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THE ECONOMICS OF CERTIFIED ORGANIC FARMING IN TROPICAL AFRICA: A PRELIMINARY ASSESSMENT

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5. Gibbon, P. (with O. Memedovic) (2006) 'Decoding Organic Standard-Setting and Regulation in Europe', *UNIDO Working Paper,* Vienna: UNIDO.
6. Gibbon, P. (2006) 'An Overview of the Certified Organic Export Sector in Uganda', *DIIS Working Paper* 2006: 13. Copenhagen: Danish Institute for International Studies.
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Abstract

The paper examines the relative profitability of certified organic and conventional farming operations in tropical Africa as well as differences between organic and conventional farmers in rates of adoption of farming practices and in household factor endowments. The paper is based on three surveys in Uganda of smallholder farmers of respectively, organic coffee, cocoa, and pineapple and of matching control groups of conventional farmers. Organic production was in all cases organised on a contract farming-type basis, in schemes operated by the firm exporting the organic product. The central conclusion from the study is that farms that engaged in certified organic export production were significantly more profitable in terms of net farm income earnings than those that engaged only in conventional production. This was the result of generally significant differences between organic and conventional farmers' gross farm incomes, although these differences were further amplified by differences in costs. Income differences related partly to differences between organic and conventional farmers' factor endowments. Preliminary analyses indicted that, among factor endowments, area under crops subject to organic certification (CSC) and numbers of CSC plants had the strongest relations to farmers' sales volume and incomes,. Labour availability and average age of CSC plants had a much lower level of importance. As for other factors, yields were strongly related to sales volumes, but average price received was of lesser importance. The precise relative contribution of these different factors to sales volumes and incomes remains to be established in a further paper, however. The results for average net income also show enormous differences in profitability between organic farmers of different cash crops, with pineapple farmers earning three and five times more than cocoa and coffee farmers, respectively. It is worth underlining that, in contrast to the experience in developed countries, we found that organic conversion in tropical Africa is associated with increases rather than reductions in yield, which relates to the low-input characteristics of conventional farming on the continent. Focus group interviews suggest that organic farmers enjoyed higher yields due to more effective farm management technique, but the survey results on rates of adoption of yield-enhancing farming practices could not verify this.

1. Introduction

Over the last fifteen years the market for certified organic agricultural products has grown from a very low base to reach 1.5-2.5% of total food sales both in North America and the EU (Willer & Yusufi 2005, Oberholtzer et al 2005, CBI 2005, *Financial Times* 16 October 2006). Most of this growth has been satisfied by increases in the area under certified organic production in North America and EU itself. Yet there has been also an increase in certified organic imports into both regions. In the case of the EU these mainly comprise cereals and oilseeds from temperate and semi-temperate countries, but also include fruit and vegetables (from a much wider range of countries) and tropical beverages.[1] Rising demand both for organic tropical products and for year-round supply of some organic temperate products has encouraged organic activists, NGOs and some donors to promote certified organic export production in a number of tropical African countries.

Emerging alongside the growth of the market for certified organic agricultural products has been a small, highly focused and generally consistent literature on the economics of organic farming. The main subject of this literature is the relative profitability of organic and conventional agriculture, in relation to which a finding of rough equivalence has been commonly arrived at. Roughly equivalent profitability is based upon the fact that organic farming's price premiums and lower input costs compensate for reduced yields (see below). These findings are however entirely based on studies carried out in North America and the EU; economic studies of organic farming in the tropics have been fewer, much less focused on the issue of relative profitability and rarely report quantitative data in any detail.

Transposing the focus on relative profitability to experiences in tropical countries would allow a better evaluation of the case for promoting organic export production there. However, such a transposition would have to take into account two very substantial differences between developed countries and the tropics. Firstly, conventional agriculture in developed countries is industrial in character while that in the tropics is generally semi-industrial or non-industrial. This has implications both for changes in yields, as well as for changes in farmers' outlays on synthetic inputs, when conversion takes place from conventional to organic agriculture in the

[1] Estimates of annual certified organic imports into the EU in 2001 (Hamm et al 2002) and 2002 (CBI 2005) are for 200,000-550,000 tons of cereals, 50,000-208,000 tons of vegetables, 30,000-50,000 tons oilseeds, 80,000 tons bananas, 14,000 tons cocoa, 13,000 tons coffee and 1,000 tons meat.

tropics. Also it has implications for the extent to which farmers in the tropics who are certified to organic standards really have to adopt a radically new set of farming practices in order to remain economically viable, as they generally have to do in developed countries when synthetic inputs are forsaken.

Secondly, the institutional context for not only conventional but also organic agriculture in developed countries is deeper and more extensive than it is in tropical ones. Amongst other things, this means that in the tropics little or no public assistance is available for conversion, while farmer incomes and domestic savings are generally too low to support independent conversion. This in turn implies that organic farming in the tropics is a realistic option only for very large-scale operators or in the context of privately financed and coordinated contract farming schemes.[2] However, participants in such schemes may be selected deliberately rather than self-recruited, just as they may be required to conform to standards over and above organic ones once they become members. In other words, transposing a relative profitability focus to the tropics requires close attention to confounding variables such as the prevalence there of conventional farming systems that are 'organic by default', as well as the organization of organic agriculture in contract farming-type schemes – with all that this may entail.

This paper describes the results of three small surveys, in Uganda. These report the relative profitability of certified organic and conventional farming operations, while also presenting information comparing the household characteristics of organic and conventional farmers, describing rates of adoption of specific farming practices identified with organic farming but not necessarily required for certification, and stating the product (as opposed to organic process) standards that farmers had to meet before 'organic' premiums were paid. The central conclusion is that farms that engaged in certified organic export production were significantly more profitable than those that engaged only in conventional production. This was the result of generally significant differences between organic and conventional farmers' gross farm incomes, although these differences were further amplified by differences in costs. Correlation analysis moreover indicated that, among factor endowments, area under crops subject to organic certification (CSC) and numbers of CSC plants / trees had the strongest relation to sales and incomes, while yields were similarly strongly related to sales. Other variables, including price, labour availability and average age of CSC plants / trees had a much lower

[2] These schemes may be coordinated by private firms or by ('Secondary') Cooperative Unions with relations to Primary Cooperative Societies that resemble those found in contract farming.

level of importance. A further paper will estimate the relative contribution of these factors to sales and income more precisely through multivariate statistical techniques.

The paper comprises six sections. Following this introduction is an overview of the existing literature on the economics of organic farming in developed countries. This is followed by a discussion of the specificities of certified organic farming in the tropics in general and Africa in particular, also taking its point of departure in a literature review. After a discussion of the research methods employed in the current study, the paper goes on to report its main results. A final section concludes.

2. The Economics of Organic Farming in Developed Countries

Organic crop farming's distinctive feature as a system, whatever the geographical context, is its emphases on building soil fertility and controlling weeds, diseases and pests through rotations and the encouragement and application of naturally occurring materials and organisms. Reliance on non-local, and to an extent off-farm inputs, is reduced as much as possible and use of synthetic inputs is generally forbidden. Certification to organic standards, including in the tropics, mainly requires eliminating use of synthetic inputs rather than following a positive list of prescribed practices. On the other hand, in developed countries yields tend to collapse completely following the abandonment of synthetic inputs unless rotations and alternative soil fertilization methods are adopted. In the case of perennial crops such as fruit trees rotations are inapplicable and alternative weed and pest control inputs must be combined with organic soil fertilization methods to maintain yields.

Because conventional agriculture in developed countries is heavily dependent on synthetic inputs, and because using rotations normally involves cultivation of certain crops that are labour intensive and/or of low value, discussion on the economics of organic agriculture has normally focused on the trade off between declining yields and increased labour requirements on the one hand and savings on expenditure on synthetic inputs and gains from premium prices on the other. The literature almost unanimously finds lower yields (in a range of 15-60%, depending on crop and country), increased commitments of labour (in a range between 20-100%) and lower non-labour costs (in a range between 50-60%) per hectare as well as

higher unit prices (averaging around 33% when most of the literature was published in the mid-late 1990s) (e.g., Henning et al 1991, Lampkin 1994, Padel & Zerger 1994, Padel & Lampkin 1994a, Nieberg & Offerman 2003). A common conclusion is that premiums and lower variable costs compensate for reduced yields to give similar gross farm margins, which when combined with similar fixed costs result in similar net farm incomes (cf. Padel & Lampkin 1994a). Unfortunately, the only available study examining organic perennial crops in developed countries (Igual & Izquierdo 2000) is an outlier in terms of findings.[3]

The literature also observes that typical organic farming operations in the EU at the time of study required a price premium of around 33% to retain a level of profitability comparable to conventional agriculture, while noting that premiums were falling in the EU. Recent EU data shows an upward adjustment in the size of typical organic operations, presumably reflecting the fact that larger operators survive better as premiums fall (Greene & Kremen 2003).

According to the literature, besides falling premiums the main economic problem confronting organic farming in developed countries is conversion costs. These comprise certification costs; additional training costs; costs of conversion-related shocks such as temporary crop failures, reductions in output of higher-value crops, inability to command price premiums during the conversion period; and costs of on-farm diversification (e.g., establishing green manures or pastures) (Padel & Lampkin 1994b). However, since the late 1980s in the EU (but not North America) conversion costs have been offset at least partly by dedicated subsidies for conversion.[4]

[3] This study examines conventional and organic orange and mandarin farming in Valencia, using a tiny sample of organic producers (25 'plots') from 1999 in comparison with region-wide data on conventional farmers from 1992. It finds that conversion is associated with a total cost increase of 25%, due to large increases in cost of inputs for fertilization and in labour costs There is a reduction in yields of 19%. The authors report no organic price premium following conversion and no receipt of dedicated subsidies.

[4] The authors of the studies described count these as additional income rather than subtracting them from costs of conversion to give a reduced estimate for the latter.

3. Certified Organic Farming in the Tropics

(A) THE EXISTING LITERATURE

To date, only a handful of studies of economic aspects of organic farming in tropical countries have been published. None report comprehensive farm budget-related survey data, and a majority either reports on sample sizes of 20 farmers or less or gives no information on sample size. The most commonly reported farm-level data is on prices, where organic premiums ranging between 19% and 150% are described for coffee in Mexico (Bray et al 2002, Van der Vossen 2005), Costa Rica (Lyngbaek et al 2001) and Nicaragua (Bacon 2005), as well as for cocoa in Costa Rica (Damiani 2001). Data on yields is reported in only three studies, all involving comparisons between organic and apparently high synthetic input-based conventional coffee production in Costa Rica and Mexico. Two of these (Lyngbaek et al op.cit., Van der Vossen, op. cit.) provide results similar to those obtained in developed countries, with organic farmers' yields respectively 22% and 43% lower than conventional ones; the third (Bray et al op. cit.) describes organic yields 15% higher than conventional ones. No detailed data on costs is provided by any of the studies. However, data on net income is reported in three. Van der Vossen (op. cit.) reports organic farmers' net incomes as 44% lower than conventional ones, while Lyngbaek et al (op. cit.) finds no consistent difference and Carpenter (2003) describes organic rice farmers in Philippines as having incomes 48% higher than conventional ones in 'grain equivalent' terms.

(B) TROPICAL AFRICA

The conventional farming systems that organic agriculture is compared with in the literature just described are relatively high-input ones by tropical standards. Africa is a special case, in that chemical input use is much lower than in other tropical regions, and has been stagnant over recent years (Kelly et al 2005).[5] It can be therefore expected that, with conversion, both reductions in yield, changes in commitments of labour and savings from reduced use of synthetic inputs will be considerably more limited. Thus, certain variables having key positive or

[5] Kelly et al (op. cit.) cite FAO data to the effect that fertilizer consumption in Sub-Saharan Africa is less than 1% of world consumption, and that while increasing from 4kg./ha. in 1970 to 10kg/ha. in 1996, then remained unchanged until 2002 (the last date for which data was available).

negative influences on organic farming's profitability in developed countries are likely to be broadly neutral in the tropical African context.

Initial consideration of the remaining variables referred to earlier seems to suggest that organic farming in tropical Africa is more likely to be of greater relative profitability than that in developed countries. Components of conversion costs relating to a number of conversion-related shocks should disappear, since conversion requirements are reduced, while the price premium should remain. Yet on the other hand the component of conversion cost related to inability to command price premiums during the conversion process remains, as do those related to certification and training. Certification and training costs may not seem prohibitive in absolute terms, but in the tropical African context of generally small average farm size and very low average income they may represent huge barriers to entry.

As for price issues, more caveats are necessary. While markets in developed countries for almost all temperate region organic products are 'medium-to-thick' (significant volumes and reasonable continuity),[6] those for many organic tropical products are smaller and more intermittent. Managing this problem implies the need for investment in marketing on a scale well beyond that required in developed countries. It further implies higher risks and lower incomes for both producers and traders. Finally, public systems of support to farming - whether through price support and other transfers, or provision of research, extension and marketing services or risk management systems - are almost entirely absent. Thus a few costs are likely to be higher in Africa than in developed countries, a number of other costs are likely to present greater constraints on conversion than they are in developed countries (or more higher-income developing ones), and neither subsidies nor public goods are available in mitigation.

Given these considerations, a necessary preliminary to discussing the relative profitability of certified organic farming in Africa is to identify the conditions under which it might take place there at all. One such set of conditions could be (and apparently is) large-scale commercial farming, for example in Zambia (Parrott & van Elzakker 2003: 110). Here, economies of scale can be large enough to cover certification and training costs, while a certain level of specialist marketing skills may be already present, and operators can spread risk to some extent by also producing large volumes of product in conventional form or certified to standards other than organic ones.

[6] Although in the second half of the 1990s European organic markets still remained less thick than conventional ones, meaning that organic products frequently had to be sold onto conventional markets (cf. Michelsen 1999).

If on the other hand smallholders are to convert to organic farming for export, it seems inevitable that this will require external private subsidies and coordination. To the authors' knowledge, there is in fact no certified organic export smallholder production in tropical Africa in the absence of these conditions.[7] Such arrangements typically involve two separate types of contract, one between agencies providing financial and sometimes other types of support and an exporter, and the second between an exporter and a group of smallholder producers. The first type of contract typically specifies that, in return for coverage of all or most certification, training and sometimes marketing costs for an initial period, the exporter sets up a so-called 'internal control system' comprising an apparatus for farmer registration, training and sales documentation, as well as paying farmers a minimum price premium for organic products. The second contract requires farmers to follow organic farming methods and promises to organize and pay for certification and farmer training in organic farming methods, and to purchase organic produce at a premium. It may also promise that farmers will be supplied on credit with specified (organic) inputs, and/or it may require farmers' conformity to quality criteria over and above basic organic requirements before premiums are triggered. Finally, it may limit the exporter's obligation to purchase organic product, 'subject to market conditions'.

(C) CONTRACT FARMING AS A CONFOUNDING VARIABLE

The contract-based nature of organic farming in tropical Africa introduces a series of potentially confounding variables to the study of relative profitability. Firstly, the organizers of organic contract farming schemes may target more established farmers of a specific crop for recruitment to a scheme specializing in that crop. These farmers may be better established because they have superior factor endowments, or greater experience of growing the crop in conventional form, or both. In any case, the result of any subsequent comparison is likely to be different from one undertaken between a group of randomly selected conventional farmers and a group sampled from a population of organic farmers who had recruited themselves.

Secondly, organic contract farming in Africa invariably involves free provision of certification and training to farmers who are scheme members. As already noted, subsidies for conversion

[7] Of the seven studies of economic aspects of organic production in the tropics reviewed above, five studies report smallholders organized into cooperatives or other types of producer organization and two provide no information on the organization of producers. Two studies report external support for certification while the other five do not state how certification was financed.

are also provided in the EU, but because they are provided in the EU in the form of cash transfers, both subsidies and certification costs appear in farm budgets (as income and fixed costs respectively). They make no such appearance in the farm budgets of organic contract farmers in Africa, meaning that it is impossible to provide completely valid data for real net farm income.

Thirdly, contracting allows scheme operators in general, including organic scheme operators, to vary production conditions and requirements from those that would be normally followed by farmers (including certified organic farmers) not under contract. These conditions and requirements may refer to obligatory adoption of specific farming methods or post-harvest techniques, or to the provision of types of input not accessible to farmers outside of contracts. In respect of adoption of specific farming methods, the point has already been made that in tropical Africa organic certification should not require farmers to make major changes in input use. By the same token, maintaining pre-existing farm income levels should not require adoption of more labour-intensive farming practices. On the other hand, since schemes may be dependent for funding upon the support of organic activists or even may be managed by such activists, it is possible that members will be expected to follow the spirit as well as the letter of organic certification requirements and thereby adopt some 'deep' organic farming practices requiring additional labour time.

A somewhat different set of considerations applies to harvest and post-harvest techniques, generally considered to be critical for attaining a given level of product quality. These standards are not strictly organic in character, but farmers can be obliged to meet them in order for their output to qualify for an organic price premium. For example, in the cases of cocoa farmers may be required to ferment and dry beans before sale, or in the case of coffee, to pulp and dry them before sale. The power to enforce such requirements rests upon the monopoly-type buying status that is conferred by scheme operation.

This status may also allow scheme operators, where they wish, to supply inputs on credit with the expectation that credit can be recovered at the point of purchase. In some cases, this can mean that the organic farmer will have unique access to an input that been used historically by all farmers of a given crop, but which is currently unavailable to conventional farmers because of market failure. This applies to organically-permitted chemical pesticides such as sulphur for treating cashew nut trees.

A final confounding variable is that contract farming schemes may be certified to standards other than organic ones, and that the crop they purchase may receive a price premium with

both organic and non-organic components. For example, a large number of organic farming schemes in tropical countries that incorporate primary cooperative societies, including four out of five of those reported in the literature discussed earlier, are also certified Fair Trade. In these schemes, to qualify for the organic price premium, members also have to conform to Fair Trade certification requirements. On the other hand, the price premium that they receive should be higher than that received by farmers certified only to organic standards.

4. Research Methods

(A) VARIABLES AND INDICATORS

In the light of the issues just described, it was decided to collect farm budget-type data for organic and conventional farmers, covering variable and fixed costs of production, processing and marketing, as well as data on production, yields and sales. Components of cost and the indicators used to measure them are described in the next section. In order to assess the extent to which the composition of organic farmer populations was affected by scheme operators' selection methods, further data was collected for both organic and conventional farmer samples on household factor endowments such as numbers of household members of working age, farm area, and number and ages of plants or trees for crops subject to certification (CSCs). Lastly, in order to assess the extent to which 'deep' organic farm practices were adopted and/or enforced as a result of contracts, data was also collected on farmers' adoption of a range of recommended organic and other 'good agricultural practices'.

(B) CASE SELECTION

Because of the overwhelming prevalence of smallholder farming in Sub-Saharan Africa it was decided to focus upon the relative profitability of organic and conventional smallholder, rather than large-scale commercial, farming. As noted, organic smallholder farming in this region is found only in contract farming-type schemes. Three schemes in Uganda were selected for study, to reflect a variety of organic export crops and scheme sizes. These were the Kapchorwa Arabica coffee scheme operated by Kawacom (U) Ltd., the Bundibugyo cocoa-vanilla scheme operated by Esco (U) Ltd. and the Luwero-Kayunga pineapple scheme operated by

Biofresh (U) Ltd.[8] In 2005-06, when fieldwork was conducted, these schemes had respectively 3,870, 1,700 and 34 members. Organic certification took place between 2000 and 2004 in all cases.

While the coffee and cocoa-vanilla schemes enrolled all farmers of these crops (other than those opting out) living within physically continuous areas, the pineapple scheme recruited by a mixture of farmer self-selection and selection by company staff. The pineapple scheme was also the only one of the three not to employ locally based field staff, trained to provide an organic extension service. Like the other schemes, it did however operate through 'contact farmers' selected from local community leaders.

In each case, a limited range and number of inputs were provided free or at cost, mainly but not exclusively to contact farmers. All the schemes received support from the Swedish public development agency Sida for feasibility studies, farmer registration, certification, training and marketing, although there are difficulties in quantifying the precise value of the support received and the extent to which different cost components were covered.[9] The pineapple scheme also received support from another donor. All schemes were certified compliant with the EU organic regulation 2092/91. The Ugandan coffee scheme was also certified to the Utz Kapeh sustainability standard.

(C) SAMPLING AND DATA ANALYSIS

Organic coffee and cocoa-vanilla scheme members were randomly sampled in a series of locations that were chosen purposively to reflect the range of agro-ecological conditions in scheme areas. In the case of the much smaller organic pineapple scheme all available scheme members were interviewed. In all cases, identification and/or sampling of respondents utilized lists of registered organic farmers provided by the schemes themselves. Sampling of conventional farmers of the same crops was in all cases performed randomly, from lists prepared by village leaders in a series of nearby locations chosen to match the (range of) agro-ecological conditions represented in the sampling frames for organic farmers. In all, 172 certified organic were interviewed, made up of 110 coffee, 30 cocoa-vanilla and 32 pineapple farmers. 159

[8] Kawacom (U) and Esco (U) are subsidiaries of the international trading houses Ecom and Schluter respectively. Biofresh (U) was jointly owned by a German importer and a Kenyan.

[9] The Sida programme's financial records refer to allocations rather than actual expenditures. In addition, many payments were channelled through agencies providing services to exporters rather than direct to exporters, and payments of this kind were not generally broken down by purpose of expenditure.

conventional farmers were also interviewed, made up of 97 coffee, 30 cocoa-vanilla and 32 pineapple farmers.

Data for farmers of the three crops was entered and analyzed separately in order to better consider the probable confounding variables specific to each of the schemes. The analysis proceeded in two main stages. First, means were calculated for organic and conventional farmers of each crop on the indicators used and t-tests (or in a few cases chi-squares) were used to establish whether differences in these means were significant. Secondly, where the means for indicators related to relative profitability were found to be significant, bivariate correlation analysis was used to identify associations between farmer performance on these indicators and other variables.

5. Results

The discussion which follows reports on which differences between organic and conventional farmers were found to be significant (sub-sections a-d) before going onto report on the analysis of the sources of significant differences in respect of different dimensions of relative profitability (sub-section e).

(A) DIFFERENCES IN FACTOR ENDOWMENTS OF ORGANIC AND CONVENTIONAL FARMERS

As noted, in the case of two of the schemes, organic operators originally registered almost all farmers in given physical locations. It appears that these were selected in the belief that higher volumes of CSCs were produced there relative to comparable areas locally, and that there was low competition from other buyers. In the case of the pineapple scheme, recruitment was initially of all members of a local farmers' association. Members of the association were supplemented by farmers from another district, selected individually by an agronomist employed by the scheme.

Table 1. Factor endowments of organic and conventional farmers

Production factor	Crop	Exact description of indicator	Unit	Organic farmers	Convent. farmers	Signific-ance	Test of differ-ence
Whole farm area	Pineapple	Extent of whole area owned or rented by household, including fallow land	Hectares	3.52	2.71	ns	t-test
	Cocoa-vanilla	Extent of whole area owned or rented by household, including fallow land	Hectares	2.31	2.06	ns	t-test
	Coffee	Total area of parcels owned or operated by household, including fallowed land and rented land (farmer estimate)	Hectares	1.07	0.98	ns	t-test
Area cultivated with CSC [a]	Pineapple	not measured					
	Cocoa-vanilla	Extent of area owned or rented under cocoa and vanilla	Hectares	1.82	1.62	ns	t-test
	Coffee	Extent of area under coffee operated or owned (GPS measure)	Hectares	0.235	0.214	ns	t-test
Number and age of trees or plants	Pineapple	Number of pineapple plants	#	29,647	26,367	ns	t-test
	Pineapple	Average age of pineapple plants in years	Years	3.1	2.2	*	t-test
	Cocoa	Number of cocoa trees	#	1,531	1,375	ns	t-test
	Vanilla	Number of vanilla vines	#	300	95	**	t-test
	Vanilla	Average age of vines in years	Years	2.3	1.9	ns	t-test
	Coffee	Number of productive coffee trees	#	599	370	***	t-test
Household labour	Pineapple	All household members > 6 years	#	6.4	5.0	ns	t-test
	Cocoa-vanilla	All household members > 6 years	#	7.1	5.5	*	t-test
	Coffee	All household members > 6 years	#	6.0	5.0	***	t-test

Key: ns = not significant, * = P < 0.05, ** = P < 0.01, *** = P < 0.001.
Notes: [a] CSC = crop subject to certification.

Given that organic scheme areas or members were actively selected by operators, it is not surprising to find that in all cases organic farmers had somewhat larger farms, larger areas under cash crops,[10] greater numbers of cash crop trees or plants and in most cases more cash crop

[10] Average areas under pineapple were not measured as the wide variety of plant spacing systems used by both organic and conventional farmers meant that it was not meaningful to compare physical areas under pineapple.

trees or plants of optimal fruit bearing age[11] (Table 1). However, only in a minority of cases (mostly concerning coffee trees) were these differences statistically significant. Organic farmers' labour endowments were also greater than those of conventional farmers in each of the cases studied. In this case, the differences (measured in terms of numbers of household members of working age, i.e., over six years) were significant for both cocoa-vanilla and coffee households.

A preliminary conclusion is that organic farmers had generally superior factor endowments relative to conventional ones. For all schemes there was at least one factor where superiority in endowments was statistically significant, although only in the case of coffee was superiority in endowments statistically significant across a range of factors. At the same time, land endowments varied considerably across between pineapple, cocoa-vanilla and coffee farmers as groups, irrespective of whether they were organic or conventional. Land areas at the disposal of pineapple farmers in the relatively thinly-populated central region of Uganda were on average three times larger than those of coffee farmers, and about 50% larger than those of cocoa-vanilla farmers.

(B) DIFFERENCES IN ADOPTION OF RECOMMENDED PRACTICES

Field staff and other extension workers undertaking training on organic schemes made recommendations to farmers both in relation to specifically organic farming methods and to ways in which standard farming and processing activities should be undertaken. Prescribed organic farming methods included mulching, use of other soil fertilization techniques such as animal and green manuring, and application of bio-pesticides to treat plant health problems. Recommendations in respect of standard farming activities included frequent weeding, regular pruning and thinning of cocoa and coffee trees, frequent harvesting, fermentation of harvested cocoa and pulping and drying of harvested coffee. They also included performing some of these activities with special equipment rather than by hand or with the otherwise ubiquitous *panga* (machete).

[11] For cocoa, organic farmers had significantly fewer trees of fruit bearing age than conventional farmers. But the greater average age of conventional farmers' trees masked the fact that many of the latter were beyond optimal maturity.

Table 2. Adoption of organic practices in crop subject to certification

Organic Practice	Crop	Exact description of indicator	Unit	Organic farmers	Convent. farmers	Signi-ficance	Test of differ-ence
Mulching	Pineapple	Mulched a majority of pineapple crop at time of interview (mulching material was visible)	% households	68.8	68.8	ns	Chi^2
	Cocoa-vanilla	Mulched the vanilla crop at time of interview (mulching material was visible)	% households growing vanilla	88.9	13.3	***	Chi^2
	Coffee	Proportion of coffee plot mulched at time of interview (visual inspection)	Proportion	0.27	0.24	ns	t-test
Other soil fertility management practices	Pineapple	Used animal manure during 2005	% households	37.5	6.3	**	Chi^2
	Pineapple	Used synthetic fertilizer during last two seasons	% households	0	0	-	-
	Cocoa-vanilla	Used animal manure during last two seasons	% households	23.3	3.3	*	Chi^2
	Cocoa-vanilla	Used synthetic fertilizer during last two seasons	% households	0	0	-	-
	Coffee	Used animal manure on plot in 2005	% plots	48.8	45.5	ns	Chi^2
	Coffee	Used synthetic fertilizers on plot in 2005	% plots	2.0	16.9	***	Chi^2
	Coffee	Planted agroforestry/leguminous trees on plot in 2005	% plots	37.0	23.8	**	Chi^2
Chemical and organic plant treatment methods	Pineapple	Used biopesticide when plant health problem was experienced	% households	38.5	10.5	ns	Chi^2
	Pineapple	Used synthetic pesticide	% households	0	0	-	-
	Cocoa-vanilla	Used biopesticides during last two seasons	% households	10.0	0.0	ns	Chi^2
	Cocoa-vanilla	Used synthetic pesticide	% households	0	0	-	-
	Coffee	Number of times biopesticides were applied on plot in 2005	#	0.12	0.05	ns	t-test
	Coffee	Number of times synthetic pesticides were applied on plot in 2005	#	0.09	0.90	***	t-test

Key: ns = not significant, * = P < 0.05, ** = P < 0.01, *** = P < 0.001.

In general, organic farmers' conformity with both types of recommendations was only moderate, with the result that organic farming systems generally continued to resemble local conventional ones (Table 2). Mulching was the recommended organic practice most commonly employed by organic farmers, although - except in the case of vanilla - its use was almost as widespread amongst conventional farmers who had not been trained to carry it out. Other

specifically organic practices such as use of animal manure and bio-pesticides had considerably lower rates of adoption by organic farmers, while they were almost unknown amongst conventional ones.

Table 3. Adoption of 'good farming practices' in crop subject to certification

Good farming practice	Crop	Exact description of indicator	Unit	Organic farmers	Con-vent. farmers	Signific-ance	Test of differ-ence
Harvesting method & frequency	Pineapple	Using a knife only as harvesting tool	% households harvesting pineapple	87.5	37.5	***	Chi^2
	Pineapple	Harvesting interval is weekly or more frequently	% households harvesting pineapple	96.9	50.0	**	Chi^2
	Cocoa	Harvesting interval is 14 days or more frequently	% households	76.7	86.7	ns	Chi^2
	Coffee	Number of times plot was harvested during last two seasons	#	3.09	3.14	ns	t-test
Pruning and thinning	Pineapple	Not applicable					
	Cocoa	Number of times majority of cocoa trees were pruned during last two seasons	#	2.23	1.53	**	t-test
	Cocoa	Use of pruning saw	% households	3.3	3.3	ns	Chi^2
	Coffee	Number of times coffee trees on plot were pruned during last two seasons (2005)	#	0.80	1.01	ns	t-test
	Coffee	Use of stumping saw	% plots	38.6	25.4	**	Chi^2
Weeding	Pineapple	Number of times majority of land under pineapple has been weeded (in a year)	#	8.10	8.64	ns	Chi^2
	Cocoa	Number of times land under cocoa and/or vanilla has been weeded during last two seasons		4.27	4.37	ns	t-test
	Coffee	Number of times plot was weeded with a hoe during last two seasons (2005)	#	3.1	3.1	ns	t-test
Processing	Pineapple	Not applicable					
	Coffee	Used improved drying method (platform, tarpaulin, metal mesh tray) last year (2005)	% households	14.6	14.5	ns	Chi^2
	Coffee	Sorted coffee before sale last year (2005)	% households	95.5	70.0	***	Chi^2

Key: ns = not significant, * = P < 0.05, ** = P < 0.01, *** = P < 0.001.

Major farm maintenance activities, such as weeding, pruning/thinning and harvesting, occurred at broadly similar intervals for both organic and conventional farmers, although pineapple was harvested and cocoa pruned significantly more frequently by organic farmers (Table 3). Use of recommended equipment for stumping coffee trees, pruning cocoa trees and drying coffee beans was low or very low for both groups, although still significantly higher for organic farmers in the case of use of stumping saws. Only where the use of specific tools or adoption of specific processing measures was a formal requirement for triggering an organic price premium (as in the cases of use of knives to cut pineapple or processing cocoa or coffee beans) was adoption by a large majority of organic farmers combined with statistically significant differences in adoption rates between organic and conventional farmers.

The otherwise broad similarity of organic and conventional farming practices and systems is underlined by the very low levels of use of synthetic inputs by conventional farmers; with zero use by the conventional pineapple and cocoa-vanilla farmers surveyed and use by only a minority of conventional coffee farmers.

(C) DIFFERENCES IN PRODUCTION VOLUME AND YIELDS

Calculating volumes and yields for two of the CSCs discussed here (cocoa and coffee) is not straightforward, as these crops may be sold in processed or unprocessed form. Cocoa beans may be sold as fermented or unfermented. Those that are fermented and then sun dried weigh around a third less than beans that are sun dried without having been fermented. Arabica coffee beans may be sold in raw form, as pulped but not dried ('wet'), or as pulped and dried ('parchment'). Pulping without drying results in a weight loss of about a third from the unprocessed state, while pulping combined with drying results in a total weight loss of 70-75%.

The main constraints on fermentation of cocoa beans are labour, and to a greater extent time-to-sale. For cocoa the cycle of preparation for fermentation, fermentation itself and subsequent drying takes on average 13 days from harvesting. The main constraints on coffee processing are cash for hiring a hand pulper and, again, labour and time-to-sale. Processing coffee to the standard required by the organic buyer takes 1-3 weeks, depending on weather.

In the organic farming schemes surveyed, scheme operators purchased only fermented cocoa or pulped, fully dried and sorted coffee beans. Conventional buyers also bought crop in this form from conventional farmers at premium prices. However, because of cash shortages, many cocoa and coffee farmers chose to forego the sizeable premiums commanded by full

processing, in favour of sales in unprocessed forms to roaming middlemen. And while buying farmers' unprocessed cocoa or coffee, these middlemen would also buy beans from farmers that were semi- or fully-processed. Thus, while organic farmers sold only organic crop to organic buyers, both organic and conventional farmers sold crop in all forms to conventional buyers.

Table 4. Sales volumes of crop subject to certification

Crop	Exact description of indicator	Unit	Organic farmers	Convent. farmers	Signific-ance	Test of differ-ence
Pineapple	Organic pineapples in 2005	Pieces	2,632	0	***	t-test
Pineapple	Conventional pineapples in 2005	Pieces	8,422	5,362	ns	t-test
Pineapple	All pineapples in 2005	Pieces	11,055	5,362	**	t-test
Cocoa	Fermented organic cocoa during last two seasons	Kg	474	0	***	t-test
Cocoa	All fermented cocoa during last two seasons	Kg	674	400		t-test
Cocoa	All unfermented cocoa during last two seasons	Kg	220	436	ns	t-test
Cocoa	All cocoa during previous two seasons	Kg fermented equivalent	821	691	ns	t-test
Vanilla	Organic vanilla during last two seasons	Kg	6.3	0	*	t-test
Vanilla	Conventional vanilla during last two seasons	Kg	0.1	3.4	ns	t-test
Vanilla	All vanilla during last two seasons	Kg	6.4	3.4	ns	t-test
Coffee	Coffee sold as organic during last two seasons	Kg parchment	181.0	3.7	***	t-test
Coffee	Coffee sold as conventional during last two seasons	Kg parchment equivalent [a]	63.6	174.6	***	t-test
Coffee	Fully processed (dry parchment) coffee sold during last two seasons	Kg	222.0	102.9	***	t-test
Coffee	Raw or partly processed coffee sold during last two seasons	Kg parchment equivalent [a]	26.8	74.2	***	t-test
Coffee	All coffee sold during last two seasons	Kg parchment equivalent [a]	248.7	177.1	**	t-test

Key: ns = not significant, * = P < 0.05, ** = P < 0.01, *** = P < 0.001.
Notes: [a] The conversion factor from raw cherries to dry parchment equivalent (DPE) is 0.25, and from pulped/wet to DPE the conversion factor is 0.625.

Table 4 reports volumes for each type of cocoa and coffee sold, as well as an aggregate volume based on 'fermented cocoa (or parchment coffee) equivalent'. It appears that, on average, organic cocoa farmers sold 57.7% of their crop in organic form to the organic scheme, 24.4% in fermented form to conventional buyers and 17.9% in unfermented form. Conventional cocoa farmers sold 57.9% of their crop in fermented form and 42.1% in unfermented form

(all measurements in both cases are in 'fermented cocoa equivalent'). While organic cocoa farmers sold 18.8% more (fermented equivalent) cocoa on average than conventional ones, this difference was not significant.

Organic farmers also sold more coffee than their conventional counterparts. In this case the difference was significant. In addition, they sold 89.3% of their coffee in the form of parchment, compared to conventional farmers who sold only 58.1% in this form. Twenty-six percent of organic farmers' coffee was sold through non-organic marketing channels, often as raw or wet coffee commanding a lower price (all measurements in 'parchment equivalent').

Pineapple volumes are meanwhile reported here in pieces rather than weight, since they were universally bought in a piece form. Organic farmers produced significantly more pineapple pieces than conventional ones. As in the case of cocoa and coffee, organic pineapple farmers sold a majority of their crop without a premium to conventional buyers. In this case this was not because of labour, time or cash constraints, but because the organic buyer had an export market only for pineapple weighing 1.2-1.6 kg. Pieces this size comprised a little less than a quarter of all pineapple pieces harvested for both organic and conventional farmers.

Table 5. Crop yields for crop subject to certification (CSC)

Crop	Exact description of indicator	Unit	Organic farmers	Convent. farmers	Signific-ance	Test of difference
Pineapple	Not available					
Cocoa	Cocoa yield per area unit (computed from volume sold and area under cocoa). [a]	Kg fermented equivalent per hectare	208	151	ns [c]	t-test
Coffee	Coffee yield per area unit (computed from volume sold and area under coffee). [b]	Kg parchment equivalent per hectare	836	630	*	t-test

Key: ns = not significant, * = P < 0.05, ** = P < 0.01, *** = P < 0.001. [a] Cocoa: two cases with extreme high yields were omitted from the analysis. N = 28 for organic and 27 for conventional. [b] Coffee: N is 78 for organic and 42 for conventional. Areas were measured by GPS. Only cases with yield values below 2000 kg DPEQ are included. Another t-test was run where all cases with yields below 3000 kg DPEQ were included and this gave a stronger result in favour of organic farmers (980 kg versus 667 kg; P=0.011; N = 86 for organic and 43 for conventional). Yields are positively influenced by rainfall, which increases with altitude. Organic coffee plots were on average located 50 m higher than conventional plots (1880 m. vs. 1828 m.; P = 0.000), but this difference in altitude is not big enough to explain the observed 33% difference in yields. [c] P=0.102.

Organic and conventional farmers' yields were calculated only for cocoa and coffee. They were not calculated for pineapple due to a combination of this crop being sold by the piece rather than by weight and substantial variations in farmers' crop spacing systems. The calcul-

ations for yield reported in Table 5 are in fermented/parchment equivalent terms. In both cases, organic farmers' yields were higher, and in the case of coffee significantly higher. Differences between organic and conventional farmers in proportions of trees of productive age do not seem to explain differences in yield. Nor do differences in farming practices, since those that were significant had little relevance for yields. Differences in agro-ecological conditions between organic and conventional areas, such as they were, were also too small to explain the difference.[12]

A possible explanation for differences in yield may be more effective farm management technique. Although no attempt was made to measure this directly, some anecdotal evidence supports this interpretation. Focus group interviews conducted with coffee farmers after the survey suggested that while organic farmers may not have weeded more frequently, they did so more conscientiously. This is turn may reflect either organic farmers' greater exposure to extension and inspections, or their lower levels of reliance on paid labour, or both.

Overall, organic farmers produced CSCs in higher volumes than conventional farmers, in two cases significantly higher. Where processing of the crop was associated with a premium, they also sold a higher proportion of their crop in processed form. Higher CSC volumes and yields are based on some combination of organic farmers' superior factor endowments, such as land under CSCs, and/or proportions of trees or plants of productive age, and/or labour availability, and/or better farm management technique, as well as the possible incentive effects of price premiums.

(D) DIFFERENCES IN INCOME, COSTS AND RELATIVE PROFITABILITY

In this paper relative profitability is operationalized as total farm income, net of fixed and variable costs. Many users of the type of accounting-based cost-benefit methodology employed here adjust fixed costs by dividing investment costs incurred in the year in which information was gathered by the number of years that the investment is likely to be utilized. Likewise, they add in the annualized cost of past investments, where these investments are still utilized. Finally, they allow for depreciation. Because farmers' recall of the scale and timing of earlier investments was poor, and their ability to estimate how long into the future current

[12] These differences were significant only in the case of coffee, where organic coffee farms were located on average at an altitude 50m higher than conventional ones. However, the magnitude of this difference does not seem likely to generate a wide divergence in yields.

investments were likely to be utilized was low, calculation of fixed costs in a discounted form has not been attempted. Therefore, the fixed costs reported here are the actual fixed costs incurred in the 12 months previous to interviews. This is likely to mean that the resulting data may reflect respondents' stages of overall farm development rather than propensity to invest as such, since less established operations will have higher investment requirements than more established ones. On the other hand production volume, and consequently crop income, is likely to be affected by the farm development cycle in the same way.

The components of farm income considered comprise income from CSCs, income from other crops and income from land. Livestock holdings and incomes were in all cases negligible. Income from CSCs is a product of volume produced and the proportion of production sold in different forms (see above) commanding different unit prices. Although organic cocoa and coffee farmers did not, and organic pineapple farmers could not, maximize their incomes by selling their entire product in forms commanding the highest unit prices, premiums for organic production nonetheless had a visible effect on the average price organic farmers received for CSCs (Table 6.a). Differences in average income from CSCs between organic and conventional farmers of all CSCs were uniformly greater than differences in aggregate production volume (Table 6.b). The CSC income difference between organic and conventional farmers was significant for all CSCs except cocoa, and was at a higher level of significance than the difference in production volume in the cases of coffee, vanilla and pineapple.

Equally interesting was the huge differences in average income from CSCs between *all* farmers of pineapple, cocoa-vanilla and coffee. Conventional and organic pineapple farmers' CSC incomes were 5-7 times higher than conventional and organic coffee farmers, and 2.5-3 times higher than conventional and organic cocoa-vanilla farmers.

In respect of incomes from on-farm sources other than CSCs, conventional farmers tended to earn more than organic ones, but this trend was not systematic across all schemes and the differences in question were not significant. As a result, organic farmers' gross farm income was significantly higher than conventional farmers' ones, or on the borderline of being significantly higher, for each of the groups of CSCs (or combination of CSCs in the case of cocoa-vanilla) considered. Since pineapple farmers (organic and conventional) earned more from non-CSCs than cocoa-vanilla farmers as a group and coffee farmers as a group, differences in gross farm incomes between pineapple farmers and farmers of other crops were even greater than they were for incomes from CSCs alone.

Table 6. Relative profitability

6.a. Prices

Prices	Crop	Exact description of indicator	Unit	Organic farmers	Convent. Farmers	Signific-ance	Test of differ-ence
Average price	Pineapple	Average price, all pineapple	Ush./piece	370	355	ns	t-test
	Cocoa	Average price, all cocoa	Ush./kg fermented equivalent	1,465	1,277	*	t-test
	Vanilla	Average price, all vanilla	Ush./kg	7,231	2,875	**	t-test
	Coffee	Average price, all coffee	Ush./kg parchment equivalent	2,189	1,806	***	t-test

Key: ns = not significant, * = P < 0.05, ** = P < 0.01, *** = P < 0.001.

6.b. Farm income

Farm Income (sales of crops & land)	Crop	Exact description of indicator	Unit	Organic farmers	Convent. Farmers	Signific-ance	Test of differ-ence
Sales of crop subject to certification	Pineapple	Average income from total sales of all pineapple	Ush.	3,835,500	1,824,345	***	t-test
	Cocoa	Average income from total sales of all cocoa	Ush.	1,273,979	920,552	ns	t-test
	Vanilla	Average income from all sales of all vanilla	Ush.	46,433	9,250	*	t-test
	Coffee	Average income from all sales of all coffee	Ush.	591,724	340,550	***	t-test
Other crop income	Pineapple	Average income from all sales of other crops	Ush.	316,008	501,469	ns	t-test
	Cocoa-vanilla	Average income from all sales of other crops	Ush.	114,250	31,931	ns	t-test
	Coffee	Average income from all sales of other crops	Ush.	202,883	289,381	ns	t-test
Income from land	Pineapple	Average income from sale or rent of land (last 12 months)	Ush.	0	2,625	ns	t-test
	Cocoa-vanilla	Average income from sale or rent of land (last 12 months)	Ush.	27,667	2,667	ns	t-test
	Coffee	Average income from sale or rent of land (per year)	Ush.	23,009	16,969	ns	t-test
Gross farm income	Pineapple	Average total farm income	Ush.	4,151,508	2,328,439	**	t-test
	Cocoa-vanilla	Average total farm income	Ush.	1,462,329	996,553	ns [a]	
	Coffee	Average total farm income	Ush.	817,616	646,901	ns [b]	t-test

Key: ns = not significant, * = P < 0.05, ** = P < 0.01, *** = P < 0.001.
Notes: [a] P = 0.16. [b] P=0.08.

6.c. Fixed costs of crop production

Fixed costs	Crop	Exact description of indicator	Unit	Organic farmers	Convent. farmers	Signific-ance	Test of differ-ence
Purchase and transport of planting materials	Pineapple	Purchase and transport of pineapple suckers	Ush.	2,188	187,664	**	t-test
	Cocoa-vanilla	Purchase of cocoa seedlings	Ush.	7,167	2,377	ns	t-test
	Coffee	Purchase of coffee seedlings (average cost per year since 2000)	Ush.	605	1,749	**	t-test
Cost of long-term soil fertilization	Pineapple	Purchase and transport of coffee husks	Ush.	115,625	578,125	ns	t-test
	Cocoa-vanilla	Not applicable					
	Coffee	Not applicable					
Cost of land	Pineapple	Expenditure on land purchase and rental	Ush.	133,396	879,759	ns	t-test
	Cocoa-vanilla		Ush.	48,333	97,000	ns	t-test
	Coffee	Average expenditure per year since 2000 on purchase and rental of land used for coffee	Ush.	17,377	17,059	ns	t-test
Interest on farm-related loans	Pineapple	Interest on loans for purchase of land or equipment	Ush.	0	4,063	ns	t-test
	Cashew	Not measured					
	Cocoa-vanilla		Ush.	500	2,643		
	Coffee	Interests paid during the previous year (2005) on loans for purchase of farm land, farm inputs, or equipment (including interest free loans)	Ush.	377	1,010	ns	t-test
Cost of farm equipment	Pineapple		Ush.	19,991	11,750	*	t-test
	Cocoa-vanilla		Ush.	20,500	33,587	ns	t-test
	Coffee	Purchase of farm equipment last two seasons (2005) (hand hoes, *pangas*, bags, mats, tarpaulins, pulping machines, excl. equipment hire).	Ush.	16,119	8,390	**	t-test

Fixed costs	Crop	Exact description of indicator	Unit	Organic farmers	Convent. farmers	Signific-ance	Test of differ-ence
Cost of scheme membership	Pineapple	Total entry fees and subscriptions paid for membership of farming schemes of projects	Ush	6,032	500	***	t-test
	Cocoa-vanilla		Ush.	1,500	0		t-test
	Coffee	Expenditure on all farming-related project membership and entry fees during the previous two seasons (2005) [b]	Ush.	3,678	2,099 [a]	ns	t-test
Total fixed costs	Pineapple		Ush.	277,231	1,661,861	ns	t-test
	Cocoa-vanilla		Ush.	78,000	135,607	ns	t-test
	Coffee	Cost of coffee seedlings, land, interests on farm loans, equipment, and farming-related project membership	Ush.	38,157	30,308	ns	t-test

Key: ns = not significant, * = P < 0.05, ** = P < 0.01, *** = P < 0.001.
Notes: [a] Two outliers dropped from sample. [b] Registration cost since 2000 standardized to Ush./year.

6.d. Variable costs of crop production

Variable costs	Crop	Exact description of indicator	Unit	Organic farmers	Convent. farmers	Signifi-cance	Test of differ-ence
Labour costs	Pineapple	Total expenditure on hired labour	Ush	149,039	380.252	ns	t-test
	Cocoa-vanilla	Total expenditure on hired labour	Ush	131,804	297,338	ns	t-test
	Coffee	Total expenditure on hired labour	Ush	32,583	54,405	ns	t-test
Non-labour costs (marketing and seasonal inputs)	Pineapple	Total expenditure on marketing of all crops, and total expenditure on seasonal inputs	Ush	11,900	24,934	ns	t-test
	Cocoa-vanilla	Total expenditure on marketing of all crops, and total expenditure on seasonal inputs	Ush	18,452	25,729	ns	t-test
	Coffee	Non-labour variable costs of *crop farming* (fertilizers, manure, mulch, inorganic and organic pesticides, herbicides, hire of sprayer for spraying, seeds for all annual crops; excluding coffee seedlings)	Ush	76,898	58,247.5	ns	t-test
	Coffee	Non-labour variable costs of *crop processing and marketing* (pulping fees, transport costs to the point of sale)	Ush	13,800	3,782.5	**	t-test
	Coffee	All non-labour variable costs	Ush	90,697	62,030	ns	t-test
Total variable costs	Pineapple		Ush	160,939	405,185	ns	t-test
	Cocoa-vanilla		Ush	150,256	323,068	ns	t-test
	Coffee		Ush	123,280	119,435	ns	t-test

Key: ns = not significant, * = P < 0.05, ** = P < 0.01, *** = P < 0.001.

6.e. Profitability

Net farm income	Crop	Exact description of indicator	Unit	Organic farmers	Convent. farmers	Signific-ance	Test of differ-ence
	Pineapple	All crop + land income – (fixed + variable costs)	Ush.	3,713,337	261,392	***	t-test
	Cocoa-vanilla	All crop + land income – (fixed + variable costs)	Ush.	1,234,086	526,005	**	t-test
	Coffee	All crop + land income – (fixed + variable costs)	Ush.	656,177	497,159	ns [a]	t-test

Key: ns = not significant, * = P < 0.05, ** = P < 0.01, *** = P < 0.001.
Notes: [a] P = 0.061.

Fixed farm costs were considered in terms of CSC planting materials, long-term soil fertilization materials such as coffee husks for pineapple (including costs of transport in both cases), cost of land, cost of farm equipment, interest payments and subscriptions to farmer organizations (Table 6.c). Across the different CSCs (or combination of CSCs in the case of cocoa-vanilla) organic farmers' average fixed costs were in a narrow range between 4.7-6.7% of average gross farm income, reflecting uniformly low levels of current investment. Conventional farmers' average fixed costs represented higher shares of average gross farm income in every case, although the shares in question varied dramatically from one CSC to another. For coffee the average share for conventional farmers was only slightly above that for organic farmers; for cocoa-vanilla it was three times higher, while for pineapple it was more than 10 times higher. In fact, conventional pineapple farmers' average fixed costs were equivalent to around 71% of their average gross farm income. The very high underlying levels of investment in planting materials, long-term fertilization and land reflected the fact that conventional pineapple farmers were in the process of spectacularly expanding their production. Most conventional pineapple farmers had begun commercial production of the crop later than organic ones, but their average number of pineapple plants was already similar. On the other hand, organic pineapple farmers were also expanding production, albeit at a lower rate.

Farm variable costs were considered in terms of hired labour (including costs of using exchange labour in the cases of cocoa and coffee), seasonal inputs and marketing costs in the form of porterage to buying posts (Table 6.d). In the case of pineapple and cocoa-vanilla, conventional farmers' variable costs were higher than organic ones, while for coffee they were almost equal. And in most cases total variable costs were dominated by labour costs. While conventional farmers' labour costs were systematically higher than organic ones, in no cases was this difference significant. Higher conventional farmer labour costs are probably related to differences between conventional and organic farmers in average size of the household labour forces (as noted above, this difference was significant in the cases of both coffee and cocoa-vanilla households). The significantly higher cost of coffee processing among organic farmers corroborates the earlier observation that they sell coffee with a higher level of processing than conventional farmers. While in most cases farmers' expenditure on seasonal inputs and crop marketing was low, expenditure on labour was high enough (and investments low enough) to mean that variable costs exceeded fixed ones. Pineapple farmers (both organic and conventional) were the only ones where the reverse was the case.

Since organic farmers in all cases enjoyed higher gross farm incomes than conventional ones, and since conventional farmers' total costs were higher in two cases and only slightly lower in one (coffee), organic farmers' average net incomes consistently exceeded those of convention-

al farmers (Table 6.e). Furthermore, this difference in net farm income was statistically significant across the board (although for coffee P = 0.06). As differences in gross income were significant or close to significance in each case, while difference in costs were not (even in the case of pineapple), it can be concluded that gross income in general, and income from CSCs in particular, was the driver of this outcome. At the same time, the results for average net income underline the enormous differences in profitability between organic farmers of different cash crops. At well over $2,000 a year, the average incomes of organic pineapple farmers' were three times as high as organic cocoa-vanilla farmers and more than five times higher than organic coffee farmers.

(E) VARIABLES MOST ASSOCIATED WITH CROP SALES AND INCOMES

The remainder of the analysis undertaken comprised an attempt to identify the extent to which different variables were associated with overall differences in volumes of crop sales and incomes from these sales. As there were few differences in farming practices between the majority of organic and conventional farmers, attention was focused on the respective roles of different types of factor endowment, on differences in yields and on the role of price in determining sales volume (price incentives). Associations between these variables and the most relevant aspect of crop sales and/or income were tested for individually, using bivariate correlation analysis.[13] For these tests, the samples of both conventional and organic farmers were pooled, but separate tests were still performed for the different crops.

The first set of bivariate correlations to be considered were those for the cultivated areas under CSCs, the yields per hectare for these crops, and the average prices received for them, in relation to total volumes of CSCs sold (Table 7). These variables were taken to be indicators of CSC land endowments, farm productivity and price incentives respectively. The analysis showed a weak correlation between price received and volume and generally medium-to-strong correlations for both CSC land endowments and yields (land endowments and yields were not tested for in the case of pineapple, for the reasons referred to). The finding of weak price effects is suggestive in relation to the low levels of farm investments found amongst (premium-earning) organic farmers.

[13] The method used was Pearson's correlation. This assumes a linear relationship between two variables and does not take account of confounding variables. For each variable, extreme cases were identified and removed through outlier analysis.

Table 7. Pearsons correlation of 'volume[a] sold of crop subject to organic certification' with yield, cultivated area, and price

Independent variable	CSC	r	P	N [b]	r^2 (%)
CSC yield per area unit	Pineapple		not applicable		
	Cocoa	0.601**	0.000	55	36.1
	Coffee [c]	0.441**	0.000	119	19.4
Area cultivated with CSC	Pineapple		not applicable		
	Cocoa	0.634**	0.000	56	40.2
	Coffee	0.277**	0.001	136	7.7
Number of CSC plants	Coffee [d]	0.542**	0.000	199	29.4
Average price received for CSC (all sales)	Pineapple	-0.316*	0.023	52	10.0
	Cocoa	0.277	0.037	57	7.7
	Coffee	0.241**	0.001	204	5.8

Key: * Correlation is significant at the 0.05 level. ** Correlation is significant at the 0.01 level.
Notes. [a] Volume is measured in pieces for pineapple, 'kg fermented equivalent' for cocoa, and 'kg dry parchment equivalent' for coffee. [b] Case numbers vary from full sample due to removal of cases with extreme or missing values and of cases where the volume sold was 0. [c] Cases with calculated yields above 2000 kg 'dry parchment equivalent' were omitted from this analysis as these were considered unrealistically high and caused by measurement errors. [d] In the case of coffee, CSC volume sold was also correlated with number of coffee trees due to the many data gaps in the area cultivated.

Table 8. Pearsons correlation of 'income from sales of crop subject to organic certification' with household factor endowments

Independent variable	CSC	r	P	N [a]	r^2 (%)
Number of persons in household above 6 years	Pineapple	0.312*	0.013	63	9.7
	Cocoa	0.303*	0.022	57	9.2
	Coffee	0.107**	0.125	207	1.1
Area cultivated with CSC plants	Pineapple		not applicable		
	Cocoa	0.549**	0.000	57	30.1
	Coffee	0.233**	0.006	136 [b]	5.4
Number of CSC plants	Pineapple	0.612**	0.000	62	37.5
	Cocoa	0.564**	0.000	57	31.8
	Vanilla	0.404*	0.012	38	16.3
	Coffee	0.525**	0.000	199	27.6
Average age of CSC plants	Pineapple	0.435**	0.000	63	18.9
	Cocoa	0.182	0.176	57	3.3
	Coffee		not applicable		

Key: * Correlation is significant at the 0.05 level. ** Correlation is significant at the 0.01 level.
Notes. [a] Case numbers vary due to removal of cases with extreme values and cases where the income was 0. [b] 70 cases omitted due to incomplete coffee plot size data, including one of two control sub-groups (many households had coffee plots located far from homestead and these were not measured).

The role of land endowments was then tested for alongside that of other factor endowments, in relation to incomes from CSC sales. The other endowments tested for were numbers of CSC plants/trees, average age of CSC plants/trees and numbers of household members aged 6 years and over – indicators respectively for magnitude and condition of capital stock and for labour availability (Table 8). The analysis showed a mostly strong relationship between CSC income and number of CSC plants, a medium-to-strong relationship between it and land endowments, a weak-to-medium relationship between it and average age of CSC plants, and a weak relationship between it and household labour force size.

Table 9. Pearson's correlation of 'income from sales of all crops' with household factor endowments

Independent variable	CSC	r	P	N [a]	r^2 (%)
Number of persons in household above 6 years	Pineapple	0.282*	0.025	63	8.0
	Cocoa-vanilla	0.334*	0.010	58	11.2
	Coffee	0.090	0.198	208	0.8
Whole farm area	Pineapple	0.179	0.167	61	3.2
	Cocoa-vanilla	0.567**	0.000	58	32.1
	Coffee	0.499**	0.000	210	24.9
Area cultivated with CSC plants	Pineapple	not applicable			
	Cocoa	0.575**	0.000	58	33.1
	Coffee	0.417**	0.000	140 [b]	17.4
Number of CSC plants	Pineapple	0.468**	0.000	63	21.9
	Cocoa	0.592**	0.000	58	35.0
	Vanilla	0.473**	0.000	58	22.4
	Coffee	0.564**	0.000	203	31.8
Average age of CSC plants	Pineapple	0.392**	0.002	63	15.4
	Cocoa	0.206	0.124	58	4.2
	Coffee	not applicable			

Key: * Correlation is significant at the 0.05 level. ** Correlation is significant at the 0.01 level.
Notes. [a] Case numbers vary due to removal of cases with extreme values and cases where the income was 0.
[b] 72 cases omitted due to incomplete coffee plot size data, including one of two control sub-groups (many households had coffee plots located far from homestead and these were not measured).

These same variables, together with total farm area, were lastly tested against income from all crop sales (Table 9). There were medium-to-strong correlations areas for areas under CSCs and number of CSC plants/trees, a medium strength correlation for total farm area, a weak-to-medium correlation for average age of CSC plants/trees and again a weak correlation for labour availability.

Summing up, it is clear that, amongst factor endowments, area under CSCs and numbers of CSC plants / trees were correlated with sales and incomes to a uniformly medium-strong or strong degree. Yields had a similar level of correlation with sales. Other variables, including

price incentives, labour availability and to a lesser extent average age of CSC plants/trees had a much weaker relation to crop sales and incomes (the latter was not tested for correlation with price).

6. Conclusion

Returning to the differences between the economics of organic farming in developed countries and in tropical Africa, this study produces some striking findings. Significant or close to significant differences in gross income in favour of three cohorts of organic farmers in tropical Africa generated uniformly significant higher *net* incomes for these cohorts, relative to control groups of conventional farmers. Organic farmers' gross farm income benefited primarily from higher income from CSCs (significantly higher in the cases of pineapple, vanilla and coffee). Although this reflected production by organic farmers of higher volumes of CSCs, differences between organic and conventional farmers on this variable had lower levels of significance than those for CSC incomes. Thus, the relative shares of CSCs sold at premium prices also had a bearing on gross farm incomes. Leaving aside for a moment the precise sources of organic farmers' higher farm incomes, it is worth underlining that organic conversion in tropical Africa is associated with increases rather than reductions in yield. The absence of yield loss relates to the low-input characteristics of conventional farming on the continent.

Most economic studies of organic agriculture in developed countries observe few differences in fixed costs between organic and conventional farmers, except for organic farmers incurring some additional short-term costs associated with conversion-related diversification. The economic drama lays in differences in variable cost structures, with organic farmers spending more than conventional farmers on labour and less on fertilizers, pesticides and herbicides. Organic farmers' cost structure in tropical Africa, as reflected in this study, has a completely different character. Expenditure on fixed costs represented a remarkably low share of organic farmers' gross income – and in most cases also of conventional farmers'.[14] Overall expenditure on vari-

[14] This was not the case for one of the conventional farmer control groups (pineapple). This discrepancy may relate to the fact that the cohort in question seem to have been at an earlier stage in the cycle of overall farm development than their organic counterparts.

able costs was higher than on fixed costs for organic farmers, but it was characterized neither by rising expenditure on labour nor by falling expenditure on synthetic inputs. Instead, organic farmers incurred higher variable costs on post-harvest handling and processing activities required to meet the higher quality standards of the organic exporter. In respect of labour, organic farmers exhibited only low levels of adoption of more labour-intensive recommended organic and other 'good agricultural' farming practices, resulting in requirements for hiring-in that did not differ significantly from those of conventional farmers. Meanwhile, the prohibition on using synthetic inputs was financially neutral, since their level of use in conventional agriculture was generally negligible. As a result, differences between conventional and organic farmers' costs had little impact on differences in net incomes. If anything, differences in net income in favour of organic farmers were amplified by the fact that the latter's costs were generally lower than conventional farmers' ones.

What remained to be explained at this point was the underlying difference between the two groups in terms of sales and incomes, particularly from CSCs. Possible reasons for this included the apparently superior factors endowments of organic farmers (in terms of total land area, area under CSCs, numbers of CSC plants/trees, average ages of CSC trees/plants and availability of household labour), price incentives and generally higher yields. Correlation analysis revealed that, among factor endowments, area under CSCs and numbers of CSC plants / trees had the strongest relation to sales and incomes, while yields were similarly strongly related to sales. Other variables, including price incentives (in relation to sales volume), labour availability and – to a lesser extent – average age of CSC plants/trees had a much lower level of importance.

The weak nature of the correlation between average unit price received and CSC sales is somewhat puzzling but tallies with the trend for high shares of organic farmers' production to be sold off-scheme. Real price premiums were relatively high, so it is unclear what level of incentive (if any) would be necessary to generate greater levels of output of crop in the form demanded by organic exporters. Given this, organic scheme operators may find it more cost effective to increase sales volumes through enrolling more farmers, rather than increasing premiums to existing ones.

The weak correlation of household labour availability with sales and volumes did not seem to reflect a general state of neglect of farms. Instead it tallied with high levels of investment in hiring-in of labour, particularly for cocoa and pineapple, where average annual expenditure on labour hiring was around $136 per household. This appears to suggest a pattern where household family members prefer paid labour on their neighbour's farms to unpaid or poorer paid

labour on their own. Finally, the weak correlation between average age of CSC plants/trees and sales of incomes seems to mainly reflect the inadequacy of this measure as a proxy for crop maturity, except in the case of pineapple.

Assuming that the higher factor endowments of organic farmers, especially in terms of cultivated area and number of CSC plants/trees, are not mainly caused by their organic status (a possibility that is very remote due to the youth of the schemes studied here), but rather by their organic project design, a coming study will use multivariate regression techniques to assess the income effects of organic status while controlling for the effects of factor endowment variables. These methods will also be used to assess the contributions to income of each of the variables found to be critical, when the effects of other variables are controlled for.

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