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Cooperative and Contract Farming for Export Crops in the Guatemala Highlands

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Authors' contributions

This work was carried out in collaboration between both authors. Author MB was responsible for the field work, data collection and elaboration. Author FMS supervised the research design and the data analysis. Both authors were jointly responsible for the literature search, questionnaire design and text elaboration.

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ABSTRACT

This research describes two types of smallholders' organizations (cooperative and pyramidal contract farming) which produce for an export oriented processor. The research took place in the Departments of Chimaltenango and Sololà, Guatemala. The survey was designed in 2011, with visits to the area, focus groups and semi-structured interviews with farmers and key witnesses. The first version of the questionnaire was tested in June 2012. After modifications, the interviews were by master students of a local university, with a sample size of 170 families; codification and data entry took place in August 2012; statistical analysis was realized with SAS version 9.1.
The farmers belonging to the two modalities do not show meaningful differences, with regard to age, household size, land availability, price determination, and access to credit. For other variables, the two groups are less similar: farmers in the pyramidal contract modality have more years at school, less diversified farming system, more formal and individual contracts, are paid faster, declare to have suffered hunger less frequently and reveal a higher willingness to change for new

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crops. The latent class regression analysis has determined two clusters: the Small Diversified Collective, which fits 99.95% of the cooperative members and only 0.05% with contract farmers, and the Medium Homogeneous Individual, 83.96% with contract farmers and 16.04% with cooperative members.
Both the cooperative modality and the pyramidal contract farming approach contribute to solve some of the problems of these very tiny smallholders in Guatemala. On the other hand, due to their extremely small land size, poverty and risk of hunger and malnutrition cannot be totally eliminated. In many cases, the lack of trust towards the buyers and the belief to be price takers indicate that these smallholders still feel to be exploited and that their efforts are not properly recognized.

Keywords: Value chain approach; latent class analysis; market led development.

1. INTRODUCTION

After the Millennium Development Goals [1], which had to be achieved by 2015, the new Sustainable Development Goals 2030 [2], still call for the elimination of poverty and for the eradication of hunger. For both goals, to be achieved, the situation of agriculture and rural areas in most developing countries must be considered, with a specific focus on the very tiny smallholders, who manage extremely small farm areas and have to feed very large families [3].

On the other hand, subsistence agriculture cannot be the answer for poverty eradication. Consequently a new market led but fair approach is demanded. The markets for agricultural commodities are evolving globally, with the consolidation of modern market channels, for both domestic and export markets. National and international traders, as well as food processors and retailers demand at the same time huge quantities with well-defined characteristics. These changes represent a great opportunity, but also a very hard challenge for smallholder farmers [4], who can supply consistent volumes of higher quality products, at better or stable prices, to more demanding buyers.

The next question is how to exploit these market opportunities for improved rural livelihoods by smallholders and rural communities [5]. Driven by trade liberalization and by the new technologies in food processing and retailing, markets are more concentrated, than they used to be, at all levels (wholesale, retail and intermediary traders). New large traders are defining stricter standards in terms of production methods, product qualities, and modalities for delivery.

Procurement models are being adapted to these new requirements. Such new patterns of supply and marketing guide the smallholders towards different modalities of aggregation, because the individual small producer alone cannot afford to invest in the new equipment, production inputs and handling methods needed to meet such new demands. Furthermore, the large traders cannot deal with thousands of unorganized tiny suppliers and prefer to interact with a few counterpart, which can guarantee the regularity of the supply and the respect of standards.

The only solutions appear to be farmers' organization, meaning that smallholders must organize themselves (and should be supported in this process), in order to be able to dialogue with large traders. On the other hand, there are several types of farmers' organizations (unions, cooperatives, marketing boards, product associations, etc.) and several types of feasible contracts between the producers and the buyers [6,7].

The study presented in this article has been elaborated within a much larger research, that has already generated a first article [8] about the climate change resilience of the very tiny smallholders who live on the Highlands of Guatemala, where several market driven projects have been implemented in the recent years. This second paper focuses on two different forms of aggregation: the multi-purpose cooperatives and a pyramidal contract farming organization, with Lead Farmers, to verify their impact on the smallholders' livelihood. The producers working within these two modalities nowadays supply fresh products to the same buyer, a very large export oriented firm.

As a matter of fact, many community-based organizations initially were not market oriented and this might determine important differences with the contract farming aggregations, whose establishment has been shaped, since their very beginning, by private investments and market opportunities.

2. CASE STUDY

The study area is located on the Highlands of Guatemala, whose socio-economic characteristics are described in our previous paper [8] and where the public extension service was suspended in 1989 [9]. For more than 25 years, farmers had to rely on themselves and, in the best cases, on their associations and cooperatives, sometimes supported by foreign Non-Governmental Organizations. In other cases, the technical advice was provided by private operators, as the case studied in this paper.

CCCC (the real name cannot be revealed) is an export oriented company operating in Guatemala, primarily supplying the United States market and secondarily Japan and the European Union. Most relevant items for iced export include broccoli, melons, okra, zucchini, and sugar snap peas. This firm works with very small growers, principally in the Guatemalan Highlands of Chimaltenango. With an average annual output of over 6,800 tons, broccoli represent for CCCC the most relevant commodity, both in terms of volume and value.

Table 1. CCCC basic data (2010)

Processed vegetables (T)	**68,000**
No. of employees during processing	530
No. of Technical Advisors (TA)	11
No. of Lead Farmers (LF)	217
No. of smallholders linked with LFs	3,212
No. of smallholders per LF	15
No. of smallholders per TA	292
No. of Lead Farmers per TA	19.7

To ensure a regular supply to its central processing plant, CCCC uses a network of actors and services, which can be described as a) producers' cooperatives, and b) pyramidal contract farming.

For the first typology, in the research area 480 families are associated in three multi-purpose cooperatives that have been linked to the production of broccoli since April 2010. The cooperatives have important business functions, such as the purchase and production of inputs (seedlings and organic fertilizer), as well as post-harvest value addition and factoring. The three cooperatives are technically and financially supported by foreign Non-Governmental Organizations and appear to be well structured, with own buildings, administration and technical staff, managing board and president. The cooperatives employ technical advisors to ensure the maximum respect of the contracts signed with the processing firms. The cooperatives are also active in the national market, where they supply several wholesalers and individual grocery stores.

CCCC signs contracts with the cooperative leaders each December/January, after completing negotiations with its American client and analysing the local supply capacity to gather enough product to meet the American demand.

Once the contract is signed with the cooperative leaders, the member farmers decide about the area and likely output that each one has to grow and deliver, the inputs needed, and the technical measures to apply to achieve the standards described by the contract. The advisors employed by the cooperatives are available during the cultivation period, to prevent and resolve any technical problem that could occur. After the harvest, the raw commodity is delivered to the cooperative, where the broccoli are washed, cut, and sorted in the collection and first processing centre (*centro de acopio)*, to get an higher price from CCCC. The product is then transported to the CCCC processing plant. The by-products of the first processing are sent to the domestic markets as second quality category, while the worst by-products are used to make compost to be used later to fertilize the fields.

The second pyramidal organization needs a more detailed description. It is based on a first layer of almost 220 *Lead Farmers* who then organize a second layers of about 3,000 small and very small individual producers (some are associated in local groups).

Each Lead Farmer holds a volume-related contract, that includes financing for inputs (seedlings, chemicals, and fertilizers). The Lead Farmers are responsible for the distribution of the short term inputs supplied by CCCC. Most Lead Farmers are innovative and/or dispose of relatively relevant assets within the communities where they subcontract the smaller producers, sharing the volumes with them. The Lead Farmers are easily distinguished because of their larger land base and/or because they own of a storage and/or a *centro de acopio.* The construction of such infrastructure is often financed by CCCC itself, through low interest loans or equity sharing. This action is beneficial for both parties: on one side, the Lead Farmers

see their role enhanced and their income improved, and on the other side CCCC strengthens its relationships with the Lead Farmers and guarantees their cooperation for the years to come.

Lead Farmers are mainly responsible for gathering the product and delivering the volumes agreed with CCCC, by interfacing with smallholders. On average, the number of Lead Farmers annually varies between 210 and 230. More in details, the Lead Farmers:

i. Assume contractual responsibility with CCCC for a given volume and a given price each season;
ii. Fill volume contracts with CCCC by making informal (verbal) agreements with several smallholders in their community; Lead Farmers do not sign contracts with smallholders nor have any standardized paperwork to establish price or volume agreements;
iii. Act as the formal link between small growers and the CCCC's Technical Assistance program. They liaise with Technical Advisors to discuss the farmers' needs, arrange visits, and ask for inputs or advice;
iv. Arrange for growers to bring together the established product on the delivery date – at the location chosen by CCCC.

On their side, the subcontracted smallholders:

a. Verbally discuss at the beginning of the season and agree to sell their product to Lead Farmer/CCCC, without any written formal contract;
b. Are entitled to Technical Advisors (TAs) through the Lead Farmers;
c. Are supposed to make formal requests for TAs through the Lead Farmers (although some of them directly call the advisor);
d. Have up to three months for completing the cultivation, the deadline being the same as the Lead Farmers for the broccoli to be sold to CCCC.

The assignment of specific volumes and areas to each smallholder is the result of a process of market research and negotiation by the other actors of the value chain. This negotiation includes demand and contract/volume forecasts. Each December, the American firm discusses its needs with CCCC, and then CCCC gathers its field advisors and senior staff, to analyse the production capacity of the producers to meet the requests. Prices are negotiated with the American firm, and final prices are set for the year. It is important to note that CCCC reports a high stability in the farmers engaged in the broccoli production, with more than 70% of the smallholders having been linked to the value chain for longer than 10 years. This is considered to be a key factor for high quality outputs for exigent foreign markets.

However, it also happens that farmers side-sell their produce after they have already received the inputs through the Lead Farmers, and do not deliver the established quantity to their Lead Farmer. Since the small producers are not guaranteed a price through a formal contract, only trust relationships between the small growers and the Lead Farmers (or fear of negative consequences) may play a significant role in discouraging side-selling. Farmers may be driven by the fear of not getting a good price, or may have had negative experiences with the lead farmer or CCCC in the past. As a matter of fact, CCCC states that side-selling happens most often when local and international prices are high.

Contracts for Lead Farmers are elaborated with the TAs, who provide CCCC with the names of capable farmers and data about the potential output from the smallholders around/below them. The Lead Farmers receive their contracts in January at large meetings with CCCC representatives. All Lead Farmers get the same base price, but a system of incentives guarantees premium prices for quality (colour, dimension, absence of incrustants), for value addition (farmers with *centros de acopio* receive additional price for processing services), and whenever the farmers purchase the inputs from other sources.

Every Lead Farmer is linked with a specific TA who takes care of all technical aspects. Since there are between 7-10 TAs for about 220 Lead Farmers, each advisor has between 10-50 Lead Farmers under their geographical jurisdiction. TAs also visit the parcels of the individual producers with a good frequency, offering technical advice, mainly to cover issues communicated by the Lead Farmer. The majority of TAs have their primary office/reporting place at the CCCC plant, and only few TAs are located in the *centros de acopio* in the communities. Some TAs are available to be contacted directly by the small farmers themselves. Other TAs do targeted

visits when the Lead Farmer requests assistance on behalf of a farmer.

Depending on the problem, advice might be given with a phone conversation, a talk with the Lead Farmer, a field visit, and could be accompanied by the order for a particular input. Input packages are determined by the CCCC's Agricultural Manager and are distributed through the TAs.

The input package for smallholders includes a) initial seedlings and crop schedule, b) fertilizers, fungicides, other chemicals (within Global GAP – Good Agricultural Practices - standards), c) control plans for pests, diseases and weeds, d) general advice, including quality assurance support, e) TA visits each 15 days. Whenever there is a contact between TAs and producers, a formal report is written and filed in a digital management system at CCCC, which allows tracking the performance and issues of each Lead Farmer.

Contractually, the Lead Farmers are given a date by which the product must be ready for pick-up by CCCC. Dates can be flexible, based on a two weeks prior to harvest review by TAs. TAs' proximity to the assigned Lead Farmers allows to have an updated forecast of volumes and quality before the harvest and the formal quality control checks. Some output instability has been reported in the last few years, mainly attributed to increased frequency of extreme weather events during the last weeks before harvest.

Prior to entering into the CCCC facilities, all batched produce is evaluated, checked for quality, and passed through an initial sorting. In some communities, basic processing might have occurred already at the *centros de acopio* managed by the Lead Farmers, but the bulk of the product is still processed at the central plant. A sample of each product batch is tested in a laboratory within the CCCC facility for unauthorized or above limits pesticide residues. If the product is unfit for export, the batch is tracked back to its Lead Farmer, while the TAs and quality control staff are alerted. When the product meets the standards, it is processed (frozen), and is then authorized for export through another round of laboratory testing. Finally, the frozen product is boxed and is ready for transport to port and shipping to Europe, Japan or United States.

Lead Farmers are paid when the tests for prohibited pesticide use or residue levels come back negative, usually two weeks after CCCC has received the product; they are then responsible to pay their group of small farmers. Delays have been recorded in both steps.

3. MATERIALS AND METHODS

This survey was designed in late 2011, for better understanding the dimensions of livelihoods, business models and food security of smallholders in the Departments of Chimaltenango and Sololá. Communities and smallholders were selected in order to include the two categorical modalities (cooperative and informal pyramidal contract farming) to prove statistically if relevant differences between smallholders working under the two different business models might be present.

Sample size was based [10] on N:p suggested ratio (where N is the sample size and p is the number of items included in analysis) of at least 1:3, since this ratio has shown good recovery of population parameters. Since the entire questionnaire included 80 questions, collecting a higher number of variables due to multi-entry questions, data about the contract farming modality was collected from 30 cases. The sample for the cooperative model was chosen at a much lower N:p ratio, because of two main reasons: the higher proportion of population associated in cooperatives, not involved in the non-traditional exports and the higher variability observed for the composition and structure of the cooperatives. This has led to a sample of 140. Consequently, the total number of collected questionnaires has been 170.

The survey was tested in three communities (two under the cooperative modality and one with the vertical contract farming model) in early June 2012. After the validation, the questionnaire was consolidated and the data were collected by a team of 10 Masters' Students of FLACSO (Latin American Studies Faculty). The students were trained in Guatemala City and in Sololá by FLACSO during the second week of June and the data collection took place during the last two weeks of June and the first week of July 2012. The main challenge during the data collection was the length of some parts of the questionnaire on food security, that has caused some missing answers for specific variables in both modalities.

Table 2. Variables and codifications

Variables	Names	Answers and codifications
Modality of organization	MOD	1= Cooperative, 2= Pyramidal contract farming
Age of farmer	AGE	Number of years of the respondent
Size of family	FAM	Number of people in the household
Education	SCH	Number of years at school of the respondent
Cultivated area	SUP	Number of hectares
Fruit trees in the farm	HORC	1= yes, 2= no
Type of relationship	CONT	1= Formal written contract, 2= Oral agreement
Type of relationship	CONT2	1= Individual, 2= Collective
Price determination	PRIDET	1= by the buyer, 2= by the seller, 3= negotiated
Time of payment	PAYDAYS	Number of days between delivery and payment
Trust in the buyer	TRUST	1= Very limited, 2= limited, 3= high, 4= very high
Food scarcity in the Previous year	HUNG	1= yes, 2= no hunger
Strategy in case of hunger	STRAT	1= Reduced meal frequency, 2= minor quantities, 3= migration, 4= other jobs
Agricultural innovations	PRACT	1= New agricultural practices introduced in the previous 12 months, 2= no new practices
Willingness to introduce new cash crops	SWITCH	1= yes, 2= no
Access to credit	CRED	1= Access in the last 12 months, 2= no access

Out of the over 80 variables surveyed, only 16 were selected for this study, because the other ones covered other technical or ecological subjects. The variables, the answers and their codification are described in Table 2.

Of the selected variables, five are continuous (age, family members, years at school, total available land, and days between delivery and payment), whereas the other 11 are categorical. The data entry and digital codification of results have been carried out during August 2012. Data have been analysed first to obtain descriptive statistics. T-tests were used for continuous variables (assuming equal variances in both samples). Categorical variables were compared using the Chi-square tests. The analyses were performed using SAS statistical package (version 9.1; SAS Institute, Inc., Cary, NC, USA).

A Latent Class Regression Analysis was then performed [11,12] to define homogeneous Latent Classes (or Clusters) of respondents according to some variables in the data and predict the person membership to the clusters on the basis of belonging to the cooperative modality or to the pyramidal contract farming modality. This analysis was performed with Latent GOLD v4.5 [13] and both categorical and continuous variables were allowed. The model with lower BIC - Bayesian information criterion - value [14] has been selected. The estimated parameters of the model have been used to classify cases into the appropriate latent classes and the profiles of the variables in each latent class for describing the classification.

4. RESULTS AND DISCUSSION

Each variable is described under the two forms of organization: modality 1= multi-purpose cooperative, modality 2 = pyramidal contract farming.

Age – The mean age for cooperative farmers is 38.02 years, with a minimum of 18 and a maximum of 73 years. For the pyramidal contract farming modality the mean is 41.41 years, with a minimum of 17 and a maximum of 67 years of age. Satterthwaite T-Test does not highlight any statistically relevant difference between the two modalities for this variable.

Fam – The mean value number of people in household is 5.99 for modality 1 and 6.14 for modality 2, with a minimum of one people households in both modalities and a maximum of 14 for the cooperative members and 12 in the pyramidal contract farming modality. Satterthwaite T-Test does not highlight any statistically relevant difference between the two modalities for this variable.

Scho – While the minimum and the maximum value of years in school for both modalities are the same (min=0, max=6), the means for modality 1 is 2.59 years at school, whereas is 4 years for the respondents of modality 2.

Satterthwaite T-Test (Pr>|t| <0.005) highlights a statistically relevant difference between the two modalities for this variable, suggesting a higher attendance to school and a more dense distribution around the mean value for the pyramidal contract farming modality.

Sup – The total available land in hectares varies from a minimum of zero to a maximum of four hectares for the cooperatives' members, with a mean of 0.59 ha; whereas for pyramidal contract farmers the minimum is 0.12 ha and the maximum 1.88. However, the similarity of distribution indicated by the standard deviation and a high value of Satterthwaite T-Test indicate that there is not any statistically relevant difference between the two groups, in terms of land availability.

Horc – The presence of fruit trees is a categorical variable with two ordinal modalities (1=yes, 2=no). Within the cooperative modality, 39 percent of farmers cultivate an orchard, while 61 percent do not. In the pyramidal contract farming modality, nobody has an orchard. The Chi-Square test (Prob=0.0003) indicates a statistically relevant difference between the two groups, that might be explained by the different orientation of the two groups: the respondents belonging to the pyramidal contract farming modality are more market oriented and less diversified, whereas the cooperative members show a higher mix of livelihood activities.

Cont – This variable has two options, namely 1=formal contract and 2=verbal contract. In the cooperative model, 62.37 percent of farmers are working under formal contracts, while the remaining 37.63 percent produce with a verbal agreement. In the case of pyramidal contract farming, almost every farmer operates with a written contract and only 3.33 percent has only a verbal agreement. The Chi-Square results (Prob<0.0001) indicate a statistically relevant difference between the two modalities, and this partially confirms the findings of other variables such as Horc, that highlights less diversification within the pyramidal contract farming model, with the tendency to dedicate most of the land to one or few pre-agreed crops.

Cont2 – Also this variable has two options: 1=individual contract, 2=collective contract; within the cooperative model, 89.25 percent of farmers have a collective contract, whereas in the pyramidal contract farming model most respondents (63.33 percent) have an individual contract. The Chi-Square results (Prob<0.0001) indicate a statistically relevant difference between the two business models. The 10.75 percent of individual contracts within the cooperative model is explained by both the side selling of individual farmers within the cooperative and the retention of portions of land that are dedicated to contracts outside the cooperative. The 36.67 percent of collective contracts in the pyramidal contract farming modality might be referred to a few farmers working with a lead farmer in informal organizations and institutions of different nature that can interact and mediate the commercial transactions in rural communities.

Pridet – The variable on price determination has three answers: 1= the buyer determines the price, 2= the seller determines the price, 3= the price is negotiated. In both modalities the most frequent response is the first one, with 100 percent for the pyramidal contract farming, and 83.78 percent for the cooperatives. Within the cooperative modality, 6.76 percent of respondents consider that the seller can determine the price and 9.46 percent of farmers negotiate the price between buyer and seller. Even if the Chi-Square (prob=0.0639) does not indicate any statistically relevant difference between the two modelities, the data can be analysed with the tendency of lock-in and reduced diversification for long-established contract farming, while the cooperative model retains a certain level of market diversification and of negotiation power through the collective contract.

Paydays – The cooperative modality has a mean number of days from delivery to payment of 48.5 with a quite disperse distribution around the mean (Standard Deviation 27.5) and minimum of 5 days and a maximum of 95 days. The pyramidal contract faming modality is faster, with 31.2 days between delivery and payment, and a more dense distribution around the mean (Standard Deviation 16.8). Minimum and maximum days to payment range from 15 to 90 days. Satterthwaite T-Test (Pr>t| <0.005) highlights a statistically relevant difference between the two modalities for this variable, suggesting that the higher contractual informality of the cooperative model generates a more volatile commercial environment, with a more disperse distribution. It has been observed that time to payment might be delayed as well by cooperative internal administrative processes, to determine the payment to each member and

account for credits to inputs and in-kind contributions of individual members. This variable was already reported during the focus groups before the survey as an important barrier to increasing the investments in the farm. Several people have expressed the need for informal credit, to cover the financial exposure generated by the delayed payment, to anticipate the operations cost for the preparation of the following planting season, or simply to support the family.

Trust – The effective sample size for this categorical variable does not allow drawing conclusions on the potential difference between the two modality. With less than 50 percent of respondents to this question, the variable can only be described. The most likely explanation for the low frequency is related to an error in the validation with cooperative model test. While recognizing the limited statistical relevance, it is worth noting that under the pyramidal contract farming model, with more long-term relationship with the buyer, 66.67 percent of the respondent have limited trust, and 33.33 some trust in their buyers.

Hung – This variable explored the frequency of food scarcity under the two modalities with two possible answers (1=yes, 2=no). Within the pyramidal contract faming group, only 27 percent have suffered from food scarcity during the last twelve months, versus the 45 percent in the cooperative group. Although in the cooperative modality there is more diversification of production, with a higher presence of orchards, which would induce to expect a higher resilience to food scarcity, nevertheless the reported scarcity might indicate otherwise. The Chi-Square does not highlight any relevant difference between the two groups. The results of the analysis of this variable might be an indication that the availability of food deriving from direct food production could be only one of the dimensions to which food scarcity can be attributed; access, stability and consumption patterns might not be directly related to the quantity and quality of the food produced.

Strat - This variable is a follow-up to the previous Hung variable question. Out of the 71 farmers reporting food scarcity in the previous twelve months, 68 have responded to the next question on coping strategies. Nobody has indicated to have looked for other jobs in the area, and this is probably due to the lack of alternatives in these economically marginal rural areas. In the pyramidal contract farming modality, all respondents report to have reduced meal quantities, whereas in the cooperative modality 61.67 percent have reduced the quantities of food and 36.76 have reduced the meal frequency. Only 1.67 percent has chosen national migration towards towns.

Pract – The introduction of new agricultural practices in the last twelve months is a categorical variable with two ordinal answers (1=yes, 2=no). Within the cooperative modality, 35.43 percent of farmers have introduced a new agricultural practice, whereas only 13.33 percent in the contract farming model have implemented some modifications. The Chi-Square test (Prob=0.0619) does not indicate any statistically relevant difference between the two groups.

Switch – This categorical variable explores the willingness to substitute areas dedicated to staple crops with market-oriented vegetables and has two responses (1=yes, 2=no). Within the pyramidal contract farming modality, over three quarters (76.67%) report such willingness to substitute. Less than two thirds (59.71%) of the farmers working with the cooperative modality show the same willingness. No difference between the two groups is highlighted by the Chi-Square, but this variable confirms the trend of Guatemala Highlands as an area where at least some small producers are interested in exploring market opportunities as a mean to improve livelihoods. At the same time, some doubts may arise, when this declared openness to change is confronted to the previous declarations, that nothing had been changed in the previous year.

Cred – On the access to credit no difference between models has been found with Chi-Square test. Farmers from both modalities (80.71 percent for the cooperative members and 76.67 percent for modality 2) have reported that they had not access to any type of credit in the last twelve months.

4.1 Latent Class Regression Analysis

The Latent Class Regression Analysis was performed, to define homogeneous Latent Classes (or Clusters) of people according to eleven variables and two covariates. This procedure allows to predict the membership to the clusters on the basis of belonging to the cooperative model or the pyramidal contract farming model.

The Latent Class Analysis has used the two marketing models as a covariate describing two significantly different (p-value of 8.00E-04) clusters (Tables 3 and 4) that have been named as follows: a) the Small Diversified Collective (SDC), and b) the Medium Homogeneous Individual (MHI). The first group (SDC) fits 78.98 percent of the smallholders interested by the survey while MHI cluster fits 21.02 percent of farmers. The regression of this latent class (clusters) with the covariates of the models (cooperative and contract farming) defines a fit between the models and the clusters.

Table 3. Latent class analysis (Part 1)

Variables	Name of cluster	Small diverse cooperative	Medium homogeneous individual
	Cluster size	78.98%	21.02%
	Intercept	-0.4038	0.4038
	Modalities	%	%
Years at school	0	36.98	17.88
	1	7.06	4.27
	2	9.30	7.04
	3	12.49	11.83
	4	3.96	4.70
	5	4.80	7.12
	6	25.40	47.15
	Mean	2.55	3.91
Total available land	Mean	0.53	0.86
Presence of orchard	Yes	39.03	7.03
	No	60.97	92.97
Contract	Formal	62.02	12.09
	Verbal	37.98	87.91
Contract 2	Individual	9.14	60.39
	Collective	90.86	39.61
Price determination	Buyer	83.22	99.74
	Seller	6.93	0.25
	Negotiated	9.85	0.01

p-value 8.00E-04

Table 4. Latent class analysis (Part 2)

Variables	Name of cluster	Small diverse cooperative	Medium homogeneous individual
	Modalities	**%**	**%**
Days for payment	Mean	48.33	32.01
Trust in buyers	Not at all	7.58	13.44
	Very limited	40.23	48.64
	Limited	35.21	29.03
	Some	14.74	8.29
	Full trust	2.23	0.58
Food scarcity	Yes	45.97	26.09
	No	54.03	73.91
Strategy to cope with hunger	Reducing meal times	36.05	7.96
	Reducing quantities	63.20	85.80
	Migration	0.75	6.23
New practices	Yes	35.06	18.09
	No	64.94	81.41
Covariates	Cooperative	99.95	16.04
	Pyramidal contract	0.05	83.96

p-value 8.00E-04

The SDC cluster fits 99.95 percent within the cooperative group of farmers, and 0.05 percent with the contract farming smallholders. Farmers fitting with the SDC cluster have a mean attendance to school of 2.55 years with a distribution characterized by two pikes, with 36.98 percent of farmers with no attendance to school and 25.40 percent with six years in school. The mean landholding is around half of an hectare (0.53 Ha) and 40 percent of the respondents included in this group cultivate an orchard. 62.02 percent have a formal contract with their buyers and 90.86 percent are working with a collective contract. The price of their products is determined largely (88.22%) by the buyer, and over two thirds of them have a limited (35.21%) or very limited (40.23%) trust in their buyers (45.97%). Slightly less than half the SDC farmers have been affected by food scarcity in the last twelve months and almost two thirds (63.20%) of the ones affected have coped with food scarcity by reducing meals quantities, while around one third (36.05%) have reduced meals times. Almost two thirds of the Small Diversified Collective cluster's farmers have not introduced any new agricultural practice in the last twelve months.

The other cluster, named Medium Homogeneous Individual, fits 83.96 percent with the contract farming model and 16.04 percent with the cooperative one. Farmers in this MHI cluster have a mean attendance to school of 3.91 years and a mean landholding of 0.86 hectares. The great majority (92.97%) is oriented to the market and does not cultivate any fruit trees. Most of them (87.91%) have only a verbal agreement with their buyer. 60 percent of the farmers in this group have an individual contract, but the fact that over one third (39.61%) have collective contracts is an evidence of the complexity of different models in market linkages in the Guatemala Highlands, with 16 percent of this cluster fitting the cooperative model. This cluster confirms the characteristics of price-taker, with 99.79 percent of farmers whose prices is determined by the buyer. The trust of this cluster towards their buyers is low, with almost 70 percent showing very limited or limited trust (48.64% very limited, 29.03% limited). Most of the farmers in the MHI cluster have not suffered from food scarcity in the last twelve months (73.91%) and among the 26.09 percent having suffered from food scarcity, 85.80 percent of them have reduced meal quantity. In terms of innovation adoption, 81.91 percent of farmers in this group have not introduced any innovations in the last twelve months.

The almost perfect (99.95%) overlapping between the SDC cluster and the farmers working under a cooperative model confirms that there are latent characteristics defined by a specific business model. The latent class regression analysis, besides confirming the alignment of the clusters with the covariates of the business model, highlights differences in landholding and education between the two groups. The reduced impact of food scarcity on the MHI cluster might be explained by the rewards of a market oriented strategy, allowing sufficient income streams to ensure stabilizing access to food. In absence of a more specific analysis on income streams for these farmers, the qualitative analysis would suggest that landholding is a determining factor. More specifically, the differences might indicate the existence of land availability thresholds that allows reaching certain levels of cost efficiency within individual farms.

Fruit trees are the main diversification strategy for food security in Guatemala Highlands, and the absence of an orchard within the MHI cluster would suggest a consolidated market orientation, that can be rewarding, but leaves the MHI cluster farmers more exposed than those in the SDC one to potential shocks, due to a less diversified farming system and a lower innovation adoption rate.

5. CONCLUSIONS

This study, a small part of a much larger research covering also topics regarding climate change, agronomic practices, biodiversity and innovations, indicates that both business modalities analysed show positive consequences for the smallholders. Modern, market oriented value chains, often driven by foreign markets, can rely on the supply ensured by organized groups of producers [15].

Both groups of farmers show similarities when some variables are considered: age, number of family members, land size, recent experience of food shortage and coping strategies, lack of innovations and credit in the previous months. For other variables, there are significant differences: the producers working under the pyramidal contract farming modality have spent more years at school, are more market oriented,

have formal individual contracts and enjoy a much faster payment for their products; furthermore, they declare to be ready to switch to other cash crops, if this opportunity might appear.

Formally established cooperatives can guarantee to their members access to national and international markets, as well as to short term inputs and extension [16]. In marginal areas, where the distribution of inputs and the public extension agents are not available, the role of cooperatives cannot be underestimated. In the case of the other modality, the absence of supporting services, as credit availability and public extension service, make the smallholders recipient of the inputs and advice provided by the advisors of the private company [17], whose primary goal is probably not the long term wellbeing of the farmers, but the regularity of the supply for the processing plant.

In both cases, the presence, in some cases, of the so called *centros de acopio*, where the different qualities are sorted, allows to keep some added value within the communities; this is probably the way to follow, to create more part time and full time jobs [18].

On the other hand, both the presence of cooperatives and the activation of the pyramidal contract farming approach are not, per se, the panacea to solve all the enormous problems faced by the smallholders and by their communities in the Guatemalan Highlands. Because of their extremely small land size, the poor soils and the hazards posed by climate change [8], the levels of poverty, as well as the risk of hunger and malnutrition cannot be totally eliminated.

In many cases, the declared lack of trust and the prevailing belief to be “price takers” indicate that these smallholders still feel to be exploited and that their labour and efforts are not properly recognized. On the other hand, not only the short term profitability, but also the long term survival of many large national and international firms depend on the regular supply of high quality raw materials, timely produced by thousands of smallholders, who should be respected and supported in their efforts for modernization [4].

Still, further research is needed, to keep track of the evolutions taking place in the global agro-food systems, as well as to develop updated guidelines for improving the relationships between the farmers’ voluntary organizations and the other actors of the food value chains.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. United Nations. United Nations Assembly Millennium Declaration, New York; 2000. Available:http://www.un.org/millennium/declaration/ares552e.htm
2. United Nations. Transforming our world: the 2030 Agenda for Sustainable Development. New York; 2015. Available:http://www.un.org/ga/search/viewdoc.asp?symbol=A/RES/70/1&Lang=E
3. Food and Agriculture Organization. Family farmers, feeding the world, caring for the earth. Rome; 2014.
4. Bruni M, Santucci FM. Agribusiness at global scale and smallholders. Bulgarian Journal of Agricultural Science. 2016; 22(1):01-09.
5. Vorley B, Del Pozo-Vergnes E, Barnett A. Small producer agency in the globalised market: Making choices in a changing world. London IIED and the Hague HIVOS; 2012. Available:http://pubs.iied.org/pdfs/16521IIED.pdf
6. Poole ND, De Frece A. A review of existing organisational forms of smallholder farmers’ associations and their contractual relationships with other market participants in the East and Southern African ACP Region. EU-AAACP Paper Series no. 11. Rome. FAO; 2010.
7. Devaux A, Horton D, Velasco C, Thiele G, López G, Bernet T, Reinoso I, Ordinola M. Collective action for market chain innovation in the Andes. Food Policy. 2009;34(1):31-38.
8. Bruni M, Santucci FM. Climate change resilience of smallholders on Guatemala Highlands. Asian Journal of Agricultural Extension, Economics and Sociology. 2016;12(2):01-10.
9. Tay K. After 20+ years, the rural extension service returns to Guatemala. Gain Report 2014005. Washington DC. USDA; 2014.
10. MacCallum RC, Widaman KF, Zhang S, Hong S. Sample size in factor analysis. Psychological Methods. 1999;4:84-99.

11. Skrondal A, Rabe-Hesket S. Generalized latent variables modelling: Multilevel, longitudinal and structural equation models. Boca Raton. Chapman & Hall/CRC; 2004.
12. Vermunt JK, Van Dijk LA. A nonparametric random-coefficients approach, Multilevel Modelling Newsletter. 2001;(2):6-13.
Available:https://pure.uvt.nl/ws/files/453563/mlnl2001.pdf
13. Vermunt JK, Magidson J. Latent GOLD 4.0 user's guide. Belmont. Statistical Innovations Inc.; 2008.
14. Schwarz G. Estimating the dimension of a model source: The Annals of Statistics. 1978; 6(2):461-464.
Available:https://www.andrew.cmu.edu/user/kk3n/simplicity/schwarzbic.pdf
15. Vorley B, Lundy M, Mac Gregor J. Business models that are inclusive of small farmers, Paper for FAO and UNIDO as background to the Global Agro-Industries Forum, New Delhi; 2008.
Available:http://www.sustainablefoodlab.org/wp-content/uploads/2016/02/Inclusive-Business-Models.pdf
16. International Cooperative Alliance and International Labour Office. The role of cooperatives in designing and implementing poverty reduction strategies. Geneva; 2003.
17. Christoplos I. Agricultural advisory services and the market. Natural Resource Perspectives 113. Overseas Development Institute. London; 2008.
Available:https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/1747.pdf
18. Matthewson M. Exploring value-added agriculture. Extension Newsletter. 2007;(II):2.
Available:http://smallfarms.oregonstate.edu/sfn/su07valueadded

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