben. Um betriebswirtschaftlich effektiver zu arbeiten wird empfohlen, den Faktor Arbeit geringer, dafür aber mehr Kapital einzusetzen bis zur Optimierung.

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