APRA

Agricultural Policy Research in Africa

RETURNS TO COMMERCIALISATION: GROSS MARGINS OF COMMERCIAL CROPS GROWN BY SMALLHOLDERS IN SUB-SAHARAN AFRICA

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ACRONYMS

APRA	Agricultural Policy Research in Africa
ER	exchange rate
GM	gross margin
ha	hectare
t	tonne, metric ton
TSh	Tanzania shilling
US$	US dollar
Z$	Zimbabwe dollar

EXECUTIVE SUMMARY

What are the returns to smallholders when they grow commercial crops for sale in rural Africa? The gross value of production per hectare is sometimes reported, with some recent estimates ranging from as much as US$10,000/ha for irrigated vegetables in Zimbabwe to as little as US$250 for sunflower grown on semi-arid land without irrigation in central Tanzania. Gross value, however, takes no account of the costs farmers incur in growing their crops. In this paper, we use gross margin (GM) analysis to take account of those costs and give a truer estimate of the returns to farmers.

GMs are computed as the value of the crop, less variable costs of production – seeds, fertiliser, agro-chemicals, fuel for irrigation pumps, and labour. Fixed costs, such as machinery, buildings or land, are not included. On most smallholdings in Africa, fixed costs are few: most farmers do not own machinery other than hand tools and a plough; their farm buildings are few and rudimentary; and most farmers do not pay for the land they farm. GMs, then, are not that much more than a net margin calculation, which would make deductions for fixed costs.

GM analysis can estimate returns to land, labour and capital. It can model the impact of changes to yields and input prices. It can compare returns to different crops, and to different methods of cultivating a crop. It can model risk, by exploring the consequences of crop failure or price slumps.

In this paper, we report on GM analysis applied to some of the commercial crops studied by Agricultural Policy Research in Africa (APRA) researchers namely:

- rice in Ethiopia and Tanzania;
- sunflower in Tanzania;
- maize and tobacco in Zimbabwe; and,
- cocoa and oil palm in Ghana.

The paper addresses the following questions:

- What is the return to land and labour from specific crops?
- What elements of costs and returns most influence the returns achieved?
- What if … another technique was used to grow the crop; prices were higher or lower; yields were better or worse; drought strikes, etc.?

To compute GMs, we use information on inputs and crop yields, costs of inputs and value of production, from surveys carried out between 2016 and 2019 by APRA researchers, taking median values. Results vary considerably across farmers in the same community, but here we take the median outcomes (we can use the analyses to model what happens to farmers who have, for example, yields at the 25th and 75th percentile of the distribution). Where the values recorded in APRA studies are questionable – above all, those for labour days – we have cross checked with studies of the crop in the same regions and corrected the APRA results where these seemed unrealistic.

We calculate two measures: returns to land per hectare, and implicit returns to labour per day worked.

Findings

Returns to land and labour vary considerably across the seven crops. GMs per hectare ranged from more than US$3,000/ha (tobacco, Zimbabwe) to just over US$500/ha (oil palm, Ghana). Returns to labour also varied, from a high of US$25 a day (oil palm, Ghana) to a low of US$4.50 a day (rice, Tanzania). In four cases, household labour was implicitly rewarded at US$10 or more a day, which should allow most farm households to earn an income per person above the (extreme) poverty line of US$1.90 a day.

Most costs of production arise from labour. Spending on inputs – seed, fertiliser, agro-chemicals – was generally a small share of costs.

Costs of production were, in all but one case (maize, Zimbabwe), significantly below the world market price – at one third to two-thirds of world prices. Most smallholders in Africa thus can compete with commodities sold at world market prices.

Prices paid to farmers differed from world prices. Generally, farmers growing crops for the domestic market were paid at or above world markets levels – as expected because import parity prices exceed world market prices. Conversely, those farmers producing export crops tended to get less than the world price – as expected for an export parity price that will be below the world market price. But actual prices paid did not conform strictly to these principles: maize growers in Zimbabwe were paid an extraordinarily high price, while oil palm farmers in Ghana were paid surprisingly low prices.

Returns to farmers were sensitive to changes in yields or prices – changes to these variables result in more than proportionate changes to returns. The converse applies to costs of production, where impacts on returns of changes to costs are in most cases less than proportionate.

Implications

The analyses generate insights on agricultural productivity and on incomes.

On **productivity**, most farmers spent little on inputs. So little, they probably spent less than the economic optimum – that is, most farmers would see their yields and revenues rise by more than the cost of additional quality seed, fertiliser and agro-chemicals, or by more than the cost of extra labour for more careful field operations.

Why did they not invest more to earn more? It probably arises from aversion to the risks of investment – what if the harvest is bad and the little cash the farmer had went on inputs? – and from lack of liquid cash when farm inputs are needed. Only a few of the farmers studied had contracts to grow crops where buyers provided inputs in advance – most notably for some of the tobacco growers in Zimbabwe and some oil palm growers in Ghana.

Although under-investment is a problem, it is also an opportunity. If farmers could get inputs on credit, could insure against risks of production, obtain quality inputs, and so on, very probably yields and revenues would rise by more than costs, thereby raising returns and incomes.

The conditional 'if' here may appear a roadblock: to date, it often has been so, but perhaps not in the future. Evidence emerging in the 2010s in rural Africa shows traders, buyers, processors and exporters in agricultural supply chains increasingly willing to provide the farmers with inputs and technical assistance. Often the actors doing so are small-scale and informal enterprises, not international companies. This has not happened in every area, for every crop, for every farmer – far from it, but a trend towards better supply chain intermediation to overcome market failures is apparent (Liverpool-Tasie et al., 2020).

Regarding **incomes and poverty**, returns to small-scale farming in Africa remain meagre, but these analyses indicate that to farm a few hectares is no longer to live in deep poverty. In four cases, implicit returns to household labour are US$10 a day or more. While that still barely allows a household to escape deep poverty, such returns are far higher than was typically seen in Africa a quarter of a century ago – when farm labour could often be hired at little more than US$1 a day.

Given the scope for raising productivity and margins, given the urbanisation of Africa with rapidly expanding local markets for (higher value) produce, the prospects for most farmers studied appear bright in the medium term.

Two messages stand out for policymakers. One, most farmers can produce at costs below world market prices: they can compete. Our data come from smallholders: their small-scale operations do not put them at a disadvantage. To compete, it is not necessary to consolidate farms to a greater scale.

Two, for more production, more productivity and higher farm incomes, the challenge first and foremost is to make use of existing technology. That means working with farmers, traders, processors and exporters in the supply chains to overcome the remaining obstacles to farmers investing on their farms. For example, for some crops, value chain finance – that is, credit linked to crop deliveries – may help. Increasing use of the internet may help some farmers link more closely to those offering technical help, inputs and wanting to buy their crops. Crop insurance may not be a commercial proposition, but policymakers may consider offering this as a public good (in partnership with insurers). Better roads that lower transport costs and increase the interactions between farmers, traders and buyers in destination markets will help – and that requires only straightforward investment in the physical work and maintenance.

That does not mean, though, that better technology is not needed – on the contrary, the returns to spending on public agricultural research and extension are high – only that, for most farmers, it is not necessary to await better technology: the means to do much better are already tried and tested.

In the medium term, however, Africa's farmers will be challenged by the need to make sure their farming is environmentally sustainable, and sustainable in the face of a changing climate. That may seem daunting, but those who know how much rural Africa has changed over the last decades should know that farmers can improve and change and meet those challenges – given appropriate public support.

1 INTRODUCTION

When smallholders grow commercial crops – crops grown largely for sale – they do so to get better returns to labour and land than crops grown for household consumption. How much are those returns? Are they adequate, especially the returns to household labour? How do returns vary by crop, and by the physical and economic circumstances in which the crops are grown? This paper reports on simple analyses of those returns.

In rural Africa in the 2010s, large differences have been recorded in the gross returns per hectare of commercial crops, ranging from more than US$10,000/ha for irrigated vegetables (Scoones et al., 2019), to around US$680/ha for crops such as oil palm (Ruml, Ragasa and Qaim, 2022), and to less than US$250/ha for crops such as sunflower grown in semi-arid areas (Sewando, 2022). Returns net of costs show similar, if less strong, differences because although the costs of production under irrigation and with intensive use of fertiliser and other inputs are higher than dryland crops grown with few inputs, the extra value of production from more intensive cultivation usually far outweighs the extra costs.[1]

GM analysis can estimate returns to land, labour and capital. It can model the impact of changes to yields, inputs, price and input costs on returns. It can compare returns to different crops, and to different methods of cultivating a crop. It can model risk, by exploring the consequences of crop failure or price slumps.

GM analysis is compatible with closely related analyses, such as **partial budgets** – used to compare small changes to the management of given farm enterprises – and **whole farm analyses** – where the margins for all enterprises are compiled and compared to fixed costs.

In this paper, we computed GMs for seven cases of commercial crops grown by smallholders in sub-Saharan Africa in the late 2010s. We chose commercial crops because increasingly farmers, even small-scale farmers, in Africa produce as much for sale as for their household consumption. The market for produce in the growing cities of Africa is burgeoning, and if farmers need to buy in food from the market, it has become less expensive to do so, and more reliable than it was in the past.

The crops we chose are those that APRA researchers have been studying since the mid-2010s, namely:

- rice in Ethiopia and Tanzania;
- sunflower in Tanzania;
- maize and tobacco in Zimbabwe; and,
- cocoa and oil palm in Ghana.

Ideally, we would repeat our analyses for more commercial crops and in more locations, but that would have been beyond the time we had.

The paper addresses the following questions:

- What is the return to land and labour from specific crops?[2]
- What elements of costs and returns most influence the returns achieved?
- What if … another technique was used to grow the crop; prices were higher or lower; yields were better or worse; drought strikes, etc.?

1 Marginal returns to additional labour, water, fertiliser, etc. can fall below their cost, but only at high yields per hectare. Most small farms in Africa produce so far below technically achievable yields that they are rarely in danger of returns not rewarding more intensive cultivation.

2 It can also look at returns to capital, but these are usually of less interest in smallholder farming.

2 METHOD AND DATA

GM analysis (Rae, 1994; Upton, 1996) computes returns to factors of production by comparing the value of production of a crop or livestock enterprise to the **variable** costs of production. It omits fixed costs such as land rent, or installed capital such as buildings or drainage, because their costs would apply to any enterprise carried out on the farm.

GM analysis may also omit the cost of labour that does not vary by enterprise, such as household labour. This, however, seems only appropriate for UK farming, where machinery is usually a more significant cost than labour. In the global south, labour constitutes a much greater fraction of costs, so labour is included in these analyses.

Rather than attribute shares of fixed costs to individual enterprises, it is simpler to omit them when the aim is to compare returns across the various crop and livestock options facing farmers.[3]

Smallholders in sub-Saharan Africa usually have few fixed costs. Land is usually collectively held, although individually farmed, which villagers can use by right of their being community residents. Most farmers do not pay rent for their user rights. Farm buildings are few and constructed at low cost, machinery is often absent, tools are also few and low cost – hoes, machetes, etc. Hence the difference between GMs and net margins – subtracting the attributed share of fixed costs from the GM – is usually small: so small, it is barely worth consideration.

For **returns**, the analysis includes the value of all production, whether sold or consumed within the household, valued at the farm gate. The price used is typically that offered by traders. For home consumed food this may undervalue production, since the true economic value is the opportunity cost of buying food from the market – and that may be substantially larger than the selling price, especially when rural market centres are distant to the household.

Two measures of GM have been calculated. One, the **GM per hectare of land**, equal to the value of production less variable costs of production, including inputs – seed, fertiliser, crop protection chemicals; labour, both household and hired costed at the local market rate for hired labour; and in some cases, machinery services.

Two, the implicit **returns to household labour**, equal to the GM per hectare, net of the costs of household labour, divided by the number of days household labour worked per hectare. For many farmers in rural Africa, this is what counts: how well rewarded are they for the days spent farming? It has the value of being an easily appreciated metric because it indicates whether farming offers a return that can lift the farmer – and household – above the poverty line.[4]

The measure can also be compared to the opportunity cost of household labour, that is what the workers in the household could earn from their time. This will vary by circumstances: in remote areas with a little

3 Allocation of fixed costs to different crop and livestock enterprises within a farm is usually arbitrary – and unnecessary – because GM analysis shows the contribution of a given enterprise towards covering fixed costs.

4 Simple arithmetic can be deployed. If living out of poverty is measured by the World Bank's deep poverty threshold of US$1.90 per person per day, and if a typical farming household has five members, then the annual income needed to live above poverty is US$3,468. Now, if the household has, say 2ha under crops which provide 90 days employment per hectare, 180 days in all, then to achieve the threshold income from the farm alone would require an implicit return to household labour of almost US$20. In this hypothetical case, however, if the household had two adults able to work 200 days, then the farm would only be providing employment for fewer than half the days available forwork. If those adults could find non-farm activities to earn when they are not farming, the target implicit return from farming would fall accordingly. The same applies if the household has more than 2ha: a 5ha holding might require 450 days labour a year and fully employ the adults.

developed rural economy, there may be few alternatives to farming, so that the opportunity cost of labour may be close to zero. Conversely, for farmers living within commuting distance of a town, there may be better paid employment in the town.

2.1 Data needs

GM analysis requires the following data for crops:[5]

Returns:

- Crop yield per unit area.
- Price received by farmer.

Costs:

Quantity per unit area and unit cost of:

- Inputs: seed, fertiliser, agricultural chemicals.
- Labour: household, hired and exchange labour, in days.
- Machinery services: tractor hire, oxen hire.
- Miscellaneous: bags, irrigation water rates, fuel used to power pumps, etc.

For tree crops with a cycle of production that extends more than a year and often for decades, a discount rate may be needed to compare the value of differing yields and costs through time, discounted to their present value. Future costs and returns are discounted because most people prefer to have money today rather than in the future ('time preference') – a preference which applies whether inflation applies or not.

The analyses in this paper model a typical producer of the crop in question. Inputs used, labour employed and yields achieved try to reflect those of the median farmer. That simplifies mightily, because almost all surveys of farmers in sub-Saharan Africa show wide dispersions of yields and input use – although usually less so for labour use and prices received. With more time, variants that reflect what may be seen at say, the 25th and 75th percentiles can be constructed. To a considerable extent, what they would show are captured in sensitivity analyses that ask, for example, what would the returns be if yields were 25 per cent greater?

2.2 Sources of data

Data come first and foremost from APRA household surveys carried out in 2017 and 2018 (Table 2.1). These provided most of the data required.

However, there were challenges in measurement of some variables, including use of labour and inputs. When median or mean values for some of these were computed,[6] these sometimes still returned incredible estimates relative to what would be expected – for example, a cereal crop for which farmers, who rarely use tractors, were working for less than 10 days a year per hectare.

In such cases, we searched the literature to find credible estimates from field studies either in the same area, or in areas with very similar physical and social characteristics.[7]

2.3 Crops description

The seven crops outlined in Table 2.1 differed mainly by their agro-ecological zone – from very humid tropical forest zones to semi-arid drylands; by irrigation – rice was mostly irrigated, other crops not; and by the market in which they were sold – cocoa and rice in Tanzania,[8] and tobacco are export crops, all the others were selling on domestic markets, and in most cases, the domestic market was also supplied by imports as well.

Otherwise, cultivation of these crops shared similarities. All cases were crops grown on smallholdings where rarely more than 2ha or 3ha were sown to the crop in question. Additional detail of the cultivation crops appears in Table 2.2.

Land preparation was either manual or using oxen, most field operations were manual with the only machinery used being knapsack (hand-operated) sprayers of pesticides and fungicides; harvesting and post-harvest processing were almost entirely manual

5 For livestock the principles remain the same, although the analysis can be more complicated when young stock are raised within the enterprise as often applies, especially in sub-Saharan Africa.

6 After data cleaning for large outliers.

7 For example, in Zimbabwe, information on smallholder tobacco cultivation came from another district, but in the same agro-ecological zone.

8 For many years, Tanzania had been a net importer of rice. Since 2014, however, imports have fallen sharply while exports have increased so that Tanzania is now a net exporter of rice. In 2020 net exports were more than 340,000t [FAOSTAT data].

operations. Growing the crops was thus intensive in labour, with several of the crops requiring more than 50 days labour a year per hectare. Peak season operations or laborious jobs were commonly carried out with the help of hired gangs of labour.

Spending on inputs tended to be low, and usually only if absolutely necessary – as applies to controlling pests and disease in cocoa groves or on tobacco fields, or when soils needed fertiliser to obtain a reasonable yield.

Sales in most cases were to local agencies, traders and depots. In many cases, over the last 20 or so years it has become ever easier for farmers to sell their crop, with distance to point of sale falling,[9] and the number of potential buyers rising. Marketing was not seen as a problem.

Most crops were produced by the farmers themselves with little outside assistance: farmers used saved seed or locally bought seed, bought in inputs where needed from local dealers, and carried out almost all operations with household labour supplemented by hired labour in peak seasons. Exceptions to this arose with contracted production where large processors and traders agreed to buy from growers and then helped them by providing inputs on credit: this applied to some oil palm growers in Ghana, to some of the tobacco farmers in Zimbabwe.

One other exception arose with cocoa groves in Ghana where some older farmers[10] lacking labour and vigour, employed share-croppers to cultivate their cocoa. The landlord provided inputs, and the sharecropper the labour, with two thirds of the harvest going to the former and one third going to the latter.

Table 2.1 APRA surveys

Variable
Ethiopia rice, Fogera Household survey with 722 households, May 2018 Also draws on Takele (2010)
Tanzania rice, Kilombero Household survey with 537 households, October 2017 Also draws on Nkuba et al. (2016)
Zimbabwe maize, Mvurwi Household survey with 647 households, March 2017 Also draws on Fintrac (2014) and Seed Co Group (2018)
Zimbabwe tobacco, Mvurwi Household survey with 647 households, March 2017 Also draws on data from: Keyser (2002), Nhorido (2013), and Chitapi and Shonhe (2020)
Tanzania sunflower, Singida Survey of 600 farmers, 2018
Ghana cocoa, Western North Structured interviews with 54 farmers, nine focus groups of men, women and youth farmers, and a household survey of 276 farmers in Juaboso District, Western North
Also draws on data from Nunoo (2015) and Abdulai et al. (2018)
Ghana oil palm, Western South Household survey with 726 households, November 2017

Source: Authors' own

9 A notable example was Kilombero, Tanzania, where in the last 20 years electrification has led to rice mills opening up locally, cutting the distance to mills dramatically – and thereby improving the price that farmers have been paid. Further examples of the number of traders arriving in villages to buy crop surpluses can be found in Chamberlin and Jayne (2009) for Kenya, and Jayne et al. (2011) for Eastern Africa.

10 Until the 1970s, it was possible for farmers resident in Western North Region to obtain and plant up tens of acres of cocoa. They could only plant owing to back-breaking efforts by the farmers and their spouses. Those who did so are now elderly and can only cultivate their trees with hired labour or sharecroppers.

Table 2.2 Cultivation of crops

	Agro-ecological zone, rains (annual in mm)	Land preparation and planting	Crop management	Harvesting and processing	Marketing
Ethiopia rice, Fogera	Highland flood plain Double rains, total = 1,100–1,300mm	Land prepared by ox plough	Irrigation	Manual harvesting Rice dried prior to sale	Sold to local private rice mills. Milled then sold domestically
Tanzania rice, Kilombero	Lowland flood plain	Land prepared either by oxen (42% of farmers 2016/17), tractor (29%) or hoe (13%)	Irrigation Weeding by hand and herbicide	Manual harvesting by sickle Rice dried prior to sale	Sold to local private rice mills. Milled then sold domestically
Zimbabwe maize, Mvurwi	Highland Single rains, 1,100mm	Most smallholders plough using oxen. A few hire tractors	Rainfed Fertiliser applied by hand Weeding by hand or herbicide	Manual harvesting Maize shelled, dried, then bagged	Maize sold to Zimbabwe's Grain Marketing Board parastatal For domestic milling and consumption
Zimbabwe tobacco, Mvurwi	Highland Single rains, 1,100mm	Most smallholders plough using oxen. A few hire tractors	Rainfed Fertiliser applied by hand, chemicals by hand sprayer Weeding by hand or herbicide	Manual harvesting. Tobacco flue cured in barn, fired by wood or coal, packed in bales	Sales either in Harare auction, or else sold to processors and exporters on contract Almost all tobacco exported
Tanzania sunflower, Singida	Upland Dual rains	Land prepared either by hand or using oxen or tractors by very few medium-scale farmers	Manual weeding using hand and herbicides	Manual harvesting	Local sale to oil mills. National consumption
Ghana cocoa, Western North	Tropical forest zone Dual rains, 1,500mm	Forest or bush cleared, before planting by hand seedlings or seeds. Four years before first cocoa yield. Food crops meanwhile grown	Weeding by hand Pruning and cutting mistletoe Chemicals applied with hand sprayer	Manual harvesting. Pods broken, beans extracted, fermented, then dried before bagging	Local sale to licensed buying companies: almost all crop exported
Ghana oil palm, Western South	Tropical forest zone Dual rains, 1,500mm	Forest or bush cleared, before planting by hand seedlings or seeds. Four years before first fruit harvested	Groves weeded, some pruning A few growers fertilise as well	Manual harvesting	Most fresh fruit bunches sold to commercial (medium to large-scale, formal plant) or artisan processors. Some fruit processed within households by artisan methods. All palm oil sold on domestic market

Source: Author's own, compiled from APRA reports and notes from field investigators

3 RESULTS

Table 3.1 summarises the results of GM analysis. The Appendix shows the GMs for each crop.

3.1 GMs, and returns to labour

GMs per hectare ranged widely between US$275 for rice farmers in Tanzania and US$1,053 for tobacco farmers in Zimbabwe.

These margins are not large when the small areas cultivated are considered. If, for example, farmers had to provide all their annual income from growing, say, 2ha of these crops, then even those obtaining margins of US$1,000 a year would barely escape poverty. For example, 2ha, at US$1,000 = US$2,000 = US$5.40 a day for a household of five people = barely more than US$1 a person per day. In some locations, however, two seasons of cropping are possible, so these margins might apply twice a year.[11]

But within that margin was payment for household labour not charged in cash? What then were the implicit returns to labour, mostly unpaid household labour?

A first approach is simply to compute margins with no labour costs, as can be seen in the eight line of Table 3.2, immediately below the GM. GMs increase by at least a quarter, and for three crops – rice in Tanzania, coca in Ghana and tobacco in Zimbabwe – the increase is to double or more the margin. But such margins would assume that labour has no opportunity at all, which is an extreme assumption.[12]

A more realistic approach is to look at the **implicit returns to labour**, computed by taking the GM,

Table 3.1: GMs, summarised

Crop		Rice	Rice	Sunflower	Cocoa	Oil palm	Maize	Tobacco
Location		Fogera	Kilombero	Singida	Western North	Western	Mvurwi	Mvurwi
Country		Ethiopia	Tanzania	Tanzania	Ghana	Ghana	Zimbabwe	Zimbabwe
					PV	PV		
Yield	t/ha	3.7	3.3	1.6	0.39	8.5	3.5	1.1
Price	US$/t	437.6	260.9	419.6	936.4	60.0	390.0	2,960.0
Revenues	US$/ha	1,600.4	860.9	673.9	1,006.9	507.1	1,365.0	3,108.0
Costs: inputs	US$/ha	152.6	31.4	114.0	245.3	9.9	375.3	777.2
Costs: labour	US$/ha	474.1	555.0	152.7	412.9	99.7	208.5	1,277.5
Total costs	US$/ha	626.7	586.4	266.7	658.1	109.7	583.8	2,054.7
GM	US$/ha	973.7	274.4	407.3	348.7	397.5	781.2	1,053.3
GM, with no labour cost	US$/ha	1,447.82	829.45	559.91	761.61	497.20	989.70	2,330.80
Labour days	days	130.0	185.0	67.2	75.7	19.9	51.0	365.0
Returns to labour	US$ day worked	11.14	4.48	8.34	10.06	24.93	19.41	6.39

Note: PV = present value after discounting through tree life cycle

Source: Author's own, using APRA data, supplemented by estimates from field reports and wider literature

11 Although often the crop grown in the second season is not the commercial crop, but a less valuable food crop. In Fogera, Ethiopia, some farmers with irrigation have managed to devise a system of year-round cropping that yields three crops – with a valuable crop of irrigated vegetables added on to a cycle of rice followed by grass pea/chickpea/sorghum/maize (Addis et al. 2018).

12 We would have to imagine a farm where all labour comes from a household whose working adults have no alternative at all to working on their own farm.

subtracting labour costs, then dividing by the numbers of days of labour. This shows the value that labour has created by working on the crop in question.

Implicit labour returns (last line of Tale 3.2) varied, from as much as US$25 a day for oil palm growers in Ghana to as little as US$4.5 a day for rice farmers in Tanzania (Figure 3.1). Returns to labour were relatively high, at more than US$10 a day, in four cases (rice in Ethiopia, cocoa and oil palm in Ghana, and maize in Zimbabwe). If the average farm household had five people, with two adults working 200 days a year for this return, total farm income would come to US$4,000, or the equivalent of US$2.20 a day per household member – more than the international deep poverty line of US$1.90 a day.[13]

3.2 Costs of production

Per hectare, annual costs of production ranged from US$110 for oil palm in Ghana to US$2,055 for tobacco in Zimbabwe, with five crops lying between US$265 and US$660 (Table 3.1).

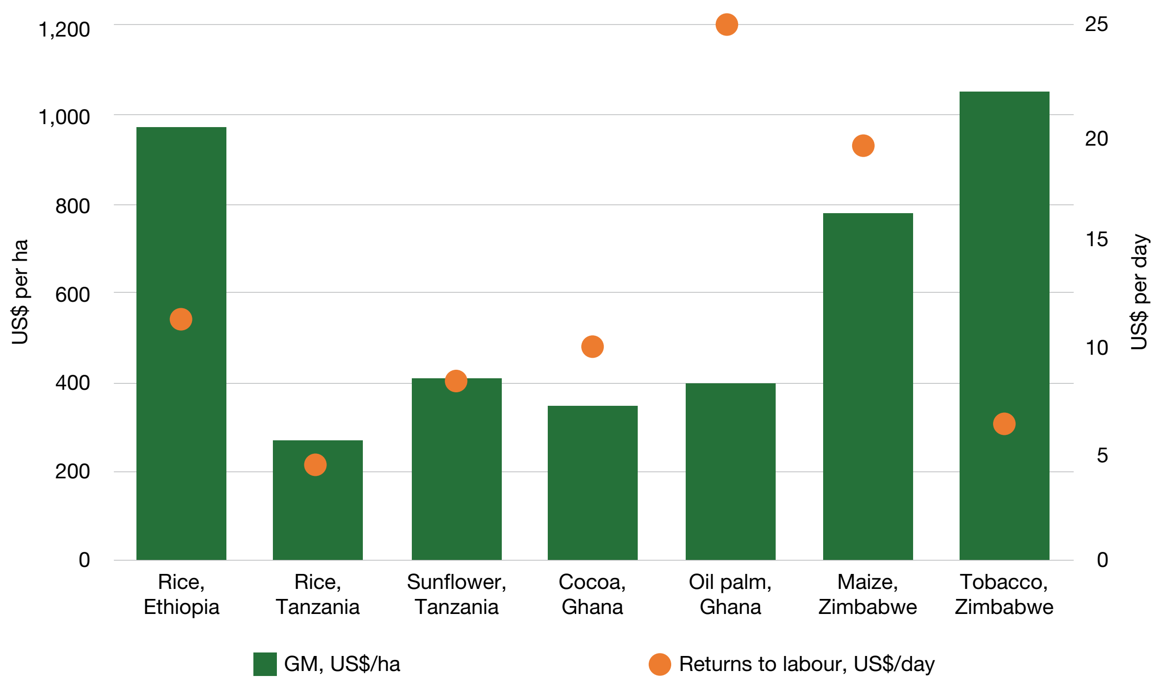
For most crops, **labour** comprises two-thirds or more of the costs, much of this being the imputed value of household labour. Reported costs of hired labour vary from around US$3 a day in Ethiopia and Tanzania, to Ghana where wages paid are around US$5 a day.[14]

The amount of labour employed annually varies from as little as 20 days/ha to as many as 365 days/ha. Most of this variation arises from the nature of the crop: some tree crops such as oil palm require little labour once the trees are established – no planting is then needed, and weeding may be modest once the tree canopy restricts growth of plants at ground level. For most of these crops almost all labour worked with hand tools for most operations: the exceptions were the use of oxen or tractors to prepare land for the field crops – rice, sunflower, maize and tobacco.

Spending on **inputs** such as seed, fertiliser, and crop chemicals was, in most cases, quite modest, ranging from US$10/ha to US$375/ha, except for tobacco where input costs reached US$777/ha.

Spending on inputs as a share of annual revenues was modest in most cases with only three crops requiring

Figure 4.1 GMs per hectare and implicit returns to labour per day



Source: Authors' own, compiled from Table 3.1

13 And well above that line if purchasing power parity exchange rates were used to convert local currency to the US dollar. Purchasing power parity reflects that most costs of living, item for item, are less in rural Africa than in New York.

14 These rates are higher than have often been seen in the past in rural Africa. For example, Oya (2013) reports day wages rates in Mozambique in 2003 as just US$0.43. In Rwanda in 2013, Bigler et al. (2017) observed men's rural day wages at US$1.26 a day – and even less for women.

more than 20 per cent of revenue to be reinvested in inputs – maize (25 per cent), tobacco (27 per cent) in Zimbabwe and cocoa (24 per cent) in Ghana. At the other extreme, inputs cost less than 5 per cent for rice in Tanzania and oil palm in Ghana.

Spending on inputs was so limited it is hard to imagine that farmers are already investing to the point where the marginal returns to seed, fertiliser and chemicals do not exceed their marginal cost. If this is commercial production, it is a cautious commercialisation: one where farmers are reluctant to invest in more intensive methods for lack of liquidity and aversion to risks.

3.2.1 Comparing costs of production to revenues and world market prices

How do these costs of production compare to world market prices? (Table 3.2). To compare the cost of the product at the farm gate to the world market commodity price, costs of processing need adding to convert harvests to saleable commodities: milled rice rather than paddy, sunflower oil rather than seeds, and palm oil rather than oil palm fruit.

All but one of the commodities (maize in Zimbabwe was the exception) were produced at significantly below the world market price – with fractions ranging from 73 per cent (cocoa, Ghana) to just 13 per cent (palm oil in Ghana – owing to the very low labour costs reported for this crop).

Particularly striking is rice. Rice can be grown in Africa at far below the world market price, dramatically so in the case of Fogera, Ethiopia. Indeed, the Ethiopian cost of production is on a par with the lowest cost producers in the world: Thailand and Vietnam. Similarly, the drylands of central Tanzania can produce sunflower oil at almost half the world market price. Yet rice is imported to Ethiopia and vegetable oil to Tanzania, imports that arise not because local agriculture is uncompetitive: but because of obstacles to invest in domestic farming.

Table 3.2 Costs of production and prices

Crop		Rice	Rice	Sunflower	Cocoa	Oil palm	Maize	Tobacco
Location		Fogera	Kilombero	Singida	Western North	Western	Mvurwi	Mvurwi
Country		Ethiopia	Tanzania	Tanzania	Ghana	Ghana	Zimbabwe	Zimbabwe
Production costs per tonne	US$	112	178	166	1,704	13	167	1,957
Saleable commodity		Milled rice	Milled rice	Sunflower oil	Dried beans	Palm oil	Maize	Tobacco leaf
Extraction rates to saleable commodity	%	0.68	0.68	0.30	1.00	0.20	1.00	1.00
Processing cost	US$/t	15	15	75	0	20	0	0
Full cost per tonne	**US$/t**	**267**	**276**	**628**	**1,704**	**85**	**167**	**1,957**
World price, Aug 2020	**US$/t**	**484**	**484**	**1033**	**2350**	**675**	**147**	**2,960**
Production cost as share of world market prices	%	55%	57%	61%	73%	13%	113%	66%
Locally paid prices as share of world market price	%	133%	79%	135%	40%	44%	265%	100%
Parity: export (X) or import (M)		M	X	M	X	M	M	X

Source: Authors' own, compiled from GM calculations, and world prices from International Monetary Fund data, except for tobacco where Harare auction prices are taken as the world price

Only one of the seven crops was produced at a cost higher than the world market price; maize in Zimbabwe which cost 70 per cent more to grow than the world reference price. Since maize is an import substitute in Zimbabwe, this is not too alarming: by the time the (high) costs of shipping from the world market to Harare (US$100/t or more) have been added to the world price, local production costs will be below the import parity price.

How did the locally paid prices to farmers compare to world market prices? In three cases, local farmers were paid over the world market price: rice in Ethiopia, 33 per cent premium; sunflower in Tanzania, 35 per cent premium; and maize in Zimbabwe, 165 per cent premium. This should not surprise for import substitutes: the import parity price would be above the world market price. Even so, the Zimbabwe price for maize at more than two-and-a-half times the world market price looks very high indeed.

Tobacco growers in Zimbabwe were paid exactly the world market price, but that is because the auction floors in Harare are as good a definition of the world price for tobacco as any.

In the other cases, growers were paid less than world market prices.

In Tanzania rice farmers received 79 per cent of world price; in Ghana cocoa farmers were paid 40 per cent and oil palm growers 44 per cent of the world price. For Tanzania's rice and Ghana's cocoa, a lower price than the world price is expected: prices should reflect an export parity price, the world market price less costs of transporting rice from Tanzania to destinations very largely in the East African Community, and of sending cocoa from rural Ghana to trading floors in London, Rotterdam, New York.

The low palm oil price in Ghana is harder to explain given that Ghana is a net importer of palm oil: it may reflect a discount for mediocre quality of oil – some is processed by artisan methods.

3.3 Sensitivity to changes in yields, prices and costs

GM analysis allows us to explore how sensitive these estimated returns are to key variables, such as prices, physical yields, costs and the labour needed to grow

Table 3.3 Sensitivity of GMs per hectare to changes in yields, costs and labour time

Crop	Rice	Rice	Sunflower	Cocoa	Oil palm	Maize	Tobacco
Location	Fogera	Kilombero	Singida	Western North	Western	Mvurwi	Mvurwi
Country	Ethiopia	Tanzania	Tanzania	Ghana	Ghana	Zimbabwe	Zimbabwe
Sensitivity to +25% change							
New GM							
To price, yield	1,374	490	576	600	524	1,122	1,830
To all costs	817	128	341	184	370	635	540
To labour time	855	136	369	246	373	729	734
Change to GM, abs							
To price, yield	400	215	168	252	127	341	777
To all costs	- 157	- 147	- 67	- 165	- 27	- 146	- 514
To labour time	- 119	- 139	- 38	- 103	- 25	- 52	- 319
Percentage change to margins							
To price, yield	41%	78%	41%	72%	32%	44%	74%
To all costs	-16%	-53%	-16%	-47%	-7%	-19%	-49%
To labour time	-12%	-51%	-9%	-30%	-6%	-7%	-30%
What if: +50% costs incurred to raise yields by 25%?							
New GM	1,060	196	442	271	469	831	803
Change to GM	87	- 78	35	- 77	72	49	- 250
Percentage change to margins	9%	-28%	9%	-22%	18%	6%	-24%

Source: Author's own

the crop. How much would a 25 per cent increase in each of these variables have on the GMs? (Table 3.3).

If either prices or yields were to rise by 25 per cent, GMs would rise more than proportionately, by 32 per cent – 78 per cent. In three cases – rice in Tanzania, cocoa in Ghana and tobacco in Zimbabwe – a 25 per cent rise in yields would boost the margins by more than 70 per cent. Hence farmers able to intensify and improve their crop management should be well rewarded for their efforts. The corollary – imagine a 25 per cent fall in prices or yields – is that growers of these crops would see their margins cut – by 32 per cent to 78 per cent depending on crop and place – if their harvest were hit by bad weather, pests, diseases or a low market price.

Sensitivity to costs also varies. A 25 per cent rise in costs leads to the margins falling by as little as 7 per cent for oil palm growers, to as much as 53 per cent for rice farmers in Tanzania.

If days of labour needed rose by a quarter, margins are less affected, falling by just 7 per cent for maize farmers in Zimbabwe to as much as 51 per cent for rice growers in Tanzania.

Two points emerge from these calculations. One, changes to prices and yields have a stronger impact on returns than changes to costs. Agronomists who observe farmer yields and lament the gap between them and what they can achieve on trial plots may have a point. Raising yields may well be highly worthwhile, even if it means spending more on inputs and labour.

Sensitivity analysis can shed light on this. If the increase in costs were proportionate to the increase in yields, GM and labour returns would rise proportionately. For example, a 25 per cent rise in costs to give 25 per cent more yield would raise returns by 25 per cent.

But what if, given how low some of the current costs of production are, it were necessary to spend 50 per cent more on costs to boost yields by 25 per cent?[15] (Table 3.3, last four rows). For four crops, the investment would pay off in increased margins; but for three crops it would not: for rice in Tanzania, cocoa in Ghana, and tobacco in Zimbabwe, the increased spend would exceed the value of extra production.

Two, returns to some crops seem much more sensitive to potential changes than others. Changes make little difference to the returns to the rice farmers of Fogera, Ethiopia, but make a strong impact on returns to rice farmers in Tanzania, to cocoa growers in Ghana and to tobacco farmers in Zimbabwe.

15 These considerations are speculative: if we want to test the probable effect on returns of intensifying production, we need to work with agronomists to specify the additional costs needed to achieve a specific increase in yield. GM analysis is a simple way to model the economic effects.

4 CONCLUSION AND DISCUSSION

Key findings from these analyses can be summarised as follows:

Returns to land and labour vary considerably across the seven crops, but in most cases, returns were enough to allow farmers to live out of poverty. Taking the returns to household labour, in four cases, household labour was implicitly rewarded at US$10 or more a day, which should allow households able to farm 2ha or more to have an income per person above the (extreme) poverty line of US$1.90 a day.

Most costs of production arise from labour. Spending on inputs – seed, fertiliser, agro-chemicals – was generally a small share of costs.

Costs of production of these crops were, in all but one case, significantly below the world market price – by one third to two-thirds of the world price. Smallholders in Africa can compete with commodities sold at world market prices. Indeed, production costs of rice in Fogera, Ethiopia were similar to the lowest production costs anywhere in the world.

Prices paid to farmers differed from world prices. Generally, those producing crops for the domestic market were paid at or above world market levels, as expected because import parity prices exceed world market prices. Farmers growing export crops tended to get less than the world price, as expected because an export parity price would be below the world market price. Actual prices paid, however, did not necessarily conform strictly to these principles: maize growers in Zimbabwe were paid an extraordinarily high price, while oil palm farmers in Ghana were paid surprisingly low prices.

Returns to farmers were sensitive to changes in yields or prices – changes to these variables result in more than proportionate changes to returns. The converse applies to costs of production, where impacts on returns of changes to costs are, in most cases, less than proportionate.

Two insights come from these analyses: on productivity and on poverty.

Agricultural productivity

Most farmers spent little in inputs. So little, they probably spent less than the economic optimum – that is, most farmers would see their yields and revenues rise by more than the cost of additional quality seed, fertiliser and agro-chemicals, or by more than the cost of extra labour for more careful field operations.

Why did farmers not then invest in inputs and labour to boost output and returns? Most probably it stems from what has often been observed for small-scale farmers in sub-Saharan Africa (Wiggins, Glover and Dorgan, 2021): a combination of aversion to the risks of investment and lack of liquid cash when farm inputs are needed. Only a few of the farmers studied had contracts to grow crops with buyers providing inputs in advance – most notably for some of the tobacco growers in Zimbabwe and some oil palm growers in Ghana.

Although under-investment is a problem, it is also an opportunity. If farmers could get inputs on credit, could insure against risks of production, could obtain quality inputs, and so on – very probably yields and revenues would rise, and rise by more than costs, thereby raising returns and incomes.

The conditional 'if' here may appear a roadblock, but perhaps not. Emerging evidence in rural Africa shows traders, buyers, processors and exporters in supply chains are increasingly willing to work with the farmers they buy from to overcome such obstacles. Often the actors doing so are small-scale and informal enterprises, not international companies. This has not happened in every area, for every crop, for every farmer – far from it, but the evidence shows a trend towards better supply chain intermediation to overcome market failures (Liverpool-Tasie et al., 2020).

Poverty and incomes

Returns to small-scale farming in Africa remain meagre. These analyses indicate that to farm a few hectares is no longer to be condemned to live in deep poverty. For four crops, implicit returns to household labour are

US$10 a day or more. While that still barely allows a household to escape deep poverty, such returns are far higher than was typically seen in Africa a quarter century ago – when farm labour could be hired at little more than US$1 a day.

Given the scope for raising productivity and margins, given the urbanisation of Africa with rapidly expanding local markets for produce, especially for higher-value foods, the prospects for most farmers studied appears bright in the medium term.

Policy considerations

Two messages stand out for policymakers. One, **most farmers are able produce at costs below world market prices:** they can compete. Our data come from smallholders: their small-scale operations do not seemingly put them at a disadvantage. It is not necessary to consolidate farms to achieve greater scale to compete.[16]

Two, for more production, more productivity and higher farm incomes, **the challenge first and foremost is to make use of existing technology.** That means working with farmers, traders, processors and exporters in the supply chain to overcome the remaining obstacles to farmers investing on their farms. For example, for some crops, value chain finance – that is, credit linked to crop deliveries – may help. Increasing use of the internet may link some farmers more closely to those offering technical help, inputs and those wanting to buy their crops. Crop insurance may not be a commercial proposition,[17] but there can be a case for providing this as a public and merit good. Better roads that lower transport costs and increase the interactions between farmers, traders and destination markets will help – and that requires only some straightforward investment in physical work and maintenance.

That does not mean, though, that even better techniques are not needed – on the contrary the returns to spending on public agricultural research and extension are high – only that for most farmers, it is not necessary to await better technology: the means to do much better are already tried and tested.

In the medium term, however, Africa's farmers will be challenged by the need to make sure their farming is environmentally sustainable, and sustainable in the face of a changing climate. That may seem daunting, but those who know how much rural Africa has changed over the last decades realise that farmers can improve and change and meet those challenges – given appropriate public support.

16 In the medium term, as population growth slows, as countries urbanise, it is likely that more farmers will leave the land and the remaining land will gradually be consolidated in larger holdings, much as happened in Europe in the twentieth century. That process can be left for individual farm households to decide. It does not require land reform.

17 Agricultural insurance has been trialled many times in sub-Saharan Africa since the 1990s, often using indices to trigger pay-outs. While farmers have often appreciated insurance, rarely have they been willing to pay a commercial premium. Given the value of insurance to farmers on low incomes, and given that some of the reluctance to pay a premium may stem short-term horizons of farmers, insurance may well be a public and merit good (Wiggins, Glover and Dorgan, 2021).

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APPENDIX: GMS FOR THE SEVEN CROPS

Table A1: Rice, Ethiopia

Location	Fogera Plain, Ethiopia					
Date	2018					
	Per hectare					
			Ethiopian Birr	Ethiopian Birr/ha	US$	US$/ha
Value of production	Unit	Quantity	Unit price	Total	Unit price	Total
	t	3.66	12,000	43,884	438	1,600.44
Total revenues				**43,884**		**1,600**
Operating costs						
Input costs						
Seed	kg	178.2	10.77	1,920	0.4	70.02
Fertiliser	kg	170	10.30	1,751	0.4	63.87
Herbicide	kg	0.931	133.19	124	4.9	4.52
Insecticide	kg	1.33	200.50	267	7.3	9.73
Fungicide	kg	0.453	271.08	123	9.9	4.48
Sub-total input costs				**4,185**		**153**
Labour costs						
Ploughing	day			0		-
Weeding	day			0		-
Harvest	day			0		-
Threshing	day			0		-
Labour cost	day	130.00	100.00	13,000	3.6	474.11
Sub-total labour cost		**130.00**		**13,000**		**474.11**
Total operating cost				**17,185**		**627**
GM				**26,699**		**974**
Costs and returns ratio				2.55		2.55
Labour, day/ha						130.00
GM, exc labour				39,699		1,447.82
Returns to labour, per day				305		**11.1**
Crop yield, t/ha						3.66
Price, US$/t						437.64
Exchange rate (ER): Ethiopian Birr to US$ 2018	27					
Acres to ha	2.471					

Source: Author’s own

Table A2: Rice, Tanzania

Location	Kilombero Valley, Tanzania					
Date	2018					
	Per hectare					
			TSh	TSh/ha	US$	US$/ha
Value of production	Unit	Quantity	Unit price	Total	Unit price	Total
	t	3.30	600,000	1,980,000	261	860.87
Total revenues				**1,980,000**		**861**
Operating costs						
Input costs						
Seed	kg	14.6	750	10,950	0.3	4.76
Fertiliser	kg	8.09	1,400	11,326	0.6	4.92
Other inputs				50,000		21.74
Sub-total input costs				**72,276**		**31**
Labour costs						
Ox-ploughing	day			0		-
Land prep using hoe	day			0		-
Sowing by hand	day			0		-
Weeding by hand	day			0		-
Harvesting by hand	day					-
Labour cost	day	185.00	6,900	1,276,500	3.0	555.00
Sub-total labour cost		**185.00**		**1,276,500**		**555.00**
Total operating cost				**1,348,776**		**586**
GM				**631,224**		**274**
Costs and returns ratio				1.47		1.47
Labour, day/ha						185.00
GM, exc labour				1,907,724		829.45
Returns to labour, per day				10,312		**4.5**
Crop yield, t/ha						3.30
Price, US$/t						260.87
ER: TSh to US$ 2018	2,300					
Acres to ha	2.471					

Source: Author's own

Table A3: Sunflower, Tanzania

Location	Singida, Tanzania					
Date	2017					
			TSh	TSh/ha	US$	US$/ha
Value of production	Unit	Quantity	Unit price	Total	Unit price	Total
	bags	24.71	60,000	1,482,600	27	673.91
Total revenues				**1,482,600**		**674**
Operating costs						
Input costs						
Seed	kg	6.18	923	5,702	0.42	2.59
Bags	pcs	24.71	2000	49,420	0.91	22.46
Sub-total input costs				**57,500**		**114**
Labour costs						
Land prep using hoe	day	20	5,000	100,000	2.27	45.45
Sowing by hand	day	20	5,000	100,000	2.27	45.45
Weeding by hand	day	14.17	5,000	70,833	2.27	32.20
Harvesting by hand	day	13	5,000	65,000	2.27	29.55
Sub-total labour cost		**67.17**		**335,833.33**		**152.65**
Total operating cost				**393,333**		**267**
GM				1,089,267		407
Costs and returns ratio				3.77		2.53
Labour, day/ha						67.17
GM, exc labour				1,425,100		
Returns to labour, per day				21,217		9.64
Crop yield, t/ha						1.61
Price, US$/t						419.58
ER: TSh to US$ 2017	2,200					
Acres to ha	2.471					

Source: Author's own

Table A4: Cocoa, Ghana

Key parameters per hectare
Inputs
Tools, e.g. machetes: US$20 a year
Cocoa seedlings, 1,300: @ US$0.09
Food crops seeds and planting material, first four years until cocoa matures: US$315 a year
Tree seedlings to plant for shade: US$27
Agro-chemicals: fertiliser, fungicide, insecticide: US$130 a year at first rising to US$192 a year at peak
Labour
To establish cocoa seedlings and plantains, 117 days
To plant food crops, 27 days a year, first four years
To harvest food crops, 95 days year, first four years
To weed, prune, apply chemicals to cocoa, 21 days a year
To harvest cocoa pods, break them, ferment and dry, 18 days year
Labour cost if hired by day: US$5.45 a day
Outputs
Food crops, first four years: US$2,790 a year
Cocoa beans, dried: starts in year five at 144kg, rising to 700kg at peak after 20 years
Price paid for dried beans: US$0.94/kg
Value of shade trees, harvested after 30 years: US$762
Time and discounting
Cocoa lasts 30 years before it needs to be replanted
Time discounted at 5% a year
Returns, discounted over 30 years
Annual equivalent input costs: US$245
Annual equivalent labour: 76 days
Annual equivalent labour costs: US$413
Annual equivalent returns: US$1,007
Equivalent return to labour: US$10.06 a day

Note: Annual equivalents computed by taking the amounts through time, discounting them at 5%, summing them, and dividing the sum by 30, the number of years for the analysis. Full calculation can be obtained from authors.

Source: Authors' own, using Nunoo (2015) data for inputs, cocoa yields, and food crop returns in first four years from surveyed farmers in Sefwi. All other data from interviews with informants in Juaboso, late 2019.

Table A5: Oil palm, Ghana

Key parameters per hectare
Inputs
Seedlings, 150/ha, at a cost of US$1/ha Fertiliser: neglible use for most farmers
Labour
To plant, 25 days To weed, prune trees and other maintenance, 10 days To harvest, four days starting in year three, rising to 12 days by year six Labour, if hired, US$5 a day
Outputs
Fresh fruit bunches, begins in year three at 4t, rising to 12t by year six Price paid for fruit: US$60/t
Time and discounting
Oil palm lasts 25 years before it needs replanting Time discounted at 5% a year
Returns, discounted over 30 years
Annual equivalent input costs: US$9.94 Annual equivalent labour: 20 days Annual equivalent labour costs: US$100 Annual equivalent returns: US$507 Equivalent return to labour: US$24.93 a day

Note: Annual equivalents computed by taking the amounts through time, discounting them at 5%, summing them, and dividing the sum by 30, the number of years for the analysis. Full calculation can be obtained from authors.

Source: Authors' own, using data from APRA surveys

Table A6: Maize, Zimbabwe

Location	Mvurwi					
Date	2016–2017					
	Per hectare					
			Z$	Z$/ha	US$	US$/ha
Value of production	Unit	Quantity	Unit price	Total	Unit price	Total
Maize	t	3.5	390	1,365	390	1,365.00
Total revenues				**1,365**		**1,365**
Operating costs						
Input costs						
Seed	kg/ha	25	3.00	75.0	3.00	75.00
Fertiliser	kg/ha	385	0.78	300.3	0.78	300.30
Sub-total input costs				**375**		**375**
Labour costs						
Hire Ox ploughing	cost/ha	1	30	30.0	30	30.00
Labour	day	51.0	3.50	178.5	3.50	178.50
Sub-total labour cost				**208.5**		**208.5**
Total operating cost				**584**		**584**
GM				**781**		**781**
Costs and returns ratio				6.55		6.55
Labour, day/ha						51.00
GM, exc labour				960		959.70
Returns to labour, per day				18.82		**18.82**
Crop yield, t/ha						3.50
Price, US$/t						390.00
ER: Z$ to US$ Dec 2016	1.00					
Acres to ha	2.471					

Source: Author's own

Table A7: Tobacco, Zimbabwe

Location	Mvurwi					
Date	2016–2017					
	Per hectare					
			Z$	Z$/ha	US$	US$/ha
Value of production	Unit	Quantity	Unit price	Total	Unit price	Total
Tobacco	t	1.05	2,960	3,108	2,960	3,108
Total revenues				**3,108**		**3,108**
Operating costs						
Input costs						
Seed	kg/ha	25	3	75	3	75
Fertiliser	kg/ha	400	0.8	320	0.8	320
Chemicals				138.2		138.2
Packaging				174.0		174.0
Coal for curing	t/ha	1	145	145	145	145
Sub-total input costs				**777**		**777**
Labour costs						
All labour	Day	365	3.5	1,278	3.5	1277.5
Sub-total labour cost		**-**		**1,277.5**		**1,277.5**
Total operating cost				**2,055**		**2,055**
GM				**1,053**		**1,053**
Costs and returns ratio				2.43		2.43
Labour, day/ha						365.00
GM, exc labour				2,331		2,330.80
Returns to labour, per day				6.39		**6.39**
Crop yield, t/ha						1.05
Price, US$/t						2,960.00
ER: Z$ to US$ Dec 2016	1					
Acres to ha	2.471					

Source: Author's own

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