SOCIAL INTERACTIONS AND RETURNS TO FARM INPUTS IN SMALLHOLDER AGRICULTURE IN KENYA

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Abstract

In this paper, we use OLS, IV-2SLS and Control Function regression methods on cross-sectional data to analyze effects of social interactions among smallholder farmers in rural Kenya on demand for fertilizers and on farm yields. The main finding is that social interactions have large effects on demand for fertilizer and on its return. The interactions are also found to significantly influence returns to basic farm inputs, notably land, farm equipment, and labor.

Keywords: Smallholder agriculture, social interactions, returns to farm inputs

1.0 Introduction

In smallholder agriculture, farmers do not always possess full information when making decisions. They partially overcome this problem of information asymmetry by learning from neighbors, peers or extension officers. The learning takes place during social interactions or from inferences made from observing other farmers' production activities. Through such interactions, a farmer may gather new ideas on farming (Munshi, 2004). This process is known as learning through word-of-mouth.

In the absence of a local extension agent or an informed farmer to provide precise and unbiased estimates of expected crop yield, a smallholder farmer may observe his neighbor's activities regarding usage of inputs and production of farm produce and form opinions about particular aspects of farming (Conley and Udry, 2001; Munshi, 2004; Eisenkopf, 2010). Past observations of a neighbor's actions regarding inputs usage, e.g., the acreage planted or the amount of fertilizer applied and the outcome thereof may provide insights from which current input decisions can be made. A neighbor's previous input usage and plot-level outcomes when observed properly and repeatedly may provide credible basis for social learning by observation (Munshi, 2004). Thus, neighbors' experiences with inputs can importantly influence a farmer's decision-making process.

In an extreme case, a farmer may make decisions solely on information learnt from neighbors and completely ignore his own experience or private information (Banerjee, 1992). Were this to happen, the neighbors' and the farmer's own experiences would be perfect substitutes in the process of making decisions about technology choice.

However, there are cases when a neighbor's experiences may not be useful to an observing farmer even though observed. If the neighbors' decisions are functions of unobserved characteristics peculiar to him, social learning breaks down because such characteristics are not available to an observing farmer.

Ellison and Fudenburg (1995) propose a rule of thumb that individuals only learn gainfully from neighbors with characteristics similar to theirs. If that is the case, then farmers only learn from peers. Peer farmers are neighbors that a given farmer interacts with. To that extent, individual characteristics of interacting neighbors are important determinants of an individual farmer's knowledge in agriculture and his crop yields (Munshi, 2004).

A farmer may also take into account average village level yields in the past to make current decisions on input usage on his own plot as well as in updating his own estimates of expected yields. Thus, neighbors' experiences with inputs can importantly influence a farmer's decision-making process. Their previous decisions and plot-level outcomes may provide credible basis for social learning when observed properly and repeatedly by a farmer.

In the absence of social learning, a farmer will tend to experiment on his plot in a bid to generate information that he desires. Social learning, therefore, saves on costs of experimenting. The disadvantage of social learning is that it curtails generation of new information that could emerge from further field trials (Munshi, 2004).

In certain situations, a farmer may adopt a new technology, e.g., growing a new maize variety, just because his neighbors are growing the variety. The farmer is influenced by the adoption rate in the surrounding area. This behavior is characteristic of social influence (Hogset and Barret, 2010). Social influence does not entail social learning since the influenced farmer lacks details of the technology, and his adoption behavior is based on general perceptions (Foster and Rosenzweig, 1996).

For social interactions with neighbors to result in social learning, there must be distinguishable change in a farmer's productivity (Foster and Rosenzweig, 1996). Social learning provides positive information externalities that should be reflected in an increase in a farmer's productivity. Social interactions occur whenever one farmer in a network affects other farmers' choices directly without the intermediation of the market (Hartmann *et al.*, 2008). They lead to social effects on members of a defined group. A reference group in smallholder farming would be that set of other farmers whose behavior affects the focal farmer. At a micro level, a reference group could be a neighborhood or a village (Ellison and Fudenburg, 1995).

Foster and Rosenzweig (1995), Conley and Udry (2001), Munshi (2004) and Bandiera and Rasul (2006) show that a farmer's initial decision to adopt a new technology is influenced by decisions taken by others in his or her social network of relatives, friends and neighbors. These are the individuals with whom a farmer holds strong ties with, and is likely to exchange information and learn from. The average cumulative experiences of neighbors provide positive learning externalities or spillovers that impact positively on profit growth in an individual smallholder farm (Foster and Rosenzweig, 1985).

Although social effects are important in decisions and actions of smallholder farmers (Gathiaka, 2010), literature on the subject is scant. In addition, many studies fail to control for social effects when estimating production functions or when calculating returns to farm inputs. This can introduce bias in the estimated returns (Kimenyi *et al*., 2006). Estimates of returns to farming have conventionally measured the marginal value product of an input (Randrianarisoa and Minten, 2001) and monetary returns for money invested (Farquharson, 2006). While these conventional measures are by all means useful, they may be biased because they ignore social interactions and externalities. For example, Farquharson (2006) in simulating wheat production response to fertilizer does not consider that fertilizer demand may be influenced by social interactions among farmers.

Previous studies in Kenya have not taken into account the effect of social interactions in smallholder agricultural production (see for example, Nyangena and Kohlin, 2008; Kabubo-Mariara, 2010; Kabubo-Mariara *et al*., 2010). There is need to investigate how input demand and returns to farming behave in the presence of social interactions because these social phenomena are common in farm environments.

This paper builds on available literature by focusing on a sample of smallholder farms in Kenya with regard to input demands and the returns to the inputs while paying due attention to social effects. The paper estimates parameters of input demand functions controlling for social interactions. Social interactions are proxied by average neighborhood variables of fertilizer usage, animal feeds usage, conservation efforts, soil ridging practices, grass stripping efforts and property rights bundles.

The rest of the paper is organized as follows. The next section discusses materials and methods employed in the paper. It also shows the empirical model followed in this paper to estimate demand for farm inputs and returns to the inputs in smallholder farms while controlling for social interactions. Part three presents and discusses the estimation results. The last part summarizes the paper and draws policy conclusions.

2.0 Materials and Methods

The data for this paper were collected from Nyeri County in Central Province of Kenya between July and September 2007. This County was purposively selected because it has smallholder farming as the dominant land use activity (Republic of Kenya, 1997; 2002). The unit of analysis was the household and the data were collected in face-to-face interviews with farmers. The questionnaire that was used asked questions on farm activities, inputs and their usage, land tenure, farm output, marketing, infrastructure, and soil conservation practices.

Sample selection was guided by the National Sample Survey and Evaluation Program (NASSEP) of the Kenya National Bureau of Statistics (KNBS). NASSEP maps the whole country into enumeration areas (EAs) first, and then classifies them into clusters based on population density. A cluster contains between 50 and 150 households. Nyeri has three enumeration areas with 34 clusters, of which 24 are rural and 10 urban. One of the 10 urban clusters is classified as peri-urban because of its agricultural activities. The sample was drawn from the 24 rural clusters and from the single peri-urban cluster so that the sampled households were spread across 25 clusters. The sampling frame was the households list. In each cluster, a sample of 17 households was systematically selected but in a random fashion to arrive at the desired sample size of 425 households, consistent with Yamane's (1967) sample size formula.

2.1 ***Descriptive Statistics***

Table 1: Characteristics of Smallholder Households and Farms in Nyeri

Variable	Mean	Std. Dev	Min.	Max.
Head is male	0.76	0.43	0	1.0
Age of household head	51.00	13.90	16	90
Household size	4.30	1.75	1.0	9.0
Highest level of education of head				
No education	0.13	0.34	0	1.0
Primary	0.50	0.50	0	1.0
Secondary	0.31	0.47	0	1.0
Post-secondary	0.05	0.21	0	1.0
Other	0.01	0.08	0	1.0
HH head trained in agriculture	0.15	0.35	0	1.0
Main occupation				
Farmer	0.59	0.49	0	1.0
Casual employment	0.13	0.34	0	1.0
General business	0.11	0.31	0	1.0
Formal employment	0.08	0.26	0	1.0
Other	0.04	0.20	0	1.0
None	0.05	0.23	0	1.0
Land ownership and mode of acquisition				
Average land holding per head	2.28	3.01	0.08	23
Purchased	0.10	0.30	0	1.0
Inherited	0.80	0.38	0	1.0
Rented	0.01	0.07	0	1.0
Other	0.07	0.26	0	1.0

Person registered on land title deed				
Father	0.47	0.50	0	1.0
Head	0.36	0.48	0	1.0
Other	0.17	0.15	0	1.0
Tenure rights				
Land sale	0.44	0.50	0	1.0
Bequeathing the land	0.40	0.50	0	1.0
Renting the land	0.14	0.35	0	1.0
Other land transactions	0.02	0.15	0	1.0
Security of rights				
Unlikely to lose land ownership	0.80	0.40	0	1.0
Other stakeholders on land	0.20	0.45	0	1.0
Main crops				
Maize	0.91	0.28	0	1.0
Beans	0.81	0.40	0	1.0
Irish potatoes	0.56	0.50	0	1.0
Bananas	0.33	0.47	0	1.0
Coffee	0.41	0.49	0	1.0
Horticultural crops	0.15	0.36	0	1.0
Tea	0.15	0.35	0	1.0
Harvested crop output per annum in kilograms				
Maize	304.41	391.77	0	3240
Beans	116.96	231.56	0	1920
Irish potatoes	165.03	367.22	0	3500
Bananas	12.9	44.22	0	620
Coffee	367.35	843.25	0	9000

Horticultural crops	620.00	3018.08	0	40000
Tea	694.68	7506.33	0	150000
Quantity of selected farm inputs				
Family labor, person-days	137	154	0	954
Hired labor, person-days	22.5	64.3	0	587
Manure, kilograms	1,597	2,530	0	21,000
Fertilizer, kilograms	45.9	72.6	0	600
Erosion control practices				
Plot with some conservation	0.60	0.49	0	1.0
Terraces	0.18	0.39	0	1.0
Planted trees	0.03	0.17	0	1.0
Ridging	0.20	0.39	0	1.0
Grass strips	0.30	0.45	0	1.0
Other practices (e.g., mulch, fallow, etc.)	0.07	0.25	0	1.0
Nature of the practices				
Short term investments	0.46	0.50	0	1.0
Long term investments	0.54	0.50	0	1.0
Mineral addition practices				
Fertilizer use	0.17	0.37	0	1.0
Manure use	0.17	0.38	0	1.0

Neighborhood variables				
Mean fertilizer usage in a village, kilograms	46.0	27.45	2.31	130.06
Mean of grass stripping practices at the village (1=stripping)	0.287	0.157	0	0.5
Mean of soil ridging practices at the village (1= ridging)	0.185	0.145	0	0.5
Common property rights regime in a village (1,2…*n*), where *n* = private	2.955	0.537	1.438	4.2
Distance to the nearest infrastructure in kilometers				
Market centre	3.0	2.44	.01	16
All-weather road	1.67	2.20	0	15
Tarmac road	4.18	4.89	.01	30
Cooperative society	5.4	7.62	.01	60

2.2 ***Empirical model***

In farm production, observable as well as unobservable inputs determine output level. While observable inputs are clearly understood and have a market value, unobservable inputs are not. Unobservable inputs may relate to a farmer's own characteristics or to neighborhood behavior (with regard to production choices), exogenous attributes of the neighborhood and to personal characteristics of the neighbors. The linear-in-means model can capture the effect of observable as well as unobservable inputs in a production function.

2.3 ***The linear-in-means model***

Following Halliday and Kwak (2007), Gaviria and Raphael (2001) and Fletcher (2010), the linear-in-means model was modified to show the crop output of farmer *i* in village *s* as follows:

$$Y_{is} = a_0 + a_1 X_i + a_2 \bar{Y}_{is} + a_4 F_i + a_4 W_i + a_5 V_i + \square_i \ldots\ldots\ldots\ldots (1)$$

where,

Y_{is} = output of farmer *i* in village *s*

X_i = endogenous input used by farmer *i* (e.g., fertilizer)

$\bar{Y}_{is}$ = vector of neighborhood variables in village *s* when farmer *i*'s variable in same respect is excluded

F_i = vector of farmer *i*'s observable characteristics or observed heterogeneity

W_i = vector of other covariates of inputs demanded by farmer *i*

V_{is} = village *s* fixed effects

a_i= parameters (i=0,1,…)

□$_i$ = error term.

$\bar{Y}_{is}$ vector contained the variables of crop output, fertilizer usage, conservation efforts of soil ridging and grass stripping practices and property rights bundles measured at the village level. It was a proxy for social interactions. X_i is an endogenous input, say fertilizer. To estimate equation (1) while also addressing problem of endogeneity, Xi was instrumented (see Greene, 1997). That is, demand fertilizer was predicted and the actual fertilizer variable in equation (1) was replaced with the predicted fertilizer demand. Predicting fertilizer demand involved estimating a fertilizer demand function with an exclusion restriction, namely, C_{di}, the distance from a household to the nearest cooperative society. The effect of distance on fertilizer demand was hypothesized to be non-linear, and for this reason distance was included together with its square in the demand equation as in Thori and Mehlum (2010).

The predicted fertilizer demand was a reduced form of equation of the form:

$X_{is} = b_1 + b_2\overline{X_{is}} + b_3 F_i + b_4 W_i + b_5 V_i + C_d +$ □$_{fi}$ ……………………………(2)

where,

X_{is}= amount of fertilizer used by farmer *i* in village *s*

$\overline{X_{is}}$ = mean fertilizer used by farmer *i*'s neighbors in village *s* when farmer *i*'s fertilizer usage is excluded

F_i = vector of farmer *i*'s observable characteristics

V_i = village *s* fixed effects

C_{di} = distance to the cooperative society nearest to farmer *i*

b_i = parameters to be estimated (i=1,2…)

□$_{fi}$ = error term

3.0 Results and Discussion

3.1 ***Demand for Fertilizer***

Four specifications of fertilizer demand, each with a different neighborhood variable of social interaction were estimated. Results are shown in Table 2. The characteristics of the household head and social interactions at the village level were the control variables.

Table 2: First Stage Regression– Demand for Fertilizer (*t*-statistics in parentheses)

Variables	*OLS Estimates*			
Factor Inputs				
Capital , index	2.664(1.36)	2.081(1.03)	1.804(0.89)	1.805(0.90)
Labor, person days	.043(2.25)	.034(1.71)	.034(1.69)	.039(1.95)
Land, hectares	.268(0.23)	-.451(0.38)	.200(0.17)	-.228(0.19)
Farmer and Neighborhood Characteristics				
Age, years	.526(0.33)	-.203(0.12)	-.303(0.18)	-.409(0.25)
Age^2	.034(0.23)	-.735(0.00)	.001(0.03)	.002(0.11)
Education, level	3.632(0.76)	3.362(0.69)	3.167(0.64)	4.048(0.83)
Mean fertilizer usage in a village, kilograms	.675(5.42)	-	-	-
Mean of soil ridging practices (1= ridging)	-	55.781(2.30)	-	-
Mean of grass stripping practices (1=stripping)	-	-	31.474(1.37)	-
Common property rights regime in a village (1,2…*n*), where *n* = private	-	-	-	-17.214(2.68)

Exclusion Restrictions				
Distance to a cooperative society	-3.603(3.75)	-3.396(3.41)	-3.570(3.58)	-3.510(3.55)
Distance to a cooperative society squared	.097(4.55)	.095(4.35)	.098(4.45)	.093(4.23)
Constant	28.389(0.67)	45.529(1.04)	50.896(1.16)	111.047(2.35)
R^2	.125	0.0739	0.066	0.079
F-statistic [p-value]	6.550[0.000]	3.65[0.000]	3.25[0.001]	3.93[0.000]
Root MSE	68.619	70.644	70.933	70.404
Observations	423	423	423	423

The estimation results show that fertilizer demand is positively associated with labor and neighborhood variables, proxied by the means of fertilizer usage, soil conservation efforts and property rights within a village. An increase in labor endowment at the household by one person-day is associated with an increase in fertilizer application on a plot of 0.043 kilograms. The social effects of fertilizer usage and soil ridging are positive. A rise in the mean fertilizer usage at the village level by one kilogram encourages an observing farmer within the village to increase his own fertilizer usage by close to 0.7 of a kilogram. This finding is suggestive of social learning among farmers and of positive social information externalities within the village.

An increase in distance to the nearest cooperative society reduces demand for fertilizer. For every kilometer increase in distance to a cooperative society, a farmer reduces the annual demand for fertilizer by 3 kilograms. Long distances to cooperative societies which are the main sources for farm inputs in rural areas discourage fertilizer usage.

A unit change in the property rights regime in the direction of private ownership reduces fertilizer demand by 17 kilograms. In smallholder agriculture farmers often use organic manure rather than inorganic fertilizer when they are certain of using a plot for a long period of time. Use of manure is advantageous in that soil fertility and water retention lasted for a longer period. The results suggested that private rights regimes reduced plot level application of fertilizers.

The same analysis was performed as in Table 2, but entering the basic farm inputs into the fertilizer demand equation separately in an attempt to control for any multicollinearity among them. The results were the same as in Table 2 showing that multicollinearity was not a problem in this specification.

Characteristics of household heads did not influence demand for fertilizer in any systematic way. The result was consistent with Akwasi's (2010) finding that household characteristics, including basic education do not affect fertilizer demand.

3.2 ***Returns to farm inputs***

In crop production, some inputs are basic to all farmers while others are not. Every farmer uses some form of farm equipment, labor and land in production so that these factors are basic farm inputs. In contrast, only some of farmers use fertilizers.

Table 3 presents estimated returns to farm inputs. The dependent variable is log of crop output in kilograms.

Table 1: Parameter Estimates of Crop Production Function (fertilizer is the endogenous input)

	Dependent Variable is Log Crop Output		
Variables	*OLS Estimates*	*IV-2SLS Estimates*	*Control Function Estimates*
Factor Inputs			
Fam equipment, capital	.056(3.21)	.046(2.39)	.046(2.55)
Labor*10^{-1}	.004(2.09)	.002(1.00)	.002(1.18)
Land	.024(2.39)	.022(2.04)	.023(2.26)
Fertilizer*10^{-1}	.006(1.38)	.040(1.93)	.045(2.27)
Farmer and Neighborhood Characteristics			
Age	-.012(0.82)	-.010(0.65)	-.009(0.67)
Age^2*10^{-1}	.001(0.85)	.001(0.71)	.001(0.73)
Education	.013(0.31)	-.006(0.13)	-.008(0.19)
Mean fertilizer used by neighbors within a village	.005(4.54)	.003(2.00)	.003(1.68)
Controls for Unobservables			
Reduced-form fertilizer residual	-	-	-.004(1.75)
Fertilizer*reduced-form residual*10^{-3}	-	-	-.003(1.02)
Constant	9.061(24.39)	9.017(22.53)	8.996(24.20)
R^2	0.1152	.	0.1244
F-statistic	6.74	6.09	5.86
[*p*-value]	[0.000]	[0.000]	[0.000]
Root MSE	.607	.652	.605
Observations	423	423	423

(Absolute t Statistics in Parentheses)

The OLS estimates show that controlling for neighborhood effects in fertilizer usage, returns to factor inputs with the exception of returns to fertilizer are statistically significant at the 5 percent level. In IV-2SLS estimation, capital, land, fertilizer and mean fertilizer usage are the most important determinants of crop production. The latter results are more credible and indicate that controlling for endogeneity matters in estimations of returns to farm inputs. When endogeneity and the effects of village level fertilizer are accounted for, returns to fertilizer are estimated at 0.4 percent. The coefficient on reduced-form residual is statistically significant confirming that fertilizer is indeed endogenous to crop production.

Since the coefficient on the reduced form fertilizer residual interacted with fertilizer variable is not statistically significant, heterogeneity is not a problem and thus, the control function estimates were not an improvement over the IV estimates. Multicollinearity among basic farm inputs is also not a problem in this specification.

Fertilizer usage at the village influences individual farmer's demand for fertilizer and this in turn influences crop yields. Table 4 shows additional estimation results.

Table 4 Production effects of soil conservation and property rights (*t*- statistics in parentheses)

	Dependent Variable is Log Crop Output		
Variables	*Soil ridging*	*Grass strips*	*Property rights*
Factor Inputs			
Capital	.046(2.40)	.038(2.12)	.040(2.09)
Labor*10^{-2}	.016(0.84)	.028(1.50)	.013(0.69)
Land	.019(1.78)	.013(1.23)	.018(1.66)
Fertilizer*10^{-1}	.039(1.90)	.029(1.53)	.044(2.01)
Farmer and Neighborhood Characteristics			
Age	-.008(0.55)	-.009(0.60)	-.008(0.50)
Age^2*10^{-3}	.083(0.59)	.097(0.73)	.079(0.56)
Education	-.008(0.18)	.008(0.19)	-.014(0.30)
Mean of soil ridging effort by neighbors within a village (1=soil ridging)	.431(1.74)	-	-
Mean of grass stripping efforts by neighbors within a village	-	-.958(4.78)	-
Property rights held by neighbors in a village	-	-	.176(2.40)
Constant	9.059(22.43)	9.407(24.43)	8.586(17.35)
R^2	.	0.080	.
F-statistic [*p*-value]	4.380[0.000]	6.080[0. 000]	3.59[0.001]
Root MSE	.652	.619	.661
Observations	423	423	423

Village level soil conservation efforts have mixed effects on returns. While average soil ridging in a village has a positive effect on returns, grass stripping has a negative effect. In either case, the coefficients on social interaction variables are significant indicating evidence of social effects. Soil ridging efforts in a village are positively associated with higher levels of crop production. A 10 percentage increase in the proportion of farmers engaged in this practice is associated with an increase in crop output of 4.31 percent. The result suggests that there are positive production social effects in a village stemming from farmers that practice soil ridging. This finding contrasts with the case of grass stripping, where estimates show that when grass stripping by neighbors increases, crop output on individual plots declines.

Soil ridging by neighbor farmers effectively checks soil erosion leading to positive externalities to non-conserving farmers and raising plot level productivity. In contrast, depending on how they are constructed, grass strips may not be effective in controlling soil erosion, and erosion downstream during heavy rains may occur in spite of their presence. This may lower productivity in the eroded farms.

Further, if a farmer observes his neighbors' grass strips and plants the same in his farm, the strips may compete for space with crops and reduce yields. This however might be a short-run result because in the long run, the grass strips control erosion and crop output may increase. Existing studies show that soil conservation is a boost to crop production (Kabubo-Mariara, 2010; Kabubo-Mariara *et al*., 2010)

The property rights held by neighbors tended to private ownership of land. Private ownership bestowed on plot owners "full" or "complete" land rights bundle, i.e., right of access, right of withdrawal, right of management, right of exclusion and right of alienation (Demsetz, 1967). The social effect of these property rights on demand for fertilizer was negative but positive in the case of crop production. As already noted farmers tended to apply manure in plots that they were sure to cultivate for a long time and this had several benefits that increased yields. Secure property rights have been observed to encourage more investments by way of inputs thus affecting yields (Kabubo-Mariara, 2007; 2010; Kabubo-Mariara *et al*., 2010).

If the prevalent land tenure in a neighborhood is private property, it may, under certain assumptions suggest that most farmers have the incentive to practice good farming techniques and to invest in conservation (Fenske, 2011). A farmer in a neighborhood no matter his tenure system receives spillover benefits in form of demonstration effects. For a given level of inputs, productivity can be expected to be higher due to demonstration effects of good farming practices. A private land tenure system creates positive social effects while common property and poorly defined regimes may be associated with negative social effects.

Information on responsiveness of crop output to changes in factor inputs is important in policy formulation. It is useful in making decisions regarding optimal factor inputs. The section that follows looks at the issue of the elasticity of crop output with respect to factor inputs, highlighting the policy value of the relationship.

3.3 *Crop output elasticities*

Table 5 presents estimates of the responsiveness of crop output to changes in factor inputs and to neighborhood variables based on results reported in Tables 3 and 4.

Table 0 Elasticities of Crop Output

Variable	*Elasticity*
Farm equipment	0.081
Labor	0.048
Land	0.060
Fertilizer usage, own farm	0.206
Fertilizer usage by neighbors	0.131
Grass stripping by neighbors	0.272
Soil ridging by neighbors	0.078
Property rights	0.508

Crop output is inelastic with respect to changes in the factor inputs and to variations in neighborhood variables. This is a pointer to low demand for inputs at the farm level. With regard to land, the results suggest that soils are over cultivated without adequately replenishing lost soil nutrients. Thus, an increase in cultivated area does not automatically translate to higher crop yields.

The poor response of crop output to changes in fertilizer suggests that the amounts of fertilizer used in the farms are too low such that any increases in the amount used do not reach the threshold of nutrients required for healthy plant growth. This is consistent with the findings of Kelly (1995) in a study of fertilizer application in smallholder farms in sub-Saharan Africa, and those of Jha and Hojjati (1993) with regard to the same in Zambia.

The capital equipments in the smallholder farms studied are rudimentary and any change in their demand could not make any change on crop yield. Without proper complementary inputs, any change in labor demand could also not change crop yield.

In smallholder agriculture in the studied area family labor, traditional seeds and farming methods (e.g., hand digging) dominate. Timely land preparation and weeding using a hand hoe is difficult. The quantities of fertilizer used particularly on food crops are quite low or none at all as was observed in most of the farms. Agriculture in these smallholder farms was largely rain-dependent and crop response was bound to be poor in the cases of rain failure.

Due to low response of output to changes in inputs, a decline in, say, wage rate relative to crop output price cannot attract significant labor on the farm (Hayami, 1969). Low crop response discourages increased input usage at the farm level.

In smallholder agriculture, as land becomes scarce, and as the price of fertilizer relative to price of land continues to decline, the use of fertilizer and of fertilizer-responsive crops particularly the high breed varieties can be expected to increase. Factor substitution can be encouraged along the isoquant of a meta-production function as happened in Japan (Hayami, 1969).

With a fixed supply of land, opportunities for higher yields from land lie in combining it with factors that push up crop production functions, such as fertilizer. This is a prudent farming strategy because crop elasticity with respect to land is 0.06, compared with a fertilizer elasticity of 0.206 percent. Crop increments are highest for investments in grass strips, but their productivity benefits seem to lie in the future. Crop expansion also responds strongly to property rights that give farmers complete control of their plots.

4.0 Conclusion

This paper has investigated the extent to which village-level variables influence farm decisions regarding inputs usage, and how social interactions affect returns to inputs in smallholder agriculture in Kenya. Towards this end, parameters of farm input demand functions and farm production functions were estimated controlling for the effects of social interactions.

Smallholder farmers operate in a social context. Using fertilizer as special case of more general situations, the paper shows that social interactions matter in smallholder agriculture. Beegle and Dercon (2007) found similar results in their study of banana growing in Tanzania. Social interactions directly influence demand for inputs and have large impacts on returns to inputs at the plot level. The effect of the social interactions on an individual farmer (through social learning and peer pressure) is evident, but the paper was unable to separate out the the two effects. Usage of farm inputs is correlated with property rights regime at the village level. The dominant property rights regime in a village and soil conservation significantly influences crop production.

The property rights that give farmers ownership of their plots are associated with increases in crop production. Although property rights go beyond mere possession of title deeds, these documents may be necessary for long-term investments in soil conservation. Easing the legal and regulatory framework to enable households acquire property rights would improve soil conservation practices and raise farm output.

Farm output in smallholder agriculture is inelastic with respect to changes in farm inputs. This finding suggests that farm inputs would have to increase considerably before appreciable increases in farm output can be noticed. With declining land holdings and productivity in smallholder agriculture, farmers can gain a lot by using inputs that are known to raise output, the prime examples being fertilizers and improved land husbandry practices.

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