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Research Application Summary

Financial institutions and farming systems characterisation in the southern province (Amajyepfo) of Rwanda

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Abstract

One of most prominent interventions that governments world over and especially in Africa have adopted is the enhancement of agricultural finance systems, the provision of agricultural credit to farmers, and creation of policy environments that promote the smooth operation of financial institutions, with an aim of increasing access to credit among smallholder farmers. The cross-cutting aspect among all the de-risking ventures is that for their effective implementation, the intended beneficiaries and the finance institutions have to be profiled (characterized). This is because financial institutions' and farming systems of smallholder farmers are heterogeneous. Non-recognition of that heterogeneity by governments when coming up with policies for agriculture de-risking and hence development has often resulted into the ineffectiveness of such policies. Farming systems have to be characterized, in order to maximize the impact and/or effect of any value chain de-risking interventions in the agricultural sector, which are meant to improve productivity. Given that most interventions are finance related, finance institution characterization's consequently become paramount as well. This study was done with an aim of characterizing finance institutions and farming systems in the southern province of Rwanda. A multistage sampling procedure was used, in which sampling was done for the at district level (Stage 1), sector level (Stage 2), cell level (stage 3), village level (stage 4) and household level (stage 5). The study used structured interviews to collect the data from the sampled smallholder farmers. Characterization of specifically farming systems was done using the analytical methods; principal component analysis (PCA) and cluster analysis (CA). Institutional characterization was done descriptively. Partitioning of the dendogram resulted into five clusters which were taken as most representative of farm households in the southern province. What makes cluster I (27% of households) different from other farm household clusters in Southern province is its discriminative power based on household farm labor, farm household in this cluster use hired labor as opposed to family labor on their farms. Cluster II (14%) consists of households that use chemical inputs on their farms, practice crop rotation, and more of terrace agriculture. Cluster III (29% of the farm households) differs mainly by the nature of chemical inputs they use on the farm, with most using organic fertilizer. The majority of them however own the pieces of land they use, are male and use hired labor. Cluster IV (19%) consists of more female headed households, with small farm land sizes, usually practice monocropping, and rely more on family labor on the farm. Cluster V (21% of farm households) consists of farm household with large land sizes, have very small household sizes, little use biological in puts, and little use of terrace cultivation. Farming systems in the southern province are highly heterogeneous, and thus any future de-risking interventions that are especially monetary have to take that heterogeneity into consideration. Due to possibly low access to credit, majority of the farm households in the southern

province are not using modern farming systems, and use few inputs on their farms, yet they could possibly do more on their farms since many own the farm lands they cultivate. Government finance institutions which could offer easier access to credit for those farmers are spread thin in the province, yet the widely spread privately owned ones require collateral in the form of land titles that some do not own, although the interest rates are seemingly low.

Key words: De-risking agriculture, agricultural finance systems, smallholder farmers, Rwanda

Résumé

L'une des interventions les plus importantes que les gouvernements du monde entier et en particulier en Afrique ont adoptées est l'amélioration de systèmes de financement agricole, l'octroi de crédit agricole aux agriculteurs et la création d'environnements politiques qui favorisent le bon fonctionnement des institutions financières, dans le but d'augmenter l'accès au crédit des petits exploitants. L'aspect transversal de toutes les entreprises de réduction des risques est que pour leur mise en œuvre effective, les bénéficiaires visés et les institutions financières doivent être profilés (caractérisés). En effet, les institutions financières et les systèmes agricoles des petits exploitants agricoles sont hétérogènes. La non-reconnaissance de cette hétérogénéité par les gouvernements lors de l'élaboration de politiques de réduction des risques pour l'agriculture et, partant, de développement a souvent entraîné l'inefficacité de ces politiques. Les systèmes agricoles doivent être caractérisés afin de maximiser l'impact et / ou l'effet de toute intervention de réduction des risques dans la chaîne de valeur dans le secteur agricole, qui vise à améliorer la productivité. Étant donné que la plupart des interventions sont liées au financement, la caractérisation des institutions financières devient par conséquent également primordiale. Cette étude a été réalisée dans le but de caractériser les institutions financières et les systèmes agricoles dans la province méridionale du Rwanda. Une procédure d'échantillonnage à plusieurs degrés a été utilisée, dans laquelle l'échantillonnage a été effectué au niveau du district (étape 1), au niveau du secteur (étape 2), au niveau des cellules (étape 3), au niveau du village (étape 4) et au niveau des ménages (étape 5). L'étude a utilisé des entretiens structurés pour collecter les données auprès des petits agriculteurs de l'échantillon. La caractérisation des systèmes spécifiquement agricoles a été effectuée à l'aide des méthodes analytiques; analyse en composantes principales (ACP) et analyse en grappes (AC). La caractérisation institutionnelle a été effectuée de manière descriptive. Le partitionnement du dendogramme a donné lieu à cinq grappes considérées comme les plus représentatives des ménages agricoles de la province du Sud. Ce qui différencie le groupe I (27% des ménages) des autres groupes de ménages agricoles dans la province du Sud, c'est son pouvoir discriminatoire basé sur le travail agricole des ménages, les ménages agricoles de ce groupe utilisent du travail salarié par opposition au travail familial dans leurs exploitations. Le groupe II (14%) comprend les ménages qui utilisent des intrants chimiques dans leurs exploitations, pratiquent la rotation des cultures et davantage l'agriculture en terrasse. Le groupe III (29% des ménages agricoles) diffère principalement par la nature des intrants chimiques qu'ils utilisent à la ferme, la plupart utilisant des engrais organiques. La majorité d'entre eux

possèdent cependant les parcelles de terre qu'ils utilisent, sont des hommes et ont recours à une main-d'œuvre salariée. Le groupe IV (19%) comprend plus de ménages dirigés par des femmes, avec de petites terres agricoles, pratiquent généralement la monoculture et dépendent davantage du travail familial à la ferme. Le groupe V (21% des ménages agricoles) se compose de ménages agricoles ayant de grandes superficies, ayant de très petites tailles de ménage, peu d'utilisation de produits biologiques et peu de culture en terrasse. Les systèmes agricoles de la province méridionale sont très hétérogènes et, par conséquent, toute future intervention de réduction des risques, particulièrement monétaire, doit tenir compte de cette hétérogénéité. En raison de l'accès éventuellement limité au crédit, la majorité des ménages agricoles de la province du sud n'utilisent pas de systèmes agricoles modernes et utilisent peu d'intrants dans leurs exploitations, mais ils pourraient peut-être en faire plus dans leurs exploitations car beaucoup possèdent les terres agricoles qu'ils cultivent. Les institutions financières publiques qui pourraient offrir un accès plus facile au crédit à ces agriculteurs sont peu répandues dans la province, mais les institutions privées largement répandues nécessitent des garanties sous la forme de titres fonciers que certains ne possèdent pas, bien que les taux d'intérêt soient apparemment bas.

Mots clés: réduction des risques pour l'agriculture, systèmes de financement agricole, petits exploitants agricoles, Rwanda

Background

There is no region in the world that has developed diverse and modern economies without a history of establishing firm and success agricultural foundations (AGRA, 2017), which puts agriculture at the forefront of economic development in all its spheres. In Africa where close to 80% of the population is involved in agriculture as smallholder farmers working on parcels of land that are, on average, less than 2 hectares (AGRA, 2017), that assertion is going to be critically true for Africa. According to World Bank estimates of 2018, African food markets have continued to grow, and will be worth US$1 trillion by 2030 up from the current US$300 billion. Therefore, there exists opportunities for smallholder farmers in Africa since they already produce 80% of the food eaten on the continent.

In cognizance of the evidently significant role that smallholder farmers can play in fostering economic development in Africa, governments have greatly intervened to boost smallholder farmer productivity. Some of these interventions are premised on the fact that agriculture is inherently risk prone, and required agriculture production value chain de-risking.

The interventions range from development of smallholder farmer finance portfolios, increased accessed to finance, warehouse receipt financing, input supplier financing, asset financing and out-grower schemes, farmer productivity enhancement, establishment of a stable and efficient policy environment that encourages investment in enhancing the productivity of agriculture, provision of agricultural credit facilities, and adoption of policies to deregulate agricultural markets, reduction of price distortions. One of most prominent interventions that governments world over and especially in Africa have adopted is the enhancement of agricultural finance systems, the provision of agricultural credit to farmers, and creation of policy environments that promote the smooth operation of financial institutions, with an aim of increasing access to credit among smallholder

farmers. The cross-cutting aspect among all the de-risking ventures is that for their effective implementation, the intended beneficiaries and the finance institutions have to be profiled (characterized). This is because financial institutions' and farming systems of smallholder farmers are heterogeneous. Non-recognition of that heterogeneity by governments when coming up with policies for agriculture de-risking and hence development has often resulted into the ineffectiveness of such policies (Duvernoy, 2000; Ridley, 2005; Jellema, 2009). It is that ineffectiveness that has resulted into the still apparent constraints in accessing agricultural finance and the low agricultural productivity from the farming systems in place.

According to the World Bank (2018), financial sector institutions in developing countries currently lend a disproportionately lower share of their loan portfolios to agriculture compared to agriculture sector's share of GDP. Less than 50% of the smallholder farmers who need agricultural credit do access it. In addition, there are numerous constraints to the growth and deepening of agriculture finance markets including i) inadequate or ineffective policies, ii) high transaction costs to reach remote rural populations, iii) covariance of production, market, and price risks, and iv) absence of adequate instruments to manage risks, v) low levels of demand due to fragmentation and incipient development of value chains, and vi) lack of expertise of financial institutions in managing agricultural loan portfolios (World Bank, 2018).

Due to the constraints in agricultural financing, resulting in part from the fact that agricultural finance institutions are lending less to smallholder farmers, agricultural productivity from majority of the farming systems is still low in Africa. Cereal production has been unable to keep pace with population growth in Africa, whose population has doubled overall and tripled in urban areas, within the last 30 years. Cereals are staples in most African households, but it has only increased by a factor of 1.8 (AGRA, 2017). As a result, Africa has become a net importer of cereals, from being self-sufficient in the 1960's; the continent now imports products that compete with its own: meat, legumes, dairy products, cereals and oils. Imports account for 1.7 times the value of exports. As a result, African agricultural product exports have fallen by half since the mid-1990s; the annual food import bill is between $35 billion and $50 billion, and it is estimated to rise to $110 billion by 2025 (AfDB, 2018).

The situation is not significantly different when it comes to Rwanda; although it was the first country to endorse the initiative of the Maputo Declaration which called for the allocating over 10 per cent of national budgets to the agricultural sector (Tumwebaze, 2016). The Rwanda Agriculture Board (RAB) has put in place interventions to support smallholder farmers and ensure better harvests, and access to markets. The government and its stakeholders targeted to push the sector's growth to at least 8.5 percent by 2018; however, it is still far from being reached. Despite the government efforts to transform agriculture sector, many farmers in the Southern province remain largely in subsistence farming, with relatively lower access to agricultural credit, and low level of commercialization where nearly 21% of crop production is sold (MINAGRI, 2013; IPAR, 2015).

Solving the aforementioned issues of low access to agricultural credit and low agricultural productivity require government or nongovernment interventions that are adequately

targeted to the different realities of heterogeneity in agricultural finance institutions and farming systems (Andersen, 2007; Zabbini, 2007; Pardos, 2008; Ruiz, 2009; Carmona, 2010; Righi, 2011; Mądry, 2016). This underpins the need for finance institution and farming systems characterization. Farming systems characterization or typology recognizes that farmers are not a monolithic group and face differential constraints in their farming decisions depending on the resources available to them and their lifestyle. A farming system is an economic and agricultural concept that holistically describes a farm household in terms of agricultural land use (the systems of crop and livestock production, non-agricultural economic activities of farm household members, the income generated and the structure) and in terms of the natural, social, economic, infrastructural and institutional resources and environments that determine these all of economic activities (Köbrich, 2003; Iraizoz, 2007; van de Steeg, 2010).

According to Soule (2001) and Ellis (1993), smallholder farmers are always and everywhere typified by internal variations along many lines. Although every farm and farmer is unique in nature, they can be clustered into roughly homogeneous groups. Developing a typology constitutes an essential step in any realistic evaluation of constraints and opportunities that farmers face and helps forwarding appropriate technological solutions, policy interventions, and comprehensive environmental assessment (Andersen *et al.,* 2009). Researchers have also established that farming system heterogeneity is due to factors such as farm resources such as cash and labor (Ojiem *et al.,* 2006; Tittonell *et al.,* 2007; Bidogeza *et al.,* 2009; Guto *et al.,* 2010; Tittonell *et al.,* 2010), infrastructure such as agency and markets (Tittonell *et al.,* 2006), management practices (Tittonell *et al.,* 2005) and technological level (Gómez-Limón e*t al*., 2007). Regardless of the causes of heterogeneity, farming systems have to be characterized, in order to maximize the impact and/ or effect of any value chain de-risking interventions in the agricultural sector, which are meant to improve productivity. Given that most interventions are finance related, finance institution characterization's consequently become paramount as well.

Methods

Study area. The study was conducted in the Southern Province of Rwanda; a province located in the South of Rwanda and has a common border with: Kigali City to the North, The Eastern Province to the East, The Western Province to the West, and Burundi to the South. The Southern province is made of eight (8) districts which are: Gisagara, Huye, Kamonyi, Muhanga, Nyamagabe, Nyanza, Nyaruguru and Ruhango. It is also composed of one hundred and one 101 sectors, 532 cells and 3501 villages.

Sampling procedures. A multistage sampling procedure was used, in which sampling was done for the at district level (Stage 1), sector level (Stage 2), cell level (stage 3), village level (stage 4) and household level (stage 5). Probabilistic methods will first be used to sample the sector, cells, and villages, and those was stratified sampling followed by simple random sampling. Since the study sought to have a representative sample of smallholder farmers in the Southern Province, all districts in the province were stratified into 8 strata with each strata representing 1 district. In each district, simple random sampling was used to sample 1 sector. The sectors were then stratified as the districts were, and then simple random sampling was used to sample 1 cell from each sector/ stratum. The cells sampled from the sectors were also stratified, following which simple random sampling was used to sample half the number of villages from each cell cluster. In each village sampled, convenience sampling was used to sample 150 households.

Map of the Southern province of Rwanda

According to the 2012 Population and Housing Census (Comprehensive Report), the demography of the Southern Province is as follows

Table 1. Administrative districts of the Southern province of Rwanda

District	Area km^2	Population	Sectors	Cells	Village
Gisagara	679.2	322,506	13	59	524
Huye	581.5	328,398	14	77	508
Kamonyi	655.5	340,501	12	59	317
Muhanga	647.7	319,141	12	63	331
Nyamagabe	954.1	342,965	17	92	536
Nyanza	672.1	323,719	10	51	420
Nyaruguru	884	294,334	14	72	332
Ruhango	626.8	319,885	9	59	533
Total	5,701	2,589, 975	101	532	3,501

Data collection techniques. The study used structured interviews to collect the data from the sampled smallholder farmers, which was then captured using structured questionnaires. Structured interviews are a form of interview in which respondents are asked questions in a non-flexible manner that allows them to only select responses from a set of responses provided to them by the interviewer.

Data analysis. The Assessment of the farming systems diversity and typology can generally be performed using expert methods (Landais, 1998; Duvernoy, 2000; Clavel, 2011) or

analytical methods (Riveiro, 2008; Castel, 2010; Righi, 2011). Expert methods are based on expert knowledge supported by land cover maps, which guide researchers or agricultural extension experts, and all available official synthetic information collected by state and local administrations (Clavel, 2011). These methods were historically the first to be used, but for more than two decades, they have frequently been replaced by more formal and reliable analytical (statistical) methods, referred to as analytically based farming system typology or statistical farming system typology (Lesschen, 2005; Blazy, 2009). Therefore in this study, characterization of specifically farming systems was done using the analytical methods.

Both univariate descriptive statistics and multivariate statistical techniques were employed for the analysis of data. Multivariate statistical techniques have been widely used for farm typology and characterization (Guto *et al.,* 2010; Andersen et al. 2009; Kobrich *et al.,* 2003). For the present study, farming system characterization was identified by using two sequential multivariate statistical techniques: principal component analysis (PCA) and cluster analysis (CA) (Ding and He, 2004). Principal Component Analysis (PCA) can condense independent variables into a smaller set of factors (Jolliffe, 2002; Abdi, 2007), which were then in this study identified using orthogonal rotation using the varimax method (Kaiser 1970; Gorsuch 1983) so that a smaller number of highly-correlated variables could be put under each factor for easier interpretation (Field, 2005). In accordance with Kaiser's criterion, all factors exceeding an eigen value of 1 were retained (Kaiser, 1970).

For cluster analysis, the number of clusters was determined using two steps; the hierarchical method and K-means clustering method. For hierarchical clustering, Euclidian distance and Ward's computation method was considered. The number of clusters retained from Ward's method was used as starting values in the K-means method. The number of clusters that were most realistic (after tree cutting in the dendogram) and meaningful were chosen for the final solution.

Results and Discussion

During Principal component analysis, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) and the Bartlett sphericity test were performed to check whether the data obtained from 150 households in the southern province could be factored. The results at this stage revealed that the KMO test was greater than 0.5 (0.505), while the significance of the Bartlett sphericity test was 0.000, meaning that is was significant, and that the data collected in the survey could be factored.

A total of 24 variables for farming system characterization were included in the PCA of which 8 were obtained, based on their possession of eigenvalues greater than 1; they were the ones considered for further analysis.

The 8 principal components explained 79.1% of total variability in the data. Particularly, the first component explained 23.5% of variance, the second component explained 34.1% of variance, the third explained 43.3% of variance, the forth explained 51.4% of variance,

Variables description for farming system characterization

Variable	Description
Farm household demographics	Education of household head, gender of household head, ownership status of land, household farm size, household size, family labor characteristics
Land use	Cropping systems, agricultural land use practices
Farming systems cost of Cultivation	Cost of all inputs used (In RwF), for all enterprises of the farming system including the cost of family labor
Farming system inputs	• Chemical input based (Organic fertilizer, Inorganic fer-tilizer, Pesticide) • Biological input-based (Bi-opests, Improved livestock, Improved seed) • Biodiversity-based farming systems (intercropping, diversified field edges, crop sequences, cover crops, species/cultivar/breed diversity)
Farming system income	Total revenue earned) from all the components of the farming system
Farming system cost	Gross return from sale of output/Total cost of input used
Benefit Ratio	

Variables description for financial institution characterization

Variable	Description
The financial system	1. Institutions in the public sec-tor (Name and number of branches) 2. Institutions in the private sector (Name and number of branches) 3. Institutions and their smallholder farmer customer segments (Farm production, Farm development, Input pro-duction, fixed capital, Input production, Agro-processing etc)
Interest rate structure	Interest on long term loans, short-term loans, overdrafts etc.
Loan disbursement terms to smallholder farmers	Collateral requirements, guaran-tee schemes, loan payment periods
Distribution	Number per sector, number of per district, ownership of institutions per district

the fifth explained 59.1% of variance, the sixth explained 66% of variance, the seventh 72% of variance and the eight explained 79% of variance.

The first principal component (23.5% of variance) was highly and positively correlated with household size, duration in smallholder farming, number of crops grown, and income per crop season, age of farmer, shifting agriculture, and irrigation. This implies that with increasing household size, there is possible increment in number of crops grown, age of farmer, and income per crop season, shifting agriculture and irrigation practice.

The second component is positively correlated to the use of chemical inputs during cultivation, number of children under five years in farmer households, and provision of farm labor by household members. The third component is positively related with inputs used on farm, reception of any form of formal education and cropping systems do you usually practice. The forth component is negatively related with source of labor on farm, ownership of a piece of land cultivated on, but negatively related with gender of farmer.

The fifth component is related to only farm inputs, the sixth was related to the cost benefit ratio, and the seventh is related to the chemical inputs usually used, while the eighth component was related to cropping system usually practiced.

After analysis with the Wald method, the resultant dendogram was used to determine the resultant farm household clusters. Using the y axis as a starting point for drawing cutting lines, it was found that there were 23, 19, 11, 6, and 2 clusters respectively. Basing on acute representativeness, partitioning of the dendogram resulted into five clusters which were seen as most representative of farm households in the southern province.

What makes cluster I (27% of households) different from other farm household clusters in Southern province is its discriminative power based on household farm labor, farm household in this cluster use hired labor as opposed to family labor on their farms. Furthermore, farm households in this cluster have large family sizes (exceeding five), have farmers with many years of experience in smallholder farming, earn more from their farms, grow at least three crop types on their farms, and use some form of irrigation on their farms.

Cluster II (14%) consists of households that use chemical inputs on their farms, practice crop rotation, and more of terrace agriculture. However, these farm household are headed by youthful farmers (below 39 years), who are majorly female, less educated, use relatively fewer inputs on their farms, and cultivate on relatively smaller land sizes (less than 2 acres).

Cluster III (29% of the farm households) differs mainly by the nature of chemical inputs they use on the farm, with most using organic fertilizer, farmers in this cluster have done smallholder farming for shorter periods of time, and earn less from their farms. The majority of them however own the pieces of land they use, are male and use hired labor.

Cluster IV (19%) consists of more female headed households, with small farm land sizes, usually practice monocropping, and rely more on family labor on the farm.

Cluster V (21% of farm households) consists of farm household with large land sizes cultivated on (more than 4 acres), majority owns the pieces of land, and are relatively more educated. What distinguishes the farm households in this cluster from other clusters is the fact that they have very small household sizes, little use biological in puts, and little use of terrace cultivation.

Institutions. The findings on finance institution characterization showed that 9 out of every 10 cells in the southern province have a finance institution, with a fair mixture of both formal and non-formal ones in some areas (52%), but with most areas being predominated by informal ones (36.7%). The provinces are served by only 10.8% of formal institutions in its financial sector. The majority of the institutions are savings banks, with few commercial banks. The majority of the institutions are privately owned (79%), and in the informal sector, the majorities are SACCOs (66%). Almost three quarters of the financial institutions in the southern province are sources of credit for farmers (74%), with the most commonest sources being informal institutions (60%). However, almost the same proportion reportedly targets specific farmers segments more so those at in input production. To lend money to farmers, the majority of the institutions require collateral (89.2%), and the majority of them give short term loans not exceeding a year (56%) but at low interest rates (rarely exceeding 10%). Land titles are the commonest collateral requested for (80%).

Conclusions

Farming systems in the southern province are highly heterogeneous, and thus any future de-risking interventions that are especially monetary have to take that heterogeneity into consideration. Due to possibly low access to credit, majority of the farm households in the southern province are not using modern farming systems, and use few inputs on their farms, yet they could possibly do more on their farms since many own the farm lands they cultivate. Government finance institutions which could offer easier access to credit for those farmers are spread thin in the province, yet the widely spread privately owned ones require collateral in the form of land titles that some do not own, although the interest rates are seemingly low.

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