

Socio- economic Evaluation of manure contract exchange; Impact on Farm Productivity in North western Nigeria.

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Abstract

This study evaluates manure exchange contract as new emerging traditional institution that has evolved to solve the exchange problems between herders and croppers in the Zamfara Forest Reserve, North-western Nigeria. It evaluates the determinants of the exchange process and the impact of farmers participation in manure contract on their farm productivity. Data were collected between December 2001 and August, 2002 from farmers, using structured questionnaires. Econometrics techniques were used to determine factors that stimulate farmers participation in manure contract and the impact of such participation on farm productivity was investigated. Results show that the farmers socio-economic and cultural characteristics determine participation in manure contract. It also shows that the participation in manure contract has brought many benefits such as increased productivity and more cordial and convivial relationship between herders and croppers who now see each other as partners in progress in the use of resources within their common environment.

Keywords: Manure exchange, crop-livestock integration, crop productivity, croppers and herders, Nigeria

1. Introduction

There are different shades of crop-livestock interaction that have evolved over ages in sub-Saharan Africa. As strategies adopted by farmers for soil fertility management they enhance sustainable productivity of farmers soil. The most popular right from ages is the possession of crop and livestock under the same management. This process has equally been described as crop-livestock interaction. The major characteristic of this mixed farming system is its complimentarity as defined by McIntire *et al* (1992), as the supply of inputs from one sector to the other, such as using draught animals and manure for crop production or crop residues as animals feeds.

However, the other new emerging form of interaction occurs between croppers who exchange crop residues or grains with herders for manure and other animal products. This has been described as contract based on the exchange of manure deposition for crop residues grazing with transhumant herders (Williams *et al*, 1995; Powell *et al*, 1996). The development of these interaction is highly favoured in the rural areas

with high cultivation densities (Norman *et al*, 1982; Jahnke, 1982; Powell and Taylor-Powell, 1984; McIntire *et al*, 1992).

This new emerging traditional institutional exchange of manure for crop residues evolved as a consequent of the felt needs of the two groups requiring each other services and goods for which there is yet to be a formal institutionalised market arrangement. The informal institution has thus brought succour and relief to the two parties, involved in the process of smoothening transfer of goods and services between them.

Manure, an important by-product of integrated farm is very important in crop production, especially, in sub-Saharan African where soil degradation has been identified as a very serious problem impeding sustainable farm production (Oucho,1998). The benefits of the use of manure in crop production are improvements in soil physical properties and provision of N.P.K and other mineral nutrients. The application of livestock manure increases soil organic matter content, and this leads to improved water infiltration and water holding capacity as well as an increased cation exchange capacity. Manure and urine raise the PH level and accelerate the decomposition of organic matter and termite activity (Brouwer and Powell, 1995; 1998). If organic fertilizer, especially nitrogen, is combined with manure, the manure reduces soil acidification and improves the nutrient buffering capacity and the release of nutrients (Williams *et al*, 1995).

While many studies have documented the wide practices of crop-livestock interaction in general in West Africa, few studies, so far available on the manure contract adoption participation, are descriptive without recourse to the driving force behind croppers adoption of the practice and the impact of the adoption on crop productivity. The main focus and objective of this study is therefore to empirically evaluate the factors driving the participation of croppers in manure contract and the impact of such adoption on his crop productivity. Consequently, the questions that will be addressed by this study are:

- 1). What are the factors driving farmers participation in the adoption of manure contract in the study area?
- 2). Does the farmers participation in manure contract have any impact on the productivity of his crop?

2. Material and methods

2.1 Description of the study area

The study was carried out in Zamfara reserve in Zamfara state located in north western geopolitical zone of Nigeria. The Zamfara Forest Reserve is located between 6⁰30' and 7⁰15'E, and 12⁰10' and 13⁰05'N in the northern part of Zamfara state, sharing border with the Niger Republic to the north, Sokoto state to the West and Ruka Reserve of Katrina state to the East. Annual rainfall ranges from 500mm in the north to 850mm in the south with considerable inter-annual variations. The vegetation of this area is Sudan and Sahel in nature. The reserve, established in 1918, covers today a total area of 2,300 km² including four enclave villages (Dumb rum, Shamushalle, Tsabre and Ajja). About 50 villages occupied the western fringes of the reserve and altogether, about 130,000 people live within and around the reserve and utilise

its natural resources (ARCA, 1995). The reserve is an important rainy season grazing area for transhumant pastoralists as well as for the herds of the settled herders living in the enclaves or the adjoining villages. After harvesting, most livestock are fed on stubble based on contract with the croppers. Despite average population density of about 80 person per km², pressure on cropland is high resulting in degradation and deficient soil nutritional problem. Estimate of the actual cropping area per household of about 8 persons (Hassan, 2000; Eckert and Hoffmann, 1998) are between 1.6 to 1.8 ha. As arable land is limited, shifting cultivation and fallow are no longer practised, and the fields are under permanent cultivation for the past 40 years (Hoffmann, 2002). The study area is populated by Hausa farmers, and by semi-sedentary, and transhumant nomadic Fulani. Livelihood in the area is based on crop and livestock production. However, most of the pure croppers remaining in the area depend predominantly on manure contract as a source for managing the fertility of their soils.

2.2 Material and methods

Data for this study came from 85 crop farmers selected from four enclave villages of Dumburum, Shamushalle, Tsabre and Ajja all located in Zamfara reserve. The data was collected using structured questionnaires in 2002 at the end of the harvest of 2001 cropping season. It was not possible to have more observation due to the fact that more farmers now practised crop-livestock mixed enterprise combination particularly all over the northern parts of Nigeria. The randomly selected farmers included those involved in manure contract participation as soil fertility management measure as well as those not involved in the adoption of the practise. Efforts were also made to inquire from the farmers those factors that guide their decision making in manure contract adoption participation. Other information collected were about the inputs expended on crop production as well as the output realised.

2.3 Theoretical Approach for the study

The theoretical basis of the study is founded on the utility theory as has been demonstrated in many adoption studies (Lancaster, 1966; Rahn and Huffman, 1984; Adeshina and Zinnah, 1993; Kebede *et al*, 1990). Supposing that we have two farm practices, old and new, an individual household's preference (utility) of adopting the new practice, for a given vector of economic, social and physical factors (X) is denoted by $U_n(X)$ and the preference (utility) of adopting the old practice by $U_o(X)$. Then, the preference for adopting the new and old practices can be defined as a linear relationship:

$$U_n(X) = X\beta_n + E_n \dots \dots \dots (1)$$

$$U_o(X) = X\beta_o + E_o \dots \dots \dots (2)$$

Where B_n , B_o and E_n , E_o are response coefficients and random disturbances associated with the adoption of the new and old practices, respectively. A farmer will take a decision to adopt the new practice when the utility from:

$$U_n(X) = X\beta_n + E_n > U_o(X) = X\beta_o + E_o \dots \dots \dots (3).$$

2.4 Analytical technique for the study

In the course of performing his duties, a farmer has to make numerous decisions, both of day to day and on the long term basis. Some of these decisions relate to the adoption of specific practices used in the farming operation. One of the appropriate models to analyse this type of decision problem is the qualitative response model which is also known as binary or discrete or dichotomous model. Alternative functional forms of dichotomous models which may provide greater reliability and statistical sophistication that have been developed and found appropriate for used for adoption analyses are Probit, Tobit and Logit models. In the present study, Probit model is used. The main advantage of the Probit is that it is bounded between 0 and 1, hence the problem of predicted values being outside the probability range is overcome. Furthermore, it compels the disturbance term to be homoscedastic because the form of the probability function depends only on the distribution of the difference between the error terms associated with one particular choice and another (Amemiya, 1981; Domencich and McFadden, 1975; Hill and Kau, 1973). Furthermore, the Probit also allows the generation of the predicted probability that all farmers would have participated in the adoption which then allows the estimation of the impact of the adoption on farms productivity in the study area.

Based upon the assumption of utility theory as shown above the Probit and OLS models developed for the estimation of the adoption decisions and the impact on crop productivity of the farmers are as stated below:

$$A_i^* = Z_i'\gamma + \mu_i \dots \dots \dots (4) \text{ for adoption determinants.}$$

$$Y_i = X_i'\beta + \delta A_i^* + e_i \dots \dots \dots (5) \text{ for impact of adoption on productivity.}$$

Where A_i^* = The adoption of manure contract

Z_i' = the vector of explanatory variables explaining adoption

γ = are the coefficients to be estimated

μ_i = random disturbance associated with the adoption

Y_i = Crops yields in grain equivalent

X_i' = vector of explanatory variables explaining yields

β = coefficients to be estimated

δA_i^* = the probability prediction of farmers participation in manure contract

e_i = the random explanatory variable associated with productivity

The maximum likelihood approach is used to estimate the coefficients of the Probit model in equation (4).

2.5 Variables in the models

The theoretical probit model discussed above suggests many important hypotheses related to the adoption of manure contract as soil management strategy by crop farmers in the study area vis-à-vis socio-cultural and economic characteristics of the farmers. The model is derived from the equation, which was developed bearing in mind the economic motives as well as the socio-cultural environment in which the farmers operate. The model assumes that the dependent variable for the probit which is the participation of crop farmers in the adoption of manure contract for soil fertility maintenance depends on the following explanatory variables: intended duration of animals stay on fields during contract, prior business relation between the cropper and herder, cropper belonging to same tribe with the herder, trust between cropper and herder, other reasons not mentioned and no reason in particular. On the other hand, the explanatory variables in the OLS for productivity were: labour expended on crop production, the probability of participation in manure contract and the capital used in crop production while the dependent variable is the yields of crops in kilogramme in grain equivalent as a proxy for productivity. The lists of variables used in the probit model and the OLS and the hypothesised signs is presented in Table 1. On relationship between the duration of animals camping on field and the adoption of participation in manure contract, it is expected that the longer the herder is ready to camp his animals on the croppers field, the more the cropper is willing to participate in manure contract. This is because duration of animal stay on cropper field is considered a purely economic decision that is within the ambit of farmer rational behaviour predicated on the motive of what amount of manure he would gain from participating in manure contract. Knowing fully well that the longer the livestock are camped on his field, the more the quantity of manure that would be voided on his field and the better for the fertility of his field and consequently the better the nutritional status of his field. It is therefore expected that arrangement between the croppers and herder that allows the herd to stay long on the field will elicit positive decision to participate in manure contract by the croppers. Farmers response on this variable was obtained by asking the farmers to say for how many days will he expect a herder to camp his animals on his field to elicit his participation in manure contract. The second explanatory variable has to do with the prior business relationship of the croppers and herders. A contract that has no formal agreement is fraught with the danger of defaults by either of the parties involved and consequently under this informal institutional business arrangement, care is taken in selecting partner with utmost certainty of non default. Since there is no better way of guaranteeing non-default, each party is more comfortable with someone they have had such informal business relation with before. Such prior relations are usually very important in guiding the decision of farmers to participate in manure contract. The third variable is tribal affinity with the herder. People usually have better confidence reposed on people from their own tribe under the rural settings of these farmers since

there is no legal basis yet in getting agreement executed. Therefore, finding person of the same tribe willing to do manure contract will encourage the cropper to participate in manure contract. In fact, there is a very close relationship between the Hausa farmers and the Fulani herders in the whole country to the intent that they are said to be people of same origin and bounded together by same culture and religion. This made them to be generally referred to as Hausa-Fulani. This is because there is basically no difference between them when looked at from all point of view. Because of these understanding which is nationally recognised, these people have come to regard themselves as the closest tribe among the many tribes we have in Nigeria and are able to do things together in common. The fourth variable is trust in the other partner involved in the manure contract. People are generally more comfortable with the person they feel they can trust when it comes to dealing with other in an informal contract that has no legal backing and as such trust is an essential ingredient in guiding the decision of croppers to get involve in manure contract or finding contract partners. The fifth variable was, that a farmer adopt manure contract, because he sees another farmers engaged in the practise while the sixth and the last was termed other reasons which the farmers did not specified.

The impact of farm households participation in manure contract on farmers' crop productivity was also investigated . Under this, crop yields was the dependent variable and as a proxy variable for productivity measure. The three explanatory variables were the labour in man-hour expended on production per hectare, the capital used per hectare and the manure contract participation predicted from the manure contract adoption model. Since all the farmers under investigation did not participate in manure contract adoption, the probability of participation was obtained from the execution of the adoption model. Labour and capital are also very important variables in farm production and it is expected that all things being equal, there will be linear and positive relationships between yields and the use of labour and capital as well as manure use up to certain level of increasing the levels of use of these variables to other factors of production.

Table 1: Hypothesised relationship with manure contract participation

Variables Description	Variable	Hypothesised sign
Duration of animal stay on field	DURASTAY	+
Prior relation between partners	RELATION	+
People of same tribal relation	TRIBE	+
Trust between contract partners	TRUST	+
Because I see others farmers doing it	BANDWAGON	+/-
Other unspecified reasons	OTHERS	+/-
Labour expended on crop production	LABOUR (Man-hour)	+
Capital expended on crop production	CAPITAL (N)	+
Predicted probability of manure contract participation	PMANURE	+

3. Presentation of results

3.1 Determinants of decision to participate in manure contract by croppers in the study area

From Table 2, the general response by croppers to the factors that determine croppers decision to participate in manure contract adoption as strategy for soil fertility management were as shown. The model correctly predicted 96.47% of the observations, with significant chi-squared of 86.39. All the six variables explaining adoption had coefficients that were significantly different from zero. Three of these variables were positively associated with the adoption of manure contract participation for the 85 crop farmers in the study area. This attests to the importance of this informal institutional arrangement of manure contract adoption participation as a bail out measure for the farm households without self livestock to produce manure and who could not afford the conventional chemical fertilizers for maintaining the fertility of their soil. The veracity of motives claimed by these farmers and the significance of their results showed that without any doubt, the manure contract adoption participation have taken roots in the place between the croppers who are poised to ensure they could maintain the fertility and sustainability of their soil productivity. The farmers in this part of Nigeria are generally poor and manure use will continue for the nearest future to be the most feasible alternative for them for keeping their soils productive. Looking at the variables, the duration of stay of the livestock on the field of croppers during contracting is a very economic decision in farmer decision to participate. The longer the herder agree to camp his animals on the field, the more likely the cropper is favourably disposed towards participation. This is because the longer the animals stay, the more the manure that will be voided on the field and the better for the fertility of the soil and consequently the better the productivity of the soil. In the same vein, the prior business relationship with the herder was found to be significant but with negative sign. This may be an indication that such a business relationship in the past have turn soured and will consequently not encourage farmers participation in manure contract. On the other hand, tribal closeness of the parties involved and the level of trust they reposed on each other that can serve as guarantee to allay the fear of cheating will all encourage the croppers to participate in manure contract adoption as a strategy for soil fertility management by the croppers in the study area. However, the last two, which are that because the farmer see other farmers participating in manure contract and other reasons are negatively associated with manure contract participating. Expectedly, the reaction of farmers, as regards what their counterparts do is expected to encourage adoption of a particular practices that are considered capable of bringing about improvement in farm productivity. The negative sign in the variable relating to other farmers participation in manure contract have shown that even though this variable is important in the adoption determinant, it may not invariably translate into increase adoption of manure contract

participation. Moreover, on the variable other reasons, these reasons are important in adoption determinants but may work more against adoption than encouraging it.

Table 2 Results of Probit model for the adoption of manure contract participation by croppers in the study area.

Variables	Coefficients	St. deviation	t-ratio	P-value
Duration of stay on field	0.37 ^{***}	0.075	4.85	0.000
Relationship with herders	-2.69 ^{**}	0.86	-3.07	0.002
Tribal closeness	1.72 ^{**}	0.61	2.84	0.005
Trust reposed on contract partner	1.08 [*]	0.53	2.05	0.040
Because I see other farmers doing it	-1.12 [*]	0.47	-2.37	0.018
Other reasons	-2.24 [*]	0.95	-2.36	0.018
% correctly predicted = 96.47 Model CHI-SQ = 86.39 ^{***} Df= 5 Log Likelihood function = -15.44 N = 85				

* = significant at 10% level, ** = Significant at 5% level, *** = 1% level.

3.2 The impact of manure contract on crop productivity of croppers in the entire study area.

The overall results from all the croppers sampled has demonstrated that all the inputs in the model equation seemed to have played very important roles in the productivity of farmers crop yields in the entire study area. It was seen that the capital used, manure contract adoption participation and the labour expended on production were all positively associated with crop productivity improvement. The positive signs on the coefficients of these variables showed that the more the cropper use of them, all things being equal, the more the increase in crop yields. Equally important to note is the fact that all the variables coefficient were significant. Capital and labour were significant at 5% and 10 % level of probability respectively while the manure use probability which is the major variable of investigation was significant at 10% level of probability. This clearly confirmed the hypothesis that croppers participation in manure contract will have positive impact on farmers crop yields and hence productivity in the study area and a reflection of the fact that manure contract is serving as alternative means of soil fertility management among the resource-poor farmers in the area who are generally too poor to afford the conventional chemical fertilizers as means of managing the fertility of their soils.

Table 3 showing impact of manure contract on crop productivity by all croppers

Dependent Variable	Mean	Standard deviation	
Yields of crops in grain equivalent	1339.54	941.65	
Explanatory Variables	Coefficients	St. error	t-statistic
Constant	0.407	0.264	1.54*
Capital	0.137	0.041	3.35**
Probability of manure use	0.481	0.271	1.78*
Labour used	0.672	0.322	2.09*
R-square = 0.21 R-adjusted = 0.18 F-statistic = 6.99*** Durbin-Watson = 1.75 N = 85			

*, **, *** = significant at 10%, 5% and 1% respectively

4. Some preliminary conclusions

All the investigated factors contributed to explaining the decision of farmers to participate in the adoption of manure contract as soil management strategy. Of particular interest was the duration of stay of the herders livestock on croppers fields during the contract. This is a factor purely motivated by economic gains in terms of the quantity of manure that will be voided on croppers field which will equally influence the fertility of their soils. This particular factor will continue to play a prominent role in farmers decision making process in the adoption of manure contract as strategy for soil management.

The prior business relation was significant with negative sign and this could be an indication that prior relationships have brought about sour experiences that may prevent the croppers from dealing with such partners. This boil down to the negative consequences of informal agreements that may not be binding and therefore subject to failure or violations by the parties involved. This calls for the review of the way this contracts are handled. It may be worthwhile to strengthen the existing customary judicial system to give legal muscle to such an agreement so as to prevent default by prescribing punishment to serve as deterrent to erring defaulters. Since the government is not capable of embarking on any measure to help the farmers manage the fertility and productivity of their soils presently, efforts should be made by government to create legal backing that will make the informal institutional innovative framework these farmers have invented through the manure contract to work to the positive advantages of all the parties involved so that the common goal of economic survival of all can be attained and the mutual benefits of all sustained.

Furthermore, the tribal relation was also found to be positively correlated and significant. This is because people tend to have closer affinity in doing things with people from their tribal relations especially when such things bother on informal agreements. This was found to be the case in the study area.

Above all, the trust the croppers have on the herder of commitment not to cheat will also go a long way in facilitating the desire to participate in the manure contract with the herder. This is because, it might be difficult to track down the herder if he chooses to move with his animals after they might have eaten up the crop residues since they are always on the move.

It was equally discovered that the adoption of manure contract has positive impact in explaining crop yields and productivity in the study area.

The contract exchange now existing between Croppers and the Fulani has changed the perception towards the Fulani who were formally regarded as enemies and they are now looked at as partner in progress. It is like the biblical “stone rejected by the builders now the chief corner stone of the house”. The Fulani and his animals formally regarded as the enemies of the croppers and his crops are now needed as facilitator for soil improvement for sustainable crop production in the area by making manure available to croppers through manure exchange contract participation.

On the impact of manure contract on crop yields and productivity, it was found that participation of croppers in manure contract in the study area have contributed to better yields and productivity. This is attested to by the positive sign of this variable with significant coefficient. It was also found that other variables like capital and labour all have significant coefficients with positive correlation. They were all important inputs in enhancing productivity of crops in the study area.

Finally, it was discovered that the new found relationship brought about by manure contract between the Fulani herders and the croppers have reduced drastically to the barest minimum the incessant strife and crisis of confidence between the two groups as they now see themselves as partners in progress rather than enemies. They now realised that they need each other for mutual benefits and survival and hence the Fulani and his livestock like the biblical “stone that was rejected by the builder now occupy the cornerstone of the house”, enabling the croppers to facilitate productivity of their crops. The manure once treated as common commodity has now become an essential source of nutrients for soil fertility maintenance and sustainable crop production in the area. They are equally important in ensuring that the environmental degradation problem is minimised since fertile soils have a role to play in ensuring good vegetative cover.

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