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Productivity of improved plantain technologies in Anambra State, Nigeria

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The poor plantain output problem in Anambra centers on the efficiency with which farmers use resources on their plantain farm. It also borders on how the various factors that affect plantain production can be examined, so as to improve plantain production in the country. The inefficiency problem is attributed to factors such as use of low input technologies, lack of knowledge of high input technologies, amongst others. The study therefore examined farmers' productivity of improved plantain technologies in Anambra State, Nigeria. Data collected were analyzed using descriptive statistics, productivity indices, multiple regression and gross margin analysis. Analysis of productivity indices based on resource use efficiency shows that the farmers are highly efficient in the use of planting materials and labor. The results of the multiple regression analysis revealed that farmers' age, farm size, household size, educational status, planting materials, extension contact and labor are the main determinants of plantain productivity in the state. Gross margin per hectare of plantain averaged ₦988750 while net farm income averaged ₦980250. Rate of returns on capital invested is ₦2.3 implying that plantain production is a profitable and viable venture. The study therefore recommends the organization of field days and farmers' training on the use of high yielding planting materials. Procurement and distribution of improved varieties to farmers by Anambra State Agricultural Development Programme at the right time and at affordable prices are effective strategies for stimulating plantain productivity in the area.

Key words: Gross margin, plantain production technologies, productivity, resource-use.

INTRODUCTION

Plantain (Musa spp., ABB genome) is a giant herb that is cultivated in humid forest and mid- latitude zone of sub-Sahara Africa. Its origin is believed to be the South East Asia. However, a remarkable diversity of plantain exists in sub- Sahara Africa. The food crop is generally triploid, sterile and develops fruits by parthenocapy. Total world production is estimated to be over 76 million metric tons. Twelve million metric tons are produced in Africa annually (INIBAP in Fakayode et al., 2011).

Nigeria is one of the largest plantain producing countries in the world. It is the largest producer in West Africa with annual production of about 2.4 million metric tons mostly obtained from the southern states (FAO, 2006). Despite its prominence, Nigeria does not feature among plantain exporting nations. It produces more for local consumption than for export (Fortaleza, 2012). To harness the export potential of plantain, the current level of its production must be improved. This implies that the limited resources

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available to plantain farmers have to be optimized. The poor plantain output problem in Nigeria therefore centers on the efficiency with which farmers use resources on their plantain farm. It also borders on how the various factors that affect plantain production can be examined, so as to improve plantain production in the country. This quest therefore raises research questions as to how could farmers be enhanced to produce a basic stable crop like plantain more efficiently? How productive is the plantain enterprise? How viable is it? This study thus examined the productivity of plantain farms in Nigeria using Anambra State as a case study.

However, Kebede (2001) predicated the growth on productivity gained through greater technical and allocative efficiencies of the farmers in response to the changing technological and production environment. He also stated that despite all human and material resources devoted to Nigerian agriculture, the productive efficiency of farmers for most crops still fall below 60%. The inefficiency problem is attributed to factors such as use of low input technologies, lack of knowledge of high input technologies and poor farm management skills, poor extension services, unavailability and high cost of inputs (Obasi, 2005; Anyanwu and Obasi, 2010a, b). Previous studies on efficiency of resource utilization and productivity (Ike and Ogba, 2004; Oluwatosin, 2006; Moses and Adebayo, 2006) showed that there are wide variations in the levels of productivity and productive efficiency for the major food crops and the levels are far from the optimum. This indicates therefore that ample opportunities exist for the farmers to increase their productivity and productive efficiency. However, the importance of plantain in National economy has caused several researches to be carried out on plantain production. International Institute of Tropical Agriculture (IITA) concluded a five year US$ 4 million project that improved plant breeding techniques and developed new cultivars to increase yields of Musa crops (banana and plantain). This is for application in poverty reduction and income generation efforts throughout sub-Saharan Africa (SSA).

The project also developed new methods for deploying the varieties in a way that preserves traditional varieties while offering additional value-adding processing options (IITA, 2009). An underlying factor behind much of these works is that if farmers are not making efficient use of existing technology, introducing new technologies as a means of increasing agricultural output would be defeated, thus efforts designed to improve efficiency would be more cost-effective (Shapiro in Fakayode et al., 2011). In an economy where resources are scares and opportunities for new technologies are lacking, efficiency studies can show the possibility of raising productivity by improving efficiency without expanding the resource base. Plantain farmers can thereby maximize profit and produce more, leading to food security and competitiveness in plantain production. This study will therefore serve as a guide to agricultural key players on plantain production investment decisions.

Objectives of the study

Specifically, this study was designed to examine the socio- economic characteristics of plantain farmers in the study area, identify the major plantain cultivars and techniques used by farmers, analyze the productivity, cost and returns of plantain production in relation to technologies used and determine the factors affecting plantain productivity of the farmers in the study area.

METHODOLOGY

Area of the study

The study was conducted in Anambra State, which is located in the south-east geopolitical zone of Nigeria. It consist of twenty-one Local Government Areas grouped under four agricultural zones of Anambra State Agricultural Development Programme, these are Ogbaru, Ayamelum, Anambra west, Aguata and Awka North. The study area has an approximated land area of 4,416 km^2 and lies between longitude 6°20N/ and 7°00/E and latitudes of 7°16/N and 7°00/E. Its boundaries are formed by Delta State to the West, Imo State to the South, Enugu State to the East and Kogi State to the North (NBS, 2007).

The State Agricultural Development Programme currently provide extension services, imparts new technologies and financial assistance to apex farmers. The apex farmers are involved in all types of food production including research and often collaborate with the institute of tropical Agriculture and university of agriculture Umudike.

Method of data collection

Data used for the study were sourced mainly from primary and secondary sources. Primary data were collected using structured questionnaire administered to the plantain farmers in the study area. The secondary data were sourced from journals, articles and relevant extension agencies in the area. A multi-stage random sampling technique was used for the study.

The first stage involved the random selection of four Local Government Areas. In each selected Local Government Area, five communities/villages were randomly selected. Lastly, ten farmers involved in plantain production were randomly selected from each community from a list obtained from the Local Government Area. This gave a total of two hundred respondents. However, due to incomplete information in some questionnaires, only one hundred and eighty six of the respondents constituted the sample size for the study.

Method of data analysis

Descriptive statistical tools such as frequency counts, percentages and means were used to describe the data collected, while inferential statistical tools such as Multiple Regression Model, Gross Margin Model and Productivity Indices were also employed to analyze the data for the study.

Multiple regression model

The regression equation estimated is stated as Equation (1)

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + e_i \quad (1)$$

Where; Y = Gross value of plantain productivity {Output (₦)}, X_1 = Age of farmers {Years}, X_2 = Farm size {Hectares}, X_3 = Household size {Number}, X_4 = level of education {years}, X_5 = Farm income {Naira}, X_6 = Farming experience {Years}, X_7 = Farmers contact with extension agents {Monthly}, X_8 = Expenditure on planting materials (₦), X_9 = Expenditure on chemical fertilizer (₦), X_{10} = Labour input (man-days), e_i = Stochastic error term, b_0 = intercept, $b_1 – b_{10}$ = regression coefficients of the explanatory variables, $X_1 – X_{10}$ = explanatory variables (socio-economic characteristics)

The gross margin analysis

The gross margin analysis was employed to determine the overall gross margin per hectare and net farm income (NFI) per hectare. The gross margin and net farm income were estimated as Equations (2) and (3)

$$GM = TR – TVC \quad (2)$$

$$NFI = GM – TFC \quad (3)$$

Where; GM = Gross Margin (₦), TR= Total Revenue (₦), TVC = Total Variable Cost (₦), NFI = Net Farm Income (₦), TFC = Total Fixed Cost (₦)

Other estimations from the gross margin were profit margin and return per naira outlay. The profit margin (%) is the ratio of profit/net farm income to total revenue. The Rate of Return on Capital Invested (RORCI) is the ratio of the profit / net farm income to the total cost of production. It indicates what is earned by the business per naira outlay. The profit margin (%) and the rate of return on capital invested were estimated as Equations (4) and (5).

$$\text{Profit margin (\%)} = \text{profit / total revenue} \quad (4)$$

$$\text{Rate of return on capital invested (₦)} = \text{Profit / total cost of production} \quad (5)$$

Productivity indices

This shows the output earning per naira expenditure on the resources used. The resource productivity for labour and material used were estimated as Equations (6) and (7).

Resource productivity

$$\text{Labour productivity (₦)} = \text{total revenue / Labour input} \quad (6)$$

$$\text{Material productivity (₦)} = \text{total revenue / material input} \quad (7)$$

RESULTS

Socio-economic characteristics of farmers

Table 1 shows the summary statistics of some socioeconomic variables. The mean age of the respondent is 45 years. This is because younger farmers have the tendency to operate more efficiently than older farmers and the more experienced they ought to be in terms of their knowledge of improved plantain technologies and good varieties of plantains. About 67% are male while 33% are female. This could be due to the fact that men are stronger, more active and have the potential to work for longer hours on the farm than their women. By implication, the level of productivity of the farmers in term of the application of labor is expected to be higher than that of the female.

The mean household size is 6 persons. According to Onu (2005), large family size could be as a result of polygamous nature of the rural farmers. He further opined that this could be linked to the fact that most rural farmers look at large household size as a good and economical way of maximizing farm returns by using free family labor. There is high level of literacy in the study area, 85% has a formal education while only 15% has no formal education. Access to education as well as exposure to agriculture workshops betters the farmers' skill and his or her overall productivity (Apata et al., 2010). In addition, education is reported to have a significant impact on farmers' efficiency in production (Arene, 1996; Maurice, 2004). 84.4% had a plantain farm between 0.5 to 1.0 ha. While only 1.6% of the respondents had above 2 ha. This implies that the respondents are mainly smallholder farmers. However, plantain production may not be greatly influenced by farm size since farmers with fragmented farm land often try to make maximum use of their plots. Also majority (32.3%) of the farmers had farming experience of over 12 years in plantain production an indication that many of the farmers are quite knowledgeable about plantain production in the study area. It was observed that majority of the respondents were low income earners, with farming being their major occupation. Majority (60.8%) of the respondents had no visits. It could be that, lack of assistance from national extension systems is often major reasons why farmers do not adopt farming innovations which might lead to low productivity (Agwu and Afieroho, 2007).

Major plantain varieties and technologies used by respondents

Plantain varieties cultivated by respondents

Table 2 shows that 57.5% of the respondents cultivated only local varieties of plantain and 22.6% cultivated improved varieties only. However, 19.9% cultivated both (local and improved) varieties. This reveals that the improved varieties were poorly used and may be as result of limited availability in the area and the poor extension practice on plantain technologies.

The local varieties cultivated by the farmers in the study area include; Agbagba, Une ukam, Aka nkita, Aka Agboha, Ovudaa, Une Ogbanu, Anumuyoho, Mkpalaliki and Mkpuene. The improved varieties cultivated are Pita 3 and 7, Pita 14, Obino I' ewai, Ogba Ibuo, Ojoko Osukwu, among others. Most of the farmers could not identify the improved varieties by their current scientific

Table 1. Distribution of respondents socioeconomic characteristics (n = 186).

Gender	Frequency	Percentage
Male	124	66.7
Female	62	33.3
Age of the farmers (years)		
Less than 20	5	2.7
20-30	11	5.9
31-40	47	25.3
41-50	66	35.5
Above 51	57	30.6
Marital status		
Singled	11	5.9
Married	140	75.3
Divorced	11	5.9
Widowed	24	12.9
Household size		
1-3	37	19.9
4-6	95	51.1
7-9	40	21.5
10-13	9	4.8
13 and above	5	2.7
Educational status		
No formal Education	28	15.1
Primary Education	74	39.8
Secondary Education	45	24.2
Tertiary Education	39	21.0
Occupational status		
Farming	98	52.7
Civil service	45	24.2
Trading	40	21.5
Others	3	1.6
Farm size (Ha)		
Less than 0.5	20	10.8
0.5-1.0	157	84.4
1.5-2.0	6	3.2
Above 2.0	3	1.6
Farmers income (₦)		
Less than 100000	74	39.8
100,001 to 200,000	36	19.4
200,001 to 300,000	31	16.7
300,001 to 400,000	12	6.5
400,001 to 500,000	6	3.2
Above 500,000	27	14.5
Farming experience (years)		
Less than 1	3	1.6

Table 1. Contd.

1-3	26	14.0
4-6	50	26.9
7-9	36	19.4
10-12	11	5.9
Above 12	60	32.3
Extension visits		
No visit	113	60.8
Once in a month	35	18.8
Twice in a month	21	11.3
Thrice in a month	8	4.3
Four times in a month	9	4.8
Total	**186**	**100.0**

Source: Field survey, 2014.

Table 2. Distribution of respondents according to plantain varieties cultivated.

Varieties cultivated	Frequency	Percentage
Local varieties	107	57.5
Improved varieties	42	22.6
Both varieties	37	19.9
Total	**186**	**100.0**

Source: Field survey, 2014.

Table 3. Distribution of respondents according to reasons for cultivating variety chosen.

Reason (s)	Variety	Frequency	Percentage
Resistance to disease/pest attack	Improved	147	79.0
High yield	Improved	140	75.3
Early maturation	Improved	131	70.4
Taste of the plantain fruit	Improved	119	64.0
Height of the plantain tree	Improved	107	57.5
Shape of the plantain fruit	Improved	97	52.2
Availability of the cultivar	Local	75	40.3

Source: Field survey, 2014, multiple responses.

names. However local names were given to the cultivars by the farmers.

Reasons for cultivating variety chosen by respondents

Table 3 shows that majority (147 respondents representing 79%), opined that they cultivated the variety they chose because of its resistance to disease attacks and 140 respondents because they believed the chosen variety was high yielding. Only 40.3% of the respondents cultivated the cultivar chosen because of such reason as its availability.

Techniques practiced by respondents

Analysis in Table 4 shows that propping (staking) is the most practiced plantain technique. Majority 69.9% of the respondents practiced propping, followed by fertilizer / manure application, plant spacing, mulching and pruning having 59.7, 59.7, 55.9, and 54.8%, respectively. The least practiced plantain production technique was

Table 4. Percentage distribution of respondents according to production techniques practiced.

Techniques practiced	Frequency	Percentage
Propping (staking)	130	69.9
Fertilizer / manure application	111	59.7
Plant spacing	111	59.7
Mulching	104	55.9
Pruning	102	54.8
Sucker multiplication	37	19.9
Sucker cleaning	24	12.9
Debudding	14	7.5
Hot water treatment	1	0.54

Source: Field survey, 2014, multiple responses.

Table 5. Result of productivity analysis.

Resource	Value (₦)
Total revenue	1713750
Labour input	82900
Material input	451500
Resource productivity	
Labour productivity	$\frac{1713750}{82900}$ =20.67
Material (capital) productivity	$\frac{1713750}{451500}$ =3.8

Source: Field survey, 2014.

hot water treatment with only 0.54% of the respondents practicing it. The reasons for most of the respondents practicing propping may not be unconnected with the height of most local varieties they cultivated and manuring was basically organic compost. Tall plantain plants are more susceptible to lodging by wind than short ones. Propping, manuring, plant spacing, mulching and pruning may not be new to the farmers since these techniques were traditionally practiced. Other improved technologies and techniques which plantain farmers were expected to adopt include; desuckering, debudding, hot water treatment, inorganic fertilizer application, among others. These were technologies promoted by Agricultural Development Programme and IITA in the area.

Plantain productivity of the farmers in the study area

Table 5 shows that the Labor productivity of the farmers was 20.67. This shows that output earning per ₦1 expenditure on labor was ₦20.67, implying that labor was well utilized. Material productivity of the farmers was 3.8. This also shows that output earning per ₦1 expenditure on material was ₦3.8, implying that material was well utilized.

Costs and return of plantain production in relation to technologies used in the study area

Table 6 shows the estimated costs and return of plantain farmers cultivating 1 hectare on the average were ₦733500 and ₦1713750 per annum, respectively. Among the cost components, cost of material input had the largest share of the total cost (61.55%), followed by labor inputs (11.30%). The gross margin and net farm income on the average for plantain farmers was ₦988750 and ₦980250 respectively. The profit margin percentage was 57.2%, while return per naira outlay was ₦2.3 implies that for every ₦1 invested in plantain production enterprise there is a return of ₦2.3 to the enterprise. These measures of performances indicate that plantain production in the study area is viable and profitable.

Determinants of plantain productivity in the study area

Table 7 shows the result of the multiple regression analysis on the determinants of productivity of improved

Table 6. Cost and returns of plantain production in relation to technologies used in the study area.

Variable	Amount in Naira (₦)
Total value of production (revenue)	1713750
Total variable cost	725000
Gross margin	988750
Total fixed cost	8500
Net farm income	980250
Profit margin %	57.2%
Rate of return on investment (ROR) %	₦ 2.3

Source: Field survey, 2014.

Table 7. Multiple regression result of the determinants of plantain productivity.

Variable	Coefficient	Standard error	t- statistics	Sig T
Farmers' Age (X_1)	0.097*	0.058	1.667	0.107
Farm Size (X_2)	0.555***	0.162	3.423	0.001
Household Size (X_3)	0.013*	0.019	1.487	0.139
Educational Status (X_4)	0.152**	0.060	2.526	0.019
Farmers' Income (X_5)	0.022	0.237	0.093	0.926
Farmers' Years of Experience (X_6)	0.015	0.201	0.073	0.942
Frequency of extension visit (X_7)	-0.072*	0.042	-1.714	0.101
Planting materials (X_8)	1.093***	0.252	4.343	0.000
Chemical fertilizer (X_9)	-0.102	0.155	-0.659	0.513
Labour input (X_{10})	0.113**	0.052	2.173	0.04
(Constant)	56.698	11.628	4.876	0.000
R^2	0.794			
$\overline{R^2}$	0.736			
F- Ratio	23.624***			

Source: Data analysis, 2014. ***Significant at 1%,**Significant at 5%, *Significant at 10%.

plantain technologies in study area. Based on the magnitude of the models' R^2, the number of independent variables that were statistically significant, and the number of independent variable's co-efficient signs that conform to *a priori* expectation, the double log function was chosen as the lead equation and used for further analysis of the data.

The coefficient of multiple determination (R^2) of 0.79 implies that 79% of the variations in productivity are explained by the joint action of the independent variables while the remaining 21% is due to error term. This is high and seems to show that the variables may be responsible for the productivity of the technologies in the study area. The analysis shows that farmers' age (X_1), farm size (X_2), household size (X_3), educational level (X_4), planting materials (X_8) and labor (X_{10}) had positive and significant relationships with productivity.

This suggests that total factor productivity will increase significantly if these factors are increased above their present levels of use. It is expected that productivity will increase if more educated farmers with large household size as family labor and also hired labor with adequate planting materials, cultivate greater hectares of farm land. However extension contact (X_7) is significant at 10% but inversely related to productivity. It negates *a prior* expectation. The negative coefficient implies that a unit increase in this variable will reduce the productivity of plantain. It could be due to the fact that extension support for the productivity of the improved plantain technologies under study was almost non-existent with 60.8% respondents recorded a no visit by extension agents.

DISCUSSION

Out of the 186 respondents interviewed in the study area, majority (67%) of farmers are men while 33% are women. This implies that higher proportion of the plantain being produced in the study area is carried out by men. The mean age of the farmers in the study area is about 45 years and majority is within the age group of

41 to 50 years. This shows majority of the farmers are in their productive age. Further analysis on the socio-economic characteristics shows that 75.3% are married.

The average household size in the study area is 6 persons with the majority (51.1%) having between 4 and 6 persons, an indication of large family size in the study area. Households with greater numbers of members are more likely to have available labor compared to households with fewer household members for timely execution of important farm activities. The majority of the respondents (85%) had formal education while only 15% had no formal education. This shows a high level of literacy in the study area, this will enable the farmers to be fast adopters of innovation. Majority (52.7%) of the respondents in the study area are engaged in farming activities as their primary source of income while the rest engaged in civil service (24.2%), trading (21.5%) and others (1.6%). This shows that agriculture is main occupation in the study area. The result also shows that majority (39.8%) earned between ₦100001 and ₦200000 per cropping season, an indication that the general income per cropping season from plantain production seems low and may be attributed to the low productivity of cultivars used.

Majority (84.4%) had plantain farm between 0.5 to 1.0 ha. This implies that the respondents are mainly smallholder farmers which might not really be favorable for adoption of plantain technologies. The result also shows that majority (32.3%) of the farmers had farming experience of over 12 years. This reveals that many of the farmers are quite knowledgeable about plantain production in the study area. Majority 69.9% of the respondents practiced propping, followed by fertilizer or manure application, plant spacing, mulching and pruning having 59.7, 59.7, 55.9 and 54.8%, respectively. The least practiced plantain production technique was hot water treatment with only 0.54% of the respondents practicing it. It can be because propping, manure application, plant spacing, mulching and pruning may not be new to the farmers since these techniques were traditionally practiced. Also, 57.5% of the respondents cultivated local varieties, 26.6% cultivated improved plantain varieties while 19.9% cultivated both. The reasons for cultivating the chosen varieties are because of; its resistance to pest and disease attack, high yield, early maturation, the height, based on its availability and among others.

The analysis of the regression shows that farmers' age, farm size, household size, educational level, planting materials and labor had positive and significant relationships with productivity. Among the included independent variables, extension contacts deviated from the *a priori* expectation in terms of the sign. This study further determined the viability of plantain production in the area using the gross margin analysis. The total variable cost (TVC) was found to be ₦725000 per hectare while the total revenue (TR) per hectare basis was found to be ₦1713750 thus giving a gross margin (GM) of ₦988750, which indicated a positive gross margin, proving plantain production in the area to be viable.

The low production of plantain in Anambra State is largely attributed to several factors one of which was farmers' use of local varieties and production practices. Improved production technologies were developed by IITA Ibadan. The production technologies have potentials of boosting the productivity of plantain. Based on the results of the analysis, we conclude that plantain productivity will increase in the area if the level used of factors such as farm size, labor input, household size and planting materials is increased. Similarly, productivity will also increase if farmers with higher educational level and greater years of farming experience engage in agriculture.

Conclusion

From the overwhelming findings conveyed by the data in this study, it can be concluded that, provided the innovation is profitable, compatible, simple, triable, and accessible to the farmers, and the disincentive that can inhibit farmers from its usage are removed or weakened through the visible and or feasible motivations, farmers will not hesitate to make a positive decision. As such, a thorough examination of the felt need or constraints through baseline survey should be accorded importance before technology development and transfer is undertaken.

The importance of agricultural sector in the country cannot be overemphasized, particularly in the area of promoting the economic growth. Increased use of improved plantain technologies through increase in agricultural productivity would generate multiplier effect that goes beyond the farm to the wider rural economy helping to improve standard of living. The measures of performances from the gross margin analysis result, indicates that plantain production in the study area is viable and profitable. Finally, technology delivery should target peers' support rather than relying on external influence of research and extension that is not sustainable and lacks proximity to the end users.

RECOMMENDATIONS

Based on the findings of this study, the following below are the suggested recommendations:

(i) The state government through the Agricultural Development Programme (ADPs) should partner with research institutions such as IITA to encourage increased sucker multiplication, procurement and distribution of improved varieties at the right time and at affordable prices are effective strategies for stimulating plantain

productivity. This recommendation flows from the significance of the planting materials. Also the ADPs should be intensified to sensitize and motivate farmers towards enlisting in farmers' co-operative societies with the aim of encouraging them to use improved plantain technologies which are capable of improving their productivity.

(ii) Efforts should be made at making lands available to enhance plantain production. This recommendation flows from the significance of farm size. Land which is a very scarce commodity, especially in the study should be made available readily to the plantain farmers. In the light of this, Government and other stake holders should sought ways by which some of the degradated soils in the study area could be reclaimed for agricultural uses.

(iii) Farmers' adult education / enlightenment workshops are needed to provide information on the technologies. This recommendation flows from the significance of the age which rules them out of regular schools. Farmers also need to play a lead role in the development and testing of improved plantain technology, assessing on-station trials, conducting researcher designed and farmer-designed trials, and providing feedback to researchers on their experiences.

(iv) Also, from the findings, it was observed that the techniques used were not new to the farmers and were practiced traditionally. Therefore it is expected that improved plantain technologies developed should be appropriate for farmers. This requires enhancing the partnership between researchers and farmers. Researchers and farmers together need to understand the circumstances, problems, and preferences of rural households and how these vary among different types of farmers. Participatory techniques are available to ensure that farmers take the lead in this diagnostic process (Chambers et al in Harrison and Okoedo-Okojie, 2013).

Conflict of interests

The author has not declared any conflict of interests.

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