Title: Facilitating healthy seed yam entrepreneurship in the Niger River system in Nigeria:
the value of 'Research into Use'

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Abstract

This paper explores the results of a programme designed to facilitate entrepreneurship centred on healthy seed yam (*Dioscorea rotundata*) production on the eastern bank of the River Niger. Ware yam farmers residing along the eastern bank, upstream from the Niger/Benue confluence, source their planting material from towns such as Ilushi, Edo State which involved significant travel and expense. This project sought to encourage 10 ware yam farmers living in Edeke village (Idah Local Government, Kogi State) to specialise in healthy seed yam production by employing the Adapted Yam Minisett Technique (AYMT). The AYMT employs a sett size of around 80-100g treated with a joint insecticide and fungicide dip. The treated setts are planted directly into the field rather than first planting into a nursery as with the Yam Minisett Technique (YMT). The Edeke farmers received a loan from the Diocesan Development Services (DDS) to employ the AYMT to produce healthy seed yams on a significant scale. However, while sales of seed yam by four of the farmers generated a significant and positive gross margin, six of them opted to plant their seed yams in the succeeding season (2012) to produce ware yams. This paper presents some of the results, discusses the decisions taken and dilemmas faced by the farmers around the production of seed and ware yam and the possibility of initiating and developing new markets for seed yam in the Idah area.

Keywords: Healthy seed yam, entrepreneurship, Kogi State, Nigeria

Introduction

It is well established that one of the key constraints to the production of white yam (*Dioscorea rotundata*) in West Africa is the availability of affordable and good quality planting material (Okoli and Akoroda, 1995). A series of research projects have sought to address this issue over the years, and answers have ranged from the use of small setts cut from ware yam to the use of vine cuttings (Akoroda and Okonmah, 1982). The success of these initiatives, including Yam Minisett Technique (YMT), has been limited. YMT involves the division of a ware yam tuber into minisetts of between 10 to 80g in size, with a recommended weight in Nigeria of 25g (Kalu et al., 1989). Thus one ware yam tuber of 500 to 1000g should allow the creation of 20 to 40 minisetts of 25g. The minisetts are dusted with a pesticide and a wood ash mixture after which they are planted into a nursery for sprouting. Once sprouted they are transplanted to the field at a density of 40,000 stands/ha (4 stands per square metre) and can yield about 13.6 tonnes/ha of seed yams for every tonne of minisett material planted (Okoli, 1986). However, despite being promoted in Nigeria since the mid 1980s (Chikwendu et al., 1995) uptake of YMT by farmers has been relatively low (Agbaje and Oyegbami, 2005). The reasons for this may be myriad, but the economic performance of YMT relative to other options available to farmers is no doubt an important consideration (Ezeh, 1991), although perhaps surprisingly this aspect has received relatively little attention within the scientific literature (Morse et al., 2009). Indeed local systems of seed yam production have also been relatively underexplored in socio-economic terms, including the various market processes linking growers with traders (Ibana et al., 2012).

A more recent initiative to encourage healthy (clean) seed yam production in Nigeria was funded by the UK's Department for International Development (DFID) 'Research into Use'

(RIU) programmes (Lenné, 2008; Ugbe, 2010; Hirvonen, 2011; website www.researchintouse.com). The RIU programme sought to build upon the DFID Renewable Natural Resources Research Strategy implemented between 1995 and 2006, and had the stated aim to:

"accumulate and evaluate evidence to shape and share lessons on how best to enable innovation in the agricultural sector so as to achieve social and economic gains in diverse developing country settings." (www.researchintouse.com)

While RIU was primarily a research programme, it aimed to *"put existing research products into use at scale"* (www.researchintouse.com) and thus directly addressed a commonly perceived problem that research geared towards helping the poorest often ends up filling journal pages and shelves with little development impact. It is what Hall et al. (2010; page 6) have referred to as an example of a suite of more or less contemporary *"innovation-centric agricultural research and development programmes"* put into place by a number of development and research agencies and designed to address this perceived problem of poor adoption. Indeed the adoption/adaptation of research results to bring about impact is well trodden territory and doesn't need to be covered here in any detail (see Hall et al., 2010).

Since 2007, RIU has established country programmes in six African countries (Malawi, Nigeria, Rwanda, Sierra Leone, Tanzania and Zambia) and a suite of 'Best Bet' (or Opportunity-Driven Initiatives) projects in Ghana, Kenya, Nigeria, Uganda and elsewhere, as part of experiments on promoting private sector-driven agricultural innovation. The goal of these interventions include *"learning and disseminating lessons and evidences from the outcomes of multi-stakeholder agricultural research for development interventions through*

Innovation Platforms, to inform institutional learning and change as well as scaling up of successful trials” (RIU Nigeria Programme Plan 2008). The Nigeria programme created three Value Chain Innovation Platforms (VCIPs) focusing on cassava, cowpea/soybean-livestock, and aquaculture. RIU interventions in each of these value chains aimed to increase farm production and productivity, increase and improve post-harvest value addition, and contribute to institutional learning and change (i.e. bring about supportive policies). The country programme portfolio included a range of strategies:

1. Field-level economic activities through the Innovation Platforms
2. Engagement with policymakers to bring about institutional learning and change in support of the three value chains
3. Training and other capacity-building assistance to national institutions and relevant but weak private sector stakeholders to enable them participate in agricultural research for development (AR4D) activities
4. Inter-linkages and collaboration with other public sector and development programmes to impact on the assisted value chains.

The conditions that RIU-Nigeria sought to change included the issue of poor uptake of outputs from the National Agricultural Research System (NARS; Ugbe, 2010). There were various reasons in the Nigerian context that explain poor uptake of research including a supply-driven approach to agricultural research and extension combined with problems that arose from a top-down, state-run approach to the delivery of agricultural extension services. On top of this there have been erratic and sometimes unsuitable agricultural policies; as well as poor incentives for, and inadequate involvement of, the private sector in agricultural research and development initiatives (Ugbe, 2010).

RIU have funded a number of projects in Nigeria, including the use of 'triple bagging' as a way of controlling weevils attacking grains such as cowpea (*Vigna unguiculata*) in storage. The use of 'triple bagging' (3 layers within each storage bag) creates an airtight space where insects cannot survive and hence reproduce and cause damage (Sanona et al., 2011). Hence it removes the need to apply storage insecticides and provides a relatively low-cost and reusable option for farmers to address this common problem. The Purdue Improved Cowpea Storage (PICS) technology, as it is called, was initially funded by the Bill and Melinda Gates Foundation and promoted by RIU via a range of media, including television and radio. The 'triple bagging' project sat firmly within the VCIP structure established by RIU. By way of contrast the clean seed yam production initiative, funded by RIU between 2010 and 2012 as a 'Best Bet' project in Nigeria, was managed directly by the project holders, outside the terms of the hosting arrangement under the RIU-ARCN Memorandum of Understanding. The RIU seed yam project followed on from a series of DFID funded research projects (as part of the Renewable Natural Resources Research Strategy) designed to look for ways in which clean yam planting material could be multiplied on an economically viable basis. Indeed one of the contentious issues that farmers had often expressed about the YMT was the need to use a nursery stage as minisetts were too small to plant directly in the field. The result of the DFID funded research was an 'Adapted' YMT which utilised a larger sett size (roughly 80-100g; compared with 25g recommended in Nigeria for the YMT) which allowed for a direct planting into the field, provided the setts were suitably treated with insecticide and fungicide (Coyne et al., 2011). Rather than use a pesticide/wood ash based dust, as with YMT, the AYMT used a water-based 'dip' process where the setts were immersed into a pesticide suspension (Morse et al., 2009). The technical success of the AYMT combined with it being

regarded by farmers as more suited to their needs than YMT (Morse et al., 2009) made it a prime candidate for up-scaling via the 'best bets' component of the RIU.

The RIU project sought to bring about an up-scaling of the AYMT by focussing on a number of key yet diverse locations in yam growing areas of Nigeria, notably the Federal Capital Territory (FCT) of Abuja, where there is a highly-developed seed and ware yam production system with associated credit provision and markets, and the eastern bank of the River Niger (Kogi State), which is a much more rural setting than Abuja without the same degree of market development and credit availability. In the Niger system it was decided to focus on an area near Idah, for reasons to be detailed later. There are local yam markets in the Niger valley but nothing like those geographically concentrated in Abuja (a city of approximately one million inhabitants and a density of 1100 people per square km). Similarly, while there are formal and informal credit supply systems in the Niger valley in the authors experience they do not appear to match the extent of availability in Abuja, which is after all the Federal capital of the country. A further and outstanding difference is the agricultural extension services. The FCT has excellent resources, with a good coverage by well-trained and highly motivated extension staff that are also well-resourced. In areas like Kogi State this expertise to support farmers is severely lacking. Despite this, the Niger-based yam production systems are sophisticated, with farmers travelling many miles and at significant cost to purchase seed yams at markets along the river, such as Ilushi in Edo State. In addition to these two main locations, a number of secondary schools and prison sites were selected to take part in the RIU project. In the former case it was seen as a process of educating students within the agriculture curriculum while in the latter it was seen as part of a process of rehabilitation of prisoners by providing them with usable skills as well making them aware of business opportunities (provided provision be made for inputs).

The demonstration plots established in the RIU project were managed by farmers, and involved a series of planned visits by other farmers in the locale. However, although the RIU project had demonstration sites spanning a number of locations in Nigeria, only the sites in the Niger system near Idah were observed in detail in terms of their agronomic and economic performance. This was largely because the farmers owning and managing these sites were members of a local Catholic Church-based NGO – the Diocesan Development Services (DDS) – which had a long history in the area (initiated in 1970). The services include a microfinance scheme. As part of the latter, DDS employed a business-plan approach to its dealings with farmers, with monitoring of plots as part of the conditions required. This provided an excellent opportunity to explore the performance of the Idah-based plots, and the objective of this paper is to present some of these results and how farmers responded. This study provides a number of important insights not only about the production of healthy planting material but also how it might impact on resource-poor farmers.

Methodology

Site selection

A collection of villages, referred to in the local language as ‘Edeke’ and located near Idah on the eastern bank of the River Niger, was selected for the RIU project largely because of its previous involvement in the DFID-funded seed yam research projects. Edeke is located within the geographical scope of DDS; one of the key partners in the RIU project and indeed was involved in a number of other DFID-funded research projects on yams. Edeke provides ideal conditions for yam production, and farmers living there specialise in the crop as well as rice and some vegetables. While there is some marked spatial variability in characteristics,

the Fluvial (Fle-VRgd-1; IUSS/FAO) soil is rich, heavy and experiences annual flooding, which helps replenish soil fertility while sanitising it through the reduction of soil-borne pest and disease pressures. These conditions allow for a virtual monoculture of yam. Edeke has a population of approximately 4,072 people (1,894 male and 2,178 female), based on the 2006 official census (Federal Republic of Nigeria Official Gazette data for Edeke Ward; personal communication from Idah official), including many migrants some of whom hail from the wider hinterland. Farmers purchase their seed yams from specialist producers further south along both of the Niger banks. Seed yams are expensive not least because once purchased they need to be transported by power boat back up the Niger to Edeke.

RIU project

The intention of the RIU project was to encourage a group of farmers in Edeke to begin producing their own healthy material rather than continuing their traditional approach of travelling long distances, at significant cost and risk, to markets on the Niger River, such as Ilushi on the western bank of the Niger in Edo State. The assumption was that if some farmers could begin producing their own seed yam then it may be possible to supply their own needs plus those of other yam farmers in Edeke and beyond. For the RIU project DDS supplied 1200 ware yam tubers to each of 10 farmers on a loan basis. The tubers were provided as an ‘in kind’ loan in early 2011, and the intention was for the loan to be repaid in 2012 (with a small nominal interest charge of 1% per annum) after harvesting and selling of the seed yams. The 10 farmers selected were asked to complete a business plan ahead of the enterprise, by first detailing what they thought would be their costs, revenue and hence gross margin. The farmers then recorded their ‘realised’ costs, revenues and gross margin during the season and at harvest. They were helped with this by DDS staff who visited the farmers on a regular basis.

Sett preparation

The farmers were asked to use the AYMT for producing their setts. This involved cutting ware yam tubers into setts weighing approximately 80-100g. The setts were dipped into a suspension comprising 150 ml of an Endosulfan-based (35EC) insecticide and three sachets of 'Seed Plus 30WS' in 10 litres of water. 'Seed Plus 30WS' comprises 10% (by weight) of the pesticides: Imidacioprid (insecticide), Metalaxyl (fungicide) and Carbendazim (fungicide). The setts were set aside to dry before planting at a spacing of approximately four per square metre in heaps, which were staked after germination. Farmers were trained on how to prepare the treatment and supported and supervised by DDS staff while doing it for the first time. Developing a business plan was an important component of the project. DDS staff underwent training for this and in turn helped and supported the 10 farmers with their business plan.

Focus group

During the growing season all 10 Edeke farmers came together with DDS staff involved in the project for a 'focus group' meeting in Idah where progress and issues arising from the use of the AYMT were discussed.

Results

All 10 farmers opted to use the 'in kind' loan from DDS to plant ware yam alongside seed yam. The reasons proffered for this was to ensure that they would have sufficient funds to repay their loans; a point that will be returned to later. Hence here it will be necessary to provide statistics for both seed and ware yam plots, but conveniently this provides the basis

for a comparison between plots under entirely ‘farmer managed’ conditions. Such comparisons between the economics of ware and seed yam production are rare in Nigeria. Table 1 provides the yields, realised cost, revenue and gross margin for all plots extrapolated up to a per hectare basis. To arrive at per hectare values it was assumed that the seed yams (for ware yam production) were planted at an average density of one per square metre and four yam setts per square metre was employed for the seed yam plots. These figures are admittedly an approximation based upon counts of heaps, but the 10 farmers were consistent in their spacing. The picture in Table 1 is also complicated by the fact that only a few farmers opted to sell some of their seed yams, and hence the revenue figures for the seed yam plots are partial. For four farmers the seed yams that were sold were used to extrapolate to a hectare-equivalent. Thus the seed yam revenues and gross margins are likely to be exaggerated. Most of the ware yams harvested by the farmers were sold, making the figures here more representative of the economics of production.

<Table 1 near here>

The yields and costs across the seed yam and ware yams plots are variables, with costs being generally higher for ware yam than seed yam. Yields can be highly variable both between and within farms in Edeke (Morse et al., 2009), often due to small-scale differences in soil quality and pest attack. For the costs it should be noted that only those items, including some hired labour, for which farmers needed to pay are included here. Not included are items such as household labour, and experience of the authors suggests that this can vary significantly between households (Morse et al., 2009). The main cost for both seed and ware yam was planting material; seed yams (68% of total costs) in the case of ware yam and ware yams (for setts; 78% of total costs) in the case of seed yam. The next major categories of cost were

staking (9% and 12% for seed and ware yam respectively), land preparation (8% and 5% for seed and ware yam respectively) and harvesting (2% and 12% for seed and ware yam respectively). Weeding costs were relatively minor at 2.5 to 3% for both plots, although this is partly a reflection of the use of herbicide (pre- and post-emergent) by some farmers as well as household, rather than paid, labour by others. Interestingly there are some significant differences in the 'cost profiles' for the seed and ware yam plots (details of the t-tests used to make the comparison are provided in Table 2). Most notably, the harvesting costs for ware yam are significantly higher than for seed yam. This largely reflects the fact that ware yam tubers are bigger and extend deeper into the ground and thus have to be excavated or 'bored' by specialist yam borers before they can be harvested. Indeed harvesting ware yam in the fertile yet heavy soils of Edeke is something of an art form, where great care has to be taken not to damage them. Damaged tubers are more prone to pest and disease attack during storage and ultimately can lower the market price. There is also a hint in these data that the cost of seed yam planting material per hectare is higher than that for ware yam. The planting material for seed yam comprises setts cut from ware yams, and on average some 10 setts of approximately 100g can be cut from a tuber. While ware yams are expensive, especially if they have to be purchased at the time of the year for planting the setts, this may imply a relatively inexpensive method of producing planting material, but it should be remembered they are planted at four times the density of the seed yams used to produce the ware yam.

<Table 2 near here>

It is interesting to note that for the four farmers who did sell some of their seed yams, the extrapolated revenues were higher than for ware yam as were the gross margins. With the exception of farmer 3, who managed to obtain an exceptional price for some of his seed

yams, the ratio between seed yam and ware yam gross margin was between 2.2 and 2.5. Admittedly this is based upon an extrapolation from partial sales as only four of the 10 farmers sold any of their seed yams. While there are no markets for seed yam near to Edeke these farmers were apparently offered good prices and thus, as noted earlier, it seems reasonable to assume that the revenues and gross margins for the seed yam plots of these farmers is exaggerated. But the results do nonetheless suggest that if the marketing is done well then a profit from the production of clean seed yam is possible. This is highly encouraging for future adoption and sustainability of the AYMT. However, the fact that farmers retained their seed yam as opposed to selling them on, is in itself a possible indication of their perceived value by farmers in relation to their potential to produce ware yam.

Table 3 provides the labour input for the seed and ware yam plots, in person hours per hectare. It should be noted that the labour figures here include both household and paid labour, providing the best estimation possible of labour used for production. The values are generally higher for ware yam than for seed yam, and there are differences in the labour profile between the two types of yam as indicated in Table 4. Here the activities are divided into three categories: land preparation and planting; weeding; staking and harvesting (includes transportation to the store). Each of these categories comprises a number of activities (land preparation includes clearing, tilling and heap making), but they are commonly used to summarise the labour profile for yam. The major differences between the categories are in land preparation, which reflects the larger density of heaps for seed yam (although individual ware yam heaps are larger in size), and harvesting as ware yams require a lot more effort given the size of the tubers and the chances of damaging them. But of these two the only one which is statistically significant is harvesting (t-test details are provided in

Table 5). The point has already been made about the skill required to harvest ware yam given the requirement not to damage the tubers so it is unsurprising that the labour demand is higher.

<Tables 3, 4 and 5 near here>

The sample size of 10 farmers limits the statistical analyses that can be performed on the data, but Table 6 provides the results of a regression analysis between yield and the categories of labour (all data have been transformed by taking logarithms to the base e). For seed yam there is no significant relationship between any of the categories and yield but for ware yam there is a statistically significant regression. Indeed the coefficient of determination for the ware yam regression is an unexpectedly (given the small sample size) high value of 94%. It is interesting to note that three of the categories for ware yam are statistically significant; land preparation, weeding, and harvesting. The latter two are as expected, with yield of ware yams increasing as weeding and harvesting labour increase. Labour invested in weeding, whether by herbicide use or manual removal of weeds, will reduce competition for vital resources and increase yield. Harvesting is also linked to yield; the more the effort employed in harvesting yams the higher the yield. With land preparation the coefficient is negative, suggesting that yield increases as land preparation labour declines. The reason for this is not clear and may be due to a number of factors. For example, land that is more easily worked may also provide the best drainage and this will help increase yield as yam does not have high tolerance for flooding. Thus the preparation labour may reflect the quality of the land; with less labour required to prepare the better sites.

<Table 6 near here>

Discussion

The results presented here provide a number of insights. Firstly there are indications that clean seed yam production can be profitable, perhaps double that of ware yam, in the Edeke area even without a specialised seed yam market existing nearby. Secondly the farmers were reluctant to sell their seed yams but preferred instead to retain them for sowing. These conclusions can be reconciled as the Edeke farmers are ware yam producers with no history of growing seed yam on a large scale although some do grow some of their own seed yam. Ware yams provide both sustenance and revenue in a market they know well. Seed yams are smaller and although those produced in 2011 using the AYMT were healthier than many available elsewhere there is no seed yam market in nearby towns such as Idah. During a farmer meeting held in Idah in 2011 they stated clearly their concern about whether their seed yams would generate enough revenue to repay their loans. This highlighted concerns and uncertainty about the absence of a local market for their produce. But having assessed the relative risks involved in seed yam versus what they know well - ware yam - they concluded that their best option was to replant their seed yam to produce ware yam in 2012.

As already noted, only four of the Edeke farmers sold any of their seed yams but they did manage to obtain good prices. As a result the gross margins when extrapolated to a per hectare basis for seed yam were notably higher than for ware yam. Extrapolating what the farmers would gain from the planting of the clean seed yams produced in 2011 is not necessary, and indeed could be misleading as it would depend upon 2012 prices. But there is no doubt that this revenue from ware yam in 2012 will exceed what is required for loan refunds. This is an encouraging development which sits in contrast with the more economically marginal picture provided by Morse et al. (2009) based upon a series of farmer-

managed trials but working to a protocol set by researchers. Clearly in Edeke there is potential for getting the marketing right with the seed yam system and this can be a lucrative venture. After all, successful markets do exist elsewhere in the Niger Basin (Ibana et al., 2012).

But what about the future? The situation in Edeke is fluid and much depends upon the emergence of local seed yam markets for which there is great need in the area. The fact that four of the farmers managed to find a market for some of their seed yams is encouraging and suggests that such markets can be developed; the indicative gross margins for the seed crop are certainly an enticement. This statement is based on the knowledge that at the time of writing (early 2012) there is one seed yam trader in Idah market who buys seeds from elsewhere and transports them to Idah. The potential to develop this further is possible and options will be pursued within a recently initiated yam production project in Nigeria and Ghana funded by the Bill and Melinda Gates Foundation (BMGF) and led by the International Institute of Tropical Agriculture (IITA). Taken together this timeline from DFID funded Renewable Natural Resources Research Strategy through to DFID funded RIU and now the BMGF shows an important contribution from international funders towards an important African crop.

The Edeke seed yam project is but one of many initiatives of the DFID RIU programme in Nigeria which ended in April 2012. The project provides an example of how RIU succeeded in facilitating an intervention in Nigeria within a relatively short period of time. Two key features which helped success were trust and patience as the project did not go entirely to plan with farmers opting to use some of the loan to plant ware yam resulting in seed yam plots being smaller than anticipated. The logic as explained by Edeke farmers made perfect

sense in the situation. An essential requirement for this trust and patience is the presence of a facilitating agent (DDS) that will be around long after the demise of time-bound programmes such as RIU.

The seed yam project also contrasts with other initiatives promoted by RIU in Nigeria such as the 'triple bagging' approach adopted for cowpeas mentioned earlier (Sanona et al., 2011). Its origins were tied to DFID funded research on yams over many years, and it requires a significant step-change on the part of farmers rather than just the adoption of a new technology. The AYMT is a new approach in the sense of establishing different sett sizes and treatments compared to YMT, but it also requires significant changes in farm practices and marketing which in turn results in extra costs and risks to the farmer. The farmer has finite resources available to him/her in any one season, and the production of clean seed yam has to compete for those resources alongside other enterprises the farming household may wish to be involved in, and decisions involve a range of considerations about household needs and the expected returns and their risks. An RIU programme can only go so far in such a complex situation as it requires more than just the promotion/adoption of a single technology such as a 'triple bag' which can readily be picked up by the private sector and sold for a profit. Thus in the context of bigger step-changes such as promotion of clean seed yam production it is important for RIU to work through partners that can help facilitate change over the longer-term.

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Table 1. Yields, costs, revenue and gross margins for the seed and ware yam plots of the Edeke farmers

Farmer	Yield (kg/ha)		Cost (N/ha)		Revenue (N/ha)		Gross margin (N/ha)		Ratio of gross margin seed:ware
	Seed yam	Ware yam	Seed yam	Ware yam	Seed yam	Ware yam	Seed yam	Ware yam	
1	20,000	51,400	1,789,857	1,337,500	0	2,250,000	0	912,500	
2	47,200	38,845	1,755,776	1,594,072	0	1,546,392	0	-47,680	
3	20,000	71,400	2,710,373	1,337,500	7,600,000	1,725,000	4,889,627	387,500	12.62
4	47,200	112,600	778,212	1,337,500	2,249,999	2,000,000	1,471,787	662,500	2.22
5	26,400	47,120	1,570,192	1,571,250	0	3,125,000	0	1,553,750	
6	46,826	67,020	1,158,186	1,625,000	0	3,750,000	0	2,125,000	
7	48,800	79,200	1,486,758	1,546,250	4,000,000	2,666,675	2,513,242	1,120,425	2.24
8	48,000	30,460	992,661	1,546,250	0	2,025,000	0	478,750	
9	30,877	71,400	1,623,260	1,030,833	2,604,801	1,423,533	981,541	392,700	2.5
10	16,000	34,780	5,393,333	481,982	0	1,025,000	0	543,018	

Table 2. Comparison between the five main categories of cost for seed and ware yam

Note: t-test performed on logarithm (base e) of costs/ha (variances not assumed to be equal). Means and Standard Errors are those for the transformed data.

(a) Land preparation

	Mean	SE mean	t-value (significance)
Seed yam	11.54	0.37	Not significant
Ware yam	11.026	0.17	

(b) Planting material

	Mean	SE mean	t-value (significance)
Seed yam	14.071	0.17	1.96 ns (P=0.069)
Ware yam	13.676	0.11	

(c) Weeding

	Mean	SE mean	t-value (significance)
Seed yam	10.539	0.22	Not significant
Ware yam	10.406	0.25	

(d) Staking

	Mean	SE mean	t-value (significance)
Seed yam	11.850	0.21	Not significant
Ware yam	11.931	0.12	

(e) Harvesting

	Mean	SE mean	t-value (significance)
Seed yam	10.389	0.13	-6.3 (P<0.001)
Ware yam	11.873	0.2	

Table 3. Labour input for the seed and ware yam plots

Farmer	Total labour (person hours/ha)	
	Seed yam	Ware yam
1	4,607	5,575
2	4,211	4,407
3	6,407	9,675
4	2,439	10,350
5	5,490	9,838
6	4,854	8,950
7	5,087	6,600
8	2,361	7,075
9	2,684	5,117
10	9,400	2,198

Table 4. Division of labour between the main types of activity for seed and ware yam. Figures are the averages of the ten plots.

Activity	Labour (person hours/ha)			
	Seed yam	% of total	Ware yam	% of total
Land preparation	2,671	56	2,937	42
Weeding	347	7	494	7
Staking	914	19	1,266	18
Harvesting	822	17	2,281	33
Total	4,754	99	6,979	100

Table 5. Comparison between the main categories of labour for seed and ware yam
 Note: t-test performed on logarithm (base e) of person hours/ha (variances not assumed to be equal). Means and standard errors (SE) are those for the transformed data.

(a) Land preparation

	Mean	SE mean	t-value (significance)
Seed yam	7.753	0.17	Not significant
Ware yam	7.801	0.24	

(b) Weeding

	Mean	SE mean	t-value (significance)
Seed yam	5.739	0.16	Not significant
Ware yam	5.895	0.3	

(c) Staking

	Mean	SE mean	t-value (significance)
Seed yam	6.664	0.19	Not significant
Ware yam	7.002	0.2	

(d) Harvesting

	Mean	SE mean	t-value (significance)
Seed yam	6.560	0.19	-4.28 ***
Ware yam	7.633	0.16	

Table 6. Regression analysis of yam yield and labour as dependent variables.

(a) Seed yam plots

Independent variables	Coefficient	SE	t-value and significance
Constant	14.644	2.325	14.644 ***
Land preparation	-0.3647	0.2804	-1.3 ns
Weeding	0.1615	0.4345	0.37 ns
Staking	-0.4323	0.3666	-1.18 ns
Harvesting	0.0798	0.2216	0.36 ns

R^2 (adjusted) = 32.8%

(b) Ware yam plots

Independent variables	Coefficient	SE	t-value and significance
Constant	7.601	0.6571	11.57 ***
Land preparation	-0.3278	0.1018	-3.22 *
Weeding	0.61089	0.06866	8.9 ***
Staking	-0.1437	0.1789	-0.8 ns
Harvesting	0.4316	0.1269	3.4 *

R^2 (adjusted) = 93.8%