«By the pricking of their thumbs»: farmers' income dynamics towards sustainable development in rural Ethiopia

«Levantando los pulgares»: la dinámica de ingresos de los agricultores hacia el desarrollo sostenible en la Etiopía rural

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Abstract

International cooperation priorities and Sustainable Development Goals agree on the linkage between agriculture and economics in developing countries' progress towards sustainability. In rural Ethiopia, agriculture is the major source of income and livelihood. In this study, it is aimed to analyse the association between farmers' experience, education, gender, cultivation of crop diversity, access to various financial resources and income levels among different villages. The methodology adopted is action research, performed during various research stays in rural Ethiopia, and using both qualitative and quantitative surveys. The quantitative results were analysed through multivariate statistical analysis. Interesting results emerge; for example, farmers from rural villages that have been using wells previously donated by the non-profit organization (NPO) show various positive impacts. They attend continuous training in agriculture, nutrition, and economics; they have more crop diversification, and they use varied financial resources. All these factors, as well as socio-demographic variables, link farmers' income levels to villages' improvement and empowerment, creating significant challenges for institutional design of alternative policies to maximize farmers' livelihood, sustainability and socioeconomic development in Third World countries. The article adds to the very small body of research, particularly of quantitative analysis, on factors associated with farmers' income in Africa based on primary data.

Keywords: agriculture, farmers' income, action research, sustainability, Ethiopia.

Resumen

Las prioridades de cooperación internacional y los objetivos de desarrollo sostenible coinciden en el vínculo entre la agricultura y la economía en el progreso de los países en desarrollo hacia la sostenibilidad. En las zonas rurales de Etiopía, la agricultura es la principal fuente de ingresos y medios de vida. En este estudio, se pretende analizar la asociación entre la experiencia de los agricultores, la educación, el género, el cultivo de la diversidad de cultivos, el acceso a diversos recursos financieros y los niveles de ingresos entre las diferentes aldeas. La metodología adoptada es la investigación-acción, realizada durante varias estancias de investigación en zonas rurales de Etiopía, y utilizando encuestas cualitativas y cuantitativas. Los resultados cuantitativos se analizaron mediante análisis estadístico multivariante. Surgen resultados interesados; por ejemplo, los agricultores de las aldeas rurales que han estado utilizando pozos previamente donados por organizaciones sin ánimo de lucro (OSAL) muestran varios impactos positivos. Asisten a capacitación continua en agricultura, nutrición y economía; tienen más diversificación de cultivos, y utilizan recursos financieros variados. Todos estos factores, así como las variables sociodemográficas, vinculan los niveles de ingresos de los agricultores con la mejora y el empoderamiento de las aldeas, lo que crea desafíos significativos para el diseño institucional de políticas alternativas para maximizar la subsistencia, la sostenibilidad y el desarrollo socioeconómico de los agricultores en los países del Tercer Mundo. El artículo se suma al muy pequeño cuerpo de investigación, particularmente de análisis cuantitativo, sobre factores asociados con los ingresos de los agricultores en África basados en datos primarios.

Palabras clave: agricultura, ingresos de los agricultores, investigación-acción, sustentatibilidad, Etiopía.

1
Introduction

The international cooperation priorities and Sustainable Development Goals agree on the linkage between agriculture, income and productivity in developing countries' progress towards sustainability. The Sustainable Development Goals in Agenda 2030 represent a major multilateral effort to shift the world toward more sustainable, and resilient pathways, while also considering the needs of developing countries (Goyannes *et al.* 2018). This study focuses on Ethiopia, Africa's oldest independent country and its second largest in population. Although Ethiopia has suffered periodic drought and famine, its economy has experienced slow but increasing growth over the past decade. The country has also achieved more political stability under the current Prime Minister, Abiy Ahmed Ali, who received the Peace Nobel Prize in 2019. At present, however, it is suffering the initial effects of quarantine due to the COVID-19 crisis.

In rural Ethiopia, agriculture is the major source of income and livelihood. Ethiopia's government has made significant efforts in public investment to stimulate the growth of agriculture to accelerate the country's economic transformation (MOFED 2015). Public investments have not achieved the intended objectives, however, and rapid population growth is diminishing investments made in the rural sector.

Although African agriculture is dominated by small land holders, government policies are not geared to the needs of these properties. It is important that interventions ensure food and nutrition security to produce significant increases in income and economic growth for all farms as needed (Gassner *et al.* 2019). Agriculture in Africa is expected to meet the dual objectives of providing food and helping people to escape poverty. Since African agriculture is dominated by smallholdings, donors generally direct their agricultural support to the smallholder sector. The expectation is that closing the gap between actual and potential yields will enable smallholders to grow sufficient crops to feed their families while also producing a surplus to sell, thus meeting food security needs and generating income to move them out of poverty. Yet in practice, this is often impossible. While existing technologies can raise smallholders' yields three or four times, even under rainfed conditions, the amount that can be grown on the small plots of land available is limited. Per capita income from agriculture is insufficient to raise people's income above the World Bank's current definition of the poverty line, US $1.90 per day. We believe that diverse farmer typologies explain the large differences between investment incentives and the capability of individual farming households to benefit from field-level technologies aimed at increasing farm productivity. We argue for more differentiated policies for agricultural development in Africa and suggest that policymakers should tailor interventions

much more closely to the heterogeneity of farms. It is important to understand where and for whom agriculture aims primarily to ensure food and nutritional security, and where and for whom the potential exists for significant increase in income to spur wider economic growth. We must recognize the distinctness of these targets and underlying target groups, and work towards solutions that address their underlying needs (Gassner *et al.* 2019).

Another issue to be addressed is gender. Research conducted on labour-intensive production (*e.g.,* tea, coffee, and tobacco) indicates that the gendered division of labour and gendered relations of production play an essential role in the adoption of new production systems and their integration into agricultural progress (Husain *et al.* 2010, Fafchamps *et al.* 2014, Palacios-López *et al.* 2016). In line with such research, this article aims to discover whether there are gender differences also play a role between the farms studied.

Our study aims to demonstrate how farmers' experience, education, gender, cultivation of crop diversity, access to different financial resources and income levels are linked to improvement and empowerment of rural villages. This research is in line with Urquía-Grande *et al.* (2018), which demonstrated that training farmers was linked to improvements in crop cultivation, nourishment, and management that contributed to eradication of poverty and development of better standards of living. Their study showed that the introduction of certain crops (grain, different vegetables, etc.), among other variables, improved the standard of nourishment, enabling fulfilment of basic needs and the capacity to generate income. Based on these results, rural villages are empowered when their farmers improve their means of livelihood, and quality of life, participate actively in their jobs and make decisions to maximize both of these activities, with the support of the public administration.

The methodology followed is case study exploratory action-research, through both qualitative (to observe the pricking of their thumbs), and quantitative surveys. This methodology gives us a deeper understanding of the situation in rural Ethiopia, including «grass-roots» experience, a necessary supplement to academic research. The methodology is applied to an especially poor area, where a small NPO, Missionary Community St. Paul Apostle (MCSPA), has been working for more than twenty years. The field research consisted of analysing 214 smallholder farmers' economic situation in the Woreda area. Six villages were chosen, in which the NPO had already built and donated wells for the farmers and created child nutrition centres. The NPO regularly builds and donates wells for farmers and starts training programs in both agriculture and nutrition —basically on how to create small farms, cultivate several different vegetables and introduce these new vegetables into family diets (Garayalde et al. 2019, Urquía-Grande *et al.* 2018, Urquía-Grande & Rubio-Alcocer 2015)—. Prior to our study, the NPO had already achieved significant results; for example, rural villages that already used wells donated by the NPO attended the

continuous training provided, had more crop diversification on farms and used some financial resources —all results associated with the farmers' income levels—. Yet these results differed among villages. In our study, it is showed significant differences between urban villages and more rural ones, as well as gender-based differences in farmers' income levels. Our analysis of development cooperation implemented by this Ethiopian NPO shows that it is difficult to plan interventions at micro-economic level that can change Ethiopia's currently complex conditions and different commitments and cultures (Urquía-Grande & Del Campo 2017), as government support is needed, among other variables. Complexities of the Ethiopian situation that cannot be controlled include corruption, violent protests, disease, heat, and drought. In addition, the crisis of the pandemic is further disrupting life in Ethiopia.

Research contributions for both researchers and practitioners include establishment of an interrelation between infrastructure donations and continuous training, that could impact on farmers' welfare positively through cultivation of more crops, improved agricultural practices, better family nutrition and higher income levels. Such improvements may enable farmers and their families to save or to invest in future agriculture assets.

2
State of the art

In line with the SDGs, agricultural economists and other development specialists agree that investing in agriculture is an effective strategy for reducing poverty, inequality and hunger in Third World countries, in line with Larson *et al.* (2014), and Lowder *et al.* (2016). Research on farm effectiveness, which mixes agriculture and economics, in a developing continent such as Africa, where agriculture is a basic livelihood, is abundant but diversified along various lines (Gassner *et al.* 2019).

The Planning and Development Commission of Ethiopia (PDC 2019) considers Ethiopia as a country ravaged by poverty. The Household Income and Consumption Expenditure Survey (HICES) estimated the poverty headcount index (which measures proportion of the population below the poverty line in Ethiopia) to be 23.5 % in 2015/2016, with marked differences between urban (14.8 %) and rural (25.6 %) areas of the country. This Commission also shows Ethiopia's improvement in recent years, registering a reduction in people living below the poverty level.

The diversity of farm characteristics in the agricultural sector creates significant challenges for policy design and development aimed at maximizing global food and nutrition security, secure livelihood, environmental sustainability, and socio-economic develop-

ment (FAO 2014, Smith & Haddad 2015). Recent policy debates at international and regional levels have shifted from viewing smallholders and farmers as part of the hunger problem to making them the focus of its solution (Da Silva 2014, Abro *et al.* 2014, McIntyre *et al.* 2009).

Authors such as Alemu (2010), Geda *et al.* (2009), and Irz *et al.* (2001) examine the linkages between agricultural productivity and poverty in Ethiopia (Emran & Shilpib 2017). Other researchers, such as Abro *et al.* (2014), propose an agricultural productivity growth model that protects assets, and enhances market access for rural households in Ethiopia.

One line of research identifies a scarcity of farmland, even though large parts of Sub-Saharan Africa (SSA) can be land-abundant, due to growth of a larger proportion of the continent's population (Headey & Jayne 2014). Farmland is particularly critical in densely populated rural areas where off-farm employment opportunities are limited and continued dependence on traditional agriculture cannot sustain people's livelihood. Regardless of how effectively farmers use the land, they have little pressure to invest in specialization, accumulation and innovation to remain competitive and avoid losing their land (Carlson 2018). Research shows an inverse relationship between farm size and land productivity in SSA, and Holden and Otsuka (2014) have analysed the implications of this relationship for efficiency and equity. Our paper investigates the different types of villages —rural vs. urban (Urquía-Grande *et al.* 2017)— to determine which factors impact villages' crop cultivation, farming practices, and income levels.

Another research line, involving agriculture and economic analyses, determines whether farming experience enhances or discourages adoption of agricultural technology (Knowler & Bradshaw 2007). Answers are essential for policy makers, especially answers promoting adoption of agricultural technologies and participation in field farmer training programs (Duveskog *et al.* 2011, Urquía-Grande *et al.* 2018). As farmers accumulate experience and increase their income level over time, they gradually switch from traditional agricultural technologies to improved technologies, since they observe the latter's performance and learn by doing (Arrow 1962, Dosi 1982, Feder *et al.* 1985).

Still other research analyses crop diversity, linking agriculture and economics. Factors such as farmers' preferences, incentives and knowledge management practices determine the possibility of cultivating a greater variety of crops (Zimmerer 2010, Bellon *et al.* 2015). In the long term, these improvements should translate into better family welfare, but managing crop diversity on farms can be labour-intensive (Isakson *et al.* 2008, Rana & Garforth 2007, Zimmerer 1991).

From a macroeconomic perspective, empirical studies establish a correlation between agriculture, and economic growth but do not demonstrate causation in either direction (Datt & Ravallion 1992, 1998; Timmer & Akkus 2008; Christiaensen & Demery 2007; Loayza & Raddatz 2010). Public investments have not achieved the intended objectives, and rapid population growth may be leading to decreased investment in the rural sector. Furthermore, there is little empirical evidence that agricultural productivity is reducing poverty at household level.

We therefore formulate the following research question:

RQ1: What factors are associated with farmers' income dynamics?

From a micro-economic view, researchers have analysed the impact of micro-credits to farmers (Afrane 1997), in areas where not many farmers access micro-finance products (Karlan & Appel 2011; Armendáriz & Morduch 2010). Micro-finance experiments can also be performed in rural areas (Banerjee *et al.* 2015). Farmers' risk aversion is a minor issue linked to availability of financial resources. Although farmers in developing countries are generally thought to be risk averse, little is known about their actual risk preferences (De Brauw & Eozenou 2011). Using an elicitation approach to analyse a sample of Rwandan rural households, Ayalew *et al.* (2014) assess empirically the extent, nature and impact of credit rationing in the semi-formal sector, using endogenous sample separation between credit-constrained and unconstrained households. Their main results suggest that access to information has a major impact, reducing the incidence of credit constraints in the semi-formal credit sector. This reasoning leads us to define the second research question:

RQ2: Do differences in villages lead to differences in farmers' income levels?

Finally, research on gender inequality in the context of developing countries is frequently performed as tangential to development-related issues. The relationship between labour and gender relations at household level is generally neglected, and few studies analyse labour from an explicitly gendered perspective. Arturo *et al.* (2014) and Kinkingninhoun-Medagbe *et al.* (2010) use decomposition methods to analyse whether gender disparity explains differences in productivity due to differential access to productive inputs, technology, training, or individual characteristics of land managers. Such questions are particularly important with regard to labour-intensive crops, where gendered division of labour and gendered relations of production play an essential role in adoption of new production systems and their integration into farming progress (Palacios-López *et al.* 2016, Björkman-Nyqvist 2013, Mottaleb *et al.* 2015, Von Bülow & Sorensen 1993). Mbilinyi's (1988) investigation of women's role in farming in East Africa constitutes an exception but does not reach conclusive results. Glover (1987) addresses the

impact of farming on subsistence cropping, labour and processes of socio-economic differentiation. Imai *et al.* (2014) link women's empowerment through agriculture to children's better nourishment and education.

Based on the state of the art revealed in the literature review, we formulate the final research question:

RQ2a: Does gender explain some differences in farmers' income levels?

3
Sample description and instrument

In this study, it is used a case-study-based empirical «grass-roots» methodology. Thanks to a competitive university research project for development, the researchers made annual journeys to the Ethiopian villages where the NPO MCSPA worked. With the help of local translators, they surveyed farmers personally to perceive their «pricking of their thumbs». It is difficult to assess small NPOs' impact at micro-economic level, due to practical difficulties of measurement and theoretical shortcomings in methodology in this complex context.

The information was collected from the farmers' data recorded over a year, including one rainy season and one dry season, during which the farmers had harvested either once or twice. The NPO was based in Muketuri, the capital of the Woreda area, a village within an approximately 80 km-radius of Ethiopia's capital, Addis Ababa. The sample consisted of 214 farmers from six villages in the Woreda area: Muketuri, Gimbichu, Igu-Kura, Yate, Rob-Gebeya, and Mechela. In this region, MCSPA has created three nutrition centres for children of three-six years of age, built approximately 80 wells for these villages and trained farmers continuously in best practices in agriculture and women in how to nourish their families properly (Urquía-Grande & Del Campo 2017, Urquía-Grande *et al.* 2018). The authors administered the surveys in the six villages, characterized as follows. Firstly, Muketuri is the most urban village, located 78 km northwest of Addis Ababa, and connected to the capital city by a road. Its height above sea level is 2,622 metres, and it forms part of the region of North Shoa, whose population belongs mainly to the Oromo ethnic group. Secondly, Gimbichu, 79 km from Addis Ababa, is located on the Oromia region of Ethiopia. Its administrative centre is Chefe Donsa. Third, Igu-Kura is a tiny village located 17 km from Muketuri, where the NPO built a dam on the small river to provide the village with easy access to clean water. Fourth, Yate is the most rural village, with no recorded geographic information. Access to any type of transportation is especially difficult. The villagers must walk to other places or travel by donkey. Fifth,

Rob-Gebeya is located on the region of Oromiya, approximately 85 km from Addis Ababa. Finally, Mechela is situated in north-west Shewa, Oromiya.

A descriptive analysis was performed. Some averages and values for some variables were directly observable from the survey. Other values, such as «farmer's experience», were analysed using indicators, since farmer's age can be an indicator of potential experience. The directly observable variables included farmers' education level and cultivation of crop variety, divided into grain, potatoes, vegetables, and other crops. The farmers were asked about the financial resources used —credit card, consumption credit card and mortgage (see Table 1)—. The credit card is considered as a suitable indicator of «income existence»; for example, Li *et al.* (2019) found an inverse relation of credit card availability to credit default, a relationship that cannot occur in absence of income so credit card availability is an indicator of stable personal income level.

Variable	Code	Type of variable	Possible values
Monthly income ($)	I_pm	Continuous	None
			≤ 50
			50 < x ≤ 100
			100 < x ≤ 200
			≥ 200
Gender	Gen	Dummy	0 = M; 1 = F
Villages	Vill	Gimbichu	1
		Muketuri	2
		Igu-Kura	3
		Rob-Gebeya	4
		Yate	5
		Mechela	6
Village level characteristics	Vill_lev	Dummy	0 = rural; 1 = urban
Village climate	Vill_clim	Dummy	0 = less-humid; 1 = more-humid
Level of education	L_educ	None	0
		Primary	1
		Secondary	2
		University	3
Farmers' experience	Exp_f	None	0
		< 20 years	1
		20-30 years	2
		30-40 years	3
		40-50 years	4
		> 50 years	5

Variable	Code	Type of variable	Possible values
Type of crops	C_c	Grain	0 = no; 1 = yes
	C_p	Potatoes	0 = no; 1 = yes
	C_v	Vegetables	0 = no; 1 = yes
	C_o	Other crops	0 = no; 1 = yes
Financial resources	FR_cc	Credit card	0 = no; 1 = yes
	FR_Coc	Consumption credit	0 = no; 1 = yes
	FR_m	Mortgage	0 = no; 1 = yes
Valid N (listwise) = 214			

Table 1
Sample variables

The survey was designed to measure different types of variables. The variable «Monthly income» (I_pm) used a scale from 0-4, where 0 indicated no income; 1, less than 50 birrs; 2, 50-100 birrs; 3, 100-200 birrs, and 4, more than 200 birrs. The variable «Farmer's experience» (exp_f) was also an ordinal variable ranging from 0 to 3, where 0 indicated no experience; 1, 1-10 years; 2, 11-20 years, and 3, more than 20 years of experience. The variable «Level of Education» (l_educ) was another ordinal variable and ranged from 0 to 3, where 0 indicated no education; 1, primary studies; 2, secondary studies, and 3, higher education. The variable «Villages» represented the 6 villages analysed —Gimbichu, Muketuri, Igu-Kura, Rob-Gebeya, Yate, and Mechela—. The village's development level was measured with a dummy variable of 0 for rural and 1 for urban. Village climate was also defined by a dummy variable, where 0 indicated less-humid and 1, more-humid climate. The survey divided crop cultivation by type of crop, using 4 categories based on the MCSPA members' recommendation: grain (C_c) (teff, the basic grain cultivated by Ethiopian farmers, with few nutrients and proteins), potatoes (C_p), vegetables (C_v), and other types of crops (C_o). Crops were measured by dummy variables, where 0 indicated that the farmer did not cultivate the crop and 1, that the farmer cultivated the crop. The variable «Financial Resources» was classified into three categories: having a credit card (FR_cc), using consumption credit (FR_Coc), and having a mortgage (FR_m). These variables were also dummies, where 0 indicated that farmers replied that they did not use or have the specific financial resource. Finally, the question on respondent's gender was also a dummy, where 0 and 1 indicated woman and man, respectively. We observed some homogeneity in farmers' cultivation of crops, but a high dispersion in farmers' experience, education level and income level, probably because of the villages' socio-demographic and land-type differences.

To deepen the analysis, we added Table 2, which shows descriptive statistics on farmers' crop cultivation, use of financial resources, experience and education level.

Variables	N	Minimum	Maximum	Mean	Std. Deviation
I_pm	214	0.0	4.0	2.103	1.6124
Gen	214	0.0	1.0	.500	.5012
Vill	214	1.0	6.0	3.234	1.8313
Village level characteristics	214	0	1	.28	.450
Village climate	214	0.00	1.00	.6449	.47968
L_educ	215	0.0	3.0	.479	.7962
Exp_f	214	0.0	5.0	2.935	1.4423
C_c	216	0.0	1.0	.676	.4691
C_p	216	0.0	1.0	.509	.5011
C_v	216	0.0	1.0	.681	.4673
C_o	216	0.0	1.0	.319	.4673
FR_cc	214	0.0	1.0	.206	.4051
FR_Coc	214	0.0	1.0	.196	.3981
FR_m	214	0.0	1.0	.140	.3480
Valid N (listwise)	214				

Table 2
Descriptive statistics

We observed that Muketuri is the village with the highest income per month, financial resource use and education level, whereas Gimbichu cultivates the most grain, as well as vegetables and other types of crops.

After collecting the data, we designed the database and performed different multivariate analyses using the statistical package SPSS 21. A multivariate backward step wise regression was also performed to detect the variables' association with farmers' income level dynamics (RQ1). ANOVA and Bonferroni tests were used to analyse the differences in farmers' income level (RQ2) among the villages. A Kruskal-Wallis test analysed differences in farmers' gender (RQ2a).

4
Results

To determine whether the farmers' income level differed among villages, we performed an ANOVA. The results in Table 3 show differences in income level by village. The six villages differ in various ways. Some are more rural (Gimbichu, Mechela, Rob-Gebeya, and Yate) and others more urban (Muketuri, and Igu-Kura). Some have a relatively well-developed transportation infrastructure (for example, Muketuri), whereas others can only be reached by foot, donkey or horse (for example, Yate). Since geographic complexity increases in the rainy season, the Bonferroni test was run to explain differences

in income level by village. Table 4 displays the results. We observe that the income level in Yate from that in the other villages, the most rural and least accessible village, is significantly different from the other villages. Its culture also differs from that of the other five villages (Urquía-Grande & Del Campo 2017). Muketuri, the most urban village and the village with easiest access both to the main road to Addis Ababa and to sanitary water from the Ethiopian government, also shows higher farmer income levels than other villages, due to alternative non-agricultural activities developed.

	(I) Vill	(J) Vill	Mean Difference (I-J)	Std. Error	Sig.
Bonferroni	Gimbichu	Muketuri	**−1.3658***	**.4328**	**.028**
		Igu-Kura	**1.1485***	**.3239**	**.007**
		Roc Gebeya	.7398	.2825	.142
		Yate	−.7348	.3506	.560
		Mechela	.6132	.3105	.744
	Muketuri	Gimbichu	**1.3658***	**.4328**	**.028**
		Igu-Kura	**2.5143***	**.4761**	**.000**
		Roc-Gebeya	**2.1056***	**.4490**	**.000**
		Yate	.6310	.4947	1.000
		Mechela	**1.9790***	**.4671**	**.001**
	Igukura	Gimbichu	**−1.1485***	**.3239**	**.007**
		Muketuri	**−2.5143***	**.4761**	**.000**
		RocGebeya	−.4087	.3452	1.000
		Yate	**−1.8833***	**.4028**	**.000**
		Mechela	−.5353	.3685	1.000
	Rob Gebeya	Gimbichu	−.7398	.2825	.142
		Muketuri	**−2.1056***	**.4490**	**.000**
		Igu-Kura	.4087	.3452	1.000
		Yate	**−1.4746***	**.3704**	**.001**
		Mechela	−.1266	.3327	1.000
	Yate	Gimbichu	.7348	.3506	.560
		Muketuri	−.6310	.4947	1.000
		Igu-Kura	**1.8833***	**.4028**	**.000**
		RocGebeya	**1.4746***	**.3704**	**.001**
		Mechela	**1.3480***	**.3922**	**.011**
	Mechela	Gimbichu	−.6132	.3105	.744
		Muketuri	**−1.9790***	**.4671**	**.001**
		Igu-Kura	.5353	.3685	1.000
		Roc-Gebeya	.1266	.3327	1.000
		Yate	**−1.3480***	**.3922**	**.011**
		Mechela	−.1266	.3479	1.000
	Yate	Gimbichu	.7348	.3349	.405
		Muketuri	−.6310	.3474	.703
		Igu-Kura	**1.8833***	**.4111**	**.000**
		Roc-Gebeya	**1.4746***	**.3850**	**.005**
		Mechela	**1.3480***	**.3726**	**.010**

Table 3
Differences among villages in farmers' income level

Furthermore, as the NPO directors insisted on the gender difference among farmers, the authors performed a Kruskal-Wallis test to detect differences in income level, village level characteristics, education level, farmers' experience, types of crops, and financial resources based on farmers' gender. Table 4 shows no gender-based differences except for income level.

Gen		N	Mean Rank	Chi-Square	Asymp. Sig.
I_pm	Man	107	115.59	3.928	.047
	Woman	107	99.41		
	Total	214			
Exp_f	Man	107	109.57	.253	.615
	Woman	107	105.43		
	Total	214			
C_c	Man	107	105.00	.532	.466
	Woman	107	110.00		
	Total	214			
C_p	Man	107	104.00	.912	.340
	Woman	107	111.00		
	Total	214			
C_v	Man	107	103.50	1.373	.241
	Woman	107	111.50		
	Total	214			
C_o	Man	107	104.00	1.043	.307
	Woman	107	111.00		
	Total	214			
FR_cc	Man	107	107.50	0.000	1.000
	Woman	107	107.50		
	Total	214			
FR_Coc	Man	107	107.50	0.000	1.000
	Woman	107	107.50		
	Total	214			
FR_m	Man	107	107.50	0.000	1.000
	Woman	107	107.50		
	Total	214			
L_educ	Man	107	112.41	1.929	.165
	Woman	107	102.59		
	Total	214			
Village level characteristics	Man	107	107.50	0.000	1.000
	Woman	107	107.50		
	Total	214			

Table 4
Differences by gender

Finally, to analyse the association of farmers' experience, education, gender, village level, village climate, crop variety and financial resource management with farmers' income level dynamics, we

used a backward step wise regression model. This model is represented by the equation:

$$I\_pm = \beta 0 + \beta 1\ Gen + \beta 2\ Exp\_f + \beta 3\ Vill\_lev + \beta 4\ Vill\text{-}clim + \beta 5\ L\_educ + \beta 6\ C\_c + \beta 7\ C\_p + \beta 8\ C\_v + \beta 9\ C\_o + \beta 10\ FR\_cc, + \beta 11\ FR\_Coc + \beta 12\ FR\_m + e$$

The results show that social characteristics such as gender, as well as experience and education levels, are related both to monthly income and to cultivation of grain, and other types of crops. The «Beta Coefficient» column in Table 5 shows that the β (beta) for farmer's experience is positive (0.226) and almost statistically significant (p = 0.001); the same is observed for farmers' education level (β = 0.221, p = 0.000). A positive beta value indicates that education and experience levels are positively associated with monthly income. We also find a positive association between farmers' income level and vegetables cultivated (β = 0.159, p = 0.028), and a negative association between farmer's monthly income and other types of crops cultivated (beta is negative; β = −0.160, p = 0.020). In addition, income level is associated positively with different types of financial resources (specifically, credit cards; β = 0.183, p = 0.041), and negatively with mortgage (β = −0.183, p = 0.042). Finally, differences in climate affect income level (β = 0.276, p = 0.000). Surprisingly, there is no association with type of village.

	Standardized Coefficients	**t**	**Sig.**	**Collinearity Statistics**	
	βeta			**Tolerance**	**VIF**
(Constant)		1.865	.064		
Gen	−.125	−2.101	.037	.988	1.013
Exp_f	.226	3.455	.001	.824	1.213
L_educ	.221	3.599	.000	.932	1.073
Village climate	.276	4.322	.000	.865	1.156
C_v	.159	2.208	.028	.679	1.474
C_o	−.160	−2.344	.020	.758	1.319
FR_cc	.183	2.055	.041	.442	2.263
FR_m	−.183	−2.043	.042	.439	2.278
R square = 0.279					
Total=213					

The variables included in the model are: Gen, Exp_f, L_educ, Vill, Vill_ lev, Vill_ clim, C_c, C_p, C_v, C_o, FR_cc, FR_Coc, and FR_m.

Table 5
Variables associated with farmers' income level

5
Discussion of the results

In line with Headey and Jayne (2014), and Urquía-Grande *et al.* (2017), the results on the income differences among farmers from different villages may be due to how rural or urban the village is. In this case specifically, Muketuri differs most from Gimbichu, Igu-Kura, Rob-Gebeya and Mechela. This finding is logical, because Muketuri is the capital of the Woreda area. The village has both better infrastructure connections with Addis Ababa and its own fountains, built by the Ethiopian government to give Muketuri's citizens' clean water to drink and cook. Muketuri thus has the highest average farmer income levels, use of financial resources and education level. The other villages find it especially difficult to access markets at which to sell excess crops due to minimal infrastructure connections. During the rainy season, most of these villages are completely isolated, and families must walk for miles to obtain water.

In line with Holden and Otsuka (2014), we highlight that farmers with small lands on which they cultivate several crops usually are the most efficient. This is the case in Muketuri, while Yate, Gimbichu and Mechela have extensive tracts of land and are less efficient. Most of these farms use their land to cultivate grain —teff, which has very few nutrients— and have no crop diversity. Surprisingly, the average data on crop cultivation show that Gimbichu has the highest level of crop cultivation, including teff cultivation. A very rural village with great tracts of land, Gimbichu has a group of farmers with exceptional farming techniques and productivity that serve as a benchmark for other villages.

In line with other researcher's results (Palacios-Lopez *et al.* 2016, Björkman-Nyqvist 2013, Headey & Jayne 2014, Mottaleb *et al.* 2015), we observe differences in income by gender (see Table 4). Palacios-Lopez *et al.* (2016) argue different reasons for fostering women's agricultural productivity, including women's empowerment, gender composition of the household and little systematic difference among countries in female labour provision across crops or agricultural activities. When asked about this result, the NPO members in our study agreed that this area showed gender differences in agriculture-related issues. Women responded that they work hard and they participate actively in training, although they sometimes respond that they have lower salaries (Table 4) or are unemployed because they work on their husband's land, a finding in line with Urquía-Grande and Del Campo (2017).

Finally, our results show that farmers' income varies with their experience. This finding reinforces similar results in Arrow (1962), Dosi (1982), and Feder *et al.* (1985). Interestingly, villages such as

Gimbichu or Rob-Gebeya, where farmers have extensive experience in agriculture, have higher income levels, in line with research by Blackmore *et al.* (2012) on action-oriented learning theories for change in agriculture and rural networks. These farmers could serve as a model for other villages. Farmers' education level is directly associated with their income level, as in Anderson and Tushman (1990), who affirm that, the higher the farmer's education, the higher the income level and the higher the number of agricultural innovations implemented. In our case, Muketuri, the most urban village and as such an exception among these six villages, has low levels of crop cultivation and the highest income and financial resource use levels. This is the case, however, because many of Muketuri's farmers have family members who are civil servants and provide a source of income, making Muketuri's income level less dependent on land cultivation.

In line with Zimmerer (2010) and Vigouroux *et al.* (2011), the link between farmers' crop cultivation and economic variables generally suggests that cultivation of vegetables and other crops influences farmers' income level. Interestingly, however, cultivation of other crops influences farmers' income level inversely. To explain this result, we must know which other crops the farmers had in mind when surveyed. Their responses excluded beetroot, carrots and onions. Even though these crops are commonly cultivated, the farmers did not mention them in this context, because they considered them as vegetables. The NPO directors corroborated our results, indicating that cultivation of vegetables (as opposed to other crops) does in fact influence farmers' income level.

As expected, use of a credit card is directly associated with farmers' income, in line with Karlan and Appel (2011) and Armendáriz and Morduch (2014), while we find no association of farmers' consumption credit with their monthly income. We might deduce an inverse link between farmers' use of mortgage and income levels, but this topic requires further analysis.

6
Conclusions

In line with the international cooperation priorities and Sustainable Development Goals (Numbers 1, 2, 6, and 15), in this paper, it is analysed the link between agriculture and farmers' household income in countries developing towards sustainability. Our results show an association of village climate, farmers' experience, education levels, cultivation of crop diversity, and financial resources with farmers' income dynamics. Thus, the article adds quantitative analysis of determinants of farmers' income in Africa based on primary data (by the pricking of their thumbs).

It also adds qualitative discussion of the results from the NPO Ethiopian agriculture responsible.

This study focuses on rural Ethiopia, a country that has suffered periodic drought and famine, whose economy has experienced slow but increasing growth over the past decade, and where agriculture is the major source of income and livelihood. In line with Abro *et al.* (2014), we believe that a combined effort is needed to design policy interventions in this country. Such interventions should not only increase agricultural productivity but also protect rural households by enhancing access to the nearest towns for school, education and health centres to empower farmers. Agriculture is important, but agriculture alone does not reduce poverty. Reducing poverty requires economic and social aid. Further analysis is necessary to make more concrete claims about the impact that growth in farm productivity has on poverty. Our study has focused only on the direct effects of increasing farm productivity. Furthermore, little empirical evidence exists on the extent to which agricultural improvement can reduce poverty at microeconomic level through action research. Ethiopia's complexities currently include political instability, corruption, violent protests, disease, heat, and drought. It is difficult to assess small NPOs' impact at microeconomic level, due to practical difficulties in measurement and theoretical shortcomings in methodology considering the complex context. Despite these complications, we demonstrate the differences in income levels of the farmers from different villages are based on whether the village is rural or urban, as well as on cultural differences (Urquía-Grande & Del Campo 2017), low education level (Urquía-Grande *et al.* 2018), differences in crop diversity (Urquía-Grande & Rubio-Alcocer 2015), and climate.

This article contributes to the line of research on improvements in rural areas mentioned in the report prepared by the Planning and Development Committee in 2018. The sample is small, however, and does not include all villages in the area. The participating NPO and the research group are working to increase the number of participating villages to improve the data collected in the survey.

Further research must be performed to determine what crop variety is optimal for achieving better household nutrition and increasing farmers' income level to reduce poverty. Sustained increase in agricultural productivity may also have a substantial indirect effect (via prices and wages in the market) on the farmers' household assets and income —a topic also requiring further research—. In line with Banerjee *et al.* (2015), a random control trial is being designed to compare these villages to other villages in the region that have not received a donated well or training in agriculture, nutrition or economics.

7
Bibliography

ABRO ZA, ALEMU BA, HANJRA & MUNIR A (2014). Policies for agricultural productivity growth and poverty reduction in rural Ethiopia. World Development 59, 461-474. http://dx.doi.org/10.1016/j.worlddev.2014.01.033, accessed August 15, 2020.

AFRANE S (1997). Impact Assessment of Micro-Finance interventions in Ghana and South Africa. Journal of Micro-Finance 4(1):38-58.

ALEMU BA (2010). Rural poverty, land management practices and agricultural productivity in Ethiopia (Ph.D. dissertation). Justus-Liebig University of Giessen, Germany.

ANDERSON P, TUSHMAN M (1990). Technological Discontinuities and Dominant Designs: A Cyclical Model of Technological Change. Administrative Science Quarterly 35(4):604-633.

ARMENDÁRIZ B, MORDUCH J (2010). The Economics of Microfinance, Second edition. MIT Press, Cambridge (Massachusetts).

ARROW KJ (1962). The Economic Implications of Learning by Doing Author(s): Kenneth. The Review of Economic Studies 29(3):155-173.

ARTURO A, ELIANA C, MARKUS G, TALIP K, GBEMISOLA O (2014). Decomposition of gender differentials in agricultural productivity in Ethiopia. Policy Research working paper; no. WPS 6764. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/726871468252571077/Decomposition-of-gender-differentials-in-agricultural-productivity-in-Ethiopia, accessed August 15, 2020.

AYALEW D, DEININGER K, DUPONCHEL M (2014). Credit Constraints, Agricultural Productivity, and Rural Nonfarm Participation: Evidence from Rwanda. Policy Research Working Paper; No. 6769. World Bank, Washington, DC. World Bank. https://openknowledge.worldbank.org/handle/10986/17305, accessed August 15, 2020. License: CC BY 3.0 IGO.

AYALEW ABRO Z, ALAMIREWALEMU A, HANJRA M (2014). Policies for Agricultural Productivity Growth and Poverty Reduction in Rural Ethiopia. World Development. 59 (July 2014) 461-474. https://doi.org/10.1016/j.worlddev.2014.01.033, accessed August 15, 2020.

BANERJEE A, DUFLO E, GLENNERSTER R, KINNAN C (2015). The Miracle of Microfinance? Evidence from a Randomized Evaluation. American Economic Journal: Applied Economics V. 7(1):22-53

BELLON MR, GOTOR E, CARACIOLLO F (2015). Assessing the Effectiveness of Projects Supporting on-farm Conservation of Native Crops: Evidence from the High Andes of South America. World Development 70:162-176.

BJÖRKMAN-NYQVIST M (2013). Income shocks and gender gaps in Education: Evidence from Uganda. Journal of Development Economics 105:237-253.

BLACKMORE C, CERF M, ISON R, PAINE M (2012). The role of action-oriented learning theories for change in agriculture and rural networks. In: Darnhofer I, Gibbon D, Dedieu B (eds.). Farming Systems Research into the 21st Century: The New Dynamic. Springer, Dordrecht.

CARLSON C (2018), Rethinking the agrarian question: Agriculture and underdevelopment in the Global South. Journal of Agrarian Change 18(4):703-721. https://doi.org/10.1111/joac.12258, accessed August 15, 2020.

CHRISTIAENSEN L, DEMERY L (2007). Agriculture and Poverty Reduction in Africa. The International Bank for Reconstruction and Development/The World Bank.

DA SILVA JG (2014). The Family Farming Revolution. An opinion article by FAO-Director General José Graziano da Silva.

DATT G, RAVALLION M (1992). Growth and Redistribution Components of Changes in Poverty Measures: A Decomposition with Applications to Brazil and India in the 1980s. Journal of Development Economics 38:275-295.

DATT G, RAVALLION M (1998). Farm productivity and rural poverty in India. Journal of Development Studies 34(4):62-85.

DE BRAUW A, EOZENOU P (2011). Measuring Risk Attitudes among Mozambican Farmers. Harvest Plus Working Paper. September.

DOSI G (1982). Technological paradigms and technological trajectories: A suggested interpretation of the determinants and directions of technical change. Research Policy 11(3):147-162.
DUVESKOG D, FRIIS-HANSEN E, TAYLOR EW (2011). Farmer Field School in rural Kenya: A transformative learning experience. Journal of Development Studies 47(10):1529-1544.
EMRAN S, SHILPIB F (2017). Agricultural Productivity, Hired Labor, Wages, and Poverty: Evidence from Bangladesh. World Development. https://doi.org/10.1016/j.worlddev.2016.12.009, accessed August 15, 2020.
FAFCHAMPS M, MCKENZIE D, QUINN S, WOODRUFF C (2014). Microenterprise growth and the flypaper effect: Evidence from a randomized experiment in Ghana. Journal of Development Economics 106:211-226.
FAO (2014). The state of food and agriculture 2014: Innovation in family farming. FAO, Rome.
FEDER G, JUST R, ZILBERMAN D (1985). Adoption of Agricultural Innovations in Developing Countries: A Survey. Economic Development and Cultural Change 33(2):255-298. https://doi.org/10.1086/451461, accessed August 15, 2020.
GARAYALDE ML, GONZÁLEZ S, MASCAREÑAS J (2019). «Project Finance» and economic development. A case study. REVESCO Revista de Estudios Cooperativos 131:32-47. https://doi.org/10.5209/REVE.64302, accessed August 15, 2020.
GASSNER A, HARRIS D, MAUSCH K, TERHEGGEN A, LOPES C, FINLAYSON RF, DOB P (2019). Poverty eradication and food security through agriculture in Africa: Rethinking objectives and entry points. Outlook on Agriculture 48(4):309-315.
GEDA A, SHIMELES A, WEEKS J (2009).Growth, poverty and inequality in Ethiopia: Which way for pro-poor growth? Journal of International Development 21(7): 947-970.
GIZ (2013a). Learning from evaluation. Bonn, and Eschborn.
GIZ (2013b). Measuring-Assessing-Making improvements. Bonn, and Eschborn.
GLOVER D (1987). Increasing the benefits to smallholders from contract farming: Problems for farmers' organizations and policy makers. World Development 15(4):441-448.
GOYANNES GUSMAO CAIADOA R, LEAL FILHOB W, GONÇALVES QUELHASA OL, DE MATTOS DL, LUCAS VEIGAS N (2018). A literature-based review on potentials and constraints in the implementation of the sustainable development goals. Journal of Cleaner Production 198:1276-1288. https://doi.org/10.1016/j.jclepro.2018.07.102, accessed August 15, 2020.
HEADEY D, JAYNE TS (2014). Adaptation to land constraints: Is Africa different? Food Policy 48:18-33.
HOLDEN ST, OTSUKA K (2014). The roles of land tenure reforms and land markets in the context of population growth and land use intensification in Africa. Food Policy 48:88-97.
HUSAIN Z, MUKHERJEE D, DUTTA M (2010). Self Help Groups and empowerment of women: Self-selection or actual benefits? Munich Personal RePEc Archive no. 20,765.
IMAI KS, ANNIM SK, KULKARNI VS, GAIHA R (2014). Women's empowerment and prevalence of stunted and underweight children in rural India. World Development 62:88-105.
IRZ X, LIN L, THIRTLE C, WIGGINS S (2001). Agricultural Productivity Growth and Poverty Alleviation. Development Policy Review 19:449-466. https://doi.org/10.1111/1467-7679.00144, accessed August 15, 2020.
ISAKSON M, YARBROUGH R, CHOTIROS N (2008). A finite element model for seafloor roughness scattering. In: Proceedings of the International Symposium on Underwater Reverberation and Clutter. NURC, La Spezia (Italy):173-180.
KARLAN D, APPEL J (2011). Microcredit in theory and practice: Using randomized credit scoring for impact evaluation. Science 332(6035):1278-1284.
KINKINGNINHOUN-MEDAGBE F, DIAGNE A, SIMTOWE F, ABGOH-NOAMESHIE A, ADEGBOLA P (2010). Gender Discrimination and Its Impact on Income, Productivity, and Technical Efficiency: Evidence from Benin. Agricultural and Human Values 27(1):57-69.
KNOWLER D, BRADSHAW B (2007). Farmers' adoption of conservation agriculture: A review and synthesis of recent research. Food Policy 32(1):25-48.

LARSON DF, OTSUKA K, MATSUMOTO T, KILIC T (2014). Should African rural development strategies depend on smallholder farms? An exploration of the inverse-productivity hypothesis. Agricultural Economics 43(3):355-367.
LI H, MAI L, ZHANG W, TIAN X (2019). Optimizing the credit term decisions in supply chain finance. Journal of Purchasing and Supply Management 25(2):146-156. https://doi.org/10.1016/j.pursup.2018.07.006, accessed August 15, 2020.
LOAYZA NV, RADDATZ C (2010). The composition of growth matters for poverty alleviation. Journal of Development Economics 93(1):137-151.
LOWDER SK, SKOET J, RANEY T (2016). The number, size and distribution of farms, smallholder farms and family farms worldwide. World Development 87:16-29.
MBILINYI M (1988), Agribusiness and Women Peasants in Tanzania. Development and Change 19:549-583. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-7660.1988.tb00313.x, accessed August 15, 2020.
MCINTYRE BD, HERREN HR, WAKHUNGU J, WATSON R (eds.) (2009). International assessment of agricultural knowledge, science and technology for development (IAASTD): Global report. Island Press, Washington, DC.
MOFED (2015). Annual Report on Performance. Fiscal Year 2015-2016. Ministry of Finance & Economic Development, Ethiopia.
MOTTALEB KA, MOHANTY S, MISHRA AK (2015). Intra-Household resource allocation under negative income shock: A natural experiment. World Development 66:557-571.
MUKASA A, SALAMI A (2016). Sources of gender productivity differentials in Africa: A cross-country comparison Chief Economist Complex. AEB, vol. 7, issue 4.
PALACIOS-LOPEZ A, LUC CHRISTIAENSEN L, KILIC T (2016). How much of the labor in African agriculture is provided by women? Food Policy 67:52-63.
PÉREZ-ESTÉBANEZ R, URQUÍA-GRANDE E, RAUTIAINEN A (2018). Technological and Economic Factors Determining ICT Level: Evidence from Rural Micro-Businesses in Democratic Republic of Congo: Factors determining ICT level in rural micro-businesses in RDC. Journal of International Development 30(1):118-133.
PLANNING AND DEVELOPMENT COMMISSION (PDC, 2019).
RANA R, GARFORTH C (2007). Influence of socio-economic and cultural factors in rice varietal diversity management on-farm in Nepal. Agriculture and Human Values 24(4):461-472.
SMITH LC, HADDAD L (2015). Reducing child undernutrition: Past drivers and priorities for the post-MDG Era. World Development 68:180-204.
SNAPP SS, BEZNER KERR R, SMITH A, OLLENBURGER M, MHANGO W, SHUMBA L (2013). Modeling and participatory, farmer-led approaches to food security in a changing world: A case study from Malawi. Science et changements planetaires/Sécheresse 24(4):350-358.
SUMBERG J, THOMPSON J, WOODHOUSE P (2012). Why agronomy in the developing world has become contentious. Agriculture and Human Values 30(1):71-83.
TIMMER P, AKKUS S (2008). The Structural Transformation as a Pathway out of Poverty: Analytics, Empirics and Politics. Working Paper Number 150. Center Global for Development.
UDO VE, JENSSON RM (2009). Bridging the gap for global sustainable development. A quantitative analysis. Journal of Environmental Management 30(12):3700-3707.
URQUÍA-GRANDE E, DEL CAMPO C (2017). Socio-Economic factors determining the commitment to participate in an agricultural development Project in rural Ethiopia, Iberoamerican Journal of Development Studies 6(2):4-27.
URQUÍA-GRANDE E, RUBIO-ALCOCER A (2015). Agricultural infrastructure donation project: Empirical evidence in rural Ethiopia. Agricultural Water Management 158:245-254.
URQUÍA-GRANDE E, RAUTIAINEN A, PÉREZ-ESTÉBANEZ R (2017). The effectiveness of rural versus urban nonprofit organisations in the Democratic Republic of Congo. Third World Quarterly 38(9):2129-2142. https://www.tandfonline.com/doi/full/10.1080/01436597.2017.1322464, accessed August 15, 2020.
URQUÍA-GRANDE E, CANO-MONTERO E, PÉREZ-ESTÉBANEZ R, CHAMIZO-GONZÁLEZ J (2018). Agriculture, Nutrition and Economics through Training: a virtuous cycle in rural Ethiopia. Land Use Policy 79:709-716.

VIGOUROUX Y, BARNAUD A, SCARCELLI N, THUILLET A-C (2011). Biodiversity, evolution and adaptation of cultivated crops. Comptes Rendus Biologies 334(5-6):450-457.
VON BÜLOW D, SORENSEN A (1993). Gender and Contract-Farming Tea Outgrower Schemes in Kenya. Review of African Political Economy 56:38-52.
ZIMMERER K (1991). Rural grassroots development. Conference of Latin Americanist Geographers 277-281.
ZIMMERER K (2010). Biological diversity in agriculture and global change. Annual Review of Environment and Resources 35:137-166.