- Farmers' characteristics and entrepreneurial competences for innovation in Ugandan multi-stakeholder platforms -

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Abstract

The objective of this research is to assess the role that farmers' characteristics and entrepreneurial competences have on farmers' innovation in the context of Ugandan multi-stakeholder platforms for innovation. In this thesis report, the acronym MSPs is used to indicate this particular type of platforms.

In sub-Saharan Africa, MSPs are already operating as networks for sharing knowledge and developing innovation across multiple actors in the context of food and agriculture value chains (Helmsing, Bitzer, van der Linden, & van Wijk, 2009). However, MSPs have not always been successful (Abate et al., 2011). This might be due to smallholders' characteristics (Martey, Etwire, Wiredu, & Dogbe, 2014). In this research, three farmers' characteristics have been chosen: demographics, access to resources and farm size. At the same time, farmers' entrepreneurial competences will be assessed, as to check if they have a relation with farmers' innovation, when interacting with farmers' characteristics. Four types of entrepreneurial competences have been selected, according to the personality trait approach in emerging economies: innovativeness, risk-taking, proactiveness and intentions.

Different models have been developed and performed to determine which farmers' characteristics and entrepreneurial competences are likely to influence farmers' innovation. Furthermore, recommendations have been provided to Ugandan MSPs, in order to trigger the significant characteristics and entrepreneurial competences for achieving it.

Currently, few research has been conducted with regard to farmers' characteristics that have an effect on farmers' innovation in the context of MSPs. Furthermore, no literature reports whether entrepreneurial competences have a positive effect on farmers' innovation within MSPs. Hence, the present study attempts to fill the gap in knowledge and provide support to expand further research upon this topic.

Keywords

Multi-stakeholder platforms (MSPs), value chains, Uganda, farmers' characteristics, entrepreneurial competences, farmers' innovation.

Executive Summary

This paper aims at investigating the role that farmers' characteristics and entrepreneurial competences have on farmers' innovation in the context of Ugandan multi-stakeholder platforms for innovation (MSPs). There exist different types of platforms or networks that have been recently operating in developing countries (Ballon, 2009; Gawer & Cusumano, 2014). The present research will put the focus on MSPs that develop knowledge and promote innovation across multiple actors, such as researchers, farmers, NGOs and agribusinesses, in food and agriculture value chains (Amerasinghe, Cofie, & Drechsel, 2013).

In particular, farmers of coffee and honey value chains participating in Ugandan MSPs, in Manafwa district, will constitute the case study of this paper. Manafwa is located in the eastern part of Uganda, in the Elgon region, and the sub-counties in which coffee and honey farmers live and work are represented by Mukoto, Namabya, Bukhofu and Namboko. The sub-counties have been selected with regard to their landscape (lowland, midland, highland), since the different conformation of the land can impact coffee and honey productions.

MSPs have not always been successful in sub-Saharan Africa, and the literature attributed the major causes to farmers' characteristics and farmers' attitude (Abate et al., 2011). In the present research, demographics, farm size and access to resources have been chosen as farmers' characteristics, while farmers' attitude deals with farmers' entrepreneurial competences. As far as measuring entrepreneurial competences of Ugandan coffee and honey farmers concerns, the personality trait approach was used. Among the personality traits which characterize the good entrepreneur, innovativeness, risk-taking, proactiveness and intentions have been selected from the literature (Krauss et al., 2005; Lai et al., *unpublished*; George et al., 2015), and adapted to the local context afterwards.

Innovation adoption is investigated and it is defined in the present study. Innovation as adoption corresponds to the ability of the farmers to get knowledge from MSPs, in order to build an innovative mind-set for managing their value chains (Damanpour & Wischnevsky, 2006).

The ability that farmers have deals with generating, developing, implementing and adapting new ideas by re-using knowledge from MSPs, as to adopt innovation within their coffee and honey productions. In this paper, four different types of innovation have been considered: product innovation, process innovation in terms of new agricultural practices that farmers implement under suggestion of fellow farmers, process innovation in terms of new agricultural practices that farmers implement under suggestion of actors in their value chains, and market innovation.

An in-depth literature review has been carried out to describe the main concepts of this paper. Therefore, the major empirical and theoretical findings about farmers' characteristics that are likely to impact farmers' innovation, farmers' entrepreneurial competences, farmers' innovation in the context of MSPs are presented. The literature also enabled the researcher to develop four main hypotheses:

H1: *Age, gender and education level have an effect on farmers' innovation.*

- *the increasing in age has a negative effect on farmers' innovation*
- *men are more disposed to innovate compared to women*
- *higher education levels have a positive effect on farmers' innovation*

H2: *A big farm size has a positive effect on farmers' innovation.*

H3: *Access to resources has a positive effect on farmers' innovation.*

H4: *Entrepreneurial competences have a positive effect on farmers' innovation, when interacting with the selected farmers' characteristics.*

To test the hypotheses, a sample of 152 coffee and honey farmers participating in Ugandan MSPs and located in the sub-counties of Mukoto, Namabya, Bukhofu and Namboko has been analysed. The respondents were asked to answer a short questionnaire about their characteristics, entrepreneurial competences and level of innovation within their coffee or honey value chains.

Descriptive statistics showed that heterogeneity was registered in farmers' characteristics answers, contrary to the perceived level of entrepreneurship and innovation of the respondents, whose answers mostly followed a high-rated direction. The results were approximately the same both in coffee and honey value chains. In particular, males represent the majority of the respondents; most farmers are between 31 and 50 years of age; the level of education corresponds to primary or secondary the most; the size for coffee and honey vale chains, and in particular for the honey one, is relatively small; everyone has more or less access to resources, but just a few have access to the physical ones, such as artificial fertilizers for the coffee part and equipment to keep the bees for the honey part.

The combined effect between farmers' characteristics and entrepreneurial competences on farmers' innovation was tested. Surprisingly, entrepreneurial competences did not always show a positive impact on farmers' innovation. They had an effect on farmers' innovation, generally positive, only if combined with farm size. On the other hand, farmers' characteristics represented the variable of the study having the major effect on farmers' innovation. In particular, education level among the demographics, farm size and access to resources were the most relevant. In particular, the higher education level and the higher access to resources had a positive effect on farmers' innovation. Generally, farmers with a big farm size are less disposed to adopt innovation compared to farmers with a small farm size. The same situation happens when farm size interacts with entr_innovativeness, meaning that entr_innovativeness produces a negative effect on farmers' innovation, when farmers own a big farm size. However, entr_proactiveness produce a positive effect on farmers' innovation, if farmers own a big farm size.

In this paper, the limitations concern multicollinearity among variables, sample size reliability and validity in farmers' answers.

Recommendations for MSPs as to trigger the farmers' characteristics that are likely to produce a positive influence on farmers' innovation have been provided in the last chapter of the paper. Although entrepreneurial competences did not always show a positive effect on farmers' innovation, further research upon this topic should be performed in Manafwa district. This is to determine if they could lead to farmers' innovation in the context of MSPs, thereby becoming a support for the literature.

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1. Introduction

Recently in sub-Saharan Africa, multi-stakeholder platforms for innovation (MSPs) are operating as networks for sharing knowledge and promoting innovation across multiple actors in the context of food and agriculture value chains (Abate et al., 2011). MSPs are considered as a "*network of organizations, enterprises and individuals focused on bringing new products, new processes and new form of organization into social and economic use, together with the institutions and policies that affect their behaviour and performance*" (Bank, 2006). MSPs include farmers, traders, social groups, researchers, non-governmental organizations (NGOs) and a different number of governmental institutions and policymakers (Amerasinghe, Cofie, & Drechsel, 2013). In the present study, MSPs will be analysed in the context of Ugandan coffee and honey value chains, where enormous differences exist amongst actors and their behaviours. In particular, the focus will be put onto farmers of coffee and honey productions, who participate in Ugandan MSPs, in Manafwa district, and receive knowledge from it. The geographical location, Manafwa district, where the case study has been developed is depicted in ***Figure 1***.

Fig. 1 Geographical location

Empirical evidence shows that entrepreneurial competences have a positive relation with innovation (Krauss, Frese, Friedrich, & Unger, 2005; Micheels & Gow, 2008). However, no research has been conducted upon farmers' entrepreneurial competences in the context of MSPs. For this reason, in the present study the relation between farmers' entrepreneurial competences and farmers' innovation will be investigated. At the same time, the role that farmers' characteristics have on farmers' innovation will be assessed.

Ugandan MSPs are operating as networks or interfaces aiming to promote innovation among farmers, thereby making them adopting it. Hence, in the present study, farmers' innovation corresponds to the capability of the farmers to get the knowledge from MSPs as to develop an innovative mind-set for managing their value chains. Therefore, the present study refers to innovation adoption by coffee and honey farmers participating in Ugandan

MSPs, as the generation, development, implementation and adaptation of new ideas (Damanpour & Wischnevsky, 2006), within their value chains.

Recently, the role of MSPs has become fundamental to address some of the most important issues that farmers currently face, such as high transaction costs, institutional constraints and lack of knowledge (Helmsing et al., 2009). However, MSPs have not always been successful. According to Devaux et al. (2009), the diversity of actors involved and the attitudes of the key actors can affect the performance of MSPs and negatively impact farmers (Abate et al., 2011) who, in turns, might not adopt innovation.

First, as stated by Galbreath (2005), smallholders might be in disadvantage compared to other actors, because the lack of tangible (i.e. money and networks) and intangible (i.e. human resources and intellectual capital) resources limits the benefits that they can get out of this system. Moreover, according to Martey et al. (2014), different factors influence farmers' willingness to participate to platforms: demographics (gender, age, marital status, education, employment, total income), land availability, membership of association, distance from farmers' house to the meeting place, and major farming decisions have been identified as being the main ones. Thus, access to resources, demographics and farm size are only few of the factors that could impact the success of innovation platforms as MSPs. In the present research, they have been chosen as the most representative farmers' characteristics to have an influence on farmers' innovation.

Second, the attitudes of the farmers might affect the performance of MSPs (Abate et al., 2011). In the present study, entrepreneurial competences deal with the attitudes of the farmers. It might be the case that some farmers participating MSPs already have entrepreneurial competences, while some others not. Krauss et al. (2005) stated that the entrepreneurial profile is represented by different traits, such as innovativeness, risk-propensity, proactiveness, energy level, internal locus of control, intentions. In the present research, innovativeness, risk-taking, proactiveness and intentions of each farmer participating in Ugandan MSPs will be determined.

According to SCHUT et al. (2015) and assuming that in the present research only farmers' participating to these platforms are considered, assessing farmers' characteristics and entrepreneurial competences is fundamental to understand the dynamic and intensity of farmers' innovation in Ugandan coffee and honey value chains. Currently, few research has been conducted with regard to the impact that farmers' characteristics have on farmers' innovation in the context of MSPs. In addition, the literature does not mention whether entrepreneurial competences have a positive effect on farmers' innovation within MSPs in developing countries. Considering that the present research will investigate the relation among entrepreneurial competences and farmers' innovation, in case this relation is positive, a good support to MSPs for boosting farmers' entrepreneurial competences to promote innovation will be provided.

The present study is part of a broader project, developed thanks to a collaboration between Makerere University (KADLAC, NaFORRI), World Agroforestry Centre (ICRAF), Adelaide University via the Australian Centre for International Agricultural Research (ACIAR) and Wageningen University via the Global Centre for Food Systems Innovation (GCFSI). In the first instance, the value chains that have been selected by the project members were honey, coffee and dairy products. Thereafter, the researcher developed a case study, by focusing on coffee and honey value chains, given their extreme differences from an economic, technical and social perspectives. In Uganda, honey and coffee farmers generally operate on a small scale and their productions rarely emerge the market. Hence, the data gathered in this study will be available to the project members as to increase the innovativeness and the

embeddedness of Ugandan farmers within multi-stakeholder platforms for innovation, by providing them with all the support needed: funds, knowledge, networks, equipment, experts and researchers.

In order to provide a general overview of the study, objectives, research questions, theoretical and research frameworks, methodology, findings, discussions and limitations, and recommendations are presented in the following chapters.

1.1 Objectives

The objective of the research is stated as follows:

to assess the role that farmers' characteristics and entrepreneurial competences have on farmers' innovation in the context of Ugandan multi-stakeholder platforms.

The research assumes, based on the available literature about farmers' characteristics and their role within multi-stakeholder platforms for innovation, that farmers' characteristics have an influence on smallholders' way of adopting and implementing innovation in developing countries. Few studies report that there are characteristics which can impact the success of MSPs, and thus farmers can adopt innovation more or less easily according to them (Galbreath, 2005; Martey et al., 2014). Furthermore, few literature reports that farmers' characteristics have an impact on farmers' innovation in the context of MSPs (Leach, Pelkey, & Sabatier, 2002; Narrod et al., 2009).

At the same time, the research also assumes that entrepreneurial competences have an effect on farmers' innovation within MSPs. Empirical evidence shows that entrepreneurial competences have a positive effect on innovation in developing countries (Fernald & Solomon, 1987; Schumpeter, 1966; SCHUT et al., 2015). However, the literature does not report if this is true in the context of MSPs in emerging economies.

Entrepreneurship has many definitions and connotations. As a societal phenomenon, entrepreneurship is defined as "*the competitive behaviours that drive the market process, and corresponds to the introduction of a new economic activity that leads to change in the marketplace*" (Davidsson, 2016). Arguably, different types of innovations (i.e. product innovation), in both developed and developing countries are attributed to new businesses created and managed by nascent entrepreneurs (Mitra & Matlay, 2004).

The objective of the research can be split into two parts: on one side, the assessment of the farmers' characteristics and entrepreneurial competences that influence farmers' innovation; on the other, the context of Ugandan multi-stakeholder platforms for innovation.

Firstly, farmers' characteristics as demographics, farm size and access to resources have a relation with farmers' capability to innovate (Leach et al., 2002; Narrod et al., 2009). Furthermore, entrepreneurial competences have a relation with farmers' innovation (Krauss et al., 2005; Micheels & Gow, 2008), and in the present study four types of entrepreneurial competences have been identified: innovativeness, risk-taking, proactiveness, intentions.

The main reason of assessing the effect of the selected characteristics on farmers' innovation is to provide an in-depth understanding of which Ugandan coffee and honey farmers participating in MSPs are more disposed to innovate. At the same time, assessing the effect that farmers' entrepreneurial competences have on farmers' innovation is important to determine whether MSPs can use them to achieve it.

To reach the main objective, it is important to assess the combined effect characteristics-entrepreneurial competences on farmers' innovation, that can be simplified into:

farmers' innovation = farmers' characteristics + entrepreneurial competences

Farmers' innovation can be seen as a transition phase from the traditional farmer to the modern farmer (Robertson, Casali, & Jacobson, 2012). In the context of Ugandan multi-stakeholder platforms, innovation is incremental, since it does not occur in aggregate, but results from decisions within individual businesses (farms), depending on the farmer's ability to put entrepreneurial competences into practical use. Indeed, farmers' innovation first occurs at the levels of the farm, then the product and subsequently the system as a whole (Robertson et al., 2012).

Secondly, it is relevant to introduce the context, which is represented by Ugandan multi-stakeholder platforms for innovation, given that the farmers in the present study participate into them.

A definition of multi-stakeholder platforms for innovation is provided in the introduction chapter. However, it is important to highlight the distinction among this particular platform and other types of platforms, in order to avoid misunderstandings since the names of these networks are very similar to each other.

There are three main types of platforms, and to make this distinction clearer the following figure has been elaborated (***Figure 2***).

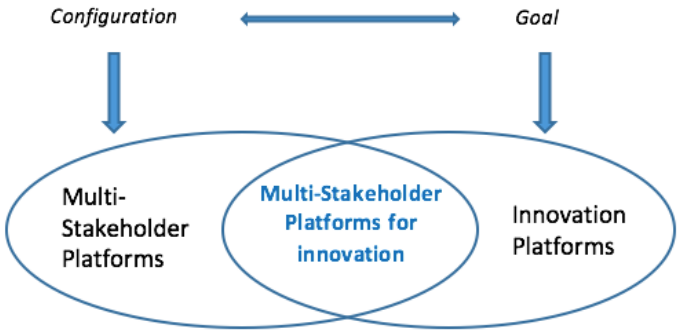

Fig. 2 Distinction between multi stakeholder platforms, innovation platforms and multi-stakeholder platforms for innovation.

The configuration determines the typology of the platform, such as the actors-roles-relations and the technical architectures as modules-functions-interfaces (Ballon, 2009). The goal represents the aim of the platform, for instance innovation, leadership creation, technology accessibility (Gawer & Cusumano, 2014). The relation between configuration and goal determines the existence of platforms with specific issues, for example platforms in which multiple actors are involved and innovation patterns are undertaken. Empirical evidence shows that the functioning of MSPs is dependent on the commitments and will of the stakeholders to contribute their skills, knowledge and time to the activities of the platform. Simultaneously, MSPs have to develop roles and responsibilities, such as awareness creation, providing labour, mobilising people and money, providing tools and equipment, providing

quality planting material and knowledge packages for their establishment and management, technology transfer and adoption, and enforcement (Eneku, Wagoire, Nakanwagi, & Tukahirwa, 2013).

In the following section, the research questions that will guide the entire study are presented.

1.2 Research Questions

A research question is a statement that identifies the phenomenon to be studied and it has to be clear, since its aim is to get valuable insights to perform the entire research (De Vaus & de Vaus, 2001). Again, the research is applied to a specific case study, which is represented by Ugandan farmers of coffee and honey productions, who participate in MSPs and receive knowledge from them.

In order to provide insights about the relation between farmers' characteristics and entrepreneurial competences with farmers' innovation, the main research question has been developed:

How are farmers' demographics, access to resources, farm size and entrepreneurial competences related to farmers' innovation in the context of Ugandan MSPs?

To give an in-depth answer to the main research question, three specific questions have been formulated. In particular, they have been divided into theoretical and empirical, depending on the methods of data collection that will be used to answer them. The specific research questions are stated below.

Theoretical question

1. To fill the gaps in the literature, which farmers' characteristics and entrepreneurial competences enhance farmers' innovation in the context of MSPs?

Empirical questions

2. What are the farmers' characteristics that significantly influence farmers' innovation?

3. What is the role of entrepreneurial competences on farmers' innovation?

1.3 Key Concepts and Definitions

A key concept is an important tool that help the reader to better understand the purpose of the whole study. In this section, five key words are listed and briefly explained, since they will be frequently used in the research.

Entrepreneurship: "*the competitive behaviours that drive the market process, and corresponds to the introduction of a new economic activity that leads to change in the marketplace*" (Nelson, 1977). In this research, the attitudes of farmers correspond to the entrepreneurial competences they have. Moreover, the relation among farmers' entrepreneurial competences and farmer's innovation will be investigated.

Farmers' characteristics: three characteristics of coffee and honey smallholders have been selected: demographics (age, gender and education level), farm size and access to resources.

Manafwa: district in eastern Uganda that lacks of developed farmer networks. Four sub-counties in this district have been chosen (Mukoto, Namabya, Bukhofu and Namboko), according to the differences in landscape, (highland, midland and lowland), since honey and coffee productions might depend on these circumstances (Joseph Tanui, 2015). Three sub-counties in Manafwa have been selected for the coffee value chain: Mukoto, Namabya, Bukhofu, which corresponds to highland, midland and lowland respectively. In addition, an extra sub-county has been considered for the coffee part, to get the estimated sample size: Namboko, which is defined as lowland. Three sub-counties in Manafwa have been selected for the honey value chain: Mukoto, Namabya, Namboko, which corresponds to highland, midland and lowland respectively. The selection of the sub-counties in Manafwa will be better described in the methodology chapter.

Multi-stakeholder platforms for innovation (MSPs): global partnership, coalition or collaboration, in which many stakeholders mobilize and share knowledge, expertise, technology and financial resources to support sustainable development, especially in developing countries (Amerasinghe et al., 2013). In this context, stakeholders are defined as actors of agricultural research and development, such as farmers, researchers, extension agents, policy makers, private firms and NGOs (Eneku et al., 2013; Tenywa et al., 2011). The aim of these platforms is to promote innovation. In the following chapters the acronym MSPs is used to indicate this particular type of platforms.

Smallholders: synonym of small farmers, who own their own farm. There are a number of characteristics common to smallholders in developing countries: they produce small volumes of products on small plots of land, have lack of resources, and are usually considered to be part of the informal economy, since they are often excluded from aspects of labour legislation, lack social protection and have scarce or no access to markets.

Value chains: the value chains that will constitute the case study of the present research are honey and coffee value chains in Manafwa district, eastern Uganda.

2. Theoretical Framework

The function of the theoretical framework is to support a theory of a research study, determining what elements to measure and what statistical relationships the researcher is looking for (Swanson & Chermack, 2013). In this study, the relationships that are analysed occur between variables. In particular, three independent variables, a dependent variable and a moderator variable have been identified as to provide an in-depth understanding of the case study. A moderator variable is a third variable that alters the direction or strength of the relationship between a dependent and independent variable (Statistics Solutions, 2016).

Farmers' characteristics represent the independent variables (X_n) and each of them is assumed to have an influence on farmers' innovation or the dependent variable (Y). The relation between independent variables and the

dependent one is influenced by a moderator variable (Z), represented by entrepreneurial competences. The moderator variable (Z) is supposed to exercises an influence on the dependent variable (Y), as well. For simplicity, in the analysis the researcher refers to entrepreneurial competences as an independent variable, since the software to perform the analysis (IBM SPSS) only uses dependent or independent variable as connotation.

There might be farmers that according to their characteristics have more entrepreneurial competences than others, and it could be that beside their own characteristics, even entrepreneurial competences can produce an effect on farmers' innovation. The relation is assumed correlational amongst X_n and Y, even though X_n and Y are not causally related to one another. The visual relationship amongst variables is depicted in ***Figure 3***.

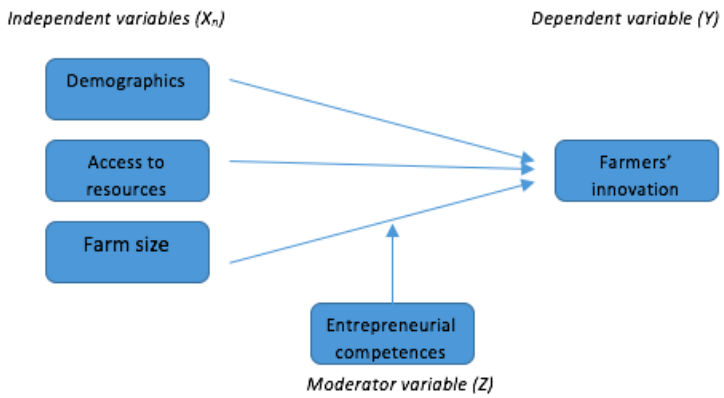

Fig. 3 Relation between variables.

Three are the elements that are part of the literature review that has been developed during the course of the whole research: farmers' characteristics, farmers' entrepreneurial competences, and farmers' innovation. These elements correspond to the main concepts presented in the research questions, and constitute the area of investigation for which the theoretical framework has been elaborated.

The first sub-chapter will provide an in-depth answer to the theoretical question. Based on the answer to the theoretical question and taking into account the relation between variables that are depicted in the theoretical framework, four hypotheses have been determined: they are presented in the second, third and fourth sub-chapters.

2.1 Answer to the theoretical question

Despite the gaps in the literature, which farmers' characteristics and entrepreneurial competences enhance farmers' innovation in the context of MSPs?

The theoretical question has been developed to get insights on the present research from a theoretical perspective.

The study focuses on farmers of Ugandan coffee and honey value chains, participating in multi-stakeholder platforms for innovation and receiving knowledge from them. It has been already stated that MSPs can be an efficient network for smallholders to overcome different types of constraints such as high transaction costs, institutional constraints and lack of knowledge (Helmsing et al., 2009), thereby promoting farmers' innovation (Abate et al., 2011).

In the present research MSPs will not be considered as networks that provide farmers with different solutions as to overcome the aforementioned constraints. For instance, whether technology is a constraint, partnerships can offer smallholders governmental research or encourage buyers in working directly with them and transferring technology to improve their value chain; if producer organizations are considered as to be a constraint, partnerships can also encourage new farmers' groups or strengthen existing ones, providing strategic capacities, leadership programmes, managerial and financial skills (Helmsing et al., 2009).

MSPs in the present study will be rather considered as networks that facilitate knowledge sharing among Ugandan coffee and honey smallholders.

The next sections will provide a description of the main information that has been found in the literature. Providing that a gap of information exists if the context, thus MSPs, is considered, farmers' characteristics (partly) and entrepreneurial competences will be self-explanatory in the following literature study, meaning that they will not be presented in relation to MSPs, but they will find a broader explanation that considers developing countries only.

Hence, in response to the theoretical question, farmers' characteristics and entrepreneurial competences that have revealed a particular significance on farmers' innovation in developing countries are listed and explained.

Farmers' characteristics. Few literature reports that farmers participating in MSPs in developing countries can adopt innovation within their value chains more or less easily, according to their characteristics (Leach et al., 2002; Narrod et al., 2009). Additional literature reports that some characteristics can impact the success of MSPs (Galbreath, 2005; Martey et al., 2014).

Some studies demonstrated that gender plays an important role in decision making, if innovation adoption of new technologies is considered (Adesina, Mbila, Nkamleu, & Endamana, 2000). Generally, in sub-Saharan Africa, women have more difficulty than men in obtaining labour in the agricultural sector (Doss & Morris, 2000). Easy access to agricultural resource by male-headed households makes them more adaptive to new innovations and technology compared to female-headed households (Martey et al., 2014).

Previous studies, showed that age has a negative relationship with adoption; more precisely, younger farmers are more disposed to innovate compared to the older ones (Adesina et al., 2000). This statement is also confirmed by Thangata and Alavalapati (2003), who demonstrated that age is negatively associated to the adoption of a new agroforestry practice, meaning that innovation adoption practice falls with increasing age. These results support the findings on the adoption of social forestry in India by Alavalapati, Luckert, and Gill (1995), adoption of live hedges in Burkina Faso by Ayuk (1997), alley farming adoption in the southwest Cameroon by Sonwa et al. (2001), and cocoa adoption in Ghana by Boahene, Snijders, and Folmer (1999).

The education level of the farmer is usually expected to have a positive impact on the decision making process, and this translates into the capability of an educated farmer to better understand the benefits of a certain agricultural practice compared to an uneducated farmer (Thangata & Alavalapati, 2003). However, this is not always true. Researchers showed that the adoption of a new agroforestry technology does not depend on the education level of the farmer, but mostly on the external contacts or network that the farmer has on his own (Adesina & Baidu-Forson, 1995; Doss & Morris, 2000; Weir & Knight, 2004).

There are other elements that have been frequently identified as being influential in determining the adoption of an agricultural innovation: farm size, human capital (human resources), credit constraints (financial

resources) and tenure (physical resources) (Zeller, Diagne, & Mataya, 1998). In particular, Zeller et al. (1998) showed that in Malawi the probability of actively participating in an innovative program rises with increasing land possession, but at a decreasing margin. In addition, they found in their research that the more the farmer has access to physical and financial resources, the more the farmer is disposed to take part into an innovative program.

There are only a few studies exanimating the relationship between human resources and innovation in developing countries (C. Dahlman, Frischtak, & Nelson, 1993). However, most findings show that in emerging economies, the resources and capabilities that generate competitive advantage are usually intangible assets, such as human capital (Barney, 1991). Furthermore, empirical evidence showed that most critical element of any successful innovation is the development of human resources (C. J. Dahlman & Nelson, 1995).

Entrepreneurial competences. Entrepreneurship "*is considered to be an important mechanism for economic development through employment, innovation and welfare effects*" (Acs, Desai, & Hessels, 2008).

What the literature affirms is that in developing countries entrepreneurial competences could lead to innovation (Fernald & Solomon, 1987; Schumpeter, 1966; SCHUT et al., 2015). However, the literature does not report whether this is true in the context of MSPs.

Naudé (2010) highlights the great potential that entrepreneurial competences have in developing countries, who shows that the higher number of demand for entrepreneurial competences in developing countries is matched by the higher rates of opportunity-motivated entrepreneurs entering the market.

In a context as Sub-Saharan Africa, what really matters to farmers, beside adopting innovation within their value chains, is alleviating rural poverty and overcoming the constraints they face (i.e. transaction costs). Beside the positive effect that entrepreneurial competences have on farmers' innovation in developing countries, the literature describes the potential that entrepreneurship has in solving these problems (Helmsing et al., 2009). Hence, the aforementioned findings could serve as a support for MSPs to use farmers' entrepreneurial competences not only to promote innovation in Ugandan value chains, but also to help farmers facing different issues. An in-depth literature review has been carried out to investigate the role that entrepreneurship has in emerging economies and how researchers measured its potential (*see* sub chapter 2.3).

The existing lack of information in the literature lead the researcher to attempt to cover this gap by analysing different traits that characterize a good entrepreneur or, in other words, their entrepreneurial competences.

Farmers' innovation in the context of MSPs. The literature suggests that raising agricultural productivity via innovative patterns, and thus improving rural welfare, remains a fundamental challenge in sub-Saharan Africa (Dercon & Hill, 2009), and especially in MSPs. However, adopting innovation is fundamental in Sub-Saharan value chains, in order to contribute to sustainable socio-economic development.

As previously mentioned, in the context of MSPs, innovation occurs through the collective interplay among different stakeholders, and it is not just about technology, but it also includes social and institutional change (Stuiver, Leeuwis, & van der Ploeg, 2004). Innovation originating from MSPs has not always been mapped by researchers, and in this regard, innovation platforms largely remain "black boxes" (Stuiver et al., 2004). Thus, to better understand innovation processes and what types of innovations have derived from MSPs, there is need for some more robust

analysis of the dynamics of innovation, while keeping the focus on the entrepreneurial patterns that positively influence innovation itself (Hounkonnou et al., 2012).

According to Micheels and Gow (2008), innovation derives from the implementation of new ideas generated through entrepreneurial competences, and these competences correspond to the ability of farmers to put innovation into their products, processes and markets (product, process and market innovation).

Certainly, innovation would not just depend on entrepreneurial competences, if they turn to produce a positive impact on it. Innovation rather corresponds to the alignment of hardware as technology, software as new modes of thinking, and orgware as new institutions and socio-organizational arrangements (Stuiver et al., 2004). In this instance, entrepreneurial competences can be meant as the software area, where new modes of thinking and learning processes underpin its role in the context of MSPs. The aim of MSPs in developing countries is to promote innovation in all its aspect (hardware, software and orgware), but in the present research the focus will be only put on entrepreneurial competences or software. In order to depict how innovation is promoted by and through MSPs, a schematic view of how MSPs are operating in Ugandan honey and coffee value chains is reported in ***Figure 4***. It is assumed that system A and system B correspond to farmers before and after the innovation process, respectively.

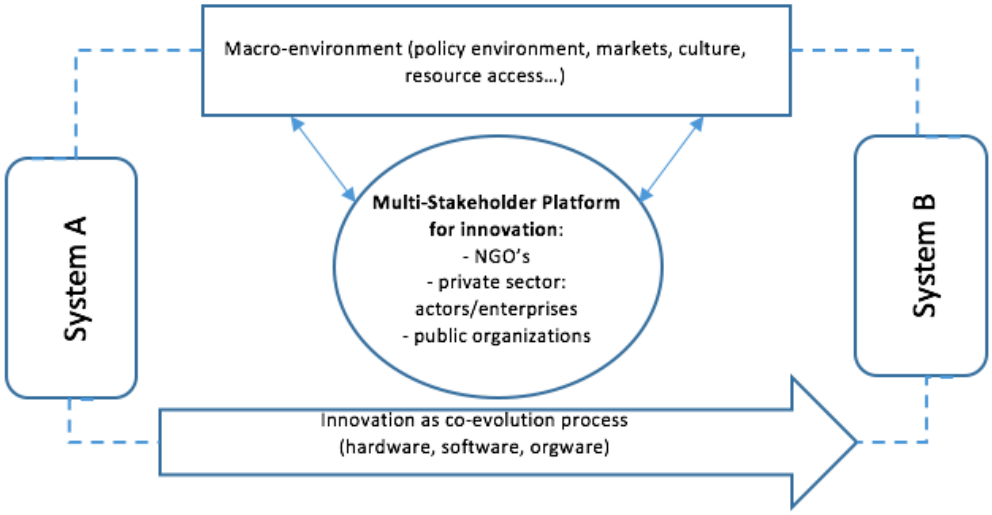

Fig. 4 Analytical framework: multi-stakeholder platforms promoting innovation.

Source: own elaboration based on Smits (2002), Stuiver et al. (2004), and Kilelu, Klerkx, and Leeuwis (2013).

There is, however, a growing recognition that innovation is not a linear process especially when researchers, agribusinesses and NGOs pass knowledge to farmers, who in turn should adopt innovation (Waters-Bayer et al., 2009). This is the reason why innovative patterns failed to be applied to specific value chains in developing countries (Schreiber, 2002).

Nevertheless, researchers showed that farmers have valuable knowledge to adopt innovation, but in order to make this adoption efficient, they need all actors' effort. Empirical evidence showed that through joint reflection of NGOs, enterprises, public organizations and researchers, innovation can be enhanced (Waters-Bayer et al., 2009). Furthermore, MSPs have not only to stimulate all actors to share new knowledge, but they also have to identify and

recognize innovation developed by local people, actively participate in the innovation development (at the field level), and join forces of the different stakeholders involved to bring about policy and institutional change.

Spielman, Ekboir, and Davis (2009) stated that "*although the development of new agricultural practices and their adoption by small-scale farmers followed different paths than for large-scale farmers, the paths shared one important common feature: all successful programs resulted from networks that worked with participatory research approaches*". Theoretical evidence showed that in order to adopt innovation, smallholders in Sub-Saharan Africa should develop a good mind-set to learn something new, know the role of the innovation they will implement and have an overview of physical and financial access to inputs (Wall, 2007).

Innovations deriving from MSPs in Sub-Saharan Africa. Yirga and Teferi (2010) report that in Ethiopia a multi-stakeholder platform for innovation has been operative since 2003 and its aim is to boost farmers' innovations, connecting farmers with communities and formal research and extension. Some of the farmers participating into this network experienced innovation within their value chains thanks to the help of external actors. During one of the workshops developed in Tigray, Ethiopia, a woman participating into an innovation platform was given a beehive; she observed it carefully and she decided to improve it afterwards, using mud and dung. Her modified beehive was able to regulate the temperature, it insulated better against sound and the production of honey was higher compared to that of the modern beehive (Yirga & Teferi, 2010). In the same area, other innovative farmers have managed to develop better methods of producing more and higher-quality honey, rearing honeybee queens and producing new bee colonies (Abebe & Puskur, 2011). Thus, they could increase their incomes and pull themselves against poverty (Abebe & Puskur, 2011).

In different areas of sub-Saharan Africa, beekeeping developed sustainable management of the natural resources that provide bee fodder.

Araya, GebreMichael, GebreAmlak, and Waters-Bayer (2006) described that during an exhibition in Mekelle, capital of Tigray Region, innovative farmers participating multi-stakeholder platforms and research institutes were asked to present their technologies. Farmers that attended the exhibition explained that they appreciated very much technologies that promise high yield, but at the same time, they wondered if the qualities of the technologies together with the knowledge behind them were also valuable. Indeed, by knowing the source of knowledge they could better say if they would be able to apply the new ideas easily in their own setting. Furthermore, farmers were more interested in seeing improved technologies from other farmers, rather than from research institutes, since they were easy to obtain or to make from local materials, cheap, easy to understand, flexible for different conditions and easy to modify or repair (Araya et al., 2006).

In Soro, Ethiopia, heterogeneous network provided smallholders with a great diversity of options in accessing information, inputs, credits, or other resources, and how certain actors play can bridge functions in making these options available to smallholders. Heterogeneity in this network allows for more integration among actors, which in turns translates into a big number of livelihoods options and opportunities for smallholders in Soro (Spielman, Davis, Negash, & Ayele, 2011)

Constraints that MSPs face in Sub-Saharan Africa. Besides the positive inputs that MSPs bring by leading farmers to innovate, implications have to be considered as well. In Uganda, for instance, a team of researchers

demonstrated that putting the innovation system concept into practice is very difficult. Farmers did not always use the technologies they were given and the capability to innovate was missing. Researchers have experienced that putting local people's perspectives at the centre of the research efforts creates ownership and effective collaboration with outsiders (Probst, Hagmann, Fernandez, & Ashby, 2003). What is needed is a "systemic" learning, which does not go via books and short exposures, but through learning by doing. Alongside the practical experience that farmers should have, they also have to mature a more reflective and critical perspective, in order to enable them to continue the learning process and prevent them from falling back into the old routines (Sanginga, 2009).

Summarizing, the stakeholders operating within an innovation platform need to be aware of the great distance between the drawing board, where ideas for innovation are conceptualized, and the reality of working in the farmers' fields. This can help them to better redirect their abilities to enrich farmers with an innovative mind-set, not only in terms of doing but also in terms of evaluating and self-criticizing their work.

2.2 Farmers' characteristics

Farmers' characteristics can influence the way of adopting change or innovation within farmers' value chains (Leach et al., 2002; Narrod et al., 2009). Demographics, farm size and access to resources have been chosen as Ugandan farmers' characteristics.

Demographics correspond to age, income level, employment, marital status, gender and education level. In this research age, gender and education level will be taken into consideration.

Income level, employment and marital status will not be analysed. Overall, individuals' employment is clearly stated in the present study and corresponds to farmers of coffee and honey value chains. Wejnert (2002) does not mention marital status as being one of the variables affecting the way of adopting innovation, whereas age, gender and education are. Although income level is a variable that is likely to influence farmers' innovation, one of the purposes behind the research is to consider innovation adoption as something deriving from an individual's attitude, rather than from their economic welfare. At the same time, the variables access to resources and farm size can give an approximate indication of it, since big farm sizes or resource-abundant farmers are likely to reflect high income (Delgado & Siamwalla, 1997).

The next paragraphs describe the farmers' characteristics that have been selected to perform the research. According to Diamantopoulos, Schlegelmilch, Sinkovics, and Bohlen (2003), socio-demographic characteristics are the key profiling variables in doing research, due to their ease of measurement and application. Age, gender and education level have been chosen as demographics, since empirical evidence shows a correlation between these characteristics and farmers' innovation in developing countries (Adesina & Baidu-Forson, 1995; Doss & Morris, 2000; Weir & Knight, 2004).

Access to resources is another important characteristic to include in the research, since not all farmers in sub-Saharan Africa have the same availability of resources and this issue can have an impact on the efficiency of their value chains. A study conducted in Kenya and Uganda by Tittonell et al. (2010) proposes a categorisation of household diversity based on resources endowment of land, livestock and labour. The authors indicated farms with large, medium and low resource endowment. In particular, the different access to resources and cash together with different soil management over long periods of time reflected on the farms under investigation, which in turn had

different soil carbon and nutrient stocks. In this research, resources will be categorized into two different blocks: on the one hand tangible resources, on the other intangible ones. According to Grant (1991), the tangible resources are represented by financial and physical assets: credit, artificial fertilizers/bee hives, seedlings/bees and networks are tangible resources in the Ugandan context. The intangible resources correspond to human resources and intellectual capital (Bontis, Dragonetti, Jacobsen, & Roos, 1999), organizational and relational capital (Fernández, Montes, & Vázquez, 2000).

Farm size corresponds to the average dimension of a smallholder's farm. In many developing countries the average farm size is relatively small (i.e. sub-Saharan Africa 2,4 hectares), which implies that the agricultural sector is dominated by owner-operated family units that combine ownership of agricultural equipment with management (Deininger & Byerlee, 2012). Although, smallholder agriculture is having a great potential in generating economic growth and reducing poverty, there is increasing demand for expanding smallholders' farm size, especially if farmers participating into partnerships are considered (Deininger & Byerlee, 2012). Zeller et al. (1998) showed that in Malawi the probability of actively participating in an innovative program rises with increasing land possession, but at a decreasing margin.

With regard to the findings about farmers' characteristics and to the purpose of the present study, three hypotheses have been formulated.

H1: *Age, gender and education level have an effect on farmers' innovation.*

- *the increasing in age has a negative effect on farmers' innovation*
- *men are more disposed to innovate compared to women*
- *higher education levels have a positive effect on farmers' innovation*

H2: *A big farm size has a positive effect on farmers' innovation.*

H3: *Access to resources has a positive effect on farmers' innovation.*

2.3 Farmers' entrepreneurial competences

Farmers' entrepreneurial competences in developing countries is not a totally new concept (Acs et al., 2008; Azmat & Samaratunge, 2009; Beck, 2009). However, gaps in the literature still exist about entrepreneurial competences as the means to innovation, and even more if entrepreneurial competences are analysed in the context of MSPs.

Assessing the role that farmers' characteristics together with entrepreneurial competences have on farmers' innovation helps the researcher to determine if entrepreneurial competences produce a more positive effect when combined with certain characteristics rather than others.

Micheels and Gow (2008) argued that innovation deals with changes in routines and that entrepreneurial competences can be considered as one of the inputs to innovation in emerging economies. Assuming that innovation and innovativeness are used as synonyms, they stated that the entrepreneurial nature of the manager could have a

positive effect on the innovativeness of a value chain. According to Micheels and Gow (2008), innovation derives from the implementation of new ideas generated through entrepreneurial competences, and improves value chains' efficiency through a technological innovation or product offerings through an externally oriented innovation.

Other findings report that the fundamental reason that lead entrepreneurs to innovate is represented by profit motives (Naudé, 2010).

In the present study, innovation and innovativeness are not used as synonyms. Indeed, innovativeness deals with the capability of a farmer to introduce changes in their value chain, while innovation corresponds to the farmer's adoption of these changes. Findings in the literature affirms that entrepreneurial competences have a positive effect on innovation (Krauss et al., 2005; Micheels & Gow, 2008). However, measuring entrepreneurial competences is not easy, especially in contexts such as developing countries, where they still represent a challenge for local communities to implement.

Lai et al. (*unpublished*) used the personality trait approach to measure entrepreneurship and they selected need for achievement, autonomy, innovativeness and risk-taking as the most valuable for the purpose of their study.

Micheels and Gow (2008) measured the entrepreneurial proclivity by using a scale made up of seven items (i.e. on our farm, we like to implement plans only if we are very certain they will work; when it comes to problem solving, we value creative new solutions more than the solutions of conventional wisdom; etc.).

Krauss et al. (2005) developed a study upon entrepreneurial orientation (EO) in southern Africa and they affirmed that EO together with its components are valuable predictors for business innovation. In the research, the components of EO corresponded to personal initiative, achievement-taking orientation, risk-taking orientation, innovative orientation, learning orientation, autonomy orientation and competitive orientation.

Furthermore, George, Kotha, Parikh, Alnuaimi, and Bahaj (2015) identified intentions as being an additional measure to evaluate entrepreneurial behaviour, while conducting their research among households in Kenya.

With regard to the findings about entrepreneurial competences and their role in the conceptual framework, the following hypothesis is formulated:

H4: *Entrepreneurial competences have a positive effect on farmers' innovation, when interacting with the selected farmers' characteristics.*

2.4 Farmers' innovation in the context of MSPs

Assefa (2003) provided a definition of innovative farmers: *"those farmers who have been trained by extension workers may also be recognized as innovators, when they are dealing with the incoming knowledge/technology by improving it or making it fit the local situation or blending it with pre-existing practices or technologies and ending up with a new way of using the knowledge or technology. […] Innovative farmers add value to existing practices through creative engagement and experimentation and with a passion to seek changes that have economic, social and environmental significance".*

Farmers' innovation is related to the capability of smallholders to put the knowledge they receive through organizations, researchers or agribusiness companies into practical use, as well as to the drivers that characterize

them (Helmsing et al., 2009; SCHUT et al., 2015). In the present study, the focus will be put onto innovation as adoption. Adoption refers to the individual level. Farmers get the knowledge from MSPs, whose aim is to promote innovation, in order to build an innovative mind-set for managing their value chains. Innovation as adoption indicates the generation, development, implementation and adaptation of new ideas (Damanpour & Wischnevsky, 2006), by farmers participating in Ugandan MSPs. In other words, the generation, development, implementation and adaptation of new ideas correspond to the capability of the farmers to re-use knowledge from MSPs, thereby adopting innovation within their coffee and honey value chains.

Farmers in developing countries, such as sub-Saharan Africa could either decide to innovate themselves or to be driven in the innovation process, in order to improve their value chains. In the first instance, it has been shown that many of the outstanding innovators are the farmers who have more access to resources; at the same time, smaller improvements of farmers with fewer resources are overlooked. In the second case, farmers are willing to be driven in the innovation process because most of them do not possess all the necessary capabilities and resources to enter a more structured agricultural system. In particular, MSPs could play an important role to stimulate farmer-to-farmer communication and develop new knowledge among local communities (Reij & Waters-Bayer, 2014). With regard to MSPs, for instance, smallholders could integrate into well-structured systems where the actors contribute resources and expertise they lack. As a consequence, smallholders usually become more confident in managing the new aspects that will characterize their value chains, such as knowledge, technology and networks. Then, stakeholders and smallholders have to collectively exchange information and resources in order to make the MSP effective (Spielman et al., 2009).

An approach that different networks use to promote farmers' innovation in sub-Saharan Africa is known as Technology Supply Push (TSP). TSP focuses on technology transfer to enhance the productivity of value chains, and assumes that in order to increase yield, research is needed to make farmers gathering most of its results (Hounkonnou et al., 2012). However, TSP as a stand-alone concept is not sufficient, as for the knowledge that smallholders receive from MSPs. Indeed, farmers have to be *"knowledgeable, skilled, motivated, and empowered, and have participated in developing technologies that are suited to their circumstances and farm management objectives; but if opportunity is lacking, these technologies still allow only marginal improvement"* (Hounkonnou et al., 2012).

In this research, farmers' innovation deals with the ability of a farmer to adopt something new to improve their own value chains in Uganda. Innovation as adoption can be measured at the individual farm level in a given time period by the amount of farm area using the new technology or by the per hectare quantity of input used (Feder, Just, & Zilberman, 1985). In other words, measures of innovation as adoption indicate both timing and extent of new inputs by farmers (Sunding & Zilberman, 2001). In the present study, product, process and market innovation represent the measures to evaluate farmers' innovation in Ugandan coffee and honey value chains.

In this study, it is assumed that farmers' characteristics have an influence on farmers' innovation, as well as farmers' entrepreneurial competences, in the context of MSPs. This assumption give importance to innovation intermediaries or brokers, since they connect farmers and actors, facilitating multi-stakeholder interaction in innovation (Klerkx, Hall, & Leeuwis, 2009). As stated by Martey et al. (2014), MSPs can create a space for learning and joint innovation in a value chain as innovation intermediaries or brokers, thus helping farmers in boosting their capability to innovate. In this study, the role of intermediaries or brokers was represented by enumerators, who connected farmers and researchers during the data collection in the field, thereby helping the researchers to fulfil

their objective. Beside the enumerators, also the actors working inside MSPs are innovation intermediaries or brokers, since they facilitate interaction in innovation with the farmers of coffee and honey productions.

3. Research Framework

The research framework displays the research process, and it consists of four phases: 1) *theoretical*, in which an in-depth literature review has been carried out; 2) *empirical*, which deals with the hypothesis generation, thus the conceptual framework, and lists the data collection methods; 3) *analysis*, where sub-questions are answered and data from the questionnaire will be analysed; 4) *conclusion*, in which the main question is answered by combining all the results. The research framework for this study is depicted in ***Figure 5***.

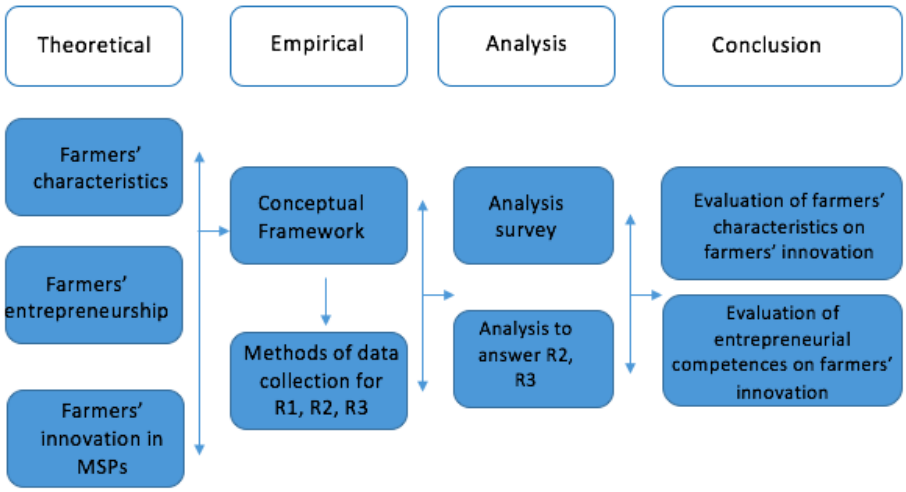

Fig. 5 Research framework

4. Methodology

The aim of the study is to assess the role that farmers' characteristics and entrepreneurial competences have on farmers' innovation, in the context of Ugandan multi-stakeholder platforms.

Beside the description of the project for which the present research has been carried out, the methodology chapter also lists the development of the research sample (sub-chapter 4.1), the operationalization of the main concepts such as entrepreneurship and innovation (sub-chapter 4.2), the questionnaire (sub-chapter 4.3), and the Confirmatory Factor Analysis as the first step or *ex-ante* part of the data analysis (sub-chapter 4.4).

Project background. The present study is part of a broader project that will be developed thanks to a collaboration between Makerere University (KADLAC, NaFORRI), World Agroforestry Centre (ICRAF), Adelaide University and Wageningen University, and is mainly supported by the Australian Centre for International Agricultural Research (ACIAR). The project has a duration of four years and its objective is to evaluate, after a four-year period, if multi-stakeholder platforms for innovation are an efficient tool to develop farmers' innovation in Uganda, by investigating smallholders' willingness and capability to use the knowledge that they have received from different actors.

Furthermore, the project has a particular focus on under-representative social classes, such as young and women, and it aims at giving them more independence and power.

Research boundaries. This study will take into consideration a timeframe of approximately six months and represents the first step of the project. Indeed, it could provide relevant information about the relation that farmers' characteristics and entrepreneurial competences have on farmers' innovation. At the same time, if the relation among entrepreneurial competences and farmers' innovation is positive, insights for Ugandan MSPs could be made as to make them using farmers' entrepreneurial competences for achieving farmers' innovation.

Study area. The case study that will be analysed is developed in Manafwa district, which is located in the eastern part of Uganda, and is site of the main municipal, administrative and commercial centres in the Elgon sub-region. However, Manafwa district is still experiencing weaknesses in developing a solid network with multiple actors (Joseph Tanui, 2015). The study region is characterised by heavy rainfalls with a moderate bimodal pattern ranging from 1500-2000 mm from April to October with peaks in May and July/August and minimum in June (Eneku et al., 2013). Elgon sub-region has three major topographic areas: highland, midland, lowland. The lowland areas are covered by savannah grassland; midlands are characterized by tropical rainforest vegetation; highland zones are mostly covered by Mt. Elgon National Park with the alpine mountain vegetation. These zones have different impacts on coffee and honey productions. Therefore, it might be important for the data collection phase to make this distinction clear, as to be aware of the different characteristics that the selected sub-counties have in landscapes and consequently on the impact that they have coffee and honey productions (Joseph Tanui, 2015). The rural communities mainly depend on subsistence farming, and the major crops are coffee, maize, beans, wheat, cassava, potato and sweet potato; apart from farming, they also keep livestock. The region is characterized by fertile soils, even though there is high incidence of soil erosion due to the steep hilly slopes and poor farming methods (Eneku et al., 2013).

Case study. The units of analysis are represented by smallholders producing coffee and honey. Besides the fact that honey and coffee value chains have been selected as case study by the ACIAR project, they are particularly interesting from an economic, technical and social perspective. In Uganda, coffee is a commodity and farms that produce coffee are specialized only in this type of culture; while honey is a niche product that is mainly considered as a "side-product" besides other major productions.

In particular, coffee contributes to around 30% of foreign exchange earnings and Uganda is the second exporter of coffee in Africa, after Ethiopia (UNDP, 2012a). However, pest and diseases, volatile market prices and poor agricultural practices often threaten this crop. The average cultivated land for coffee is 0.5 hectares per household in Uganda, and men and women have different tasks: men prepare the land, do pruning and engage in marketing aspects, whereas women do weeding. There is a little presence of youth, which is attributed to their preference to quicker income generating activities. The supply chain is particularly long and smallholders get only a small portion of the total profit (UNDP, 2012a). As far as honey production concerns, farming is still based on low yields and traditional methods, which represent the main reasons of smallholders' incapability to emerge the national Ugandan market (UNDP, 2012b). Nevertheless, Manafwa is located in the eastern part of Uganda, where the highest production of honey is registered (around 600 Mt per year), meaning that if MSPs provide farmers with knowledge and new technology, the opportunity for smallholders to have access to the Ugandan honey market increases (UNDP, 2012b).

Data collection and analysis. To evaluate the relation between farmers' characteristics together with entrepreneurial competences and farmers' innovation, two tools have been used: an in-depth literature review to answer the sub-question 1, and a survey to answer the sub-questions 2 and 3.

Literature review: desk research is completely based on existing literature and materials gathered by others. The most relevant papers have been analysed and used as systematic support to compare what was already found by various authors and what has been found during the course of this research (*see* sub-chapters 2.1, 2.2, 2.3, 2.4).

Survey: a survey was performed in order to collect as many responses as possible, thereby increasing the reliability of the answers. The data have been analysed via the software IBM SPSS and IBM SPSS Amos 23, afterwards.

A quantitative data analysis has been performed. It is important to mention that the first step of the data analysis consists in performing a Confirmatory Factor Analysis (CFA). In the present research, performing a CFA can also be considered as the *ex-ante* part of the data analysis, since it has been used to prove whether the constructs to measure entrepreneurial competences in the literature were good measures in the context of Ugandan coffee and honey value chains. In other words, performing a CFA before starting with the Multiple Regression Analysis (MRA) is important as to check whether the findings about entrepreneurial measures in the literature are supported or not in the study.

The analysis itself was helpful to detect questionnaire items or even whole measures of entrepreneurship that have been found to be not significant in Ugandan coffee and honey value chains, thereby resulting inadequate for measuring entrepreneurship in the Ugandan context. Contrary, the measures and questionnaire items that resulted significant while performing the CFA have been used to carry out a set of linear regressions afterwards, which permitted to obtain the main findings of the study.

4.1 Research Sample

The sample that was used in the present research has been developed with the collaboration of the World Agroforestry Centre (ICRAF Uganda) and Makerere University, right before the data collection started in Manafwa district, and in particular in the selected sub-counties. The research sample has been developed according to the feasibility of the data collection phase, such as time constraints, financial resources and reliability of the results.

As far as the sample for the coffee producers concern, the aim was to get at least 30 coffee farmers per sub-county, totalling 90 coffee farmers, with a margin of ten farmers to reach the amount of 100. As far as the sample for the honey producers concern, the aim was to get at least 15 honey farmers per sub-county, totalling 45 honey farmers, with a margin of five to reach the amount of 50. Finally, a sample of 100 coffee farmers and 52 honey farmers was defined.

During the definition phase of the research sample, it was not possible for the researcher to detect heterogeneity among farmers. Hence, the major challenge in the data collection phase was to avoid homogeneity among answers. Based only on the three conformations of the land (lowland, midland and highland) that can have different impacts on coffee and honey productions (Joseph Tanui, 2015), few heterogeneities among farmers' answers could have been obtained in advance.

It is important to mention that the respondents have been participating in Ugandan MSPs since July 2016. Since similar research was not conducted upon farmers participating in Ugandan MSPs until July 2016, information about them were not available when the data collection phase of the present research started in December 2016. In particular, it was not possible to identify in advance heterogeneity amongst farmers about their perceived level of innovation and their entrepreneurial competences. This condition represented not only a challenge for the study, but it can be also seen as a limitation.

The farmers producing coffee were located in Mukoto (32), Namabya (30), Bukhofu (31) sub-counties, which are characterized as highland, midland and lowland respectively. In order to reach a sample of 100 coffee farmers, 7 farmers have been identified in an additional sub-county, which has been used as a site to collect answers from honey farmers: Namboko (lowland). Beside coffee respondents, 52 answers from honey farmers have been collected. The respondents were located in Mukoto (21), Namabya (15), Namboko (16) sub-counties, which are characterized as highland, midland and lowland respectively.

The questionnaire was not addressed to a specific category of coffee and honey farmers. Hence, there is not a balanced proportion amongst the respondents between gender, age groups, education level, farm size and their access to resources. Hence, for the farmers' characteristics, heterogeneity was registered, contrary to the perceived level of entrepreneurship and innovation of the respondents, whose most answers followed the same direction. From the descriptive statistics, it emerged that males represent the majority of the respondents. Most farmers are between 31 and 50 years of age; the level of education corresponds to primary or secondary the most; the size for coffee and honey vale chains, and in particular for the honey one, is relatively small; everyone has more or less access to resources, but just a few have access to the physical ones, such as artificial fertilizers for the coffee part and equipment to keep the bees for the honey part.

4.2 Operationalization of concepts

Two main concepts will be measured in the present research: entrepreneurial competences and farmers' innovation. The literature provides a solid support for measuring them.

To evaluate entrepreneurial competences, an integration of three different papers has been carried out. In the papers, the researchers explained how to measure entrepreneurial competences in developing countries. The papers are "Entrepreneurial orientation: a psychological model of success among southern African small business owners" (Krauss et al., 2005), "Adapting the measurement of youth entrepreneurship potential to the context of Mindanao, Philippines" (Lai et al., *unpublished*), and "Social structure, reasonable gain, and entrepreneurship in Africa" (George et al., 2015). Among these papers, George et al. (2015) developed a measure that differs from the measures presented in the other two, which corresponds to intention. Krauss et al. (2005) identified seven measures for entrepreneurial competences: personal initiative, achievement-taking orientation or proactiveness, risk-taking orientation, innovative orientation, learning orientation, autonomy orientation, competitive orientation. Lai et al. (*unpublished*) selected four measures: need for achievement, autonomy, innovativeness, risk-taking propensity. Because achievement, innovativeness and risk-taking are the measures that are mainly used to assess entrepreneurial competences, they will constitute together with intentions the blocks on which the questionnaire items will be built. Intention is not often mentioned in the literature as a measure of entrepreneurial competences. However, it would be

interesting to include this category, in order to provide insights for using intention as an additional measure of entrepreneurial competences, thereby giving further support to George et al. (2015)'s findings.

The measurement model for entrepreneurial competences includes 16 questionnaire items. Under the blocks innovativeness, risk-taking and proactiveness, the items have been developed through an integration of those used by Krauss et al. (2005), and Lai et al (*unpublished*). Under the block intentions, the items have been developed according to the findings presented in George et al. (2015)'s paper.

Farmers' innovation will be measured in terms of product, process and market innovation, according to the ability of farmers to adopt something new to improve their value chains in one or more of these aspects. Hence, product, process and market innovation will be measured as part of a broader concept that is innovation adoption, as mentioned in chapter 2.4. In order to provide a better understanding of the different types of innovation, additional literature has been consulted and presented in the following paragraphs.

Wu and Pretty (2004) stated that farmers' innovation in terms of product deals with changing production inputs, which in turn results into different or improved characteristics (i.e. quality) in the end product. Process innovation corresponds to the capability of implementing significant changes in techniques or equipment, in order to build a new or significantly improved production or delivery method. Both formal networks as researchers, NGOs, processors, traders, retailers, and informal networks, such as farmers, can positively contribute to process innovation (Yang, 2013). Market innovation deals with improving the mix of target markets, by looking at new potential markets and new potential ways to serve them (Johne, 1999).

One questionnaire item per type of innovation was developed. However, for process innovation two questionnaire items originated. Indeed, as the literature reported, two networks contribute to process innovation, named formal and informal networks. By developing two questionnaire items, it was possible to assess whether farmers were more disposed to adopt innovation (i.e. production practices) under suggestion of other actors in their value chain or under suggestion of fellow farmers, respectively.

The operationalization for measuring farmers' entrepreneurial competences and innovation is depicted in **Table 1**. This table depicts the concept that was measured, the measure used, the corresponding questionnaire item and the paper from which the questionnaire item was developed.

Concept	**Measure**	**Literature**	**Questionnaire item**
Farmers' innovation	Product Innovation	"Social connectedness in marginal rural China: The case of farmer innovation circles in Zhidan, north Shaanxi" (Wu & Pretty, 2004)	17. I have improved the use of my production practices in my coffee/honey farm to improve the quality of my coffee/honey, in the past five years
	Process Innovation$_1$	"An empirical research on farmer innovation in agriculture industrial clusters" (Yang, 2013)	18. I have improved my production practices, because other fellow farmers suggested it to me, in the past five years
	Process Innovation$_2$	"An empirical research on farmer innovation in agriculture industrial clusters" (Yang, 2013)	19. I have improved my production practices, because other actors in my value chain suggested it to me, in the past five years
	Market Innovation	"Successful market innovation" (Johne, 1999)	20. I have changed where I sell my coffee/honey production in the past five years

Entrepreneurial competences	Innovativeness	"Entrepreneurial orientation: a psychological model of success among southern African small business owners" (Krauss et al., 2005), "Adapting the measurement of youth entrepreneurship potential to the context of Mindanao, Philippines" (Lai et al., *unpublished*)	21. I always like to search for the latest information and technology
			22. I like to try new technology in my farm
			23. If there is an improvement in my coffee/honey product, I am willing to change where I sell it
			24. I am willing to include new high-yielding varieties/more bee hives in my farm, to satisfy more customers.
	Risk-taking	"Entrepreneurial orientation: a psychological model of success among southern African small business owners" (Krauss et al., 2005), "Adapting the measurement of youth entrepreneurship potential to the context of Mindanao, Philippines" (Lai et al., *unpublished*)	25. I would keep my current varieties/bee hives in the farm, rather than substituting them with others that I do not know
			26. I prefer avoiding to do an investment in my farm, if I do not know the benefits that I will get
			27. I do not want to enlarge my farm, because I do not want to incur more costs
			28. If someone suggests me to include more high-yielding varieties/bee hives in my farm, I will do it and I take great risk (chances for very high profits)
	Proactiveness	"Entrepreneurial orientation: a psychological model of success among southern African small business owners" (Krauss et al., 2005), "Adapting the measurement of youth entrepreneurship potential to the context of Mindanao, Philippines" (Lai et al., *unpublished*)	29. I am willing to start practices that other farms do not do yet
			30. If asked to adopt another type of farming technology, I am one of the first farmers to use it
			31. For my job, I perform above and beyond expectations, but there is always something more to be done or improved
			32. I do not mind failing if I learn something different from another coffee/honey farming practice
	Intentions	"Social structure, reasonable gain, and entrepreneurship in Africa" (George et al., 2015)	33. I intend to start a new coffee-honey-related business in the next three years (i.e. trading, processing)
			34. I intend to include a new technology to increase the yield of my coffee/honey productions in the next three years.
			35. I intend to expand the contacts with other actors in my value chain in the next three years
			36. With my credit and savings, I intend to enlarge my farm with only coffee/honey production in the next three years

Table 1 *Operationalization of farmers' innovation and entrepreneurial competences*

4.3 Questionnaire development

All items in the questionnaire have been first evaluated by two enumerators, two students of Makerere University and a professor of Makerere University in Kampala, in order to fit the local context and being better understood by the respondents, starting from the first day of data collection in the field. For instance, specific elements, such as changing the market where to sell coffee or honey, including new varieties or bee hives in the farm and adopting another type of farming technology have been included.

The enumerators acted as innovation brokers in the field, since they connected farmers and researcher, facilitating interaction in innovation (Klerkx et al., 2009). Enumerators correspond to the survey personnel charged with counting, listing and assisting respondents in answering the questions of the survey. They performed their role as translators as well, during the data collection in Manafwa district.

Before the evaluation of the questionnaire items from enumerators, students and professor, the respondents were asked to answer on a 7-point Likert scale, not only for the sections about farmers' innovation and entrepreneurial competences, but also for the sections about farmers' access to resources. For each item, farmers were asked about their perceived level of agreement (1 Strongly disagree to 7 Strongly agree). For the part about farmers' innovation, the higher scores of each of the subscales reflected higher levels of agreement with their capability to innovate. For the part about entrepreneurial competences, the higher scores of each item reflected higher levels of agreement with innovativeness, risk-taking (it will be the other way around for questions 25, 26, 27), achievement and intentions. For the section about farmers' access to resources, the higher scores of each item reflected higher levels of agreement with their resource endowment.

After the first check to the questionnaire by the local contacts, a 5-point Likert scale has been used, in order to make the rating easier for the respondents. In particular, 1 corresponded to strongly disagree, 2 to disagree, 3 to uncertain, 4 to agree and 5 to strongly agree.

Beside the sections about farmers' innovation, entrepreneurial competences and farmers' access to resources, the questionnaire included a section in which multiple-choice questions about demographics have been included. For the part dealing with farm size, two questions were asked to the respondent: to mention the acres of coffee owned or number of bee hives owned, to mention the number of hired people working in the farm.

The questionnaire used during the data collection phase is presented in Appendix 1.

For the data analysis, the questionnaire item which represented the number of hired people working in the farm, has been left apart. While performing the survey, there were some troubles interpreting this question from the enumerator and the student helping the researcher. Contradictions appear when the answers regarding acres or bee hives owned, and the number of hired people, are compared. Indeed, some of those farmers who owned only 1 acre, affirmed that between 8-15 hired people were working in their farm. This contradiction has been due to the personal interpretation of the farmers, who answered question about hired people with the total amount of people working in the farm, thereby including even family members. For instance, by looking at coffee farms, the literature affirms that the average size in Uganda corresponds to 0,5 acres, which indicates relatively small coffee farms. Usually, coffee farms in Uganda are family farms, meaning that no hired people are working there (UNDP, 2012a). Therefore, to eliminate any misleading results, the answers about hired people have been removed from the analysis.

The questionnaire items used in the analysis are depicted in **Table 2**, together with their variable name.

Concept	Questionnaire Item	Variable name
Farmers' characteristics	Gender	GENDER
	Age	AGE
	Education level	ED_LEVEL
	Farm size	FARM_SIZE1
	1. Do you have access to new labour?	AR_Item1
	2. If YES, I believe that I have the ability to hire new people faster than other coffee/honey producers in my sub-county	AR_Item2
	3. I have more access to credit compared to other coffee/honey producers in my sub-county	AR_Item3
	4. I believe to have more access to artificial fertilizers/bee hives compared to other coffee/honey producers in my sub-county	AR_Item4
	5. I believe that I have more access to seedlings/bees compared to other coffee/honey producers in my sub-county	AR_Item5
	6. I have more access to other actors in my coffee/honey value chain compared to other coffee/honey producers in my sub-county	AR_Item6
Entrepreneurial competences	1. I always like to search for the latest information and technology	ENTR_Item1
	2. I like to try new technology in my farm	ENTR_Item2
	3. If there is an improvement in my coffee/honey product, I am willing to change where I sell it	ENTR_Item3
	4. I am willing to include new high-yielding varieties/more bee hives in my farm, to satisfy more customers	ENTR_Item4
	5. I would keep my current varieties/bee hives in the farm, rather than substituting them with others that I do not know	ENTR_Item5
	6. I prefer avoiding to do an investment in my farm, if I do not know the benefits that I will get	ENTR_Item6
	7. I do not want to enlarge my farm, because I do not want to incur more costs	ENTR_Item7
	8. If someone suggests me to include more high-yielding varieties/bee hives in my farm, I will do it and I take great risks (chances for very high profits)	ENTR_Item8
	9. I am willing to start practices that other farms do not do yet	ENTR_Item9
	10. If asked to adopt another type of farming technology, I am one of the first farmers to use it	ENTR_Item10

	11. For my job, I perform above and beyond expectations, but there is always something more to be done or improved	ENTR_Item11
	12. I do not mind failing if I learn something different from another coffee/honey farming practice	ENTR_Item12
	13. I intend to start a new coffee/honey-related business in the next three years (i.e. trading, processing…)	ENTR_Item13
	14. I intend to include a new technology to increase the yield of my coffee/honey productions in the next three years	ENTR_Item14
	15. I intend to expand the contacts with other actors in my value chain in the next three years	ENTR_Item15
	16. With my credit and savings, I intend to enlarge my farm with only coffee/honey production in the next three years	ENTR_Item16
Farmers' innovation	1. I have improved the use of my production practices in my coffee/honey farm to improve the quality of my coffee/honey, in the past five years	INN_Item1
	2. I have improved my production practices, because other fellow farmers suggested it to me, in the past five years	INN_Item2
	3. I have improved my production practices, because other actors in my value chain suggested it to me, in the past five years	INN_Item3
	4. I have changed where I sell my coffee/honey production in the past three years	INN_Item4

Table 2 *Questionnaire item and corresponding variable name*

Providing that the collected data presented a similar shape when looking at the four types of innovation (product item 17, process item 18, process item 19, market item 20), the four variables representing each of them, have been flattened into one, named "innovation". The new variable derives from the computation, or sum, of the four corresponding questionnaire items: INN_Item1, INN_Item2, INN_Item3, INN_Item4.

This procedure was helpful to understand if, with the linear regression analysis, farmers' characteristics and entrepreneurial competences had a bigger effect on the computed variable of innovation which represents innovation as a whole, rather than on the different types of innovation taken separately.

4.4 Confirmatory Factor Analysis

A Confirmatory Factor Analysis (CFA) was applied to test the model of entrepreneurship in coffee and honey value chains in Manafwa, Uganda. The software IBM SPSS Amos 23 has been used to perform the CFA. Confirmatory Factor Analysis can be performed with interval data, thus Likert scale, which is usually considered as being interval-scaled, is suited for this type of analysis (Harrington, 2009).

CFA is a theory-testing model, where the researcher begins with a hypothesis prior to the analysis in order to empirically test the measurement model in literature, using latent constructs (Hoyle, 2000). Latent constructs are indirectly observed or measured. In this study the hypothesis was to check whether innovativeness, risk-taking, proactiveness and intentions were good measurements for entrepreneurial competences in Ugandan coffee and honey value chains as well as the literature reported. Thus, CFA allows for the analysis of multiple regression relationships as they relate to one main concept, while also accounting for measurement error (Hoyle, 2000). Results of these analysis permit to evaluate the statistical effectiveness of knowledge deriving from MSPs as to measure entrepreneurial competences in coffee and honey value chains in Uganda.

The model that has been performed to measure entrepreneurial competences in Ugandan coffee and honey value chains is composed by four latent constructs that, according to theoretical and empirical foundations in literature, are typically used to measure entrepreneurial competences in developing countries (Krauss et al., 2005; Micheels & Gow, 2008; Lai et al., *unpublished*; George et al., 2015). The four latent constructs are: innovativeness, risk-taking, proactiveness and intentions. Each of them was measured by four observed variables, or questionnaire items. The questionnaire items have been adapted to the local context, after the first meeting of the researcher with the members of ICRAF Uganda. The CFA diagram of the proposed measurement model is shown in ***Figure 6***.

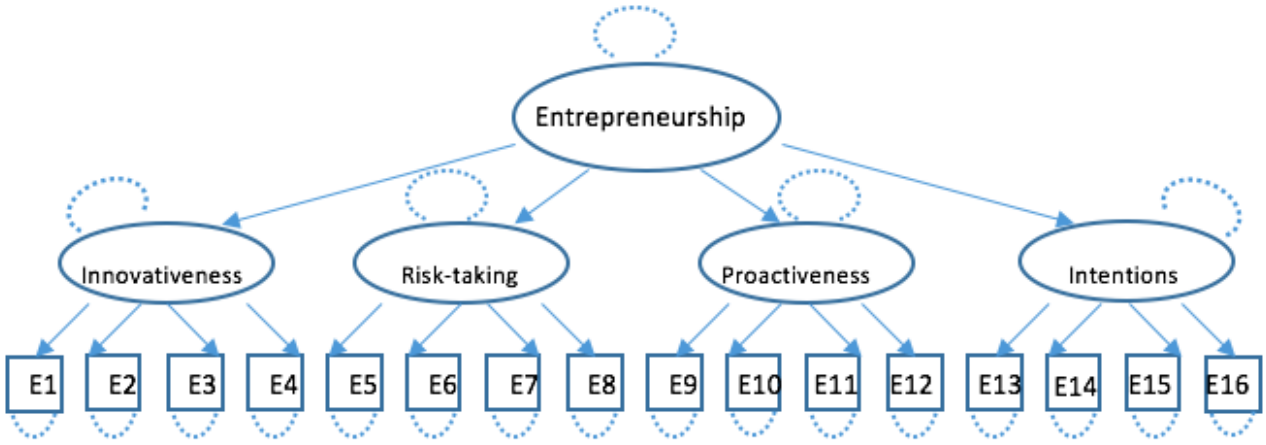

Fig. 6 Measurement model for entrepreneurial competences

Dotted lines indicate the measurement error accounted for of each variable or questionnaire item, while E1 - E16 represent the questionnaire items for entrepreneurial competences. In the diagram, the observed variables are illustrated by squares, while ovals illustrate the latent constructs. The second-order latent construct of entrepreneurial competences was defined by four first-order latent constructs that were each defined by four observed variables: innovativeness squares E1 - E4, risk-taking squares E5 - E8, proactiveness squares E9 - E12, and

intentions squares E13 - E16, respectively. Dotted lines indicate the measurement error accounted for of each measured construct or variable in the model.

In order to confirm the construct validity and fit indices of the hypothesized measurement model, absolute fit indices were evaluated (parentheses indicates model fit criteria): chi-squared test (not significant), the root mean square error of approximation or RMSEA (< 0.08 or > 0.05), good of fit index or GFI (> 0.9), adjusted good of fit index or AGFI (>0.9), comparative fix index or CFI (0 - 1) (Harrington, 2009). The statistical significance of the chi square test is not particularly relevant for evaluating the model fit, since a p value larger than 0.05 is usually due to the large sample used. The meaning of the different indices is displayed in ***Table 3***.

RMSEA	GFI	AGFI	CFI
A value of the RMSEA of about 0.05 or less would indicate a close fit of the model in relation to the degrees of freedom. The requirement of exact fit corresponds to RMSEA = 0.0. A value of about 0.08 or less for the RMSEA would indicate a reasonable error of approximation and would not want to employ a model with a RMSEA greater than 0.1.	GFI is less than or equal to 1. A value of 1 indicates a perfect fit. It is acceptable when GFI > 0.9.	The AGFI (adjusted goodness of fit index) takes into account the degrees of freedom available for testing the model. The AGFI is bounded above by one, which indicates a perfect fit. It is not, however, bounded below by zero, as the GFI is. It is acceptable when AGFI > 0.9.	CFI falls in the range from 0 to 1. CFI values close to 1 indicate a very good fit.

Table 3 *Indices*

Different combinations have been created between the different first-order latent constructs. While running the analysis, problems emerge if risk-taking is included amongst the latent constructs. In particular, if risk-taking is included the values are represented as follows: GFI = 0.855, AGFI = 0.803, RMSEA = 0.084, CFI = 0.661, and the chi square is significant (p value = 0.000). Problems also arises whether a CFA is performed for the first-order latent construct risk-taking, when taken alone, thus without any combinations with innovativeness, proactiveness and intentions.

At the same time, CFA was conducted for each of the first-order latent constructs, which did not register any issues: innovativeness, proactiveness and intentions. The correlation values of each variable with the latent construct were high and the model fit was good, as well. For innovativeness, the values are: GFI = 0.999, AGFI = 0.995, RMSEA = 0.000 and CFI = 1.000. For proactiveness the values are: GFI = 0.992, AGFI = 0.961, RMSEA = 0.036 and CFI = 0,987. For intentions the values are: GFI = 0.988, AGFI = 0.942, RMSEA = 0.073 and CFI = 0,975. Furthermore, the chi-square test was not significant in all cases.

Looking at the standardized residual covariance matrix, all items representing risk-taking register high values and this affects the overall goodness of fit. Indeed, significant values of standardized covariance indicate significant differences in covariance between proposed model based computed covariance and observed covariance. Although

the standardized residual covariance is similar to modification indices, they can directly be addressed through deletion of the concerned item. In summary, the significant residuals may be treated only after taking care of modification indices.

Removing the first-order latent construct risk-taking, which implies removing the observed variables (E5 - E8) from the general model, improves the model itself and the new values are: GFI = 0.915, AGFI = 0.870, RMSEA = 0.065, CFI = 0.872, and the chi square is significant (p value = 0.003). Moreover, all estimated correlation coefficients are depicted on the path diagram, while if risk-taking was included, the path diagram was not shown.

Overall, the model looks good. Nevertheless, further improvements to the model could be achieved, after having checked the estimates matrix. Both ENTR_Item3 and ENTR_Item12 register extremely high values (larger than 2.0) in the standardized residual covariance, constituting a limit for the goodness of the model. Running the analysis without ENTR_Item3 and ENTR_Item12 the new values are: GFI = 0.941, AGFI = 0.9, RMSEA = 0.055, CFI = 0.933, and the chi square is not significant anymore (p value = 0.05).

Summarizing, the latent construct represented by risk-taking was deleted from the measurement model for entrepreneurial competences; the latent construct intentions kept all questionnaire items, while the latent construct innovativeness was subjected to one item reduction (ENTR_Item3), as well as the latent construct proactiveness (ENTR_Item12). It has been proven that even with three items for dimension, the questionnaire can still maintain statistical authenticity (Cook, Hepworth, Wall, & Warr, 1981). Assuming that risk-taking should not be included in the questionnaire to measure entrepreneurial competences, even with one item reduction for innovativeness as well as for proactiveness, the questionnaire to measure entrepreneurial competences is still statistical authentic.

5. Findings

This section reports the findings of the research based upon the analysis of the database collected through the use of the survey. A set of linear regressions was used to perform the main part of the data analysis, thereby obtaining the findings of the present study. The present chapter also contains descriptive statistics, which permit to have an overview of the tendency of the answers registered in Manafwa district.

Descriptive statistics, the development of the linear models and the set of linear regression analysis to test the hypotheses have been performed using the software IBM SPSS 24. A description of the aforementioned analysis is presented in sub-chapters 5.1, 5.2 and 5.3 respectively.

5.1 Descriptive Statistics

Descriptive statistics are used to describe the basic features of the data in the study and provide simple summaries about the sample and the measures. Together with simple graphics analysis, they form the basis of virtually quantitative analysis of data. Descriptive statistics describe group characteristics (Black, 1999); thus, descriptive statistics for gender, age groups, education level, farm size and access to resources have been depicted (**Fig. 7** to **Fig. 17**).

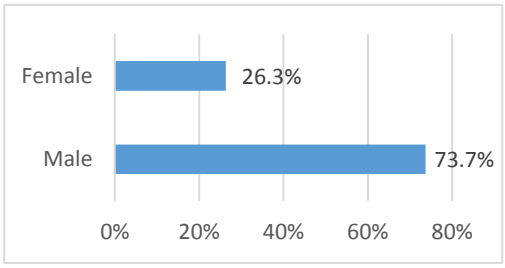

Fig. 7 Descriptive statistics for GENDER

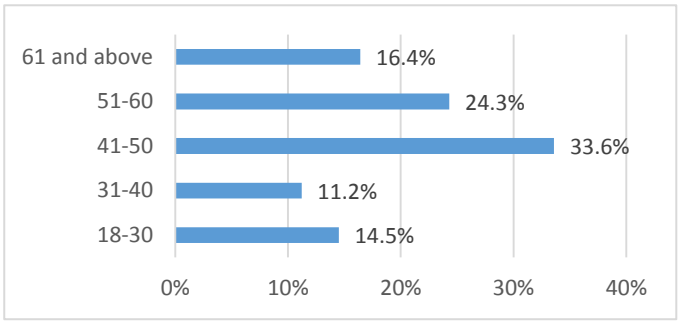

Fig. 8 Descriptive statistics for AGE

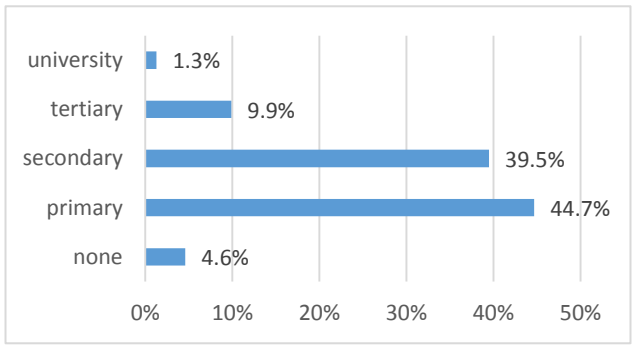

Fig. 9 Descriptive statistics for ED_LEVEL

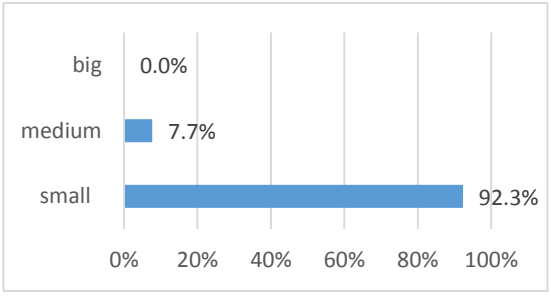

Fig. 10 Descriptive statistics for FARM_SIZE1: honey

[Small: less than 19 beehives; Medium: between 20 and 49 beehives; Big: 50 beehives and above]

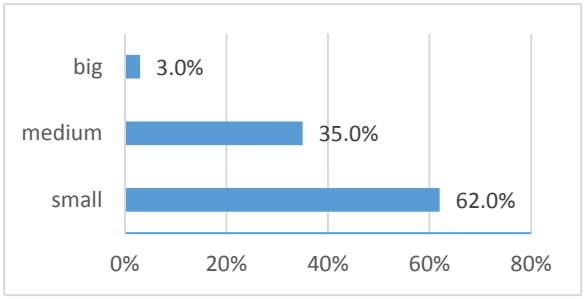

Fig. 11 Descriptive statistics for FARM_SIZE1: coffee

[Small: less than 1 acre; Medium: between 1,1 and 4 acres; Big: 4,1 acres and above]

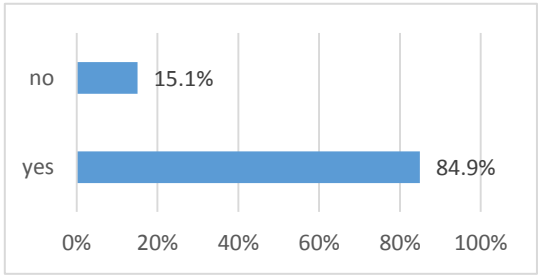

Fig. 12 Descriptive statistics for AR_item1
[Do you have access to new labour?]

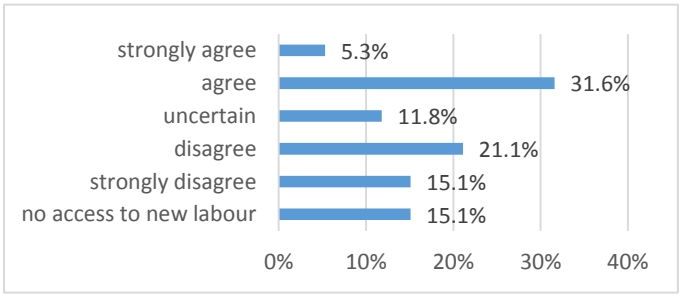

Fig. 13 Descriptive statistics for AR_item2
[If YES, I believe that I have the ability to hire new people faster than other coffee/honey producers in my sub-county]

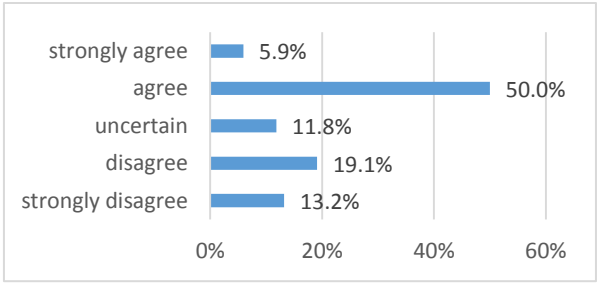

Fig. 14 Descriptive statistics for AR_item3
[I have more access to credit compared to other coffee/honey producers in my sub-county]

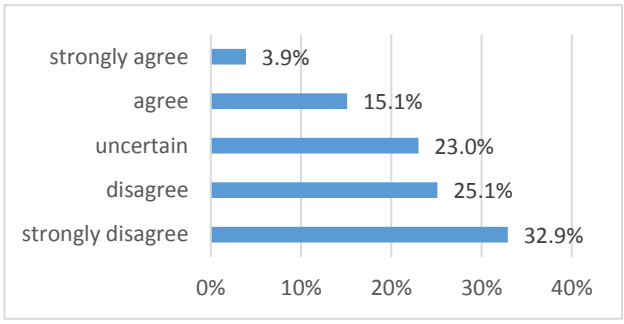

Fig. 15 Descriptive statistics for AR_item4
[I believe to have more access to artificial fertilizers/bee hives compared to other coffee/honey producers in my sub-county]

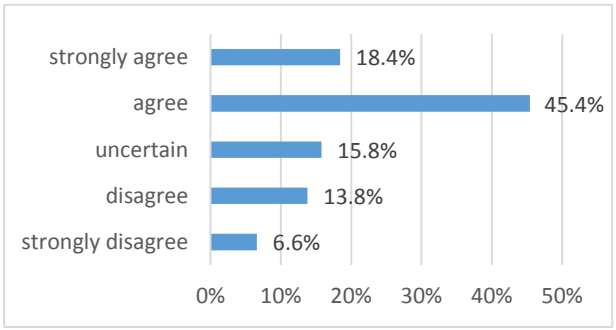

Fig. 16 Descriptive statistics for AR_item5
[I believe that I have more access to seedlings/bees compared to other coffee/honey producers in my sub-county]

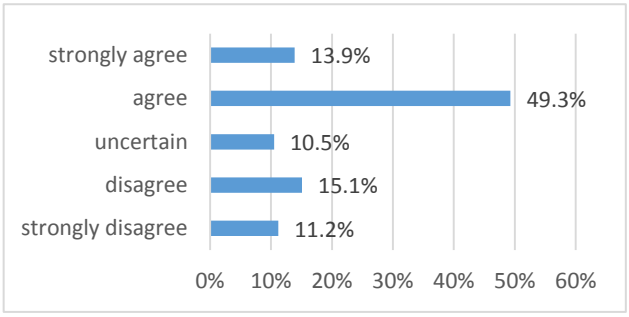

Fig. 17 Descriptive statistics for AR_item6
[I have more access to other actors in my coffee/honey value chain compared to other coffee/honey producers in my sub-county]

A remark has to be made for the variable farm size, which indicates the number of bee hives and the number of acres that a farmer owns (**Fig. 10 and Fig. 11**, respectively). The distinction into "small", "medium" and "big" has been discussed with the local contacts, such as students and enumerators, who helped the researcher during the data collection phase.

Farmers' characteristics presented high heterogeneity. Descriptive statistics for entrepreneurial competences and farmers' innovation were not reported, because farmers' answers to these questionnaire items were very homogeneous. By looking at each sub-county and type of product, the results of the descriptive statistics are quite homogeneous overall. A summary of the descriptive statistics is reported in Appendix 2. The present summary was

used as a result of the preliminary analysis of the data that have been collected in Uganda, and has been spread amongst the partners of the World Agroforestry Centre (ICRAF Uganda) and ACIAR.

The summary can be considered as a useful tool for Ugandan MSPs, once the set of linear regressions reporting the main findings will be performed. Indeed, the results can be used as recommendations for Ugandan MSPs, which can in turns redirect their support to each sub-county, according to the significant farmers' characteristics and entrepreneurial competences.

5.2 Linear Regression development

In statistics, linear regression models the relationship between a dependent variable and one or more explanatory variables using a linear function (Seber & Lee, 2012). In the present research, a set of linear regression analysis has been developed. The equations representing the linear regressions originate from the general model, which follows the objective of the study and, thus, depicts the relation among the main variables. The general model is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3$$

where:

β_0, β_1, β_2, β_3 = coefficients

Y = farmers' innovation

X_1 = farmers' characteristics

X_2 = entrepreneurial competences

X_3 = interaction effect between farmers' characteristics and entrepreneurial competences ($X_1 * X_2$)

Procedures have been taken, before starting with the concrete analysis. In particular, a computation or sum has been developed between the questionnaire items grouped under the same category (i.e. access to resources), as to have a smaller amount of variables to work with, since the shape of the data under the same category was very similar.

The computed variables are AR_Item1, AR_Item2, AR_Item3, AR_Item4, AR_Item5, AR_Item6 for access to resources; ENTR_Item1, ENTR_Item2, ENTR_Item4, ENTR_Item9, ENTR_Item10, ENTR_Item11, ENTR_Item13, ENTR_Item14, ENTR_Item15, ENTR_Item16 for entrepreneurial competences. For entrepreneurial competences, a computation of the variables under the same latent construct has been developed. Therefore, three computations have been performed: one for the variables of innovativeness (ENTR_Item1, ENTR_Item2, ENTR_Item4), one for the variables of proactiveness (ENTR_Item9, ENTR_Item10, ENTR_Item11), and one for the variables of intentions (ENTR_Item13, ENTR_Item14, ENTR_Item15, ENTR_Item16). The selection of the variables for entrepreneurial competences derives from the Confirmatory Factor Analysis, which showed that ENTR_Item3, ENTR_Item5, ENTR_Item6, ENTR_Item7, ENTR_Item8, ENTR_Item12 worsted the model fit. The name of the new variable access to resources is "access_to_resources"; the names of the new variables of entrepreneurial competences are "entr_innovativeness", "entr_proactiveness", and "entr_intentions".

For demographics, the variables of age, gender and education level are kept separate, since it was interesting to assess whether age, gender or the level of education had a diverse influence on farmers' innovation. Furthermore, the distribution of these data was quite heterogeneous.

In order to test the general model, a correlation matrix has been developed to check if correlation was registered amongst all the independent variables; Appendix 3 depicts these values. Even if some values in the correlation matrix are significant, the corresponding Spearman's rho is not particularly high. Spearman correlation coefficient has been used, since it "*evaluates the monotonic relationship between two continuous or ordinal variables. In a monotonic relationship, the variables tend to change together, but not necessarily at a constant rate. The Spearman correlation coefficient is based on the ranked values for each variable rather than the raw data*" (Chen & Popovich, 2002). If looking at the coefficients, they show that only access to resources in the general model without interaction, and farm size in combination with entr_proactiveness in the general model with interaction, are significant (*see* Appendix 3). In other words, if there is an increase of one unit in access to resources while keeping all the other independent variables fixed, the computed variable of innovation increases of one third approximately (β_1 = 0.209). At the same time, when the interaction among farm size and entr_proactiveness increase of one unit while keeping all the other independent variables fixed, the computed variable of innovation increases of one unit approximately (β_1 = 0.971). Independent variables that correlate among each other arise problems, in terms of multicollinearity: the general model testing for interactions among variables show very high VIFs (> 60.0), meaning that multicollinearity exists among them; the general model without interaction does not show multicollinearity (<2.0). While performing the analysis, either without interaction or with interaction among the variables, the general model is not significant and this is reported in the ANOVA table ($F_{\text{with interaction}}$ = 0,167; $F_{\text{without interaction}}$ = 0,341). This means that none of the independent variables helps to predict the computed variable of innovation.

Because the general model was not significant, the researcher performed the analysis as follows. As far as correlation shows whether a relation exists among two variables (X and Y), and regression analyses the shape of the relation among two or more variables and indicates how X_n and Y vary together (Cohen, Cohen, West, & Aiken, 2013), they both have been performed. **Table 4** reports the correlation patterns among farmers' characteristics or each type of entrepreneurial competence, and the computed variable of innovation or type of innovation. Furthermore, Spearman correlation coefficient is assessed, since the data are ordinal and their distribution is not normal (Chen & Popovich, 2002).

Independent variable	Dependent variable	β	Sig. (2-tail.)
GENDER	innovation	-0,007	0,935
	INN_ITEM1	0,004	0,966
	INN_ITEM2	-0,027	0,743
	INN_ITEM3	-0,097	0,233
	INN_ITEM4	-0,090	0,270
AGE	innovation	0,043	0,601
	INN_ITEM1	0,091	0,266
	INN_ITEM2	-0,018	0,830
	INN_ITEM3	-0,070	0,394
	INN_ITEM4	0,072	0,380

ED_LEVEL	innovation	0,103	0,208
	INN_ITEM1	0,081	0,321
	INN_ITEM2	0,040	0,623
	INN_ITEM3	0,205	0,011*
	INN_ITEM4	0,004	0,963
FARM_SIZE1	innovation	0,169	0,038*
	INN_ITEM1	0,132	0,105
	INN_ITEM2	0,026	0,747
	INN_ITEM3	0,065	0,423
	INN_ITEM4	0,143	0,079
access_to_resources	innovation	0,239	0,003**
	INN_ITEM1	0,199	0,014*
	INN_ITEM2	0,102	0,213
	INN_ITEM3	0,267	0,001**
	INN_ITEM4	0,089	0,278
entr_inn	innovation	-0,037	0,652
	INN_ITEM1	0,118	0,148
	INN_ITEM2	-0,006	0,944
	INN_ITEM3	0,167	0,039*
	INN_ITEM4	-0,137	0,092
entr_pro	innovation	0,074	0,364
	INN_ITEM1	0,208	0,010*
	INN_ITEM2	0,091	0,266
	INN_ITEM3	0,165	0,043*
	INN_ITEM4	-0,044	0,588
entr_int	innovation	-0,059	0,467
	INN_ITEM1	-0,015	0,850
	INN_ITEM2	0,001	0,993
	INN_ITEM3	-0,014	0,863
	INN_ITEM4	-0,028	0,731

Table 4 *Correlation patterns among variables*

**. Correlation is significant at the 0,01 level (2-tailed).
*. Correlation is significant at the 0,05 level (2-tailed).

A brief description of the correlation patterns is presented in the following paragraphs and the significant values are depicted in **Table 5**.

Age, gender and the level of education of the farmer in Ugandan coffee and honey value chains do not have any relation with the computed variable of innovation. However, if the different types of innovation (product item 17 in the questionnaire, process item 18, process item 19, market item 20) are kept separate, a relation does exist between the level of education of the farmer and process innovation item 19. Farm size in Ugandan coffee and honey value chains have a relation with the computed variable of innovation, but not with the types of innovation. Access to resources in Ugandan coffee and honey value chains does have a relation with the computed variable of innovation. In addition, access to resources has a relation with product innovation and process innovation item 19.

Each type of entrepreneurial competence in Ugandan coffee and honey value chains does not have a relation with the computed variable of innovation, but rather when the different types of innovation are kept separate. Indeed, correlation exists amongst entr_innovativeness and process innovation item 19, entr_proactiveness and product innovation, entr_proactiveness and process innovation item 19.

Variable name	**Spearman rho**	**p value**
ED_LEVEL→ process inn. item 19	0.205	0.011
FARM_SIZE1 → computed var. innovation	0.170	0.038
access_to_resources→ computed var. innovation	0.239	0.003
access_to_resources→ product inn.	0.199	0.014
access_to_resources→ process inn. item 19	0.267	0.001
entr_innovativeness→ process inn. item 19	0.167	0.039
entr_proactiveness→ product inn.	0.208	0.010
entr_proactiveness→ process inn. item 19	0.165	0.043

Table 5 *Significant correlation between independent and dependent variables*

Since correlation showed which independent variable had a relation with the dependent one (significant P value), the researcher developed regressions models in which they have been included. When a regression model contains variables whose t statistics have non-significant P values, meaning there is no relation among independent and dependent variable, it is possible to remove them from the model itself (Dallal, 2012). This procedure is called backward elimination, which is part of a broader statistics approach, that is also known as stepwise procedures. According to Dallal (2012), once the model has been run with all the independent variables, those with a non-significant P value are removed. Correlation facilitates this procedure, in the sense that it determines in advance whether a relation exists among independent and dependent variables, as Cohen, Cohen, West, & Aiken (2013) stated. In this regard, the model can be run with the variables that have a P value smaller than 0.05 or 0.10.

Backward elimination has an advantage, rather than just simplifying the model: it permits "*to have considerable predictive capability even though any subset of them does not*" (Dallal, 2012). According to George & McCulloch (1993), when P is large, the computational requirements for these procedures can be prohibitive. This is the reason why statisticians typically use heuristic methods to restrict the attention to a smaller number of potential subsets, as the backward elimination (George & McCulloch, 1993).

According to what has been found in the literature, stepwise procedures have been carried out to perform the regression analysis and test the hypotheses, thereby considering the variables that show a significant P value. The significant variables have been used to develop eleven sub-equations representing the general model. Three sub-equations for the dependent variable have been developed, representing the computed variable of innovation, product innovation, and process innovation item 19 respectively. This because process innovation item 18 and market innovation do not have any relation with any of the independent variables.

More precisely, five sub-equations are used to represent farmers' characteristics (education level, age, gender, farm size and access to resources), while three are used to represent entrepreneurial competences (entr_innovativeness, entr_proactiveness, entr_intentions). Age, gender, entr_intentions which are found to do not

have any relations with the dependent variable under consideration, will be included as a matter of formality in the linear regressions, that have been developed afterwards. Indeed, it could be possible that even age, gender and entr_intentions in combination with the complementary variable of the model (entrepreneurial competences) might turn out to be significant. The eleven sub-equations are depicted.

$$Y = \beta_0 + \beta_1 X_A + \beta_2 X_2 + \beta_3 X_3 \quad (1)$$

where:

β_0, β_1, β_2, β_3 = coefficients

Y = farmers' innovation

X_A = demographics → education level

X_2 = entrepreneurial competences

X_3 = interaction effect between education level and entrepreneurial competences ($X_A * X_2$)

$$Y = \beta_0 + \beta_1 X_B + \beta_2 X_2 + \beta_3 X_3 \quad (2)$$

where:

β_0, β_1, β_2, β_3 = coefficients

Y = farmers' innovation

X_B = demographics → age

X_2 = entrepreneurial competences

X_3 = interaction effect between age and entrepreneurial competences ($X_B * X_2$)

$$Y = \beta_0 + \beta_1 X_C + \beta_2 X_2 + \beta_3 X_3 \quad (3)$$

where:

β_0, β_1, β_2, β_3 = coefficients

Y = farmers' innovation

X_C = demographics → gender

X_2 = entrepreneurial competences

X_3 = interaction effect between gender and entrepreneurial competences ($X_C * X_2$)

$$Y = \beta_0 + \beta_1 X_D + \beta_2 X_2 + \beta_3 X_3 \quad (4)$$

where:

β_0, β_1, β_2, β_3 = coefficients

Y = farmers' innovation

X_D = farm size (or FARM_SIZE1)

X_2 = entrepreneurial competences

X_3 = interaction effect between farm size and entrepreneurial competences ($X_D * X_2$)

$$Y = \beta_0 + \beta_1 X_E + \beta_2 X_2 + \beta_3 X_3 \quad (5)$$

where:

β_0, β_1, β_2, β_3 = coefficients

Y = farmers' innovation

X_1 = access to resources

X_E = entrepreneurial competences

X_3 = interaction effect between access to resources and entrepreneurial competences ($X_E * X_2$)

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_F + \beta_3 X_3 \quad (6)$$

where:

β_0, β_1, β_2, β_3 = coefficients

Y = farmers' innovation

X_1 = farmers' characteristics

X_F = entr_innovativeness

X_3 = interaction effect between farmers' characteristics and entr_innovativeness ($X_1 * X_F$)

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_G + \beta_3 X_3 \quad (7)$$

where:

β_0, β_1, β_2, β_3 = coefficients

Y = farmers' innovation

X_1 = farmers' characteristics

X_G = entr_proactiveness

X_3 = interaction effect between farmers' characteristics and entr_proactiveness ($X_1 * X_G$)

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_H + \beta_3 X_3 \quad (8)$$

where:

β_0, β_1, β_2, β_3 = coefficients

Y = farmers' innovation

X_1 = farmers' characteristics

X_H = entr_intentions

X_3 = interaction effect between farmers' characteristics and entr_intentions ($X_1 * X_H$)

$$Y_I = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \quad (9)$$

where:

β_0, β_1, β_2, β_3 = coefficients

Y_I = the computed variable of innovation

X_1 = farmers' characteristics

X_2 = entrepreneurial competences

X_3 = interaction effect between farmers' characteristics and entrepreneurial competences ($X_1 * X_2$)

$$Y_L = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \quad (10)$$

where:

β_0, β_1, β_2, β_3 = coefficients

Y_L = product innovation

X_1 = farmers' characteristics

X_2 = entrepreneurial competences

X_3 = interaction effect between farmers' characteristics and entrepreneurial competences ($X_1 * X_2$)

$$Y_M = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 \quad (11)$$

where:

β_0, β_1, β_2, β_3 = coefficients

Y_M = process innovation item 19

X_1 = farmers' characteristics

X_2 = entrepreneurial competences

X_3 = interaction effect between farmers' characteristics and entrepreneurial competences ($X_1 * X_2$)

According to the significant values represented in **Table 5**, sub-equations 1-11 have been subjected to different combinations amongst each other. This procedure resulted in thirty linear regressions that have been used to test the hypotheses, and are represented in **Table 6**.

Hypothesis	Linear regression
H1: *Age, gender and education level have an effect on farmers' innovation.* → *higher education levels have a positive effect on farmers' innovation*	1. $Y_M = \beta_0 + \beta_1 X_A + \beta_2 X_F + \beta_3 X_3$ 2. $Y_M = \beta_0 + \beta_1 X_A + \beta_2 X_G + \beta_3 X_3$ 3. $Y_M = \beta_0 + \beta_1 X_A + \beta_2 X_H + \beta_3 X_3$
H2: *A big farm size has a positive effect on farmers' innovation.*	4. $Y_I = \beta_0 + \beta_1 X_D + \beta_2 X_F + \beta_3 X_3$ 5. $Y_I = \beta_0 + \beta_1 X_D + \beta_2 X_G + \beta_3 X_3$ 6. $Y_I = \beta_0 + \beta_1 X_D + \beta_2 X_H + \beta_3 X_3$
H3: *Access to resources has a positive effect on farmers' innovation.*	7. $Y_I = \beta_0 + \beta_1 X_E + \beta_2 X_F + \beta_3 X_3$ 8. $Y_I = \beta_0 + \beta_1 X_E + \beta_2 X_G + \beta_3 X_3$ 9. $Y_I = \beta_0 + \beta_1 X_E + \beta_2 X_H + \beta_3 X_3$ 10. $Y_L = \beta_0 + \beta_1 X_E + \beta_2 X_F + \beta_3 X_3$ 11. $Y_L = \beta_0 + \beta_1 X_E + \beta_2 X_G + \beta_3 X_3$ 12. $Y_L = \beta_0 + \beta_1 X_E + \beta_2 X_H + \beta_3 X_3$ 13. $Y_M = \beta_0 + \beta_1 X_E + \beta_2 X_F + \beta_3 X_3$ 14. $Y_M = \beta_0 + \beta_1 X_E + \beta_2 X_G + \beta_3 X_3$ 15. $Y_M = \beta_0 + \beta_1 X_E + \beta_2 X_H + \beta_3 X_3$
H4: *Entrepreneurial competences have a positive effect on farmers' innovation, when interacting with the selected farmers' characteristics.*	16. $Y_M = \beta_0 + \beta_1 X_A + \beta_2 X_F + \beta_3 X_3$ 17. $Y_M = \beta_0 + \beta_1 X_B + \beta_2 X_F + \beta_3 X_3$ 18. $Y_M = \beta_0 + \beta_1 X_C + \beta_2 X_F + \beta_3 X_3$ 19. $Y_M = \beta_0 + \beta_1 X_D + \beta_2 X_F + \beta_3 X_3$ 20. $Y_M = \beta_0 + \beta_1 X_E + \beta_2 X_F + \beta_3 X_3$ 21. $Y_L = \beta_0 + \beta_1 X_A + \beta_2 X_G + \beta_3 X_3$ 22. $Y_L = \beta_0 + \beta_1 X_B + \beta_2 X_G + \beta_3 X_3$ 23. $Y_L = \beta_0 + \beta_1 X_C + \beta_2 X_G + \beta_3 X_3$ 24. $Y_L = \beta_0 + \beta_1 X_D + \beta_2 X_G + \beta_3 X_3$ 25. $Y_L = \beta_0 + \beta_1 X_E + \beta_2 X_G + \beta_3 X_3$ 26. $Y_M = \beta_0 + \beta_1 X_A + \beta_2 X_G + \beta_3 X_3$ 27. $Y_M = \beta_0 + \beta_1 X_B + \beta_2 X_G + \beta_3 X_3$ 28. $Y_M = \beta_0 + \beta_1 X_C + \beta_2 X_G + \beta_3 X_3$ 29. $Y_M = \beta_0 + \beta_1 X_D + \beta_2 X_G + \beta_3 X_3$ 30. $Y_M = \beta_0 + \beta_1 X_E + \beta_2 X_G + \beta_3 X_3$

Table 6 *Linear regressions*

Out of the thirty linear regressions, some of them are characterized by the same terms: such as 1. and 16., 2. and 26., 11. and 25., 13. and 20., 14. and 30. Hence, each pair will lead to the same result. As stated before, age,

gender and entr_intentions are included as a matter of formality for testing the models, since they do not show any relations with the dependent variable. At least one farmer's characteristic and one type of entrepreneurial competence are considered in the same linear regression. Two examples about how linear regressions have been built, for a farmer's characteristic and for entrepreneurial innovativeness competence, are described.

Example 1: education level as a farmer's characteristic*.* To develop the linear regressions 1., 2., 3. representing the farmer's characteristic of education level, the dependent variable showing a significant correlation value with education level has been chosen as Y (in this case, product innovation which corresponds to Y_I). At the same time, in order to respect what the general model presents, a type of entrepreneurial competence has to be included in the linear regression. Therefore, entr_innovativeness, entr_proactiveness, and entr_intentions have been included each time. For instance, the linear regression 1. reports entr_innovativeness (X_F); the linear regression 2. reports entr_proactiveness (X_G); the linear regression 3. reports entr_intentions (X_H).

Example 2: entr_innovativeness as an entrepreneurial competence. At the same time, to develop the linear regressions 16., 17., 18., 19., 20. representing the type of entrepreneurial competence of entr_innovativeness, the dependent variable showing a significant correlation value with entr_innovativeness has been chosen as Y (in this case, product innovation which corresponds to Y_I). In order to respect what the general model presents, at least one farmer's characteristic has to be included in the linear regression. Therefore, gender, age, education level, farm size, access to resources have been included each time. Thus, the linear regression 16. reports education level (X_A); the linear regression 17. reports age (X_B); the linear regression 18. reports gender (X_C); the linear regression 19. reports farm size (X_D); the linear regression 20. reports access to resources (X_E).

5.3 Linear Regression Analysis

Linear regressions have been tested. As for the general model depicted in Appendix 3, VIF is very high when looking at the interaction effect between farmer's characteristic and the type of entrepreneurial competence under consideration. Appendix 4 reports the values of the linear regressions, tested with and without interaction. VIF is not presented in the same table; suffice it to say, VIF > 30 for interaction, and 1 < VIF < 2 without interaction.

The variables that show a relation with the dependent variable under consideration are education level among the demographics (positive relation), farm size (either negative or positive relation) and access to resources (positive relation). Also the type of entrepreneurial competence has an influence, generally positive, on the computed variable of innovation or type of innovation, if entr_innovativeness and entr_proactiveness are considered.

An overview of the significant linear regressions that confirm or reject the hypotheses is presented in **Table 7**.

Hypothesis	Linear regression
H1: *Age, gender and education level have an effect on farmers' innovation.* → *higher education levels have a positive effect on farmers' innovation*	1. (16.) $Y_M = \beta_0 + \beta_1 X_A + \beta_2 X_F + \beta_3 X_3$ → confirm. 2. (26.) $Y_M = \beta_0 + \beta_1 X_A + \beta_2 X_G + \beta_3 X_3$ → confirm. 3. $Y_M = \beta_0 + \beta_1 X_A + \beta_2 X_H + \beta_3 X_3$ → confirm.
H2: *A big farm size has a positive effect on farmers' innovation.*	5. $Y_I = \beta_0 + \beta_1 X_D + \beta_2 X_G + \beta_3 X_3$ → reject. 19. $Y_M = \beta_0 + \beta_1 X_D + \beta_2 X_F + \beta_3 X_3$ → confirm./reject.
H3: *Access to resources has a positive effect on farmers' innovation.*	7. $Y_I = \beta_0 + \beta_1 X_E + \beta_2 X_F + \beta_3 X_3$ → confirm. 8. $Y_I = \beta_0 + \beta_1 X_E + \beta_2 X_G + \beta_3 X_3$ → confirm. 9. $Y_I = \beta_0 + \beta_1 X_E + \beta_2 X_H + \beta_3 X_3$ → confirm. 13. (20.) $Y_M = \beta_0 + \beta_1 X_E + \beta_2 X_F + \beta_3 X_3$ → confirm. 14. (30.) $Y_M = \beta_0 + \beta_1 X_E + \beta_2 X_G + \beta_3 X_3$ → confirm. 15. $Y_M = \beta_0 + \beta_1 X_E + \beta_2 X_H + \beta_3 X_3$ → confirm.
H4: *Entrepreneurial competences have a positive effect on farmers' innovation, when interacting with the selected farmers' characteristics*	5. $Y_I = \beta_0 + \beta_1 X_D + \beta_2 X_G + \beta_3 X_3$ → confirm. 19. $Y_M = \beta_0 + \beta_1 X_D + \beta_2 X_F + \beta_3 X_3$ → confirm./reject.

Table 7 *Significant linear regressions*

Rejection or confirmation of the hypotheses. For hypothesis 1, *the higher levels of education have a positive effect on process innovation*. Age and gender do not have any effect on the computed variable of innovation or type of innovation, even when combined with levels of entrepreneurship, in the context of Ugandan coffee and honey value chains. Therefore, the increasing *in age does not have a negative effect on farmers' innovation* (either on innovation as a whole or on each type of innovation)*, and men are not more disposed to innovate compared to women* in Manafwa district.

For hypothesis 2, implications arise. When farmers have the same entr_proactiveness competences, farmers with a big farm size are less disposed to adopt innovation as a whole compared to farmers with a small farm size. Moreover, farm size in combination either with entr_innovativeness or entr_proactiveness has an effect (either positive or negative) on process innovation (item 19) and on the computed variable of innovation respectively.

In the first instance, if farmers have the same entr_innovativeness competences, farmers with a bigger farm size are usually more disposed to adopt process innovation (item 19) compared to farmers with a smaller farm size. At the same time, if farmers with a bigger farm size also have more entr_innovativeness competences are less disposed to adopt process innovation (item 19) compared to farmers with a smaller farm size who have less entr_innovativeness competences. In the second instance, if farmers have the same entr_proactiveness competences, farmers with a bigger farm size are less disposed to adopt innovation as a whole compared to farmers with a smaller farm size. At the same time, farmers with a bigger farm size who have more entr_proactiveness competences, compared to farmers with a smaller farm size who have less entr_proactiveness competences, are more disposed to adopt innovation as a whole.

For hypothesis 3, *the higher access to resources has a positive effect on process innovation and on the computed variable of innovation*.

For hypothesis 4, implications have to be considered. Both entr_innovativeness and entr_proactiveness in combination with farm size have an effect (either positive or negative) on process innovation (item 19) and on the computed variable of innovation respectively. Thus, the answer to hypothesis 3 and the answer to hypothesis 4 deriving from the findings are more or less the same. Thus, if farmers with a bigger farm size also have more entr_innovativeness competences are less disposed to adopt process innovation (item 19) compared to farmers with a smaller farm size who have less entr_innovativeness competences. Furthermore, farmers with a bigger farm size who have more entr_proactiveness competences, compared to farmers with a smaller farm size who have less entr_proactiveness competences, are more disposed to adopt innovation as a whole.

A detailed description of the significance of the linear regressions is reported in the following paragraphs.

Farmers' characteristics. When farmers' characteristics and entrepreneurial competences are considered together in the model, the farmers' characteristics that have an effect on both the computed variable of innovation and type of innovation are: education level, farm size and access to resources.

Education level has an effect on process innovation when each type of entrepreneurial competences is considered in the model (linear regressions 1.-16., 2.-26., 3.).

If the education level increases of one unit when it is assessed in combination with entr_innovativeness, process innovation (item 19) increases of one third approximately ($\beta_1 = 0.279$). In other words, the fact that farmers adopt process innovation (item 19) within their coffee and honey value chains does not depend on the entr_innovativeness competences that they have, but rather on their education level. In particular, if farmers have the same entr_innovativeness competences, farmers with a higher education level are more disposed to adopt process innovation (item 19) compared to those who have a lower education level.

The same situation happens when entr_proactiveness and entr_intentions are considered. If the education level increases of one unit when it is assessed in combination with entr_proactiveness or entr_intentions, process innovation (item 19) increases of one third approximately ($\beta_1 = 0.280$ and $\beta_1 = 0.322$, respectively). In other words, farmers adopt process innovation (item 19) within their coffee and honey value chains not because of their entr_proactiveness competences or their entr_intentions competences, but rather because of their education level. In particular, if farmers have the same entr_proactiveness competences or entr_intentions competences, farmers with a higher education level are more disposed to adopt process innovation (item 19) compared to those who have a lower education level.

The size of the farm has an effect on the computed variable of innovation, especially when the size of the farm interacts with the variable entr_proactiveness in the model (linear regression 5.); indeed, the significant values are registered only in the interaction model.

If the size of the farm increases of one unit, the computed variable of innovation decreases of about ten units ($\beta_1 = - 9.628$). In other words, the fact that farmers adopt innovation as a whole within their coffee and honey value chains does not depend on the entr_proactiveness competences that they have, but rather on their farm size. In particular, if farmers have the same entr_proactiveness competences, farmers with a bigger farm size are less disposed to adopt innovation as a whole compared to those who have a smaller farm size.

The same linear regression also explains that if the interaction effect among farm size and entr_proactiveness increases of one unit, the computed variable of innovation increases of approximately one unit ($\beta_3 = 0.818$). This

means that, farmers with a big farm size who have more entr_proactiveness competences, compared to farmers with a smaller farm size who have less entr_proactiveness competences, are more disposed to adopt innovation as a whole.

The increase in the computed variable of innovation (of one unit approximately) due to the interaction effect among farm size and entr_proactiveness, indicates that entr_proactiveness competences have a good effect on farmers with a bigger farm size rather than on farmers with a smaller farm size. Indeed, if farmers have the same entr_proactiveness competences, farmers with a bigger farm size are less disposed to adopt innovation as a whole compared to farmers with a smaller farm size; while if farmers with a bigger farm size also have more entr_proactiveness competences are more disposed to adopt innovation as a whole compared to farmers with a smaller farm size who have less entr_proactiveness competences.

Access to resources has an effect on the computed variable of innovation, when each type of entrepreneurial competence is considered in the model (linear regressions 7., 8., 9.).

If the access to resources increases of one unit when it is assessed in combination with entr_innovativeness, the computed variable of innovation increases of one third approximately ($\beta_1 = 0.203$). In other words, the fact that farmers adopt innovation as a whole within their coffee and honey value chains does not depend on the entr_innovativeness competences that they have, but rather on their access to resources. In particular, if farmers have the same entr_innovativeness competences, farmers with a higher access to resources are more disposed to adopt innovation as a whole compared to those who have a lower access to resources.

The same situation happens when entr_proactiveness and entr_intentions are considered. If the access to resources increases of one unit when it is assessed in combination with entr_proactiveness or entr_intentions, innovation as a whole increases of one third approximately ($\beta_1 = 0.191$ and $\beta_1 = 0.210$, respectively). In other words, farmers adopt innovation as a whole within their coffee and honey value chains not because of their entr_proactiveness competences or their entr_intentions competences, but rather because of their access to resources. In particular, if farmers have the same entr_proactiveness competences or entr_intentions competences, farmers with a higher access to resources are more disposed to adopt innovation as a whole compared to those who have a lower access to resources.

Access to resources has an effect on process innovation (item 19), when each type of entrepreneurial competences is considered in the model (linear regressions 13.-20., 14.-30., 15.).

If the access to resources increases of one unit when it is assessed in combination with entr_innovativeness, process innovation (item 19) increases, but just a little bit ($\beta_1 = 0.069$). In other words, the fact that farmers adopt process innovation (item 19) within their coffee and honey value chains does not depend on the entr_innovativeness competences that they have, but rather on their access to resources. In particular, if farmers have the same entr_innovativeness competences, farmers with a higher access to resources are more disposed to adopt process innovation (item 19) compared to those who have a lower access to resources.

The same situation happens when entr_proactiveness and entr_intentions are considered. If the access to resources increases of one unit when it is assessed in combination with entr_proactiveness or entr_intentions, process innovation (item 19) increases of just a little bit ($\beta_1 = 0.069$ and $\beta_1 = 0.075$, respectively). In other words, farmers adopt process innovation (item 19) within their coffee and honey value chains not because of their entr_proactiveness competences or their entr_intentions competences, but rather because of their access to

resources. In particular, if farmers have the same entr_proactiveness competences or entr_intentions competences, farmers with a higher access to resources are more disposed to adopt process innovation (item 19) compared to those who have a lower access to resources.

Entrepreneurship. When farmers' characteristics and entrepreneurial competences are considered together in the model, the types of entrepreneurial competences that have an effect on both the computed variable of innovation and type of innovation are: entr_innovativeness and entr_proactiveness.

Entr_innovativeness competences have an effect on process innovation (item 19), especially when entr_innovativeness competences are considered with the size of the farm in the model (linear regression 19.).

If entr_innovativeness competences increases of one unit when it is assessed in combination with FARM_SIZE1, process innovation (item 19) increases, but of half unit only ($\beta_2 = 0.573$). In other words, the fact that farmers adopt process innovation (item 19) within their coffee and honey value chains does not depend on the farm size they own, but rather on their entr_innovativeness competences. In particular, if farmers have the same farm size, farmers with more entr_innovativeness competences are more disposed to adopt process innovation (item 19), compared to those who have less entr_innovativeness competences.

The same linear regression also explain that if farm size increases of one unit when it is assessed in combination with entr_innovativeness, process innovation (item 19) increases of more than five units ($\beta_1 = 5.276$). This means that if farmers have the same entr_innovativeness competences, farmers with a bigger farm size are more disposed to innovate compared to farmers with a smaller farm size, independently from the entr_innovativeness competences they have.

Again in the same linear regression, if the interaction effect among farm size and entr_innovativeness increases of one unit, process innovation (item 19) decreases of approximately one third ($\beta_3 = - 0.379$). This means that, farmers with a big farm size who have more entr_innovativeness competences, compared to farmers with a smaller farm size who have less entr_innovativeness competences, are less disposed to adopt process innovation (item 19).

The decrease in process innovation (item 19) due to the interaction effect among farm size and entr_innovativeness, indicates that entr_innovativeness competences have a negative effect on farmers with a bigger farm size rather than on farmers with a smaller farm size. Indeed, if farmers have the same entr_innovativeness competences, farmers with a bigger farm size are usually more disposed to adopt process innovation (item 19) compared to farmers with a smaller farm size; while if farmers with a bigger farm size also have more entr_innovativeness competences are less disposed to adopt process innovation (item 19) compared to farmers with a smaller farm size who have less entr_innovativeness competences.

Entr_proactiveness does not have any effect on process innovation (item 19), when entr_proactiveness is combined with education level or access to resources (26. and 30. linear regressions respectively). In particular, the fact that farmers adopt process innovation (item 19) within their coffee and honey value chains does not depend on the entr_proactiveness competences that they have, but rather on their education level ($\beta_1 = 0.280$) or access to resources ($\beta_1 = 0.069$). In particular, if farmers have the same entr_proactiveness competences, farmers with a higher education level or with a higher access to resources are more disposed to adopt process innovation (item 19) compared to those who have a lower education level or a lower access to resources.

6. Discussions and limitations

Considering that the aim of the research is to assess the role that farmers' characteristics and entrepreneurial competences have on farmers' innovation in the context of MSPs, the following chapter will provide a discussion about findings and literature, and a description of the limitations encountered during the performance of the research.

The literature shows that farmers' characteristics have an effect on farmers' innovation in MSPs (Galbreath, 2005; Martey et al., 2014). Also entrepreneurial competences have a relation with farmers' innovation, generally positive, in developing countries (Fernald & Solomon, 1987; Schumpeter, 1966; SCHUT et al., 2015). However, nothing is said whether entrepreneurial competences have an effect on farmers' innovation in the context of MSPs. Hence, MSPs largely remain "black boxes" on this point of view (Stuiver et al., 2004).

The present study does not show if entrepreneurial competences have a positive effect on farmers' innovation in the context of Ugandan MSPs, when combined with the selected farmers' characteristics. However, interesting results have been found when entr_innovativeness and entr_proactiveness interact with farm size. Implications about entrepreneurial competences have been considered while performing the research, especially when measures for entrepreneurship were defined. An efficient measurement model to evaluate them is the personality trait approach, which identifies different categories that characterize the good entrepreneur (Krauss et al., 2005; Micheels & Gow, 2008; Lai et al., *unpublished*; George et al., 2015). Amongst these categories, innovativeness, risk-taking, proactiveness and intentions have been selected in the present study and adapted to the local context.

However, only innovativeness, proactiveness and intentions have been tested in the linear regression analysis, since the Confirmatory Factor Analysis (CFA) showed that the category represented by risk-taking was not fitting the model to test for entrepreneurship in Ugandan coffee and honey farms. The present result might indicate that coffee and honey farmers in Uganda do not know how to face risk, since the conditions in which they live and work are represented by extreme poverty. These conditions might impact the risk-propensity or risk-adversity of the farmers, who, in turns, are not willing to sacrifice even few resources now, to get a higher profit later on.

Farmers' characteristics as demographics, farm size and access to resources produce an impact on farmers' innovation in the context of MSPs (Leach et al., 2002; Narrod et al., 2009). Because the literature reports that amongst the demographics, age, gender and education level influence farmers' innovation, they have been chosen in the present study. Although empirical evidence showed that gender plays an important role in innovation adoption (Adesina et al., 2000), especially in sub-Saharan Africa where women have more difficulty compared to men in obtaining labour needed for agricultural activities by leading women to scarce innovation adoption (Doss & Morris, 2000), in the present research gender has no relation with farmers' innovation. In the present study, even age does not have any relations, either positive or negative, with farmers' innovation, although previous studies found that innovation adoption falls with increasing age (Adesina et al., 2000). Literature also reports that educated farmers adopt innovation faster compared to the uneducated ones (Thangata & Alavalapati, 2003). Other researchers showed that education does not always positively impact farmers' innovation, and that the network of the farmer does, though (Adesina & Baidu-Forson, 1995; Weir & Knight, 2004). In the present study, farmers with a higher level of education are more disposed to adopt innovation compared to farmers with a lower level of education.

Zeller et al. (1998) showed that the probability of actively participating in an innovative program raise with increasing land possession, but at a decreasing margin. In the present study, this is not always true, in particular when farm size and either entr_innovativeness or entr_proactiveness are in the same linear regression.

Empirical evidence shows that as far as access to resources concern, the more resources the farmer has, the more the farmer is disposed to innovate (Tittonell et al., 2010). In particular, farmers which have resource availability in terms of financial, physical and human resources (credit, artificial fertilizers/bee hives, seedlings/bees and networks, hired people) are more willing to participate in an innovative program, compared to those who do not have enough resources (C. J. Dahlman & Nelson, 1995; Zeller et al., 1998). The present findings in the literature are also confirmed in the present study.

An important remark to mention regards the analysis performance. On the one side the variables representing access to resources and entrepreneurial competences have been computed as to have a lower amount of variables to work with. On the other side also the four variables representing farmers' innovation (product, process item 18, process item 19, market) have been computed, in order to evaluate whether the combination among farmers' characteristics and entrepreneurial competences produced an effect on innovation as a whole or on each type of innovation. Computation is possible only when the shape of the data is similar.

The findings show that the increase or decrease in the dependent variable is generally due to a higher education level, bigger or smaller farm size and higher access to resources, rather than to farmers' entrepreneurial competences. Briefly, on a statistical point of view, this might be due either to multicollinearity problems where dependent and independent variables measured similar concepts, or to the homogeneity in farmers' answers for entrepreneurship and innovation. On a more critical perspective this might be due to the scarce and homogeneous entrepreneurial competences that coffee and honey farmers have in Manafwa district.

Overall, in Ugandan coffee and honey value chains, farmers' entrepreneurial competences do not have neither a positive effect on the dependent variable under consideration, nor a negative impact on it. As stated before, these findings mainly suggest that farmers' answers about entrepreneurial competences are pretty much the same, thereby indicating homogeneity. At the same time, the lack of effect between entrepreneurial competences and farmers' innovation, also suggests homogeneity in farmers' innovation answers. Nevertheless, heterogeneity is registered among farmers' answers about their characteristics, which, indeed, usually have an influence on farmers' innovation.

As far as the interaction effect among farmers' characteristics and entrepreneurial competences concern, interesting findings are represented by farm size and entr_innovativeness competences, and between farm size and entr_proactiveness competences. In particular, farmers with a bigger farm size and with more entr_innovativeness competences are less disposed to adopt process innovation (item 19) compared to farmers with a smaller farm size who have less entr_innovativeness competences. Furthermore, farmers with a bigger farm size who have more entr_proactiveness competences, compared to farmers with a smaller farm size who have less entr_proactiveness competences, are more disposed to adopt innovation as a whole. In the first instance, MSPs should keep the focus on farmers with a small farm size who has entr_innovativeness competences, as the category of farmers that can better use their entrepreneurial competences in their value chains. In the second instance, MSPs should consider farmers with a bigger farm size who have entr_proactiveness competences, as those who can better use their entrepreneurial competences in their coffee or honey productions.

When looking at the empirical findings of the present study, it is clear that limitations raised and have to be taken into account, in case further research on the same topic will be performed in Manafwa district. For instance, the models testing for the interaction among farmers' characteristics and entrepreneurial competences showed high VIFs, meaning the presence of multicollinearity problems. Multicollinearity was caused by interactions among independent variables or between dependent and independent ones, meaning that some of them were measuring the same information. This might suggest that the questionnaire items representing farmers' characteristics and entrepreneurship have to be carefully revised in relation to the dependent variable that they were influencing.

Another limitation is represented by the sample size. Having a sample of 152 farmers could give reliable results in the sub-counties of Manafwa district, but these results cannot be extended outside them, since big differences exist among farmers' characteristics.

An additional limitation is represented by the validity of farmers' answers about their entrepreneurial competences. As far as entrepreneurial competences concern, the majority of farmers answered positively to the questionnaire items about entrepreneurship, giving high scores to their entrepreneurial competences. However, while collecting the data in Manafwa district it was possible to notice their lack of capabilities in being entrepreneurs practically. Indeed, most farmers have very traditional equipment and implement very traditional agricultural practices. Being entrepreneurs also imply having access to resources (Gumpert & Stevenson, 1985), which most of the farmers in Manafwa district do not have.

Considering both findings and limitations in the present study, teaching farmers how to become good entrepreneurs could be still considered an opportunity for MSPs to achieve their aim, especially if the interaction among farm size either with entr_innovativeness or entr_proactiveness is considered. At the same time, different farmers' characteristics have an effect on farmers' innovation; in particular education level, farm size and access to resources impact farmers' innovation in Manafwa district. Although the research did not demonstrate that farmers' entrepreneurial competences in Ugandan coffee and honey farms always have a positive influence on farmers' innovation, most empirical findings in the literature showed it. Hence, further research from the side of the Global Centre for Food Innovation System (GFCSI) together with ICRAF Uganda, Adelaide University and Makerere University has to be performed in Manafwa district, with a particular regard to entrepreneurial competences as successful means to farmers' innovation in the context of Uganda MSPs.

7. Recommendations

The objective of this paper was to assess the role that farmers' characteristics and entrepreneurial competences have on farmers' innovation in the context of Ugandan MSPs. In this scope, the results of this paper offer several insights, which will be presented in the next paragraphs. First, implications for entrepreneurship in general will be discussed, In the second part the focus will be on recommendations for MSPs in Manafwa district, Uganda.

The focus of this paper has been on the combined effect of farmers' characteristics and entrepreneurial competences in farmers' innovation. In particular, empirical implications show that in Ugandan coffee and honey value chains entrepreneurial competences do not have a positive effect on farmers' innovation. On the other hand,

farmers' characteristics are the major elements that have a direct influence on it. No matter what the age or the gender of the coffee or honey farmer is. What really lead farmers in Manafwa district to adopt innovation within their value chains is represented by their level of education, access to resources and farm size; especially, educated farmers and farmers with more access to resources seem to be those who are more disposed to innovate. Farm size plays an important role if combined with entrepreneurial competences. The results of this paper identified several type of entrepreneurial competences (*see* chapter 4.4), of which only proactiveness and innovativeness have an effect on farmers' innovation when combined with farm size. Risk-taking, an additional category of entrepreneurial competences, present problems in the analysis, meaning that farmers do not know what is intended by risk. Moreover, the fact that farmers are living and working in extreme poverty conditions, lead them to do not sacrifice what they do have now, to get improvements or profits in their value chains later on.

Other implications are related to the theoretical side. In particular, it is important to define what is intended by entrepreneurial competences and how to measure them in contexts as developing countries (*see* chapters 1.3 and 2.3), in case further research upon this topic will be developed. Furthermore, the concept of innovation adoption in the context of MSPs also needs to be clarified. As stated, innovation adoption deals with farmers' generation, development, implementation and adaptation of new ideas. These multiple phases originate from farmers' ability in using knowledge from MSPs and shaping it in relation to their characteristics and entrepreneurial competences.

Recommendations to help MSPs becoming more successful, thereby promoting innovation amongst farmers of coffee and honey value chains in Uganda, are provided.

First, MSPs should valorise the characteristics that showed a positive effect on farmers' innovation. Providing that the higher level of education and the higher access to resources have a positive effect on innovation as a whole and on process innovation (item 19) although farmers under consideration have the same entrepreneurial competences, an efficient tool that MSPs in Ugandan coffee and honey value chains could use is: increasing the availability of funding to support education programs, the use of artificial fertilizers or bee equipment, the possibility of hiring new people, farmers' access to credit and farmers' access to a well-organized network.

Since a bigger farm size has a positive effect on process innovation (item 19), although farmers under consideration have the same entr_innovativeness competences, MSPs should provide farmers who own a bigger farm with supportive consultancy service. At the same time, given that a bigger farm size has a negative effect on innovation as a whole, although farmers under consideration have the same entr_proactiveness competences, MSPs may put more focus on the farmers with a smaller farm size, by providing them with more support, in terms of knowledge, network and new varieties.

Second entr_innovativeness and entr_proactiveness competences show an effect on process innovation (item 19) and on innovation as a whole respectively, when they interact with farm size, MSPs should take important precautions. In the first instance, since farmers with a bigger farm size and with more entr_innovativeness competences are less disposed to adopt process innovation (item 19) compared to farmers with a smaller farm size and with less entr_innovativeness, MSPs should put their focus on the second category. Indeed, MSPs should provide small farmers, who might have few entr_innovativeness competences, with a supportive network that can help them with consultancy service about successful ways to run their farm. In the second instance, since farmers with a bigger farm size and with more entr_proactiveness competences are more disposed to adopt innovation as a whole compared to farmers with a smaller farm size and with less entr_proactiveness, MSPs should put their focus on the

first category. Indeed, MSPs should provide small farmers, who might have few entr_innovativeness competences, with more support in terms of knowledge, network and new varieties.

Even though entrepreneurial competences did not always show a positive relation with farmers' innovation, entr_proactiveness competences did in combination with farm size. As previously stated, this might be due to the fact that farmers' answers to entrepreneurship were more homogeneous compared to the answers to farmers' characteristic questions (*see* Appendix 2). Moreover, it is also true that farmers in Ugandan coffee and honey value chains are not yet able to put entrepreneurial competences into practice, since they do still depend on traditional practices, such as manure as fertilizer for their coffee plantations or traditional beehives rather than the modern ones. At the same time, they do not have the ability to expand their network, for instance changing their market channel or having consultancy services for their coffee and honey productions.

Since it has been said that coffee and honey productions depend on the landscape, farmers living in different areas of Manafwa district may have provided different answers to the questionnaire, when comparing each sub-county (Mukoto, Bukhofu, Namabya, Namboko) to one another. Therefore, all the aforementioned recommendations can be used by Ugandan MSPs to redirect their support to the different sub-counties, according to the significant farmers' characteristics and entrepreneurial competences that have been found with the linear regression analysis.

When thinking to farmers' innovation in developing countries, MSPs have to take into account the local conditions in which farmers live and work, and assess them before delivering inputs to farmers: each technology, each funding, each type of information has to be adapted to the rural area, and being context-related. This procedure will save MSPs' time and efforts, thereby addressing valuable inputs to farmers who live and work in coffee and honey farms, not only in specific areas of Uganda but in emerging economies as a whole.

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Appendices

Appendix 1 - Questionnaire

FARMERS' CHARACTERISTICS AND ENTREPRENEURSHIP TO FARMERS' INNOVATION

The purpose of this research is to assess the role that farmers' characteristics have on farmers' innovation. To do this, the respondent is asked to answer a questionnaire (36 questions), regarding his/her personal data about his/her coffee or honey production. The answers will remain confidential and they will be used only for the purpose of the study.

Farmers' characteristics

I have been contracted by Makerere University (KADLAC, NaFORRI), World Agroforestry Centre (ICRAF), Adelaide University and Wageningen University to collect data for the project entitled Value Chain Innovation Platforms for Food Security, to help in understanding whether the farmers' characteristics in Manafwa district have a relation with their willingness to innovate their coffee and honey productions. You have been randomly selected to participate to this survey. Please note that the information provided by you will be confidential and we will protect your anonymity. We would like to thank you for the time you will dedicate to answer our questions.
Mark with a cross the statement that applies to you the most. If asked (____), specify your level of farm size.

1. Name _____
2. Phone number _____
3. Sub-county in Manafwa _____
4. Type of product _____
5. Household size

◯ none ◯ 1-3 ◯ 4-7 ◯ 8-15 ◯ 16 and above

Demographics

6. Gender

◯ Male ◯ Female

7. Age

◯ 18-30
◯ 31-40
◯ 41-50
◯ 51-60
◯ 61 and above

8. Education level

◯ none ◯ primary ◯ secondary ◯ tertiary ◯ university

Farm size

9. Land size under coffee

◯ acres_____

9. Bee hives for honey

◯ number _____

10. Number of employees (coffee)

◯ none ◯ 1-3 ◯ 4-7 ◯ 8-15 ◯ 16 and above

10. Number of employees (honey)

◯ none ◯ 1-3 ◯ 4-7 ◯ 8 and above

Access to resources

The respondent is asked to express their level of agreement with the following statements, on a scale from 1 to 5, with: 1 strongly disagree, 2 disagree, 3 uncertain, 4 agree, 5 strongly agree.

HUMAN RESOURCES

11. Do you have access to new labour?

◯ yes ◯ no

12. If YES, I believe that I have the ability to hire new people faster than other coffee/honey producers in my sub-county

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

FINANCIAL RESOURCES

13. I have more access to credit compared to other coffee/honey producers in my sub-county

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

PHYSICAL RESOURCES

14. I believe to have more access to artificial fertilizers/bee hives compared to other coffee/honey producers in my sub-county

	1	2	3	4	5	
strongly disagree	◯	◯	◯	◯	◯	strongly agree

15. I believe that I have more access to seedlings/bees compared to other coffee/honey producers in my sub-county

	1	2	3	4	5	
strongly disagree	○	○	○	○	○	strongly agree

16. I have more access to other actors in my coffee/honey value chain compared to other coffee/honey producers in my sub-county

	1	2	3	4	5	
strongly disagree	○	○	○	○	○	strongly agree

Innovation

The respondent is asked to express their level of agreement with the following statements, on a scale from 1 to 5, with: 1 strongly disagree, 2 disagree, 3 uncertain, 4 agree, 5 strongly agree.

PRODUCT INNOVATION

17. I have improved the use of my production practices in my coffee/honey farm to improve the quality of my coffee/honey, in the past five years

	1	2	3	4	5	
strongly disagree	○	○	○	○	○	strongly agree

PROCESS INNOVATION

18. I have improved my production practices, because other fellow farmers suggested it to me, in the past five years

	1	2	3	4	5	
strongly disagree	○	○	○	○	○	strongly agree

PROCESS INNOVATION

19. I have improved my production practices, because other actors in my value chain suggested it to me, in the past five years

	1	2	3	4	5	
strongly disagree	○	○	○	○	○	strongly agree

MARKET INNOVATION

20. I have changed where I sell my coffee/honey production in the past three years

	1	2	3	4	5	
strongly disagree	○	○	○	○	○	strongly agree

Entrepreneurship

The respondent is asked to express their level of agreement with the following statements, on a scale from 1 to 5, with: 1 strongly disagree, 2 disagree, 3 uncertain, 4 agree, 5 strongly agree.

Innovativeness

21. I always like to search for the latest information and technology

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

22. I like to try new technology in my farm

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

23. If there is an improvement in my coffee/honey product, I am willing to change where I sell it

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

24. I am willing to include new high-yielding varieties/more bee hives in my farm, to satisfy more customers

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

Risk-taking

25. I would keep my current varieties/bee hives in the farm, rather than substituting them with others that I do not know

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

26. I prefer avoiding to do an investment in my farm, if I do not know the benefits that I will get

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

27. I do not want to enlarge my farm, because I do not want to incur more costs

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

28. If someone suggests me to include more high-yielding varieties/bee hives in my farm, I will do it and I take great risks (chances for very high profits)

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

Proactiveness

29. I am willing to start practices that other farms do not do yet

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

30. If asked to adopt another type of farming technology, I am one of the first farmers to use it

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

31. For my job, I perform above and beyond expectations, but there is always something more to be done or improved

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

32. I do not mind failing if I learn something different from another coffee/honey farming practice

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

Intentions

33. I intend to start a new coffee/honey-related business in the next three years (i.e. trading, processing…)

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

34. I intend to include a new technology to increase the yield of my coffee/honey productions in the next three years

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

35. I intend to expand the contacts with other actors in my value chain in the next three years

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

36. With my credit and savings, I intend to enlarge my farm with only coffee/honey production in the next three years

	1	2	3	4	5	
strongly disagree	⬭	⬭	⬭	⬭	⬭	strongly agree

Appendix 2 - Summary of the descriptive statistics per sub-county and type of product

Coffee

Bukhofu (31)

- Most farmers are male; most farmers are between 41-60 years of age; 51,6% only had primary education, the 29% secondary and the 12,9% tertiary, while a small percentage is left for those who didn't go to school and no one attended university
- Most farmers own 1 acre; only one farmer owns 4 acres; the majority does not have hired people.
- Overall farmers believe to have more access to new labour and hire people faster than other farmers, more access to credit and more access to seedlings compared to other farmers. This does not happen for the access to artificial fertilizers. (These conditions apply to Namabya, Mukoto, Bukhofu → however, heterogeneity amongst sub-counties is registered).
- Most farmers improved their production practices in the past 5 years; most of them under suggestion of other fellow farmers and other actors in their value chain. (These conditions apply to Namabya, Mukoto, Bukhofu → however, heterogeneity amongst sub-counties is registered).
- Heterogeneity in the question about market innovation (as for Namabya, Mukoto, Bukhofu).
- Heterogeneity in the questionnaire items of entrepreneurship. However, there is a prevalence of those who scored high.

Namabya (30)

- 70% males and 30% females; most farmers are between 41-60 years of age; 50% had primary education, 36,7% secondary, small percentages for the rest, 1 attended university
- Most farmers own 1 acre, 4 own more than 4 acres; the majority does not have hired people
- Heterogeneity in the questionnaire items of entrepreneurship. However, there is a prevalence of those who scored high.

Mukoto (32)

- 53,1% males and 46,9% females; most farmers are between 41 and 50 years of age; 43,8% had primary education, and the 40,6% secondary, no one attended university.
- Most farmers own 1 acre; three people own more than 4 acres. The majority of the farmers does not have hired people working in the farm.
- High heterogeneity in the questionnaire items about access to resources.
- Heterogeneity in the questionnaire items of entrepreneurship. However, there is a prevalence of those who scored high.

Namboko (7)

- Male farmers, where the majority is more than 61 year of age.
- Most farmers own 1 acre; the rest has 2 or 1,5 acres; heterogeneity can be seen in hired workers.
- High heterogeneity in the questionnaire items about access to resources.
- Heterogeneity in the questionnaire items of entrepreneurship. However, there is a prevalence of those who scored high.

Honey

Mukoto (21)

- 85,7% male, 14,3% female; most farmers are between 41-50 years of age, but honey farming can be performed by farmers of different ages; all farmers received education (primary or secondary), one had tertiary education.
- Most farmers own 6 bee hives; more than half of honey farmers own more; most farmer do not have hired people.
- Overall farmers believe to have more access to new labour and hire people faster than other farmers, more access to credit and more access to seedlings compared to other farmers. This does not happen for the access to bee hives/equipment. (These conditions apply to Namabya, Mukoto, Bukhofu → however, heterogeneity amongst sub-counties and within each sub-county is registered).
- Most farmers improved their production practices in the past 5 years; most of them under suggestion of other fellow farmers and other actors in their value chain. (These conditions apply to Namabya, Mukoto, Bukhofu → however, heterogeneity amongst sub-counties is registered).
- Heterogeneity in the question about market innovation (as for Namabya, Mukoto, Bukhofu).
- Heterogeneity in the questionnaire items of entrepreneurship. However, there is a prevalence of those who scored high.

Namboko (16)

- 1 out of 16 honey farmers is a woman; most farmer are older than 61 but honey farming can be performed by farmers of different ages.
- The majority owns 3 bee hives, 8 own more and 4 own less; most farmers do not have hired people.
- High heterogeneity in the questionnaire items about access to resources, process innovation and market innovation.
- Heterogeneity in the questionnaire items of entrepreneurship. However, there is a prevalence of those who scored high.

Namabya (15)

- 73,3% males and 26,7% females; honey farming can be performed by farmers of different ages and the lowest percentage is represented by the category 61 years old and above.
- Everyone received education; 60% had primary education and 26,7% had secondary education; one farmer went to the university.
- The majority of the farmers own 3 and 5 bee hives; six people own more than 5 bee hives; no one has hired people working in the farm.
- High heterogeneity in the questionnaire items about access to resources and process innovation.
- Heterogeneity in the questionnaire items of entrepreneurship. However, there is a prevalence of those who scored high.

Appendix 3 - General model

Independent variable	Independent variable	Spearman's rho	Sig. (2-tail.)
GENDER	AGE	0,132	0,106
	ED_LEVEL	0,256	0,001**
	FARM_SIZE1	-0,065	0,426
	access_to_resources	-0,066	0,421
	entr_inn	-0,051	0,531
	entr_pro	-0,085	0,300
	entr_int	-0,232	0,004**
AGE	GENDER	-0,132	0,106
	ED_LEVEL	-0,190	0,019*
	FARM_SIZE1	0,025	0,756
	access_to_resources	-0,177	0,029*
	entr_inn	0,017	0,837
	entr_pro	-0,086	0,290
	entr_int	-0,150	0,065
ED_LEVEL	AGE	-0,190	0,019*
	GENDER	-0,256	0,001**
	FARM_SIZE1	0,086	0,292
	access_to_resources	0,268	0,001**
	entr_inn	0,172	0,034*
	entr_pro	0,172	0,034*
	entr_int	0,270	0,001**
FARM_SIZE1	AGE	0,025	0,756
	GENDER	-0,065	0,426
	ED_LEVEL	0,086	0,292
	access_to_resources	0,293	0,000**
	entr_inn	-0,076	0,349
	entr_pro	0,000	0,996
	entr_int	-0,054	0,511
access_to_resources	AGE	-0,177	0,029*
	GENDER	-0,066	0,421
	ED_LEVEL	0,268	0,001**
	FARM_SIZE1	0,293	0,000**
	entr_inn	0,124	0,128
	entr_pro	0,117	0,153
	entr_int	0,196	0,015*
entr_inn	AGE	0,017	0,837
	GENDER	-0,051	0,531
	ED_LEVEL	0,172	0,034*
	FARM_SIZE1	-0,076	0,349
	access_to_resources	0,124	0,128
	entr_pro	0,301	0,000**
	entr_int	0,400	0,000**

entr_pro	AGE	-0,086	0,290
	GENDER	-0,085	0,300
	ED_LEVEL	0,172	0,034*
	FARM_SIZE1	0,000	0,996
	access_to_resources	0,117	0,153
	entr_inn	0,301	0,000**
	entr_int	0,322	0,000**
entr_int	AGE	-0,150	0,065
	GENDER	-0,232	0,004**
	ED_LEVEL	0,270	0,001**
	FARM_SIZE1	-0,054	0,511
	access_to_resources	0,196	0,015*
	entr_inn	0,400	0,000**
	entr_pro	0,322	0,000**

Table 8 *Correlations patterns among independent variables*

**. Correlation is significant at the 0,01 level (2-tailed).
*. Correlation is significant at the 0,05 level (2-tailed).

	ANOVA	
Model	**F**	**Sig.**
1. without interaction	1,488	0,167
2. with interaction	1,113	0,341

Dependent variable	**Independent variable**	**β**	**Sig. (2-tail.)**	**VIF**
innovation	GENDER	0,037	0,959	1,194
	AGE	0,274	0,269	1,175
	ED_LEVEL	0,138	0,739	1,282
	FARM_SIZE1	0,164	0,787	1,120
	access_to_resources	0,209	0,009**	1,259
	entr_inn	-0,153	0,488	1,298
	entr_pro	0,272	0,147	1,240
	entr_int	-0,112	0,486	1,425

Table 9 *General model testing without interactions*

**. Correlation is significant at the 0,01 level (2-tailed).
*. Correlation is significant at the 0,05 level (2-tailed).

Dependent variable	Independent variable	β	Sig. (2-tail.)	VIF
innovation	GENDER	-10,934	0,166	145,573
	AGE	-3,085	0,324	185,082
	ED_LEVEL	-4,883	0,426	278,295
	FARM_SIZE1	-1,873	0,842	264,663
	access_to resources	-0,433	0,658	191,035
	entr_inn	-0,817	0,600	63,627
	entr_pro	-1,564	0,301	79,968
	entr_int	-1,064	0,410	90,650
	GENDER*entr_inn	0,006	0,991	154,753
	GENDER*entr_pro	0,371	0,392	76,304
	GENDER*entr_int	0,336	0,386	99,876
	AGE*entr_inn	0,176	0,392	76,304
	AGE*entr_pro	0,045	0,775	84,560
	AGE*entr_int	0,017	0,920	170,735
	ED_LEVEL*entr_inn	0,283	0,471	272,031
	ED_LEVEL*entr_pro	0,275	0,406	177,963
	ED_LEVEL*entr_int	-0,142	0,547	174,245
	FARM_SIZE1*entr_inn	-1,031	0,074	194,248
	FARM_SIZE1*entr_pro	0,971	0,018*	90,158
	FARM_SIZE1*entr_int	0,221	0,540	126,217
	access_to_resources*entr_inn	0,054	0,447	231,314
	access_to_resources*entr_pro	-0,062	0,285	147,141
	access_to_resources*entr_int	0,039	0,374	152,786

Table 10 *General model testing with interactions*

**. Correlation is significant at the 0,01 level (2-tailed).
*. Correlation is significant at the 0,05 level (2-tailed).

Appendix 4 - Linear regressions

Linear regression	Without interaction	With interaction
1., 16.	F = 0.019 t test = 0.029 for education level (β_1)	F = 0.048 t test = non-significant
2., 26.	F = 0.022 t test = 0.029 for education level (β_1)	F = 0.032 t test = non-significant
3.	F = 0.048 t test = 0.015 for education level (β_1)	F = non-significant t test = non-significant
4., 6., 10., 11., 12., 17., 18., 21., 22., 23., 24., 25., 27., 28., 29.	F = non-significant t test = non-significant	F = non-significant t test = non-significant
5.	F = non-significant t test = non-significant	F = 0.030 t test = 0.028 for farm size (β_1), and 0.017 for interaction among entr_proactiveness and farm size (β_3)
7.	F = 0.017 t test = 0.004 for acc. to resources (β_1)	F = 0.041 t test = non-significant
8.	F = 0.012 t test = 0.007 for acc. to resources (β_1)	F = 0.029 t test = non-significant
9.	F = 0.015 t test = 0.004 for acc. to resources (β_1)	F = 0.027 t test = non-significant
13., 20.	F = 0.004 t test = 0.004 for acc. to resources (β_1)	F = 0.008 t test = non-significant
14., 30.	F = 0.004 t test = 0.004 for acc. to resources (β_1)	F = 0.006 t test = non-significant
15.	F = 0.010 t test = 0.003 for acc. to resources (β_1)	F = 0.026 t test = non-significant
19.	F = non-significant t test = non-significant	F = 0.030 t test = 0.017 for farm size (β_1), and 0.005 for entr_innovativeness (β_2), and 0.019 for interaction among farm size and entr_innovativeness (β_3)