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Risk Sources and Risk Management Strategies in Coffee Farming: A Case Study of Rwanda

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Abstract

Purpose: The purpose of this research is to evaluate farmers' incentives and perceptions to adopt the risk coping (adaptation) strategies that have been already implemented and to determine the socio-economic factors affecting farmers' participation in the risk reduction strategies on the coffee sector of Rwanda.
Design/Methodology/Approach: In this research, both secondary and primary data were used and 110 coffee farmers were interviewed in August-September 2016. Primary data were collected using structured questionnaires that were administered to the sample of households' heads via person-interviews. The factor analysis was used to determine the risk sources of the coffee farmers and the risk management strategies in the examined coffee farms. Collected data were analyzed using SPSS 20 (Statistical Program for Social Scientists).
Findings: According to research results; the main risk sources then were identified to be: price volatility of coffee cherries, lack of enough rain, non-reproductive coffee varieties and floods, and the main risk adaptation strategies were: mixed farming (intercropping), followed by use of enough chemical inputs, use new and resistant coffee varieties and pesticides usage.
Originality/Value: No studies have been found on the risk of coffee production.
Key words: Coffee, risk sources, risk management, factor analysis, Rwanda

Kahve Yetiştiriciliğinde Risk Kaynakları ve Risk Yönetimi Stratejileri: Ruanda Örneği

Özet

Amaç: Bu araştırmanın amacı, halihazırda uygulanmış olan riskle başa çıkma (adaptasyon) stratejilerini benimsemek için çiftçilerin algılarını değerlendirmek ve çiftçilerin Ruanda kahve sektöründeki risk yönetimi stratejilerine katılımını etkileyen sosyo-ekonomik faktörleri belirlemektir.
Tasarım/Metodoloji /Yaklaşım: Bu araştırmada, hem birincil hem ikincil veriler kullanılmış ve Ağustos-Eylül 2016 döneminde 110 kahve çiftçisi ile görüşülmüştür. Birincil veriler, hanehalkı reislerine daha önceden hazırlanmış anket formları ile yüz yüze görüşülerek toplanmıştır. İncelenen kahve çiftliklerinde kahve üreticilerinin risk kaynaklarını ve risk yönetimi stratejilerini belirlemek için faktör analizi kullanılmıştır. Toplanan veriler SPSS 20 programı kullanılarak analiz edilmiştir.
Bulgular: Araştırmadan elde edilen sonuçlara göre risk kaynakları, kahve kirazının fiyat değişkenliği, yetersiz yağış, kahve çeşidinin verimsizliği ve sel; risk yönetimi stratejileri, çeşitlendirme, yeterli kimyasal girdi kullanımı, yeni ve dayanıklı kahve çeşitlerinin kullanımı ve pestisit kullanımı olarak tanımlanmıştır.
Özgünlük/Değer: Kahve üretiminde risk konusunda çalışmalar bulunmamaktadır.
Anahtar kelimeler: Kahve, risk kaynakları, risk yönetimi, faktör analizi, Ruanda

1.INTRODUCTION

The future is hard to predict. The expected result may not be obtained due to events and changes that are not under the control of the person or cannot be fully controlled. Therefore, risk and uncertainty should be taken into account in future business decisions. In agricultural production; risks and uncertainties arising from production, market, financing, technology, policy and climate conditions. The lack of precipitation at the appropriate time for the product, the increase in product prices after the sale of the product, the lack of sufficient labor force at the required time, the failure of agricultural tools and equipment in unexpected situations, the variability in government policies and similar factors lead to risk and uncertainty. All these factors cause income fluctuation in agriculture. Because, due to the risk and uncertainty factors, there is a great fluctuation in yield and prices, which leads to significant differences in agricultural income from year to year. Another important issue that should not be ignored when analyzing decision-making methods under risk and uncertainty in agriculture is the risk behaviors of farmers. Farmers show different reactions and behaviors to changes depending on their objectives and funding sources. These behaviors are important factors affecting the spreading and adoption processes of innovations in agriculture. In addition, differences in personal behavior, which are among the reasons why agricultural policies do not always produce the expected results, are also important for the future of agriculture (Akcaoz, 2001).

Risk perception plays a significant role in framing decisions to address anticipated or experienced risks. Risk perception is an individual's idea about the possibility of the incidence and impact of any risk event such as excessive rainfall, flood, drought or any other. This risk perception also includes individuals' consciousness about the happening, impact and possible coping options in its aftermath. For understanding a farmer's risk management strategies, one needs to fully comprehend his perceptions related to different dynamics of a risk event. On a broader scale, the risk is not only related to an individual farmer but it has concerns for the whole society. For example, a risk-averse farmer may decide not to opt for modern technology due to potential risks attached to it but his decision can lead to implications for national output and overall welfare of the society if all individuals behave the same way. Therefore, the welfare of the farmer's family and continuity of farming as a business may depend on how farmers manage risks at the farm level (Hardaker et al., 2004).

Rwanda is a landlocked country located in Central East Africa made up with both mountainous terrain and plateaus with numerous lakes and elevated at 800-4500m above sea level, the country is also known as 'country with a thousand hills', due to its dramatic undulating landscape. Rwanda has a total area of 26,338 km2. In 2012, a total resident population of Rwanda was 10,515,973 inhabitants (NISR, 2014) and an estimated population density of 395/ km2. According to the GoR Poverty Reduction Strategy Paper (2012), Rwanda is the most densely populated country in Africa and land holdings average less than 0.5 hectares denser than Japan. Even if we include arable land on hillsides, 60% of farmers own farmland no larger than 0.5 ha. Around 500,000 farmers produce coffee along with other crops, notably beans, savory banana, and corn. The average number of trees per farmer varies from 150 to 300, depending on the region, qualifying the production system as one of micro rather than smallholder (USAID, 2006). Rwanda has four main types of land: cultivated lands, marshlands, forests, and wetlands. Cultivated land represents 1.12 million hectares, around 46% of the country, distributed between 870,000ha for annual crops and 250,000ha for permanent crops. But the Ministry of Finance and Economic Planning (MINECOFIN, 2006) indicates that around 420,000 to 560,000 ha more could be cultivated.

The transformation of agriculture, therefore, will have the greatest impact on the economy in terms of poverty reduction and wealth creation in the country and will continue to remain so for the foreseeable future. The spatial pattern of the agricultural regions and their respective crop growth is determined by the physical environment in Rwanda. The country is characterized by dramatic contrasts in temperature and rainfall as the elevation changes from the lowland savannah areas of the east to the mountain chains of the west. The Rwandan agricultural economy depends on its climatic conditions to a high degree and is thus vulnerable to any changes of weather patterns. The agriculture sector generally is pressured by climate change in the way that periodic floods and droughts (extreme events) already cause major socioeconomic impacts and reduce economic growth in the country. The findings from the Economics of Climate Change in Rwanda (2011) study highlighted the need for adaptation and disaster prevention and the study shows that existing climate variability has significant economic costs in Rwanda. Periodic floods and droughts already cause major socioeconomic impacts and constitute an external shock that reduces economic growth (Byamukama et al. 2011). In Rwanda, agriculture is the first economic sector that is hardest hit by adverse climate conditions, as agricultural production, both pre and post-harvest, is extremely susceptible to prevailing climate change risks such as drought, intense and erratic rainfall, high winds and temperature shifts. Rural households and associated commodity basket areas rely heavily on climate-sensitive resources such as local water supplies and agricultural land; and climate sensitive activities such as rain-fed crop and livestock production, and natural resources such as fuel woods.

There are many studies on coffee production, marketing, production cost, price, profitability and so on. Some of these are; Hazell (2000), Lisa et al. (2003), Saes et al. (2003), Mojo et al. (2003), Murekezi (2003), Bernard et al. (2004), Delille (2008), Gustavo (2009), Kiemen and Beuchelt (2010), Kirumba and Pinard (2010), Alemu and Worako (2011), Narayana (2014), Nkurunziza (2014), Bunn (2015), Luna and Wilson (2015), Zuluaga et al. (2015), Mukashema et al. (2016), Church and Clay (2016). No studies have been found on the risk of coffee production. There are many studies on risk management in agricultural production such as; Rizvan et al. (2019), Ho et al. (2018), Iqbal et al. (2018), Nazir et al. (2018), Bac et al. (2018), Fahad et al. (2018), Bishu et al. (2018), Chalmers et al, (2017), Jankelova et al. (2017), Sogue and Akcaoz (2017), Ullah et al. (2016), Iqbal et al. (2016), Bagheri and Fami (2016), Ullah et al. (2015), Gebreegziabher and Tadesse (2014), Hansson and Lagerkvist (2012), Lwayo and Obi (2012), Luke (2011), Akcaoz et al. (2010), Greiner et al. (2009), Akcaoz et al. (2009a), Akcaoz et al. (2009b), Velandia et al. (2009), Medina and Iglesias (2008), Akcaoz and Ozkan. (2005), Lagerkvist (2005).

The purpose of this research is to evaluate farmers' incentives and perceptions to adopt the risk coping (adaptation) strategies that have been already implemented and to determine the socio-economic factors affecting farmers' participation in the risk reduction strategies on the coffee sector of Rwanda. So this study is mainly focused on Rwandan coffee since it is one of the major priority crops in the country which has a big share on the country's revenue and has been reportedly mentioned as the most affected crop in the last years, thus more attention should be paid on it.

2.MATERIAL and METHOD

Description of the study area

The study was conducted in Maraba Sector of Huye District in Southern Province of Rwanda. The selection of this area was based on the suitable condition for growing Arabica coffee as demonstrated by the number of coffee trees grown in this area ranging between 500,001- 849,267 in these sectors (Maraba and Kigoma) where the study lies, and also the number of coffee washing stations found in the study area. In addition, the study area hosts two best coffee cooperatives in Rwanda known as Abahuzamugambi (MARABA) and Koperative y'Abahinzi ba Kawa ba Karaba (KOAKAKA) (Dusenge, 2009). Moreover, the district hosts two institutions that carry out research in the various field namely Rwanda Agricultural Board (RAB), former Rwanda Agricultural Research Institute (ISAR) and National University of Rwanda (NUR).

Data and sampling techniques

Farm household data: Primary and secondary data were used in this study where the primary data were obtained from surveys of coffee producers located in Huye county, the southern province of Rwanda. The study has targeted the most important cooperative in coffee production in this region. The secondary data used in the research are the statistics taken from the relevant institutions and organizations, articles, thesis, research report, etc. Several sampling procedures were used to select the desired sample size. The study was conducted within the sample size of 110 households with 60 and 50 members and non-members of coffee cooperative respectively drawn using stratified sampling (Table 1). In order to be sure of all coffee growers in the study area, the lists of all members of cooperative were obtained from the leaders of the cooperatives and lists for non-members were obtained from agronomists of sectors (divisions). A simple random sampling was used for sample size selection. Therefore, a total of 110 respondents was selected from MARABA sector of Huye district for this research. However, simple random sampling is used to determine the sample size and the formula based on the average was used (Yamane, 2001).

$$n = \frac{N(ZS)^2}{Nd^2 + (ZS)^2}$$

In this formula;
n: Sample size
N: Population size
Z: Selected confidence level depending on z value
S: Standard deviation
d: Adopted deviation quantity (sensitiveness)
Here,
N=3,480
%95 With confidence level α=1-0.95=0.05, Z(α/2=0,025)=1.96
From the mean %5 with deviation d= Mean*0.05 = 0.16*0.05
d=0.024 ha
n=104

Table 1. The distribution of sample size in MARABA

	Total cooperative members	Total non cooperative members	Total coffee farmers
Population (N)	1,898	1,582	3,480
%	54.54	45.46	100
Sample size (n)	60	50	110

Factor analysis

The factor analysis was used to determine the risk sources of the coffee farmers and the risk management strategies in the examined coffee farms. In the study, the risk source factorsand the risk management strategies applied by the farmers against these factors in the coffee production in MARABA sector in HUYE District were determined. Therefore, for these analyses, the Likert Scale, was used in attitude scale methods. The Likert scale is based on the sum of the grades. In the scale, calculations are made with the scores given to the grading options. The basic approach at this scale is to present some judgments about the subject to the respondents, and to determine the distribution of people around these judgments. Judgments can be determined by scale points (5-point likert scale example) in the form of very important, important, neutral, little important, not important.

Factor analysis, which is among the multivariate analysis techniques, was also used in the study. Factor analysis aims to find the factors among the observed variables. If there are too many variables, this analysis is applied to reduce the number of variables and make it easy to interpret them. Factor analysis is one of the most widely used multivariate statistical techniques that make a large number of interrelated variables small and meaningful and independent of each other (Kalayci 2005; Kleinbaum et al. 1998).

Factor analysis is often used in attitudes and behaviors in areas such as social sciences, psychology, sociology, educational sciences, and medicine. In this study, factor analysis was used to reduce the number of variables expressed as risk sources in agricultural production and risk management strategy and to make them more understandable. Data analysis was performed using SPSS in order to run both the descriptive statistics and factor analysis.

3.RESULTS and DISCUSSIONS

Socio economic characteristics in the investigated coffee farms

Farmer and farm characteristics identification is one of the instrument to the research because they reflect the social status of the target population. Table 10 summarizes the main farm and socio-economic characteristics of coffee farmers in Huye MARABA Sector. Our sample consists of both male and female-headed households (Table 2). For the total households interviewed, the proportion of male headed-households were 81% and femaleheaded households were 19%. There is a quite big difference between the proportions of gender in coffee production in Rwanda which may be due to the importance given to coffee crops in recent years. Moreover, this crop requires a lot of intensive care which could probably and in most cases be achieved by the men's efforts. The education level of the coffee farmers was very critical such that only 61% have got at least primary education and 39% of the total interviewed farmers have not got any formal education and therefore are illiterate.

About 91.7% of the coffee cooperative members are male while 8.3% are females. It is clear that 56.7% of the coffee cooperative members are primary school graduates. 68% of non-cooperative member is male. Most of the non-cooperative member (60%) were graduated from primary school. This shows that the education level of coffee farmers is very low and therefore sufficient knowledge and skills are needed to make coffee production a more productive sector. The implication is that more should be done to raise coffee farmer's education level since coffee farming requires more adequate knowledge and skills in order to make it a more prolific industry.

Table 2. Farmer's gender and literacy level

		Coop Member		Non Coop Member		Total	
		N	%	N	%	N	%
Gender	Male	55	91.7	34	68	89	80.9
	Female	5	8.3	16	32	21	19.1
	Total	*60*	*100.0*	*50*	*100*	*110*	*100.0*
Education level	No formal schooling	20	33.3	23	46	43	39.1
	Primary school	34	56.7	26	52	60	54.5
	Secondary school	5	8.3	1	2	6	5.5
	University	1	1.7	0	0	1	0.9
	Total	*60*	*100.0*	*50*	*100.0*	*110*	*100.0*

The age of the household head: The average age of the respondents was 53 years which shows that old people predominate in coffee production (Table 3). The study has found very few youths engaging in agriculture especially in coffee production. According to the previous researchers, coffee was and still is considered as a traditional crop from its introduction to Rwanda by German colonialists and since then it was grown in big farms which are now fragmented into small farms due to the family status and family tradition of inheritance and land share. Various reasons have been fronted on why agriculture is not attractive to the youth, and in this study we concluded that it could be attributed to lack the requisite resources especially land, to carry out coffee farming activities. Therefore, since coffee is a perennial crop it doesn't attract more youth they instead go for other sectors of the economy such as service and transport.

The household size: The household size plays a very important role in farm productivity since it supplies labor needed for crop production in most of the rural communities. In our study, we have found that most of the families are large such that the average family member is 6.05 (Table 3) which is way higher than the current family size which the Government has set as a policy of family planning aiming at giving birth to not more than three for better living.

The average coffee trees: The average coffee trees per household were 408, and 362 of them were reproductive (Table 3). According to the previous MINAGRI research, this average coffee tree holding is good. But in terms of coffee productivity, there is a problem of nonreproductive (old) trees which are about 20 trees on average. This is one of the reasons why coffee production has declined in recent years according to the report of the Ministry of Agriculture and Animan Resources (MINAGRI, 2013).

Coffee land size: Our study has found that the landholding among farmers involved in coffee production in Huye District was very small. The average coffee planted area is 0.17 ha in the investigated coffee farms. This again shows how enterprise diversification would be of great importance in the coffee sector of Rwanda for farmers to not rely on a single income source which may put them into the risk of vicious cycle of poverty (Table 3).

Productivity: Coffee yield in the plants examined in the study is 2.9 kg per tree. By comparing the range of coffee productivity in coffee farms all around the world for example in Ethiopia and Brazil, we can confirm that this quantity is quite low. And we concluded that there is a need for all coffee farmers and stakeholders to look for the way of improving coffee productivity by using appropriate fertilizers and cultural practices along the production process (Table3).

Table 3. Household and farm characteristics of interviewed coffee farmers

Household and farm characteristics	Coop Member	Non Coop Member	General
AgHhead (year)	48.25	59.64	53.43
Education Level (year)	4.67	3.36	4.07
Household size (permanent family member)	6.45	5.56	6.05
Number of coffee plots (number)	1.07	1.00	1.04
Total Land size for coffee production (Ha)	0.25	0.08	0.17
Average yield per coffee tree (kg/tree)	2.94	2.86	2.90
Total Annual coffee yield (kg/ha)	1501.80	477.17	942.91
Total Revenue from coffee (RWF)	349,084.00	112,165.00	219,855.45
Number of years in farming (Years)	26.33	39.70	32.41
Number of years growing coffee (years)	18.48	25.78	21.80
Number of reproductive coffee trees (number)	591.80	171.90	362.76
Number of non reproductive coffee trees (number)	13.33	27.58	19.81
Number of cut-off-regenerated (number)	17.33	36.60	26.09
Total coffee trees (number)	655.98	202.57	408.66
Total land for other crops (Ha)	0.12	0.11	0.18
Total revenue for other crops in RWF	71,818.00	48,100.00	58,880.91
Total Annual Family Income (RWF)	420,902	160,265	278,736.36
Coffee share in household annual income (%)	**82.93**	**69.98**	**78.87**

Farming technology in coffee production

Generally, households might adopt technologies such as intercropping or use of drought- resistant crops, enterprise diversification, fertilizer usage, etc. This is very important in the sense that it allows to capture the image of agricultural pattern of the targeted population. Moreover, this is one of the instruments for the research because it reflects the farming technology adopted in coffee production.

Fertilizer usage: Currently, the application of chemical fertilizers in coffee production is almost a prerequisite for coffee producers who are members of coffee cooperatives and are mostly given to farmers in form of subsidy in order to increasing farmer's incentives and tackling with climate change effects such as floods and erosion which wash away the soil nutrients. The results of this survey show that in our sample of 110 coffee farmers almost 97 % uses chemical fertilizers in their coffee farms in order to increase the yield and only 3% do not apply chemical fertilizers (Table 4). This shows a great improvement made by the agronomists and the Ministry of Agricultural and Animal Resources to help farmers by providing chemical fertilizers in the form of subsidy as means of tackling with the risk associated with climate change such as floods and erosion which wash away all the minerals and soil nutrients and in turn increase coffee yield.

Mulching: The results of this study show that 99% of the total farmers use mulching techniques in their coffee fields and only 1% of them do not use mulching (Table 4). In coffee production, mulching is very important especially during the dry and/or sunny seasons in order to keep the crop growing healthily by providing the required water content in the soil.

Pesticide usage: One of the harmful consequences of climate change in most of crops is the spread of pests and diseases as a result of the increase in atmospheric temperature. This study has revealed three main and common pests and disease Umugese (Coffee rust), Agasurira (Antestia bug), Akaribata/Uburima (Antrachnosis). The results from descriptive statistics show that 100% of coffee farmers apply pesticides in coffee farms in order to fight against those harmful pests and diseases (Table14).

Irrigation techniques: Even though in coffee production of Rwanda irrigation techniques are not applied, this study revealed that among 110 households surveyed in this research approximately 51.8% of them apply irrigation techniques in other crops and 48.2 of them do not use it (Table 4). Generally, there are different reasons why irrigation technique is not common in coffee production. Firstly, it is probably due to the fact that coffee is generally grown on the highland (hillsides) of Rwanda where irrigation might be very demanding. Similarly, due to the water shortage, scarce water sources available in the study area are just used for other seasonal staple crops such as legumes and vegetables.

Water harvesting: Water harvesting is one of the current climate change adaptation strategies that consist of collecting water from the roofs of houses or water flow blockage during the rainy seasons and that water is stored in reservoirs and dams. This water can either be used for domestic use or for irrigation purposes. In our study, we have found that 99% of interviewed farmers use these techniques as a way of avoiding floods and water settlement on the ground and in turn help them to reduce possible harms that could be caused by excess water flow on the ground (Table 4).

Off-farm work: As it is indicated in Table 4, only 54.5% of the interviewed farmers have got jobs out of farming activities and approximately 45.5% do not work out of their farms. Since off-farm jobs are considered as a way of income diversification to support the farming activity and also as one of the risk reduction strategies. Due to the fact that coffee is a perennial crop and more farmers produce it on small scale pattern, the Government should create jobs in the region so that farmers can find enough money to use during the learning period and increase the wealth of coffee growers.

Use of credit: The use of formal credit by coffee farmers was not so common since only 23.6% of farmers use formal credit and the remaining 76.4% don't use credit to invest in the coffee business (Table 4). One of the reasons why they do not use credits is that the interest rate is high and the rate of return from coffee production is not so good. Similarily the fact that coffee is a perennial crop its payback period is very extended. Therefore most farmers are reluctant to take credit risk fearing that they may not be able to pay it on the due date. Similarly (Kloeppinger-Todd and Sharma, 2010) note that most rural households lack access to reliable and affordable finance for agriculture and other livelihood activities as they live in remote areas where banking service is limited and production risks are high. Therefore many farmers choose not to take credits from the banks.

Agricultural Extension Service: Agricultural information and communication diffusion in farming (extension) is helpful especially for rural farmers as means of getting agricultural technology transfer about the best farming practices, marketing opportunities, etc. In our study we have found that 87.3% of coffee growers receive extension service and the number of those who do not receive agricultural extension was quite low only 12.7% (Table 4). This implies that the coffee farmers in the study area were almost equipped with best farming and marketing information. This could be the result of availability of many research institutes such as Rwanda Agriculture Board and National University of Rwanda which are closer to our study area. These research institutes provide the technical capacity among the farmers and besides there are lots of projects and NGOs working closer to coffee farmers in the region.

Table 4. Farming technology in coffee production

Farming technology in coffee		Coop Member		Non Coop Member		Total	
		N	%	N	%	N	%
Application of Chemical Fertilizers	No	0	0.0	3	6	3	2.7
	Yes	60	100.0	47	94	107	97.3
	Total	*60*	*100.0*	*50*	*100*	*110*	*100.0*
Use of Mulching	No	1	1.7	0	0	1	0.90
	Yes	59	98.3	50	100	109	99.1
	Total	*60*	*100.0*	*50*	*100*	*110*	*100.0*
Use of Pesticides	Yes	60	100.0	50	100	110	100.0
Irrigation Techiques	No	35	58.3	18	36	53	48.2
	Yes	25	41.7	32	64	57	51.8
	Total	*60*	*100.0*	*50*	*100*	*110*	*100.0*
Water Harvesting	No	0	0	1	2	1	0.90
	Yes	60	100.0	49	98	109	99.1
	Total	*60*	*100.0*	*50*	*100*	*110*	*100.0*
Agriculture Insurance	No	60	100.0	50	100	110	100.0
Off farm work	No	42	70.0	8	84	50	45.5
	Yes	18	30.0	42	16	60	54.5
	Total	*60*	*100.0*	*50*	*100*	*110*	*100.0*
Use of Credits	No	56	93.3	28	68	84	76.4
	Evet	4	6.7	22	32	26	23.6
	Total	*60*	*100.0*	*50*	*100*	*110*	*100.0*
Extension Service	No	4	6.7	6	12	10	12.7
	Yes	56	93.3	44	88	100	87.3
	Total	*60*	*100.0*	*50*	*100*	*110*	*100.0*

Main food crops grown and source of farm inputs (seedlings and fertilizers)

The major crops grown in the region and the main crops grown were identified (Table 5), and were ranked as follows; the predominant crop was beans, followed by cassava, banana and lastly sweet potatoes. The results indicate that beans predominate in food crops in the study area and it is even considered as meat for most of the African people. The second most grown crop in the region is cassava which is very often consumed as fresh or processed in order to make cassava flour which also a favorable food for most of East African people. The third most grown crop in the region is banana which is rarely mixed with coffee trees in order to provide shading for newly planted coffee trees and sweet potatoes were found the last main food crop grown in the region.

Table 5. The major food crops grown in the region

Major Crops grown	Coop Member		Non Coop Member		Total	
	N	(N=60) %	N	(N=50) %	N	(N=110) %
Beans	59	98.3	45	90	104	94.50
Cassava	55	91.7	46	92	101	91.80
Banana	48	80.0	50	100	98	89.10
Sweet Potatoes	46	76.7	45	90	91	82.70

**Multiple responses*

In coffee production, there different ways through which farmers can get seedlings during the planting season. With regard to Government support in coffee production, Government has availed public nurseries so that farmers can get them easily with relatively short distance of walking. The main sources of seedling as it was mentioned by farmers was public nursery, followed by cooperative nursery and the remaining few farmers have got their own nurseries. On the other hand, chemical fertilizers usage is recommended to all coffee producers in Rwanda and the Government is involved in supporting coffee farmers since this crop was and still is considered as the main foreign currency earners. Vaucha system is the main source of fertilizer (44.5%), followed by cooperative (42.7%) and lastly bought from the market (12.7%). Water harvesting is one of the current climate change adaptation strategies that consist of collecting water from the roofs of houses or water flow blockage during the rainy seasons and that water is stored in reservoirs and dams. The main purpose of water harvesting techniques was to use at home (48.40%), to feed animals (48.40%), to adapt to climate change (1.80%) and to soil irrigation (1.30%) (Table 6).

Table 6. Source of farm inputs

Farm inputs	Source of farm inputs	Coop Member		Non Coop Member		Total	
		N	%	N	%	N	%
Origin of coffee seedling	Public nursery	13	21.7	44	88	57	51.80
	Cooperative nursery	45	75.0	6	12	51	46.40
	My own nursery	2	3.3	0	0	2	1.80
	Total	*60*	*100.0*	*50*	*100*	*110*	*100.00*
Source of chemical fertilizers	Vaucha system (subsidy)	12	20.0	37	74	49	44.50
	Cooperative	43	71.7	4	8	47	42.70
	Bought from the market	5	8.3	9	18	14	12.70
	Total	*60*	*100.0*	*50*	*100*	*110*	*100.00*
Period of Mulching	During planting	53	88.3	22	44	75	68.20
	During weeds removal	7	11.7	28	56	35	31.80
	Total	*60*	*100.0*	*50*	*100*	*110*	*100.00*
Purpose of water harvesting*	Farm irrigation	3	5.0	0	0	3	1.30
	Domestic use only	60	100.0	50	100	109	48.40
	Watering animals	60	100.0	49	100	109	48.40
	Climate change adaptation	3	5.0	1	2	4	1.80

**Multiple responses*

Coffee marketing and factors influencing coffee supply

In Coffee production of Rwanda, there are various ways through which coffee farmers can supply their produce and reach the desired customers. Table 7 shows channels through which coffee is sold after harvesting period. Generally, in order to avoid coffee supply problems, coffee farmers make a contract with their customers mostly coffee cooperative and coffee washing stations before selling. The descriptive statistics show that among the interviewed farmers 54.5% of them make contract with either Farmer's marketing cooperative (36.4%) or Cooperative CWS (18%). The remaining 45.5% of coffee farmers produce and sell coffee with no contract basis. On the other side, the research has revealed that 40% of coffee producers supply coffee to farmers' marketing cooperative, 54.5% supply coffee to cooperative CWS, 2.7 % supply coffee to private coffee processor and 2.7 % supply coffee to middlemen. After coffee supply, the type of payment generally used by most of coffee farmers was selling on credits (49.1%), followed by payment by cash (40.9%) and the remaining was paying after one or two weeks, 4.5% and 5.5 % respectively.

Table 7. Coffee marketing

		Coop Member		Non Coop Member		Total	
		N	%	N	%	N	%
Where do you sell your coffee?	Farmer's marketing coop	40	66.7	4	8	44	40.0
	Cooperative CWS	19	31.7	41	82	60	54.5
	Private coffee processor	1	1.7	2	4	3	2.7
	Middlemen	0	0.0	3	6	3	2.7
	Total	*60*	*100.0*	*50*	*100*	*110*	*100.0*
Type of payments made	Direct payment (Cash)	3	5.0	42	84	45	40.9
	Selling on Credits	48	80.0	6	12	54	49.1
	Pay after one week	3	5.0	2	0	5	4.5
	Pay after two weeks	6	10.0	0	4	6	5.5
	Total	*60*	*100.0*	*50*	*100*	*110*	*100.0*

Factors influencing coffee supply after harvesting

During the coffee supply, there a number of factors that influence coffee farmers to decide where to supply their produce either cherries of semi-dried coffee. This study has revealed seven main factors. Table 8 indicates that the price plays a leading role in influencing coffee farmers supply (1,07), followed by payment date (1.37), distance to CWS and quality share the same position in influencing coffee supply (1.44), trust (1.49), credit (1.5) and relationship with the clients was the least influential factor (1.58).

Table 8. Factors influencing coffee supply after harvesting

	Mean	Std. Dev	%					
			1	2	3	4	5	Total
Cooperative members (N=60)								
Price	1.13	0.343	86.7	13.3	0.0	0.0	0	100
Payment date	1.48	0.596	55.0	43.3	1.7	0.0	0	100
Trust	1.57	0.593	46.7	51.7	1.7	0.0	0	100
Relationship	1.63	0.610	41.7	55.0	1.7	0.0	0	100
Credit	1.65	0.880	55.0	40.0	3.3	1.7	0	100
Distance to CWS	1.52	0.651	56.7	40.0	1.7	1.7	0	100
Quality	1.48	0.624	56.7	40.0	1.7	1.7	0	100
Non cooperative members (N=50)								
Price	1.00	0.000	100.0	0	0	0	0	100
Payment date	1.24	0.431	76	24	0	0	0	100
Trust	1.40	0.495	60	40	0	0	0	100
Relationship	1.52	0.505	48	52	0	0	0	100
Credit	1.32	0.471	68	32	0	0	0	100
Distance to CWS	1.34	0.479	66	34	0	0	0	100
Quality	1.38	0.490	62	38	0	0	0	100
Total (N=110)								
Price	1.07	0.261	92.70	7.30	0.00	0.00	0	100
Payment date	1.37	0.539	64.50	34.50	0.90	0.00	0	100
Trust	1.49	0.554	52.70	46.40	0.90	0.00	0	100
Relationship	1.58	0.565	44.50	53.60	0.90	0.9	0	100
Credit	1.50	0.739	61.80	28.20	9.10	0.9	0	100
Distance to CWS	1.44	0.583	60.00	37.30	1.80	0.9	0	100
Quality	1.44	0.567	59.10	39.10	0.90	0.9	0	100

Likert scale was used: Very important =1; Important=2; Neutral=3; Little important=4; Not important=5

Risk sources in coffee production

In this study, the mean value, standard deviations and percentages for the risk sources in coffee production were calculated (Table 9). The calculated mean values show that the most effective risk sources were changes in agricultural and export policy (1.15), followed by pest and diseases (1.25), rainfall unavailability and soil infertility (1.45), high temperature variation (1.5), yield uncertainty (1.5) and small land under coffee production (1.55). In addition, it was found that insufficiency of producer organizations (3,60), theft (3,60), lack of production record keeping (3,55), insufficiency of family labor (3,51), insufficiency of rain (3,51), lack of information about marketing (3,43) and misunderstanding of family members (3,42)were the least effective sources of risk in coffee production.

The remaining variables were not significant to be considered as risk sources as they have high mean values. Nevertheless, heavy rain and price fluctuations are the two of the most frequently mentioned sources of risk in general, and it can, therefore, be expected that they could significantly influence the farmers' perception of climate change adaptation in particular and risk management in general.

Factor analysis is conducted through four steps. In the first step, the correlation matrix is generated so as to identify the variables that are related and most probably they will be in the same factor. Field (2000) states that the variables in the study have to be intercorrelated. However, this correlation should not be too high that may cause difficulties in determining the unique contribution of the variables to a factor. Correlation coefficients greater than 0.3 in the absolute value are indicative of the acceptable correlations.

The primary objective of this stage is to determine factors that are obtained by using the Principal Components Analysis, the most commonly used extraction method. Eigenvalues are used to decide on how many factors we need to represent the data set we have in the study in addition to the scree plot. As a general rule, factors whose eigenvalues are greater than one are considered.

The factors are rotated in order to make the factors more interpretable and more understandable. The most popular rotational method is the Varimax rotation. The Varimax attempts to minimize the number of variables that have high loadings on a factor which enhances the interpretability of the factors. As a general rule, the value of the common factor correlation ±0.3 or higher indicates a significant relationship between a variable and a factor, but in our study, we have only considered common factor correlation greater or equal to ±0.4 (Hair et al., 1992). The factor analysis was applied to data collected from coffee farmers. As it can be seen in Table 10, we have retained 12 factors the Eigenvalues of which are greater than one and they explain 73.75 % of the total variance.

Factor 1 was named “Sosyo-econmic risk” because it includes lack of production record keeping (0.714), insufficiency of producer organizations (0.707), lack of information about sales and marketing (0.690), accident during farm work (0.630), debt structure (0.576), indebtedness situation (0.568), theft (0.537) and insufficiency of family labor (0.510). Factor 2 was named “ Production risk” and it includes pests and diseases (0.485), Poor quality of seeds (0.519), high temperature variation (0.498), and price volatility of coffee cherries (0.485). Factor 3 “ Financial risk” and it includes lack of self-capital in finance (0.712), insufficiency of credits source (0.590), lack of enough capital for farmers (0.570), inflation (0.499), climate change and variability (0.465) and social conflicts (0.412).

Factor 4 was named “Climate Risk” because it includes floods (0.782), heavy winds (0.729), lack of machinery in farming (0,722), insufficiency of rain (0,513). Factor 5 “Productivity Risk” because it includes change in inputs costs (0,755), changes in national economic situation (0.669), frost (0,553), rainfall availability(0,526) and change in product productivity (0,468).

Factor 6 “Transportation risk” and has a negatif relationship with insuficiency of rain (-0,485) and product harm resulting from floods (0,764), long distance to the CWS (0,751) and lack of enough land for agriculture (0,402) with which it has a positif relatinship. Factor 7 was named “Technological risk” and it includes product loss during harvesting period (0,695), problem of product packging (0,532), long distance to the market place (-0,604) and hired labor cost and availability (-0,521). Factor 8 was named “Marketing risk” and it includes inadequate infrastructures (0,740) and lack of cooperative membership (0,476).

Factor 9 “includes lack of enough land for agriculture (0,767) and transportation problem (0,497). Factor 10 “Drought risk” And it includes drought (0,794) and heavy rain when not needed (0,704). Factor 11 was named “Personal risk” because it includes yield uncertainty (0,540) and family misunderstandings (0,527). Factor 12 was named “Price risk” , this factor has a positive relationship and it includes access to the market (0,638), small land under coffee production (0,562), price volatility of coffee cherries (0,551), cost of capital equipment of WS (0,542).

Table 9. Risk sources in coffee farming

Risk sources	**Mean**	**Std. Dev**	**%**					
			1	2	3	4	5	Total
Changes in agricultural and export policy	1.15	0.354	85.5	14.5	0.0	0.0	0.0	100.0
Poor quality of seeds	1.74	0.519	30.0	66.4	3.6	0.0	0.0	100.0
Small land under coffee production	1.55	0.659	54.5	36.4	9.1	0.0	0.0	100.0
Yield uncertainty	1.50	0.617	55.5	40.0	3.6	0.9	0.0	100.0
Price volatility of coffee cherries	1.63	0.728	49.1	41.8	6.4	2.7	0.0	100.0
Cost of capital equipment of ws	1.75	0.722	41.8	41.8	16.4	0.0	0.0	100.0
Access to the market	1.66	0.612	40.9	53.6	4.5	0.9	0.0	100.0
Pest and diseases	1.25	0.582	28.2	45.5	24.5	1.8	0.0	100.0
Hired labor cost and availability	2.00	0.778	31.8	44.5	20.0	3.6	0.0	100.0
Access to credit	1.95	0.818	63.6	25.5	9.1	1.8	0.0	100.0
Rainfall unavailability and soil infertility	1.49	0.739	57.3	35.5	6.4	0.9	0.0	100.0
High temperature variation	1.51	0.661	20.9	46.4	25.5	73	0.0	100.0
Low supply and high prices of inputs	1.89	0.721	34.5	42.7	21.8	0.9	0.0	100.0
Social conflicts	2.34	0.951	32.7	40.9	20.0	6.4	0.0	100.0
Changes in national economic situation	2.19	0.851	10.0	21.8	32.7	34.5	0.9	100.0
Change in product productivity	1.92	0.889	80.9	13.6	4.50	0.9	0.0	100.0
Change in inputs costs	1.89	0.770	8.2	33.6	46.4	11.8	0.0	100.0
Lack(few)government support	2.00	0.888	49.1	33.6	14.5	2.70	0.0	100.0
Long distance to the market place	2.95	1.003	25.5	44.5	22.7	7.30	0.0	100.0
Climate change and variability	2.62	0.801	22.7	44.5	22.7	10.0	0.0	100.0
Product loss during harvesting period	1.71	0.817	10.9	28.2	33.6	26.4	0.9	100.0
Problem of product packging	2.12	0.875	5.5	35.5	42.7	16.4	0.0	100.0
Transportation problem	2.20	0.907	6.4	22.7	36.4	33.6	0.9	100.0
Inadequate infrastructures	2.78	0.989	3.6	20.0	44.5	30.9	0.9	100.0
Lack of cooperative membership	2.70	0.808	1.8	13.6	47.3	31.8	5.5	100.0
Inflation	3.00	0.929	1.8	13.6	47.3	31.8	5.5	100.0
Lack of self-capital in finance	3.05	0.833	4.5	10.9	45.5	31.8	7.3	100.0
Lack of enough capital for farmers	3.25	0.829	1.8	18.2	37.3	36.4	6.4	100.0
İnsufficiency of credits source	3.13	0.836	1.8	18.2	37.3	36.4	6.4	100,0
Change in land value(price)	3.26	0.915	2.7	13.6	41.8	35.5	6.4	100.0
Change in taxes rate	3.25	0.837	0.9	10.9	30.9	46.4	10.9	100.0
Indebtedness situation	3.27	0.898	0.0	0.0	0.0	0.0	0.0	100.0
Debt sturcture	3.29	0.881	0.0	0.0	0.0	0.0	0.0	100.0
Lack of production record keeping	3.55	0.863	0.0	0.0	0.0	0.0	0.0	100.0
Insufficiency of producer organizations	3.60	0.901	2.7	6.4	32.7	44.5	13.6	100.0
Lack of information about sales and marketing	3.43	0.862	1.8	10.0	40.9	38.2	9.1	100.0
Accident during farm work	3.38	0.919	2.7	11.8	40.0	35.5	10.0	100.0
Family misunderstandings	3.42	0.817	10.9	40.9	40.0	7.3	0.0	100.0
Insufficiency of family labor	3.51	0.865	2.7	6.4	38.2	42.7	10.0	100.0
Theft	3.60	0.931	3.6	5.5	32.7	43.6	14.5	100.0
Heavy rain when not needed	3.38	1.157	4.5	11.8	24.5	29.1	30.0	100.0
Insufficiency of rain	3.51	1.353	10.9	15.5	15.5	28.2	30.0	100.0
Lack of machinery ın farming	3.15	1.394	14.5	25.5	11.8	27.3	20.9	100.0
Product harm resulting from floods	2.42	1.128	23.6	34.5	21.8	16.4	3.6	100.0
Lack of enough land for agriculture	2.61	1.189	21.8	26.4	26.4	20.0	5.5	100.0
Lack of production planning	2.96	1.049	0.0	0.0	0.0	0.0	0.0	100.0
Insufficiency of technical ınformation	3.23	0.992	4.5	18.2	35.5	33.6	8.2	100.0
Drought	3.35	0.999	7.3	9.1	32.7	43.6	7.3	100.0
Floods	3.01	1.223	14.5	20.0	25.5	30.0	10.0	100.0
Heavy winds	2.67	1.101	16.4	30.9	23.6	27.3	1.8	100.0
Very long disatnce to the cws	2.50	1.064	18.2	36.4	25.5	17.3	2.7	100.0
Family diseases	2.74	1.046	11.8	31.8	30.9	21.8	3.6	100.0

Likert scale: Very important =1; Important=2; Neutral=3; Little important=4; Not important=5

Table 10. Factors retained from rotated matrix

	Factors											
	1	2	3	4	5	6	7	8	9	10	11	12
Lack of production record keeping	**0.714**	-0.067	0.232	0.041	-0.046	0.040	-0.168	-0.05	0.135	0.184	-0.00	0.048
Insufficiency of producer organizations	**0.707**	**0.**099	0.085	0.000	0.020	-0.153	-0.175	-0.18	-0.00	0.186	-0.03	-0.12
Lack of information about sales and marketing	**0.690**	**0.**052	0.161	0.016	-0.028	-0.135	-0.010	0.143	0.086	0.112	-0.02	-0.06
Accident during farm work	**0.630**	-0.129	-0.160	0.056	0.100	0.026	-0.086	0.226	-0.06	-0.04	0.141	0.163
Ddebt sturcture	**0.576**	**0.**369	0.155	0.074	0.020	0.053	-0.062	-0.005	-0.008	0.222	-0.049	-0.129
Indebtedness situation	**0.568**	**0.**250	0.267	-0.082	-0.139	0.162	0.054	0.159	-0.166	-0.046	-0.220	0.125
Theft	**0.537**	-0.009	0.179	0.006	0.101	0.038	-0.125	0.083	0.364	0.116	-0.186	0.118
Insufficiency of family labor	**0.510**	**0.**017	-0.092	-0.209	0.095	-0.031	-0.039	0.161	0.343	-0.038	0.040	-0.062
Change in land value(price)	**0.475**	**0.**314	0.240	-0.147	0.042	0.173	0.127	0.286	-0.168	-0.158	-0.007	-0.060
Access to credit	**0.418**	-0.061	0.089	0.369	0.151	0.103	-0.227	-0.199	0.082	-0.197	0.185	-0.092
Pest and diseases	**0.**068	**0.738**	-0.041	0.097	0.036	0.194	-0.007	0.121	0.135	0.139	0.028	0.083
Poor quality of seeds	**0.**064	**0.519**	0.042	0.025	0.094	0.122	0.119	-0.046	0.061	-0.101	0.081	-0.083
High temperature variation	-0.05	**0.498**	-0.001	0.006	0.411	-0.018	0.072	-0.104	-0.043	0.001	0.027	0.025
Lack of self-capital in finance	**0.**160	-0.092	0.**712**	0.127	0.126	0.057	0.078	0.040	-0.051	0.077	-0.182	0.037
Insufficiency of credits source	**0.**331	**0.**185	0.**590**	-0.058	0.066	-0.289	0.084	0.126	-0.016	-0.062	0.018	-0.077
Lack of enough capital for farmers	**0.**394	-0.032	0.**570**	0.057	-0.145	-0.064	-0.020	-0.133	0.110	0.138	0.204	0.100
Inflation	**0.**053	**0.**117	0.**499**	-0.064	0.089	-0.207	-0.178	0.345	0.077	0.198	0.012	0.198
Climate change and variability	**0.**089	-0.033	0.**465**	0.180	0.157	0.085	-0.059	0.260	-0.153	0.013	0.464	-0.139
Social conflicts	**0.**134	**0.**336	0.**412**	0.123	0.068	-0.099	-0.394	-0.021	0.085	-0.051	0.374	0.176
Floods	-0.02	**0.**049	-0.120	0.**782**	0.029	-0.193	0.001	0.116	0.066	0.020	-0.045	0.076
Heavy winds	-0.10	**0.**171	0.174	0.**729**	0.121	0.039	-0.034	-0.058	0.014	-0.164	0.135	0.042
Lack of machinery in farming	**0.**029	-0.074	0.122	0.**722**	-0.217	-0.095	-0.021	-0.055	-0.084	-0.036	-0.133	-0.026
Insufficiency of rain	**0.**142	**0.**028	-0.090	0.**513**	0.040	-0.**485**	0.073	0.114	0.001	0.342	-0.115	0.086
Change in inputs costs	-0.04	-0.046	0.137	-0.016	0.**755**	-0.007	0.096	-0.057	0.199	-0.047	0.148	-0.031
Changes in national economic situation	**0.**168	**0.**143	0.136	-0.065	0.**669**	-0.063	-0.009	0.030	-0.045	0.015	0.013	0.044
Frost	-0.02	-0.090	-0.098	0.106	0.**553**	0.193	-0.265	-0.064	0.157	0.210	-0.310	0.071

	Factors											
	1	2	3	4	5	6	7	8	9	10	11	12
Rainfall availability and soil fertility	-0.01	**0.**252	-0.099	0.076	0.**526**	-0.032	0.166	0.196	-0.127	-0.166	-0.038	0.051
Change in product productivity	**0.**041	**0.**056	0.070	-0.020	0.**468**	0.164	0.356	0.024	0.135	0.199	0.144	0.186
Product harm resulting from floods	**0.**038	**0.**059	-0.137	-0.142	-0.124	0.**764**	0.082	-0.139	0.083	-0.155	-0.035	-0.028
Very long disatnce to the CWS	-0.08	**0.**156	-0.041	-0.063	0.185	0.**751**	0.090	0.180	-0.063	0.027	-0.042	0.035
Family diseases	**0.**132	**0.**180	-0.238	-0.260	-0.089	0.332	-0.022	0.282	0.289	-0.098	0.072	0.104
Pproduct loss during harvesting period	-0.08	**0.**132	0.013	0.051	0.151	0.102	0.**695**	-0.111	0.074	0.006	0.029	-0.029
Long distance to the market place	**0.**248	-0.059	0.026	0.039	0.013	0.012	**-0.604**	0.048	0.130	0.019	0.087	-0.084
Problem of product packging	**0.**055	**0.**160	0.153	0.092	0.161	-0.003	0.**532**	0.292	0.381	0.049	0.134	0.019
Hired labor cost and availability	**0.**237	**0.**302	0.106	0.226	-0.021	0.038	**-0.521**	0.001	0.059	0.211	-0.170	0.118
Inadequate infrastructures	**0.**183	-0.109	0.054	0.028	0.031	0.078	-0.067	0.**740**	0.029	0.148	0.107	0.001
Lack of cooperative membership	-0.03	**0.**107	0.320	0.069	-0.080	0.037	0.017	0.**476**	0.046	0.066	-0.449	-0.218
Change in taxes rate	**0.**295	**0.**344	0.228	-0.113	0.085	-0.157	0.014	0.388	0.012	-0.213	0.047	-0.039
Lack of production planning	**0.**101	-0.022	-0.08	0.106	0.015	-0.024	-0.049	-0.053	0.**767**	-0.026	0.044	-0.068
Lack(few)government support	**0.**012	**0.**273	0.116	-0.038	0.174	0.002	0.218	-0.042	0.**497**	-0.157	-0.226	0.043
Lack of enough land for agriculture	-0.00	**0.**108	-0.016	-0.290	-0.096	0.**402**	-0.004	0.199	0.**484**	-0.033	-0.151	0.120
Transportation problem	**0.**250	**0.**271	0.193	0.020	-0.032	0.160	0.384	0.371	0.**400**	0.026	-0.161	0.120
Drought	**0.**120	-0.006	0.227	0.045	-0.089	-0.191	-0.072	-0.003	-0.118	0.**794**	-0.111	0.052
Heavy rain when not needed	**0.**298	-0.028	-0.06	-0.165	0.093	-0.036	0.083	0.149	-0.054	0.**704**	0.156	-0.082
Insufficiency of technical information	**0.**212	**0.**077	0.077	-0.188	0.192	0.250	-0.195	0.158	.265	0.296	-0.014	0.039
Yield uncertainty	-0.22	**0.**243	0.007	-0.076	0.000	-0.080	0.104	0.017	-0.009	0.070	0.**540**	0.047
Family misunderstandings	**0.**460	-0.115	-0.10	-0.163	0.169	0.002	-0.011	0.189	-0.056	-0.103	0.**527**	0.114
Changes in agricultural and export policy	-0.03	**0.**331	-0.06	-0.14	0.182	-0.18	0.030	0.266	0.158	-0.189	-0.352	0.181
Access to the market	-0.12	-0.23	0.224	0.001	0.105	-0.00	0.039	-0.241	0.025	0.017	0.155	0.**638**
Small land under coffee production	**0.**066	-0.10	-0.18	0.185	0.035	0.023	0.104	0.066	-0.170	-0.385	-0.153	0.**562**
Price volatility of coffee cherries	**0.**063	**0.**485	0.021	0.007	-0.029	-0.07	-0.036	-0.010	0.083	0.097	-0.088	0.**551**
Cost of capital equipment of WS	-0.05	**0.**269	0.133	0.064	0.131	0.277	-0.135	0.221	0.171	0.149	0.174	0.**542**
Low supply and high prices of inputs	**0.**058	**0.**296	-0.117	-0.067	0.376	-0.070	0.097	0.101	-0.137	-0.056	0.037	0.387

Note: The values in bold cells are factor loadings greater than.0.4 and were considered.significant.

Risk coping strategies

In regards to the aspects of possible risk reduction strategies, 26 range questions related to the risk coping strategies were included in the questionnaire addressed to the coffee farmers (Table 11). In the research, the Likert scale was used for the risk management strategies applied by the coffee producers. Among the risk management strategies applied by the coffee producers in the investigated farms, the strategies that they express as important are to mix farming (1,22), to use sufficient chemical input (2.02), to use new and durable coffee varieties (2.02), to make enterprise diversification (2.39), to work and invest in off-farm activities (2.41). The risk management strategies that are not considered as important by the coffee producers in the surveyed farms are to buy crop insurance (4,06), to reduce family expenses (3,45), to invest in non-farm activities (3.30) and to make farm planning (3,25) is expressed as.

Table 11. Risk coping strategies in coffee farming

Risk reducing strategies	Mean	Std. Dev	%					
			1	2	3	4	5	Total
Mixed farming (intercropping)	1.22	0.415	78.2	21.8	0.0	0.0	0.0	100
Work and invest in off-farm activities	2.41	0.758	9.1	47.3	38.2	4.5	0.9	100
Enterprise diversification	2.39	0.959	17.3	40.9	29.1	10.9	1.8	100
Use of enough chemical inputs	2.02	0.778	25.5	50.9	20.0	3.6	0.0	100
Use new and resistant coffee varieties	2.02	0.824	29.1	43.6	23.6	3.6	0.0	100
Network for sharing (informal credits)	2.82	0.930	8.2	28.2	38.2	24.5	0.9	100
Reduce and avoid debt	2.88	0.896	5.5	27.3	43.6	20.9	2.7	100
Cooperative membership	2.78	0.747	4.5	27.3	53.6	14.5	0.0	100
Greater use of on farm family labor	3.02	0.857	2.7	26.4	38.2	31.8	0.9	100
Collect market information	3.11	0.902	2.7	21.8	42.7	27.3	5.5	100
Reduce the production costs	3.00	0.801	1.8	24.5	47.3	24.5	1.8	100
Enough saving	3.19	0.904	1.8	22.7	34.5	36.4	4.5	100
Add value to the coffee cherries	2.95	0.799	4.5	20.0	52.7	21.8	0.9	100
Buy coffee processing equipments	2.93	0.775	1.8	27.3	48.2	21.8	0.9	100
Sell coffee to the cooperative only	3.05	0.771	3.6	16.4	51.8	28.2	0.0	100
Avoid the delay in supplying coffee	2.98	0.824	2.7	23.6	49.1	21.8	2.7	100
Avoid processing with traditionsl means	2.91	0.685	0.9	24.5	58.2	15.5	0.9	100
Keeping farm records	3.16	0.894	0.9	21.8	45.5	23.6	8.2	100
Use of saving groups(tontines)	3.14	0.962	3.6	21.8	39.1	28.2	7.3	100
Pesticides use	2.11	1.095	32.7	40.0	16.4	5.5	5.5	100
Invest in off-farm activities	3.30	0.841	1.8	9.1	56.4	22.7	10.0	100
Buy crop insurance	4.06	1.086	1.8	9.1	17.3	24.5	47.3	100
Consolidate the land	2.86	0.943	6.4	29.1	40.0	20.9	3.6	100
Farm planning	3.25	0.952	3.6	18.2	33.6	38.2	6.4	100
Reduce family expenses	3.45	0.954	3.6	9.1	39.1	35.5	12.7	100

Likert scale was used: Very important =1; Important=2; Neutral=3; Little important=4; Not important=5

Factor analysis was conducted for the risk management strategies applied by the coffee producers in the investigated coffee farms. Principal Component Analysis was undertaken on 26 variables and 7 principal components factors with eigenvalues greater than 1 have been retained (Table 12). These new factors explained 54.75 % of the total original variability.

Factor 1 was named "Marketing plan" and this factor includes enough saving (0,551), add value to the coffee cherries (0,476), buy coffee processing equipment (0,659), sell coffee to the cooperative only (0,576), avoid delay in supplying coffee (0,606) and avoid processing with traditional equipment (0,707). Factor 2 was named "Cooperative membership" and it includes reduce and avoid debt (0,767), cooperative membership (0,599), greater use of on farm family labor (0,485) and collect market information (0,659).

Factor 3 was named "Farm record keeping" and it includes cooperative membership (0,438), reduce the production costs (0,665), keeping farm records (0,652) and mixed farming (0,472), and all these variables have a positive relationship with the factor. Factor 4 was named " Make savings" and it includes use of enough chemical inputs (0,469), network for sharing (0,444) and formal credits use (-0,717) of which the latter has a negative relationship with the factor.

Factor 5 was named "Buy crop insurance" and it includes work and invest in off-farm activities (-0,402), consolidated the land (-0,597), use of pesticides (-0,546), buy crop insurance (0,469) and farm planning (0,466). While the three variables are having a negative relationship with the factor and only the latter has a positive relationship. Factor 6 was named "Reduce family expenses" and it includes reduce family expenses (0,707) and mixed farming (0,440) and have a positive relationship with the factor. Factor 7 was named "Use resistant coffee varieties" which includes use of new and resistant coffee varieties (0,624) and invest in off-farm activities (0.725) and have a positive relationship with the factor.

Table 12. Factors retained from rotated matrix

Risk reducing strategies	Factors						
	1	2	3	4	5	6	7
Work and invest in off-farm activities	-0.169	-0.037	0.111	-0.120	-0.**402**	0.399	0.331
Enterprise diversification	0.116	0.302	0.348	0.160	-0.231	0.375	-0.218
Use of enough chemical inputs	0.094	0.270	0.255	0.**469**	-0.080	0.108	0.061
Use new and resistant coffee varieties	-0.012	0.070	-0.128	-0.019	0.129	0.029	0.**624**
Network for sharing(informal credits)	0.031	-0.047	0.179	-0.**717**	0.111	-0.001	0.218
Reduce and avoid debt	-0.035	0.**767**	0.073	0.237	0.007	0.120	-0.006
Cooperative membership	0.214	0.**599**	0.**438**	0.033	0.202	0.133	-0.254
Greater use of on farm family labor	0.162	0.**485**	0.089	0.354	-0.117	-0.189	0.096
Collect market information	0.293	0.**659**	0.005	-0.149	0.082	0.166	-0.050
Reduce the production costs	-0.046	0.356	0.**665**	0.129	0.070	-0.088	-0.010
Enough saving	0.**551**	0.351	0.012	-0.137	0.021	-0.347	0.373
Add value to the coffee cherries	0.**476**	0.268	0.243	0.300	0.188	-0.080	-0.223
Buy coffee processing equipments	0.**659**	0.191	0.047	-0.081	-0.019	-0.054	-0.071
Sell coffee to the cooperative only	0.**576**	-0.031	0.003	0.296	-0.006	0.370	0.125
Avoid the delay in supplying coffee	0.**606**	-0.005	0.260	0.121	0.027	0.136	-0.029
Avoid processing with traditionsl means	0.**707**	0.077	0.051	0.071	-0.033	0.227	-0.141
Keeping farm records	0.282	-0.007	0.**652**	-0.141	0.011	0.015	-0.058
Use of saving groups (tontines)	0.317	0.034	0.144	0.**444**	0.**457**	0.112	-0.060
Pesticides use	0.216	0.171	0.260	0.304	**-0.546**	-0.026	-0.073
Invest in off-farm activities	-0.119	-0.142	0.050	-0.066	0.077	-0.018	**0.725**
Buy crop insurance	0.176	0.142	-0.059	-0.046	0.**469**	0.334	0.183
Consolidate the land	0.219	-0.213	-0.170	0.012	**-0.597**	0.119	-0.105
Farm planning	0.222	-0.202	0.211	-0.101	0.**466**	-0.109	0.259
Reduce family expenses	0.193	0.184	-0.046	0.018	0.015	0.**707**	-0.053
Mixed farming(intercropping)	0.170	-0.165	0.**472**	0.373	0.056	0.**440**	0.136

Note: The values in bold cells are factor loadings greater than 0.4 and were considered significant.

4.CONCLUSION

The purpose of this research is to evaluate farmers' incentives and perceptions to adopt the risk coping (adaptation) strategies that have been already implemented and to determine the socio-economic factors affecting farmers' participation in the risk reduction strategies on the coffee sector of Rwanda. In this study, the factor analysis which was performed to identify the common sources of risk in the coffee sector and possible risk-reducing strategies has revealed 12 factors in which all other variables were enclosed. Those factors are: socio-economic risk, production risk, financial risk, climate risk, productivity risk, technological risk, marketing risk, drought risk, personal risk, and price risk. The main risk sources then were identified to be: price volatility of coffee cherries, lack of enough rain, non-reproductive coffee varieties and floods. On the other hand, factor analysis has grouped the risk coping strategies into 7 main factors in which all others variables were enclosed such as marketing plan, cooperative membership, farm record keeping, saving, crop insurance, reduce expenses and use resistant coffee varieties. The main risk adaptation strategies were: mixed farming (intercropping), followed by the use of enough chemical inputs, use new and resistant coffee varieties and pesticides usage.

Despite its role in risk management, crop insurance was found to almost not be known in the coffee production of Rwanda. Therefore, this study suggests that the government should take a leading role in raising awareness of farmers by mobilizing the crop insurance schemes in the coffee sectors of Rwanda. This study suggests that climatic change and absence of institutional instruments such as crop insurance, disaster payments make risk management strategies very critical for rural people especially coffee farmers. Policymakers should focus efforts on reducing production risks providing climatic information in order to increase the awareness of coffee farmers and developing risk management institutions.

In order to get a real sense of climate change in the study area, we have also included some questions which targeted the local leaders in Huye District. Some of them have recommended that the restriction of settlement /building development in risk and remote areas was implemented and they are planning for relocation of people who live in those areas which would be beneficial strategies of climate risk mitigation and reduction. Landscape planning measures to improve water balance (Tree planting, reforestation, change of land use) was pointed out as it reflects the vegetal cover which enhances the soil structure and fights against rainy erosion. They also said that improving forecasting, monitoring, information spreading would also be beneficial to farmers as it will increase their awareness about climate and take possible measures to tackleit. Improving insurance schemes against drought damages also is necessary for the region (quoting Huye District Agronomist).

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