Mémoire de fin d'études

présenté pour l'obtention du diplôme ingénieur horticole

Option : Production Végétale Durable

Objectives and priorities of Kham district's farmers

A microeconomic approach of systemic agronomy

par Bruno STRIFFLER

Année de soutenance : 2017

Organisme d'accueil : CIRAD, UR AÏDA

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Abstract

Title: Objectives and priorities of Kham district's farmers: a microeconomic approach of systemic agronomy

Kham district's farmers will face various issues in the future than can affect their livelihood. This paper is part of a broader work that aims to model farms evolution towards diverse perturbation. We studied specifically farmers' objectives to keep the results of the model up-to-date. Two topics have been approach, the farms' structural characteristics and the farmers' objectives. At first we studied the farm typology. We got the data on farms' structure by inquiries. With the FAMD method and the hierarchical clustering we got 3 different clusters based on the land use, the incomes, the cattle and assets. One cluster consists on poor farmers, one consists on farmers that focus on the paddy activities and the last one include the farmers that focus their activities on the upland area. For the study of farmers' objectives, we had to know at first the nature of the objective. We got 7 different objectives by playing a card game with the farmers. After we used the Best-Worst Scaling (BWS) method to know the priorities of each farmer. With the BWS results and their diversity, we used the hierarchical clustering to gather the farmers by preferences. We got 4 clusters with different level of preference for each objectives. Finally, we studied the relation between the typology and the priorities. It didn't appear any significant relation between the structure and the farmers' objectives. We also compare the stated and revealed objectives for the same farmers and it appears in most cases that the farmer hasn't the same objectives whether it was revealed or stated.

Keywords: farms' objectives, typology, Best-Worst Scaling, FAMD

Résumé

Titre : Objectifs et priorités des agriculteurs du district de Kham : une approche microéconomique de l'agronomie systémique

Les agriculteurs du district de Kham seront confrontés à divers problèmes dans l'avenir qui peuvent affecter leurs moyens de subsistance. Ce document fait partie d'un travail plus vaste qui vise à modéliser l'évolution des fermes face à diverses perturbations. Nous avons étudié spécifiquement les objectifs des agriculteurs afin de contextualiser les résultats du modèle. Deux thèmes ont été abordés : les caractéristiques structurelles des exploitations et les objectifs des agriculteurs. Nous avons d'abord étudié la typologie des fermes. Nous avons obtenu les données sur la structure des exploitations agricoles grâce à des enquêtes. Avec la méthode AMFD et la classification ascendante hiérarchique (CAH), nous avons obtenu 3 groupes différents basés sur l'utilisation du sol, les revenus, le bétail et les actifs. L'un des groupes est composé de paysans pauvres, l'un d'entre eux se concentre sur les activités rizicoles et le dernier comprend les paysans qui concentrent leurs activités sur la montagne. Pour l'étude des objectifs des agriculteurs, il fallait d'abord connaître la nature de l'objectif. Nous avons 7 objectifs différents en jouant à un jeu de cartes avec les agriculteurs. Après avoir utilisé la méthode de la mise à l'échelle Best-Worst (BWS) pour connaître les priorités de chaque agriculteur. Avec les résultats du BWS et leur diversité, nous avons utilisé la CAH pour rassembler les agriculteurs par préférence. Nous avons obtenu 4 clusters avec différents niveaux de préférence pour chaque objectif. Enfin, nous avons étudié la relation entre la typologie et les priorités. Il ne semble pas y avoir de relation significative entre la structure et les objectifs des agriculteurs. Nous avons également comparé les objectifs déclarés et révélés pour les mêmes agriculteurs et il apparaît dans la plupart des cas que l'agriculteur n’a pas les mêmes objectifs qu'ils aient été révélés ou déclarés.

Mots-clés : objectifs d’exploitation, typologie, Best-Worst Scaling, AFDM

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Table of content

List of figures

List of tables

List of abbreviation

BWS: Best-Worst Scaling

CIA: Central Intelligence Agency

CIRAD : Centre de Coopération International en Recherche Agronomique pour le Développement

DALaM: Department of Agriculture and Land use Management

FAMD : Factor Analysis of Mixed Data (AFDM : Analyse Factorielle de Données Mixtes)

FAO : Food and Agriculture Organisation of the United Nation

HCA: Herachical Clustering Analysis (CAH : Classification Ascendante Hierarchique)

HH : Household

Introduction

Le district de Kham (nord Laos) est en pleine transition agricole. Depuis les années 2000, les systèmes agricoles ont subi de rapides transformations. L'agriculture familiale vivrière basée sur l'abattis-brûlis a laissé place au maïs hybride en monoculture. L'accès aux intrants et aux services de labour ont entrainé une simplification et une intensification des systèmes de cultures. Ces nombreux changements rendent incertaines les prévisions d'évolution des fermes et des systèmes de cultures. Afin d'améliorer la résilience des exploitations, il est important de prévoir la réaction des agriculteurs face à diverses perturbations.

Ce mémoire de fin d'étude s'intègre dans un travail plus global de modélisation des exploitations. Nous avons identifié les objectifs et les priorités des agriculteurs afin de contextualiser l'évolution de différents types d'exploitation.

Ce travail est articulé autour de trois objectifs : le premier est la description de la diversité des exploitations dans le district de Kham à l'aide d'une typologie structurelle des exploitations. Le second objectif est la définition des objectifs des agriculteurs ainsi que leurs priorités vis-à-vis de ces objectifs. Le dernier objectif est de chercher un éventuel lien entre la typologie des exploitations et les priorités des agriculteurs.

Nous avons collecté les données à l'aide de plusieurs méthodes : jeux, enquêtes et la méthode du Best-Worst Scaling. Ces méthodes ont été appliquées auprès de 120 agriculteurs dans 6 villages du district de Kham.

En premier lieu nous présenterons le contexte régional, puis la typologie des exploitations. Par la suite, nous définirons les différents groupes d'objectifs/priorités des agriculteurs. Pour terminer nous analyserons les corrélations éventuelles entre la typologie structurelle des exploitations et les priorités des agriculteurs.

Pour les besoins du projet les parties I, II et III ont été rédigées en anglais ; tandis que l'introduction, la conclusion et la partie IV ont été rédigées en français.

I. Objectives

1. Context

1. Lao context in South East Asia

Lao PDR is a landlocked country in Southeast Asia bordered by PR China, Myanmar, Vietnam, Thailand and Cambodia. In comparison to his neighbours, Lao PDR is an underpopulated and highly rural country: among its 6.5 million inhabitants, 63% are living in rural area (UNDP, n.d.). Agriculture is playing an important role in Lao PDR's economy by contributing to an estimated 25.5 % of the Growth Domestic Product and using an estimated 75 % of the workforce. Laos's main crop is the rice with 72 % of the total cultivated area dedicated to it (FAO 2017). Agriculture production is becoming more commercial: 33 % of farmers are producing mainly for sale, but still 80% of the rural population are doing self-subsistence farming (FAO 2017).

Even if agriculture is an important activity in Laos's economy, only 10.6 % of the country's area is cultivated, notably due to its topography: mostly rugged mountains and some plains and plateaus (CIA 2017). Agricultural lands are unevenly distributed: most of them are concentrated in the Mekong floodplain. The northern part of Lao PDR is characterised by the highest elevation in the country (between 500 and 2800 m). Only 6% of the land area are with slope less than 20% and more than the half of land have more than 30% slope (Bounthong, Raintree, and Douangsavanh 2003).

Figure 1: Picture of different land uses based on the toposequence. At the foreground (I) we can see the paddy field, grazed during dry season. After we can see the upland (II) and in the background, the forests (III). Kham district. B. STRIFFLER

We differentiate two types of annual cropping systems (CS) depending on their position along the toposequence: Lowland and Upland CS, as shown in Figure 1. A lowland CS is characterised

by the flooded paddy rice cultivation, during rainy season due to its flatness and low-lying location; it could be rainfed or irrigated. Lowland CS is generally labour-intensive and have to be regularly maintained (maintenance of dikes, levelling). An upland CS relies exclusively on the rain for water supply, it could be relatively flat or sloppy. Many crops can be grown on it such as upland rice, cassava, maize, canna indica [1]and pasture.

2. Xieng Khouang's and Kham district's context

Xieng Khouang (XKH) province is located in the northern part of Lao PDR (as seen in Figure 2: Xieng Khouang's and Kham district's location. Land uses have changed quickly during the 2000's. Over that period, hybrid maize cultivation started to replace traditional upland crops, gardens, orchards and also expanded on forests and fallows areas (Castella et al. 2012).

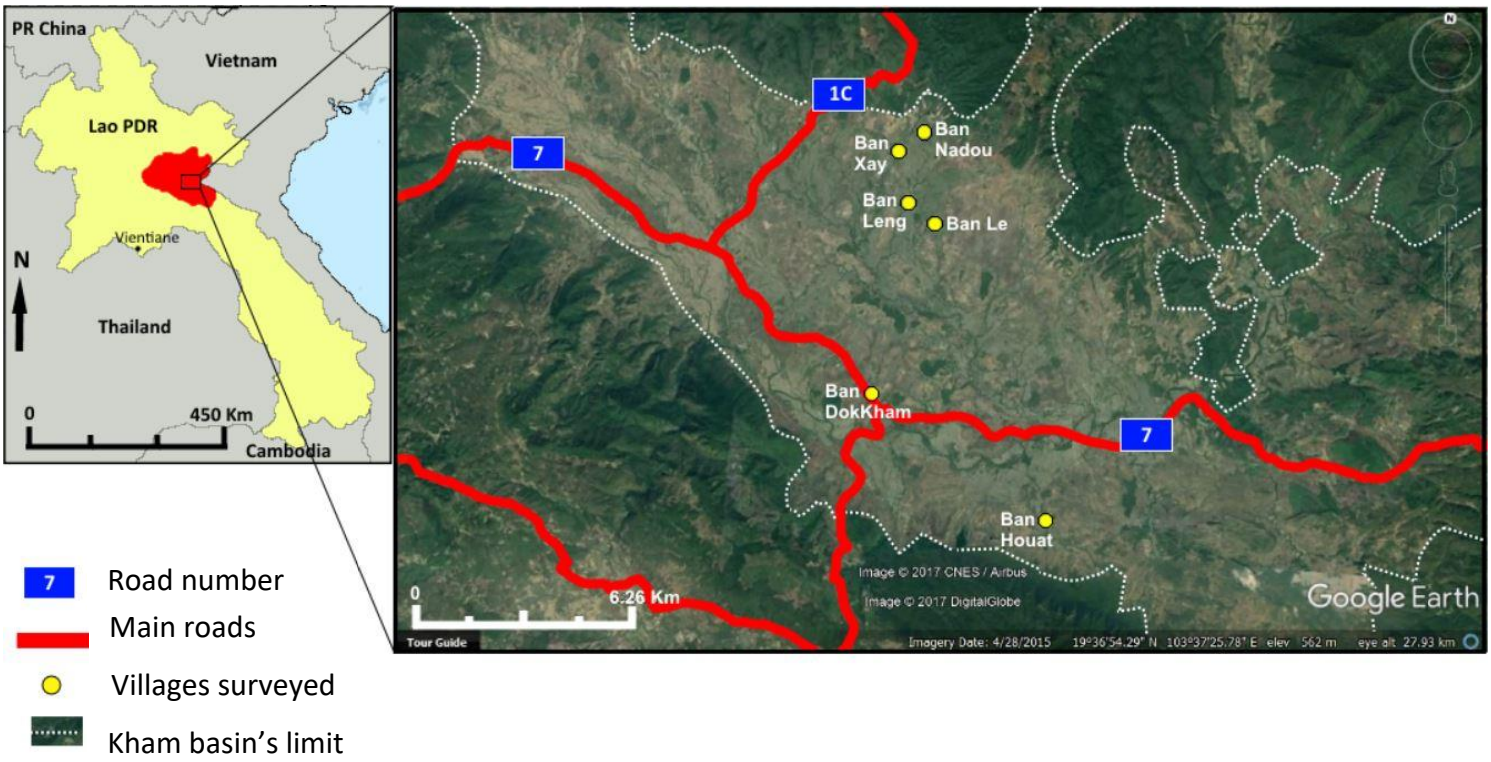

Figure 2: Xieng Khouang's and Kham district's location

This evolution of the land use is a direct consequence of the neat increase in maize demand by the industry of livestock feeding in South East Asia, and mainly in Vietnam, the nearest neighbour of XKH province. Vietnamese agricultural traders introduced hybrids cultivars of maize in the region, hence favouring the prompt replacement of the slash and burn-based shifting cultivation of upland rice by hybrid maize crops, except for the villages without, or with few, paddy area that relied on upland rice for their food security. Hybrid maize cultivation improved the farm income and their investment capacity (Castella 2014).

Mechanical ploughing and herbicides' use started to be common practices linked to the increased benefits of hybrid maize (Castella et al. 2012).. The ploughing is mostly provided by a service provider. All of these transformations appear to be an intensification and a

[1]In 2017, Canna indica was a popular crop, in 2017, seen in some villages as an eventual substitute for the maize.

simplification of the CS. Kham district is typical example of the XKH's agricultural intensification and its consequences. Kham district is characterised by fertile soils, good accessibility and a microclimate conducive to various commercial crops such as pepper, vegetable, chili, maize…

The simplification of the landscape and this rapid agricultural transition are likely to generate negative environmental impacts such as soil erosion and exhaustion, siltation of the lowland, weeds invasion, and water contamination with pesticides. The inadequate use of inputs or ploughing service may either have serious economic impacts like farms/household's (HH) indebtedness (Jobard et al. 2011). In addition to these agricultural issues, Kham district's farmer are expected to face another predicament: climate change. The projections for 2050 are estimating an increase of the rainfall (an average of 150 mm/year) and of the temperature (between 1.7°C and 1.9°C); no increase or decrease in the occurrence of water stress to crops. The current trend of shift to commercial agriculture leads us to believe that the harvest index of crops will probably increase in the future. Therefore, while the climatic risks will rise, the crops will be more climate-sensitive, with more risks of climatic events impacting the grain production. "Without any adaptation of cropping systems, climate change will have greater impacts on the poorest farmers, because of their lack of resources to cope with extreme events" (Lechevallier et al. 2017).

2. Context of the study

1. EFICAS project

The Eficas project (Landscape Management and Conservation Agriculture Development for Eco-Friendly Intensification of Agricultural Systems in the Northern Uplands of Lao PDR) is a research and development project managed by CIRAD (International Centre for Agricultural Research for Development, France) and the Department of Agriculture and Landscape Management (DALaM) of the Ministry of Agriculture and Forestry (MAF, Lao PDR). The co-founders of the project are The European Union (EU) under the Lao PDR Global Climate Change Alliance Program (GCCAP) and The French Development Agency (AFD) as a R-D component on Conservation Agriculture within the Northern Upland Development Program (NUDP).

In order to deal with various issues like, price fluctuations, market opportunities, climatic events, farmers need to find a way to adapt their CS. The EFICAS Project aims at developing innovative methods and intervention approaches to support farmers' adoption of climate smart agroecological systems, particularly based on conservation agriculture and crops rotation. The project is divided in three work packages: WP1: Village landscape management, WP2. Participatory innovation network and WP3. Multi-stakeholder communication platform. WP1's goal is to design low-carbon emission strategies at the landscape scale through Participatory Land Use Planning. Through WP2, the stakeholders are engaged in the design and the experimentation of technical and organizational alternatives to the issues identified by the WP1. The objective of WP3 is to create a favourable institutional environment for the backing of the project activities' impact pathway (EFICAS 2017).

The intervention sites are all located in five provinces of northern Lao: Phongsaly, Luang Prabang, Houaphan, Sayabouri and Xieng Khouang. These 5 provinces illustrate a gradient of agriculture intensification and land degradation. Our study is integrated in the NUDP-EFICAS project which, is currently supporting the land regeneration initiative of Xieng Khouang province in Kham District. As part of this initiative the NUDP-EFICAS project implemented different activities of research and development, such as studies on maize boom in Sayabouri province, on farmers' land use decision making or on CS's multicriteria assessment.

2. Land regeneration initiative and multicriteria assessment

This work is a part of the work on a multicriteria assessment of CS in the land regeneration initiative of XKH province. To answer the question: "what are the perspectives for ecological intensification in Kham district, Northern Laos?", an evaluation of the maize CS's performances and impacts considering farms' context and rapid dynamic. The aim of this work is to evaluate the performances and the environmental impacts of the current maize CS.; These performances could indicate the window of opportunity for ecological intensification; such as diversification (crop rotation, intercropping), soil improvement or pesticide uses reduction. In this context of rapid change, the multicriteria assessment has to consider the current dynamics of CS in order to keep the assessment results up-to-date. The dynamic of the CS is the consequence of the choice decisions at the farm's scale, depending on changes of the socio-economical or biophysical context. To gain more insight of the CS's dynamic, we need to know the farmers' priorities and objectives as well as their possible reactions in front of context's change. The CS evaluation is therefore farm-contextualised (Blazy, Carpentier, and Thomas 2011). This work on multicriteria assessment is divided in two sub-objectives:

1) Identifying the main drivers of the evolution of the CS' agronomic performances and environmental impacts that we have to consider in order to understand the CS' adaptation to performances' degradation.

2) Using the evaluation to discuss the perspectives of eco-friendlier CS and to quantify the difference of performances and environmental impacts between current production strategies and those of various scenarios minimizing the environmental impact.

3. Research question

Farm modelling is an important part of the multicriteria assessment of CS performances and impacts. To ensure the relevance of the forecast, like the farmers' decisions, we need to understand the farms' context. The farm/HH is the ideal scale to contextualise the CS's evolution, as this level allows the observation of many drivers of the CS's dynamic. Farming context is also impacted by various drivers at a higher level. Two different levels will be analysed in the multicriteria evaluation: the effect of the farm on the CS and the effect of the context on the farm. Both levels are dynamic and we aim to predict their evolutions in an uncertain future. "We define a farming context as a set of characteristics at the farm level that are likely to influence the structure and the biophysical and economic performances of [the Crop Management System] at the field level "(Blazy, Carpentier, and Thomas 2011). This work is part of the contextualisation work; that will be used in the

predictions of CS's evolution, in the case of several changes in the future, such as prices fluctuation, agricultural policy, weeds and pest issues…

The work of contextualisation aims to represent a set of contrasted farms, in order to make the scenarios fit the local circumstances. The contrast among the farms will be defined by both the structures and the decisions taken by the heads. In order to model the farmers' decisions in the most likely way, we have to identify their objectives and preferences. Some farm models consider only the profit maximisation as a proxy of the utility like in Barbier and Bergeron (1999) and others take in account more objectives; like Okumu et al. (1999) for example who considers three goals for the household : cash incomes, leisure and food production. This work aims to identify other objectives than the maximisation the HH's incomes, and if there is any link between farmers' preferences/objectives and the structure of the farm.

The farmers' objectives and preferences will be used, after our study, to create different profiles of farms in the farm modelling process. Stevenson (2010) defines a preference as "a greater liking for one alternative over another or other". In order to know farmers' preferences, we used the consumer's choice theory. Lancaster (1966) stated that the consumer chose a good or a basket of goods based on his preferences. In consumer's theory, individual prefer a product more than another based on the product's characteristics. In order to model farmers' decisions based on consumer's theory, we have to assume that farmers are consumers and the different objectives are products.

We want to describe and understand farmers' preferences in term of strategy, at the HH's level. Strategic decisions appear to be long-term choices, taken in unreliable universe, determining the major farm's orientations, investment on property or equipment, commercial or financial strategies etc. (Aubry 1995).

4. Objectives and Hypothesis

This work will be organised around 3 main objectives:

The first objective is to depict the farms' diversity, in order to create a structural typology. We would like to check the assumption that there is a farms' diversity in Kham district, based on farms' structures such as farms' size, heads of livestock or assets.

The second objective is to create a typology based on farmers' strategic preferences. We assume that there is a diversity of preferences profiles among farmers' population.

The third objective is to compare the farmers' preferences and the farms' typology; based on the hypothesis that there is a relation between the preferences and the farms' structure.

We will make the structural typology of Kham district's farms, using a quantitative survey and the Factor Analysis of Mixed Data (FAMD) method. Then, we will try to define the farmers' objectives, with a card game, and to rank them, with the Best-Worst Scaling method. Both of these approaches aim to gather farmers in homogeneous groups based on the farms characteristics and also on farmers' preferences. We will finally try to find a relation between the groups of farms/HH's characteristics and the groups of farmers' objectives.

II. Farm and farmers' typology

1. Material and methods

1. Survey

A preliminary part of the survey was a general questionnaire on the structure of the farm/HH. The questionnaire required an interview lasting about 30 minutes to be completed and was divided in 5 parts:

-Familial structure: number of members, labour force among the HH, set-up year…

- Crops management: type of crop, area, yield, input, margin…

-Livestock: type of cattle, quantity, labour needed, pasture area…

-Assets: rototiller, tractor, car…

-Off-farm: type of job, incomes, labour needed…

2. Data analysis

1. FAMD

The output of the survey was a set of data, both quantitative and qualitative. To analyse all together, we did a Factor Analysis of Mixed Data (FAMD). The FAMD is used to see the influence and the correlation within the variables of a set. Thus this approach allows the selection of the variables explaining the most the set's diversity. This method mixes the Principal Component Analysis (PCA) and the Multiple Component Analysis (MCA); used respectively for qualitative and quantitative variables. The interest of this method is the possibility of using both qualitative and quantitative variables without transforming the qualitative variables in quantitative variable. Escofier and Pagès (2008) present the concept in 4 points. The aim of the FAMD is to represent simultaneously the quantitative variables, as a PCA, and the qualitative variables, as a MCA, on the same plane. Both quantitative and qualitative variables are active variables.

The two limits of this methods are the quantity of individual needed (at least a hundred), to ensure the stability of the result, and the ratio between the quantitative and qualitative variables (less than one qualitative for twenty quantitative).

At first we applied the FAMD to a sample of 120 HH with 93 different variables. We got 3 dimensions, each one characterised by different variables. We selected the variables with their correlation scores (for quantitative variables) and R^2 (for qualitative variables) above 0.4. We have also chosen the variables based on the cos^2, to see the correlation among the variables. When various variables were too correlated, and one could explain the others, we only kept one (e.g. if the quantity of maize sold and the incomes from it are too correlated, we only kept one).

2. Hierarchical clustering

After the selection of the variables explaining the most the set's diversity, we aimed to classify the population in homogeneous groups based on these variables. The hierarchical clustering is a method to classify some observations (in our case a population of individuals)

into two or more disjoint and exhaustive clusters. These clusters are organised in a hierarchical structure and represented with a dendrogram diagram.

The clusters' characteristics are determined by the v.test value. The value of the v.test indicates the importance of the variable in the cluster. The v.test of a variable in a cluster is a measurement of the gap between the cluster's mean value of this variable and the general mean. A positive value indicate that the variable's mean value of the cluster is higher than the overall mean; a negative value indicate that the variable's mean value of the cluster is lower than the overall mean. Sd means standard deviation, it quantifies the variation around the mean of the individuals of a category. For the qualitative analysis' results, cla/mod indicates what percent of all individuals with a modality can be found in this cluster. Mod/cla indicates what percent of all individuals from a cluster present a modality.

2. Results

1. FAMD

We selected 22 variables based on their scores; show the variables that compose the dimension 1, 2 and 3.

Table 1: Meaning of the abbreviation for the qualitative variables

Abbreviation	Definition	Modalities
MaInc	Main source of income	Maize, Off-farm, Rice, Weaving
Village	Village	DokKham, Houat, Le, Nadou

Table 2: Meaning of the abbreviation for the quantitative variables

Abbreviation	Definition
Car	Number of car
GlBene	Incomes from garlic (M LAK)
HHMem	Number of member in the HH
HHMnLb	Number of labour available in the HH
IncMem	Total annual HH income per number of member
IncInf	Annual incomes from in-farm activities
M2Feed	Number of member of the HH not used as labour
MzArea	Area of maize (ha)
MzBene	Annual incomes from maize (M LAK)
MzHrv	Maize total harvest (M LAK)
MzYield	Maize yield (t/ha)
PdArea	Area of paddy field (ha)
PdHrv	Harvest of rice (t)
PdSold	Annual incomes from rice (M LAK)
PdYield	Yield of rice (t/ha)
PstArea	Area of pasture (ha)
Sago	Area of canna indica

TotArea	Total area : upland + lowland (ha)
TotCa	Total number of cattle's head
TotInc	Total incomes (M LAK)
TotUl	Total area of upland (ha)
WeInc	Incomes from weaving (M LAK)

Table 3: Variables of dimension 1

Variable	Correlation coefficient
InFInc	0.838426404
TotArea	0.804604999
PdHrv	0.730777928
PdBene	0.700626672
PdSold	0.685134302
TotInc	0.6683459
PdArea	0.642803695
MzHrv	0.634506403
TotUl	0.632611282
MzBene	0.573726598
IncMem	0.557486273
Car	0.543764875
PstArea	0.515434116
GlBene	0.503626438
MzArea	0.469509666
TotCa	0.460959564
WmArea	0.448583583
Tract	0.443691292
Sago	0.436286623

Table 4: Variables of dimension 2

Variable	Correlation coefficient
OfFaInc	0.756027294
EnInc	0.634383638
TotInc	0.505589958
Truck	0.473290472
TotCa	0.455359133
OthAre	0.406212895
PstArea	0.400831344
M2Feed	0.400116138
MaInc	0.49683691

Table 5: Variables of dimension 3

Variable	Correlation coefficient
Sago	0.482509
MaInc	0.51884445

2. Hierarchical clustering

We got 3 different clusters based on the quantitative and qualitative variables. The meaning of the abbreviation on the results' tables are in Table 1 for the qualitative variables and in Table 2**Error! Reference source not found.** for the quantitative variables with their correlation coefficient at the first FAMD. The dendrogram is represented on Appendix 6.

1. Cluster 1: "deprived farmers"

This cluster is the most populated cluster. It is composed principally by farmers from Ban DokKham (23%) and Ban Xay (22%) and most of the individuals from these villages are in this cluster: 100% from Ban DokKham and 95% from Ban Xay; as we can see in Table 6: Qualitative variables of cluster 1. The cluster is also composed by farmers from other villages. The main source of income is not a characteristic of this cluster which means that there are various sources of income among this population. Table 6 shows the quantitative variables that characterise this cluster. We can see that the variables linked to the incomes are lower than the overall mean, like the total incomes (TotInc =27,32 M LAK), in-farm incomes (InfInc=8,43 M LAK) and the incomes per HH members (IncMem = 5,6). Individuals from this cluster have also less field area such as paddy (PdArea = 0.91 ha) and upland (TotUl=2.00 ha). The harvest and the incomes from the rice is lower than the average on the overall population, respectively a mean of 3.28 t and 1.30 M LAK. It appears to be the same for the maize: the mean harvest per farm is 6.82 t instead of 9.50 t for the overall sample population; it is the same for the incomes from maize: 6.51 M LAK instead of 9.86 M LAK. We can notice also that this population has less head of cattle than the average population (6.52 instead of 8.71). Figure 4 show the v.test values of the "deprived farmers". Figure 3 shows the distribution of the population. The small pie graphs indicate the proportion of each villagers belonging to cluster 1. The big pie graph indicates the proportion of each village among cluster 1's population.

Table 6: Qualitative variables of cluster 1

Variable	Cla/Mod	Mod/Cla	Global	p.value	v.test
Village=DokKham	100	23	17	0.00125209	3.22673983
Village=Xay	95	22	17	0.01375487	2.4636021
Village=Leng	53	11	17	0.03148431	-2.15089728
Village=Houat	45	10	17	0.00282872	-2.98576287

Table 7: Quantitative variables of cluster 1

Variable	v.test	Mean in category	Overall mean	sd in category	Overall sd
HHMnLb	-2.48285	3.07	3.23	1.10	1.17

WmArea	-2.667706	0.00	0.00	0.00	0.03
GlBene	-3.403702	0.46	0.70	0.91	1.28
IncMem	-3.762233	5.60	7.10	6.20	7.27
Sago	-4.230117	0.03	0.07	0.09	0.17
TotInc	-4.492489	27.32	36.31	28.94	36.64
TotCa	-4.544451	6.52	8.71	6.99	8.83
PstArea	-4.558147	0.18	0.34	0.33	0.64
Car	-4.644009	0.11	0.22	0.32	0.41
MzArea	-4.896477	1.76	2.09	0.94	1.25
TotUl	-5.843991	2.00	2.59	1.01	1.82
MzBene	-5.930881	6.51	9.86	5.15	10.34
MzHrv	-5.955542	6.82	9.50	4.62	8.25
PdSold	-6.485486	0.75	1.52	0.92	2.19
PdArea	-6.548278	0.91	1.19	0.57	0.78
PdHrv	-6.657448	3.28	4.38	2.00	3.04
PdBene	-6.722252	1.30	3.81	2.24	6.85
TotArea	-6.954386	2.92	3.78	1.24	2.26
InFInc	-8.175409	8.42	14.78	5.86	14.25

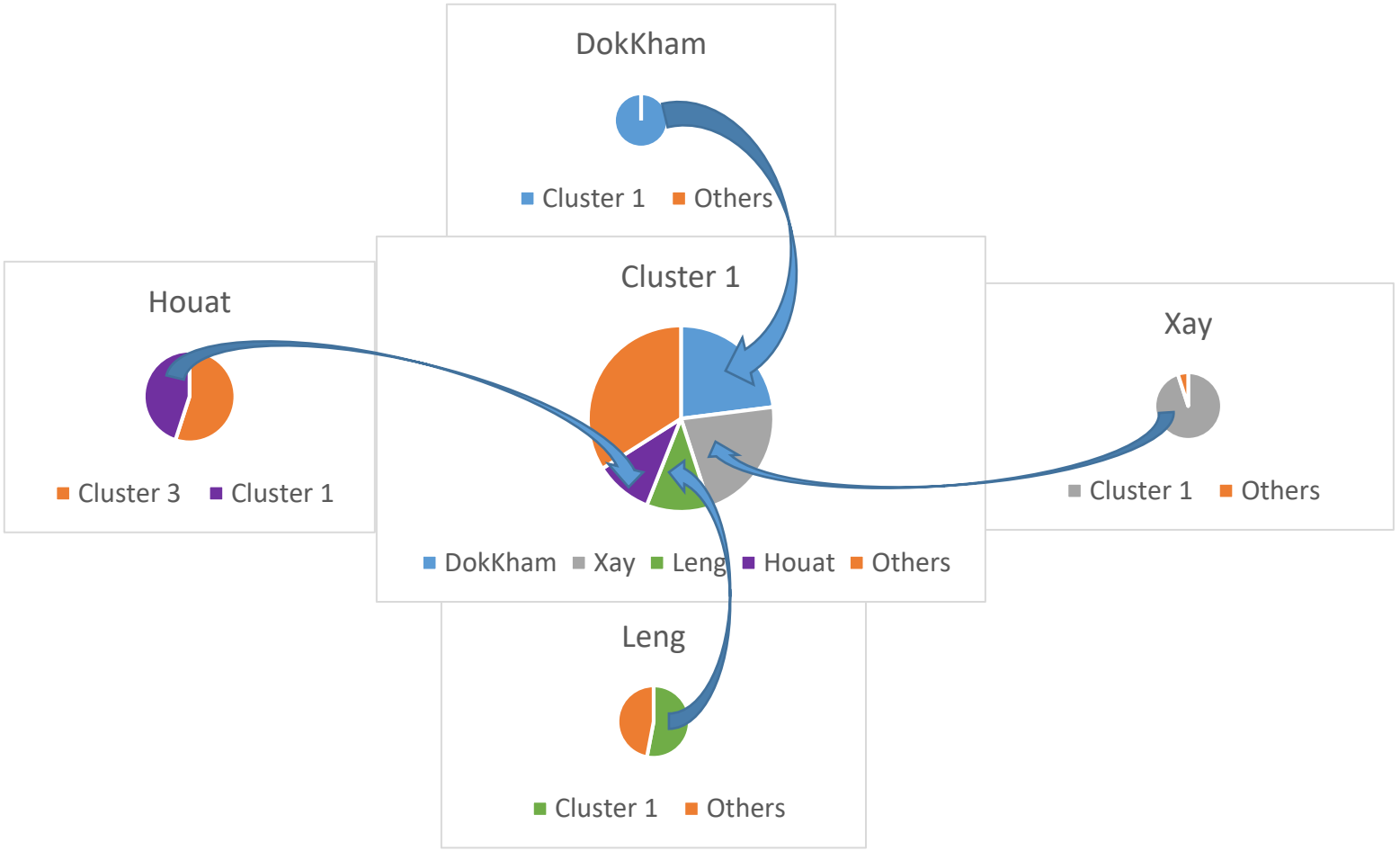

Figure 3: Distribution of the population among cluster 1, by villages

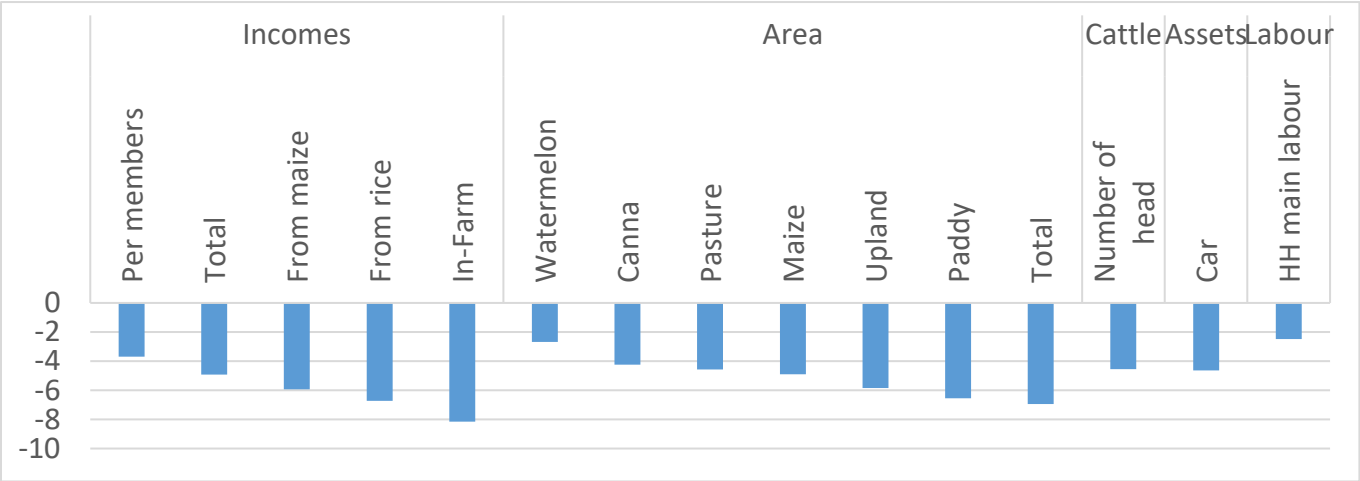

Figure 4: Results of the v.test for cluster 1 for the quantitative variables

2. Cluster 2: "The paddyists"

This cluster is composed by the farmers who are making their principal income from the rice selling. Table 8 shows the qualitative results of this cluster and **Error! Reference source not found.** the quantitative one. This cluster is composed principally (89%) by farmers from two villages: Ban Leng (47%) and Ban Le (42%). InTable 9, we notice that the average of the in-farm incomes is higher than the average in the overall population (27.86 M LAK/year instead of 14.78). The quantity of maize sold per farm (4.39 t), the incomes from it (13.48M LAK) are higher than the average in the total population, so are the paddy field area (2.04 ha instead of 1.19 ha) and the harvest (8.01 t instead of 4.38). This cluster's population has also intensified the lowland, we can see that the benefits from the garlic are higher than the average population: 2.17 M LAK instead of 0.70. Figure 5 shows the distribution of the population. The small pie graphs indicate the proportion of each villagers belonging to cluster 1. The big pie graph indicates the proportion of each village among cluster 2's population. Figure 6 show the v.test values of the "paddyists".

Table 8: Qualitative variables of cluster 2

Variable	Cla/Mod	Mod/Cla	Global	p.value	v.test
Village=Leng	47	47	16	0.0004033	3.53791528
Village=Le	40	42	17	0.00444224	2.8449212
Village=Houat	0	0	17	0.02183067	-2.29330127
Village=DokKham	0	0	17	0.02183067	-2.29330127

Table 9: Quantitative variables of cluster 2

Variable	v.test	Mean in category	Overall mean	sd in category	Overall sd

PdBene	6.6812254	13.48	3.81	6.85	6.85
PdSold	6.2076646	4.39	1.52	2.02	2.19
PdHrv	5.6534102	8.01	4.38	1.97	3.04
GlBene	5.4772359	2.17	0.70	1.90	1.28
PdArea	5.1766152	2.04	1.19	0.61	0.78
InFInc	4.3456087	27.86	14.78	10.36	14.25
WmArea	3.7192623	0.03	0.00	0.06	0.03
Sago	3.1145328	0.18	0.07	0.32	0.17

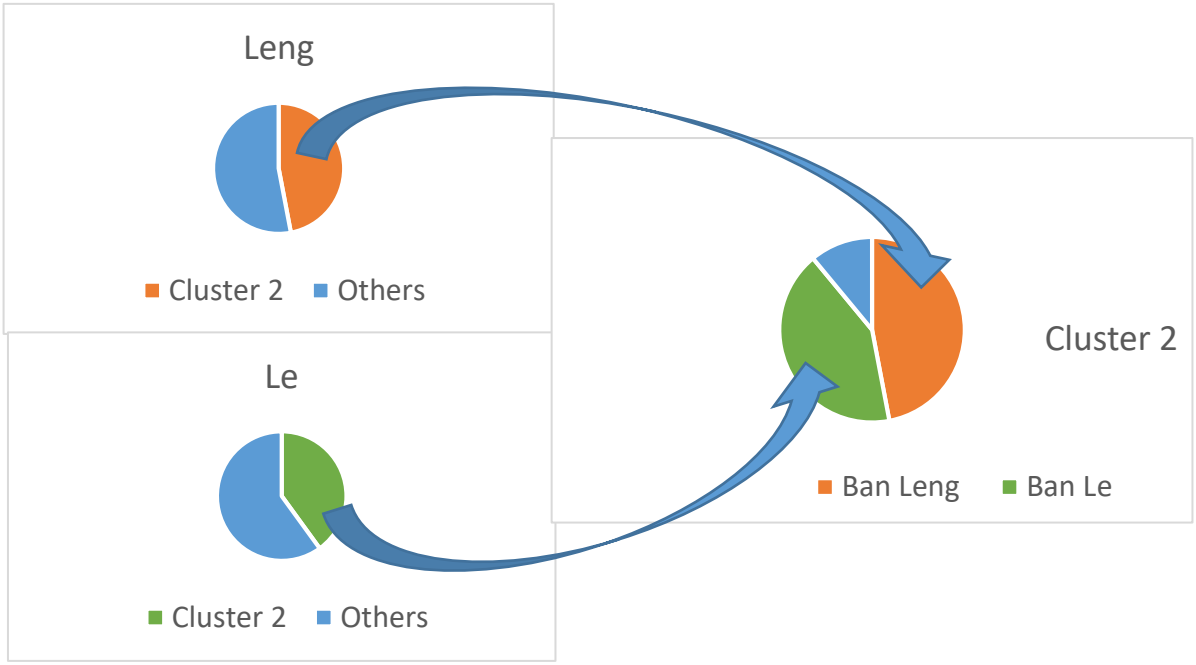

Figure 5: Distribution of the population among cluster 2, by villages

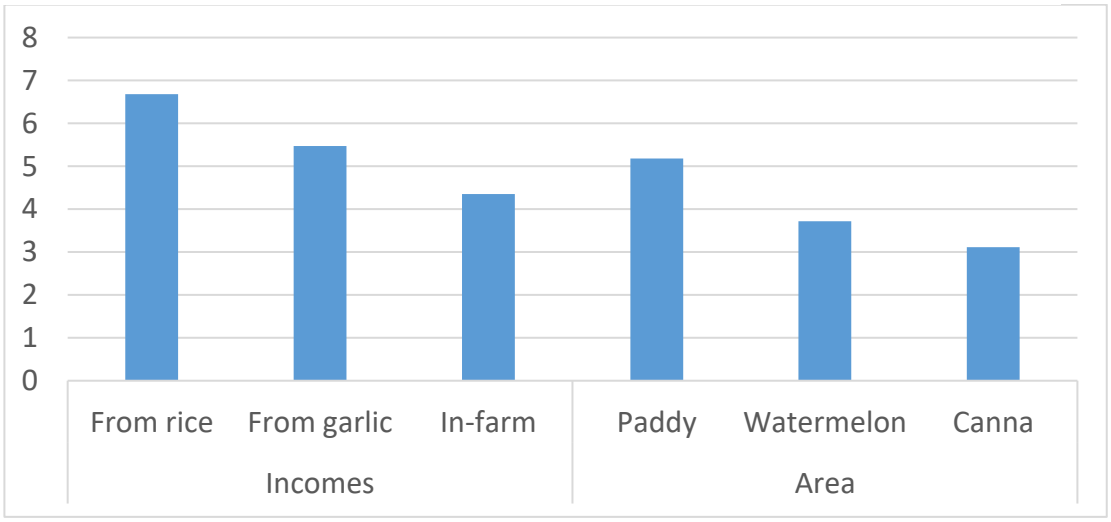

Figure 6 : Results of the v.test for cluster 2 for the quantitative variables

3. Cluster 3: "The uplanders"

Table 10: Qualitative variables of cluster 3 shows the qualitative variable of cluster 3. This cluster is mainly composed by Ban Houat's farmers (92% of the cluster population). As seen in, the farmers from this cluster have larger total field area than the average population (8.82 ha instead of 3.78). It is the case for every crop area: the upland area (6.93 ha instead of 2.59), the maize area (4.50 ha instead of 2.09) and for the paddy area (1.88 ha instead of 1.19). The harvest and the incomes from the maize are higher (respectively 28.25 t and 33.28 M LAK) than the ones for the average population. The paddy harvest is also higher in this cluster than from the average population (6.78 t instead if 4.38 t). One characteristic of this group is the livestock component: "uplanders" have more head of cattle than the average population (20.42 instead of 8.71) and more pasture area (1.68 ha instead of 0.34). This cluster's population is growing more area of *canna indica* than the others (0.18 instead of 0.07). This cluster is also wealthier than the others: the total annual income are higher than the average (92.79 M LAK instead of 36.31); so are the in-farm incomes (40.78 M LAK instead of 14.78), the incomes from weaving (9.68 M LAK instead of 5.74) and the income per HH members (15.77 M LAK/ person). The wealth can be seen also by the mean number of car: 0.75 instead of 0.22. The HH from this cluster have more labour available than the ones from other clusters (4.42 instead of 3.23). Figure 7 show the distribution of the population among the cluster. The small pie graphs indicate the proportion of each villagers belonging to cluster 1. The big pie graph indicates the proportion of each village among cluster 3's population. Figure 8 shows the results for the quantitative variables.

Table 10: Qualitative variables of cluster 3

Variable	Cla/Mod	Mod/Cla	Global	p.value	v.test
Village=Houat	55	92	17	1.78E-09	6.01680062

Table 11: Quantitative variables of cluster 3

Variable	v.test	Mean in category	Overall mean	sd in category	Overall sd
TotUl	8.6708403	6.93	2.59	1.66	1.82
MzHrv	8.2693103	28.25	9.50	7.29	8.25
MzBene	8.2405876	33.28	9.86	11.98	10.34
TotArea	8.1025141	8.82	3.78	2.37	2.26
PstArea	7.5204923	1.68	0.34	1.07	0.64
MzArea	7.0059281	4.50	2.09	0.76	1.25
InFInc	6.6302955	40.76	14.78	18.71	14.25
TotInc	5.6065551	92.79	36.31	53.84	36.64
TotCa	4.8232624	20.42	8.71	12.43	8.83
Car	4.6792055	0.75	0.22	0.43	0.41
IncMem	4.3404864	15.77	7.10	10.89	7.27
HHMnLb	3.6995813	4.42	3.23	1.19	1.17
PdArea	3.2477049	1.88	1.19	0.90	0.78

PdHrv	2.8268347	6.74	4.38	4.54	3.04
WeInc	2.6482438	9.68	5.74	6.07	5.42
Sago	2.3771637	0.18	0.07	0.18	0.17

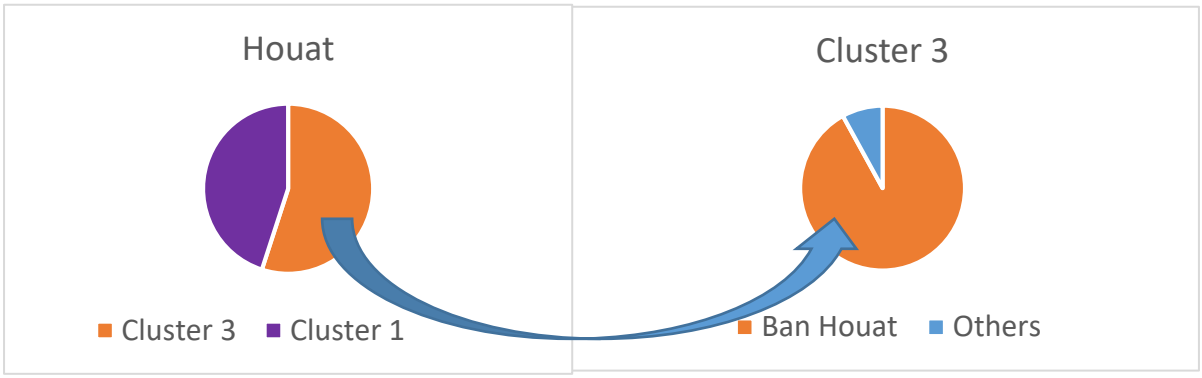

Figure 7: Distribution of the population among cluster 3, by villages

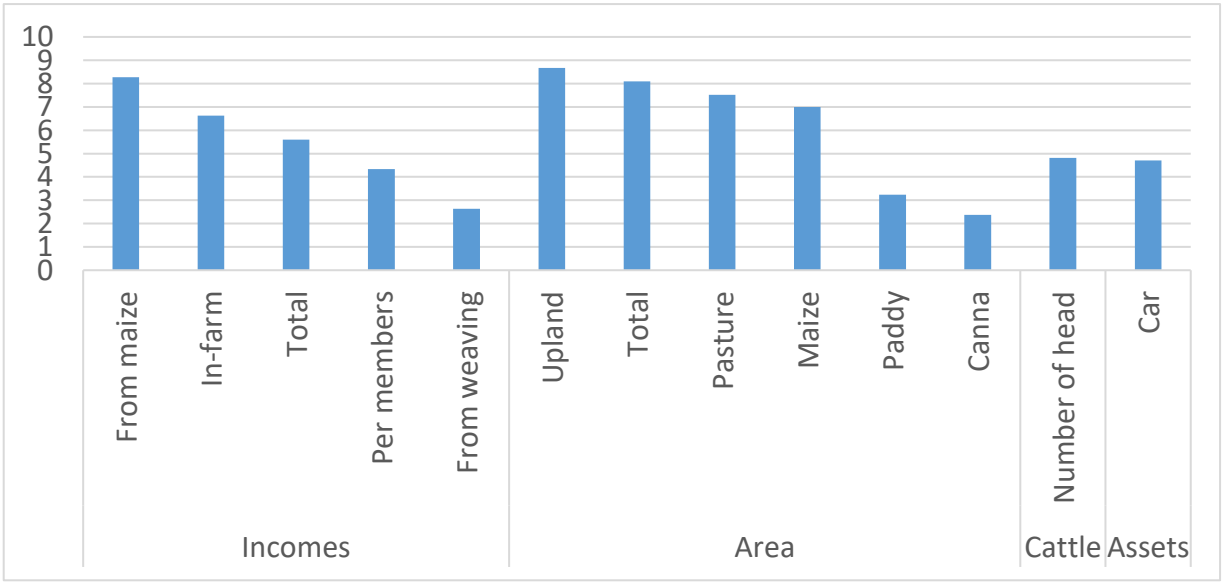

Figure 8: Results of the v.test for cluster 3 for the quantitative variables

II. Farmers' objectives – Best-Worst Scaling

1. Material and method

1. Conceptual framework

1. Objectives are part of the modelling process

Usually, farm modelling is based on 1) structural and functional variables of the farm, 2) biophysical components (soil types, climate, etc.), 3) decisional module of the farm, usually based on profit maximization under constraints. In this part of the study we seek to understand one piece of the farmers' decision making process, at the farm's scale in term of strategic objectives. Knowing the farmers' objective and their relative importance could help to contextualise CS' simulation, like forecasting farmers' behaviour in response to any variation of the farm context (e.g. climate change or drop of maize price, increase of input prices).

2. Finding the objectives

How can we know the objectives of a farm/HH? Asking directly the farmers "what are your objectives" doesn't seem to be the right methods, because the surveyed is not always aware of the reason leading to his decision and different decisions can be induced by the same objective. Finding farmers' objectives can be done with a work of qualitative survey, similar to the naturalistic inquiry. Naturalistic inquiry is "an approach to understanding the social world in which the researcher observes, describes, and interprets the experiences and actions of specific people and groups in societal and cultural context" (Armstrong 2010). This approach of the qualitative survey involves the study of single case and can take lot of time and also needs an immersion work. The process works in circular way where the researcher shares his conclusion with the surveyed in order to validate it or not. This kind of survey is contextualised with a narrative part telling the story of the surveyed, and ends with open questions.

Observing and discussing farmers' objectives can be a day-by-day process, by watching them managing the farm. Limited by the time we decided to set up a game. The aim of the game was to make the surveyed telling his HH's story by playing with cards and to start a discussion on his objectives. The interest of presenting an inquiry as a game is to make the farmer focus on his farm's story. It is also a way to avoid the pressure of a usual survey that could be stressful for the farmer because it requires a lot of questions to be asked.

3. Ranking the objectives according to the farmers' preferences: The Best-Worst Scaling method

Being acquainted with the farmers' objectives is not enough; we need to find a way to make the surveyed rank by priorities these objectives. This paragraph is a review of the existing methods used to rank the preferences of the consumers -in our case the farmers.

We can cluster in two groups the methods to evaluate preferences. The first group is the score based methods that evaluate the preferences by giving an independent score for every attributes, the objective is to free the results from the eventual bias due to every individual's characteristics while conserving the discriminating capacity. These methods are

based on notation. The second group is the choice based methods which gather all the methods based on sorting, ranking and choices (Dekhili and Sirieix 2012).

1. Score based methods

One first way can be to free the surveyed from the limits inflicted by the size of the rating scale, by offering unbounded rating (Marder 1997). The surveyed is free to give negative scores and to calibrate his scores according to his own scale of reference. A common way to operate is to offer to the surveyed a non-graduated segment limited by two opposed expressions (totally disagree, totally agree) like a semantic scale. According to some authors (Chandon and Bartikowski 2004), the duration of the questionnaire is twice longer than a 5 or 7 rates- Likert Scale[2], especially when the surveyed are allowed to give negative rating. Paradoxically, and from the author's acknowledgement (Marder 1997) the discrimination capacity and the predictive value of the methods are not significantly better. It needs a harmonisation process of the scales. The second way to free the surveyed from the limits of the rating scale is to remove the constraint of the scale's intervals. It consists of proposing to the surveyed to evaluate the attributes by comparing to the first attribute's rate by multiplying or dividing this rate according to the perceived importance between attributes ("magnitude estimation", Lodge, 1981).

The assumption of this method is that the individual operates comparatively and hierarchically in relation to what he already knows. This approach implies also that the surveyed are able to multiply or divide the score with the same ease which has not been demonstrated. This approach is also very sensitive to the effect of the presentation order and the quantity of the attributes, which needs a balanced experimental design (Dekhili and Sirieix 2012). The operation is twice longer compared to a classical Likert Scale, but a calibrated scale by the individual gives a better predictive value and a good discrimination between the individuals (Chandon and Bartikowski 2004).

2. Choice based methods

These approaches make the surveyed comparing or choosing the attributes. The method of Pairs Comparison has been used by Finn and Louviere (1992) to measure the opinion dispersion by putting the surveyed in a choice situation. However, these authors underlined that this kind of rating method using pairs only allows a restricted number of attributes, generally no more than 10. The discrete choices method based on utility measure, allows to exceed these items number (Finn and Louviere 1992)). This approach proposes to the surveyed, tasks of successive choices according to an experimental design putting in competition the modalities of the studied attributes. These successive choices reveal the relative preferences of an individual for some attributes.

Discrete choices methods have superior qualities than others methods, in term of discrimination between attributes and in term of predictive validity. These methods have two major limits. The first one is the high cost of the implementation and the necessity of using a complex software to build the experimental design. The second limit is the difficulty of comparison of utilities from other methods (Goodman, Lockshin, and Cohen 2005). If the

[2] Likert scale is a ranking method based on a score on a scale from 1 to 5 or from 1 to 7.

amount of attributes and their modalities are high, it needs a very large sampling of individual. Another current choice approach, is to rank these choices by importance order. This method's interest is to use a unique point in the scale for each attribute, which is not the case of "importance scales", where two attributes can be in the same point of the scale . However, this method suffers from bias due to the order effect and is not usable when the number of attributes are too high. The surveyed would be inclined to choose every time the same (Dekhili and Sirieix 2012).

3. Concept of BWS

To rank farmers' priorities, we have chosen the Best-Worst Scaling method, which is a choice-based approach. Best-Worst Scaling is a survey-based method developed by Louviere and Woodworth (1991) to model "the cognitive process by which respondents repeatedly choose the two objects in varying sets of three or more objects that they feel exhibit the largest perceptual difference on an underlying continuum of interest." (Finn and Louviere 1992). Usually, the respondent is asked to choose between a number of attributes, in various sets, which one he perceives to be the best and the worst. Every attribute has to be the same kind of item: concept, products etc. We can predict that the item that has been indicated more often as "the best" will be the most favourite and the item designated the more often as "the worst" will be the least favourite (Dekhili and Sirieix 2012).

4. Comparison with others methods

Goodman, Lockshin, and Cohen (2005) have compared the results from Best-Worst Scaling to those from Likert Scale on one hand, and to those from Pairs Comparison one the other hand. The duration of the survey is three times longer with the BWS method and Pairs Comparison than with the Likert Scale, because of the involvement and concentration required in the BWS and Pairs Comparison methods. Through a test of means equality of the attributes' rates, BWS is considered as the most performant in term of discrimination capacity and Likert Scale as the least performant. Likert Scale seems to be the least performant in term of discrimination between individuals and Pairs Comparison seems to be slightly better than BWS. BWS seems to be the most stable method as it shows the most-satisfying *test-retest* reliability [3].

5. Balanced Incomplete Blocks

The sets present a limited number of attributes and are created with a combinatory experimental design of balanced incomplete blocks (Rao 1960). This design ensures that each attribute is compared the same number of times to the other attributes. It is an extension of the Latin Square in which the *n* modalities are arranged in *n* lines of *n* columns so that each line and each column presents every modality. Every line can be considered as a set of choices. The first step is to consider the number of attributes that will be compared together. It is important to have a balance between the number of modalities and the list of attributes. Too many modalities could make the choice difficult and a too long list of choices could discourage the surveyed (Dekhili and Sirieix 2012).

[3] *Test-retest* reliability is a measure of the stability of a method's results.

2. Pre-survey before BWS: the card game

1. Creation of the game

In order to know the farmers' objectives a card game has been created. The game was composed with a deck of 54 cards, with 44 different cards. The deck is divided in 3 kinds of illustrated cards: the activities, the assets and the bonus cards. The activities' cards represent different in and off-farm activities such as growing paddy rice, breeding cattle or doing a salaried job. The assets' cards represent a set of productive and non-productive assets of the HH, such as rototiller, thresh machine, motorbike or television. The 3 bonus cards can remove constraints mentioned by the surveyed: labour, land and money.

A list of eventual objectives from the scientific literature have been done with Solano et al. (2003).

2. Game's implementation

The card game has been played in 4 villages: Ban Le, Ban Leng, Ban Xay and Ban DokKham with a total sample of 20 farmers. The farmers have been chosen by using the data an available database. These data have been used to do a Principal Component Analysis.

The game was systematically played the same way. At first the farmer was asked to tell the story of his/her farm from the set-up to now. While the surveyed is telling the story, the interviewer is illustrating the evolution of the farm with the cards. Any change in the activities or in the assets means a new card added and eventually an old removed. When an activity is developing, we represent it by adding next to an activities card, the same card.

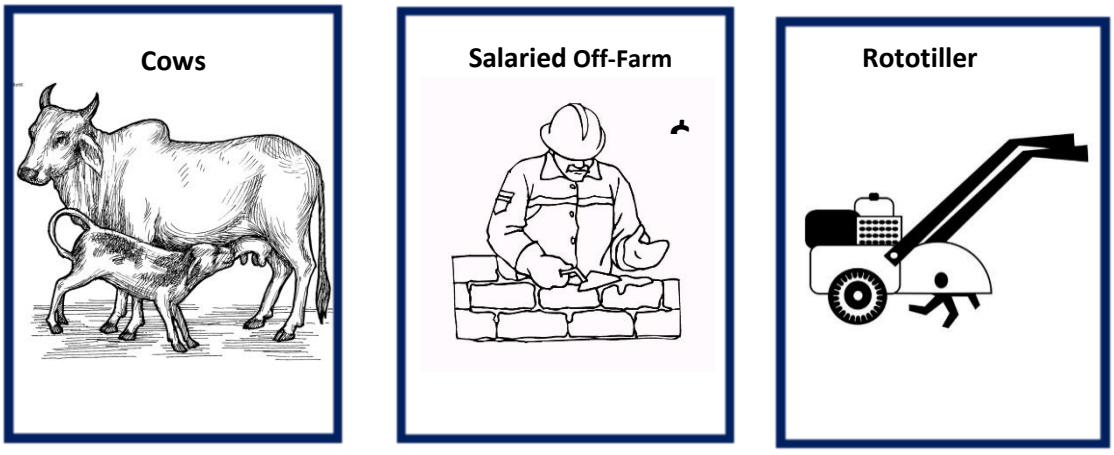

Figure 9: Example of a set of cards : 2 activities (breeding cattle and off-farm job) and 1 asset (rototiller)

For example:

1. The surveyed says that in the years 1990's he was doing shifting cultivation of upland rice, every year growing one hectare.

→The interviewer puts an "upland rice" card.

2. The surveyed says that in 2000 he started to grow one hectare of maize instead of upland rice.

→The interviewer removes the “upland rice” card and put a “maize” card.

3. The surveyed says that in 2001 he bought a rototiller and extended the maize area from one hectare to two.

→The interviewer adds one more “maize” card and put a “rototiller” card.

During the storytelling, the interviewer does an active listening, in particular by asking questions to the surveyed and by jotting down the reason of every change. The aim of these approach is to understand what lead farmers’ choices without being too intrusive in their lives. After telling the story of the farm from the beginning to the ongoing condition, the card combination should show the current situation of the farm in term of activities and assets. This card combination is a medium of conversation. The surveyed is asked about what kind of changes in the assets or in the activities in a perspective of five years.

Once the farmer has exposed his 5-years perspectives, the interviewer proposes to substitute some activities by others, expecting the surveyed to react. The game ends by giving the surveyed bonus cards and asking what changes could happen in the farm by removing the land, labour and investment constraint. Every choice has to be explained until a socio-economic objective occurred. From an initial and general objective, the interviewer seeks to find the objectives beneath. These factors can be considered as farmers’ objectives, once found, the farmer’s confirmation is asked; and if confirmed added to the list of objectives. The picture of Figure 10 shows an example of a game set. Figure 11**Error! Reference source not found.** summarise the process of the objectives’ search with the card game. The whole set is available in the appendix (Appendix 1, Appendix 2, Appendix 3 and Appendix 4).

Figure 10: Example of a set during a game. The household produce maize, rice, garlic and forage. It breeds poultry and cattle and has two off-farm activities: entrepreneur (in this case weaving) and agricultural (helping a neighbour). The household owns also one TV and one motorbike. Kham district. B. STRIFFLER

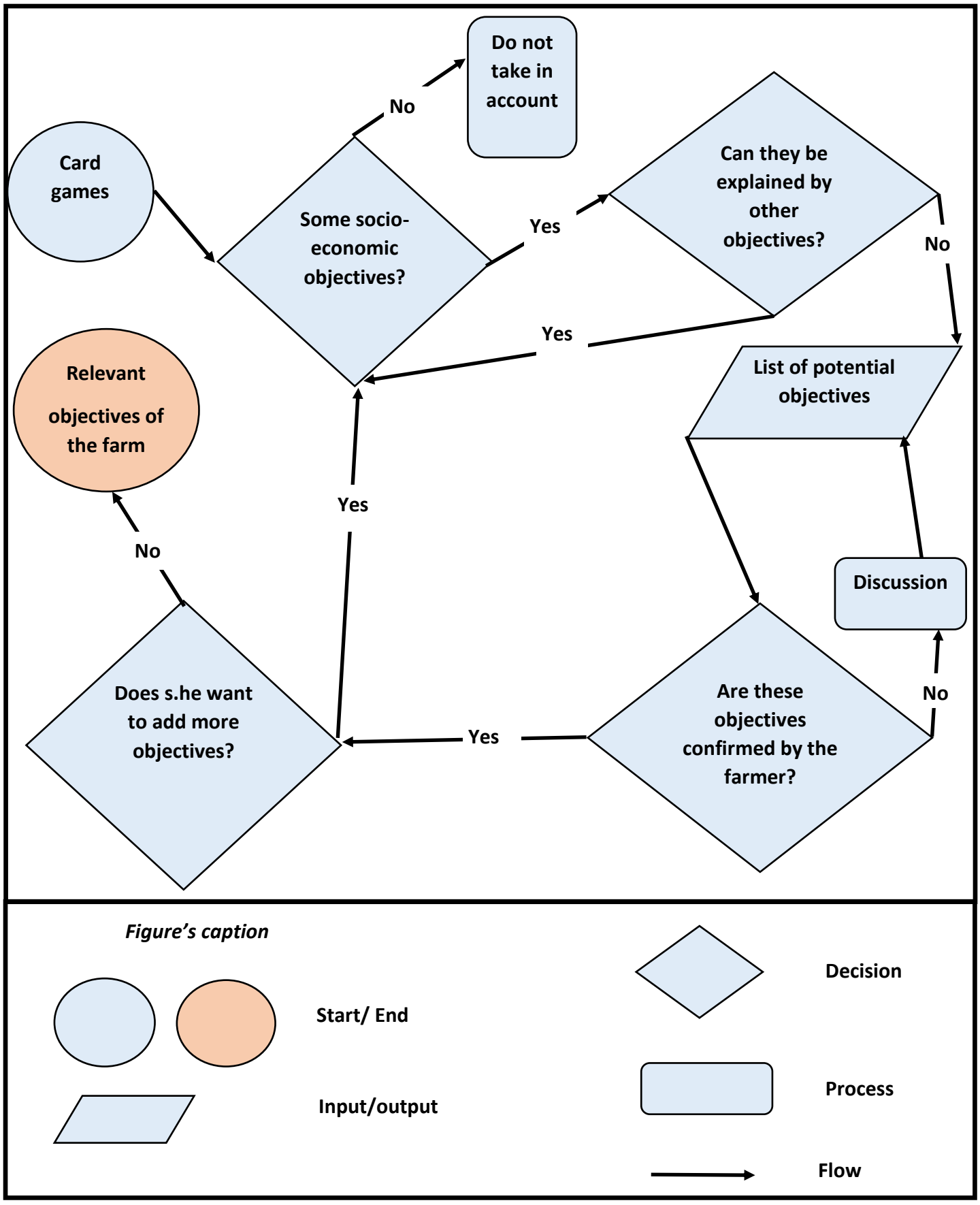

Figure 11: Flowchart of the objective search process

1. Survey's implementation

To check the relevance of the objectives found with the card game; a preliminary part of the BWS has been done among 10 families from 2 villages: Ban Leng and Ban Le, during May 2017. The second part has been done on 120 families from 6 different villages: Ban Leng, Ban Le, Ban Xay, Ban Nadou, Ban Houat and Ban DokKham. This part of the survey has been done between the end of May to the beginning of July 2017.In this study we used the BWS to rank 7 different objectives relevant for Kham district's farmers. The survey was programmed with the software [which one], in order to do a balanced incomplete block design. The BWS administration has been done in two parts: a preliminary part to check the relevance of each objective and a second part to rank them.

Both preliminary survey and survey were administrated the same way: each objective has been illustrated and translated in lao; printed three times and organized in balanced incomplete block design. We obtained a set of 7 envelopes, each containing 3 different objectives. Every objective was confronted to the 6 other objectives by pairs. For every choice set, the objectives were numbered from one to three.

Every objective has been explained the same way to every farmer and they were asked if they understood every concept well. For every set of three objectives, the surveyed had to show the interviewer at first what was the most important objective in a perspective of 5 years. Once the most important objective is identified, it is removed from the table and then the surveyed is asked to show the least important. Every set (or envelope) and every objective (inside the envelope) have been presented randomly to every surveyed in order to avoid an "order effect". The numbers of the "best" and the "worst" were written for each set.

2. Data analysis

The following analyses will be conducted:

1. Analysis of average priorities

All choices from the different respondents are pooled into one set. This would then correspond to some form of "average decision" inferred from the respondents seen as a group.

Once pooled, we are calculating the following indicators for each objective: (a) B: number of times it was mentioned as best, (b) W: number of times it was mentioned as worst, (c) raw score: S = B-W, (d) average score: AS = (B-W)/(N*3) (where N is the number of survey, and 3 reflect the fact that each objective is presented three times), and (e) the analytical best–worst: ABW (Marley, et al., 2016).

Each indicator is anticipated to give the same kind of ranking, but (Lipovetsky and Conklin, 2014) and (Marley, et al., 2016) showed that the ABW indicator to provide better fits to the aggregate choices in several best-worst choice data sets.

2. Differentiation of farmers in terms of their priorities

In a second step of the analysis, we will consider individual farmer's priorities. As we have 7 decision sets per farmers, we can calculate the same indicators for each farmer. We

will evaluate the diversity of the importance of each objective (univariate analysis such mean, variance and histograms), and then investigate whether some homogenous groups of priority are observable in the population (multivariate analysis).

A principal component analysis (PCA) of the 7 ABW individual scores, followed by a hierarchical cluster analysis will allow us to identify if such groups can be identified. Once the groups are identified, we will analyze whether they are correlated with some observable indicators of the farmers and of the farming systems[4].

3. Correlation between farm's characteristics and farmers' objectives

Once we gathered the farms in different clusters based on the characteristics and based on the objectives, we would like to know if there is a relation between these clusters. We implemented a χ^2 test to compare the clusters given by the HCA on farm characteristics (structural typology) with the clusters of the HCA of farmers' objectives. χ^2 test is used to compare the dependence between 2 variables. We also compared the objectives' clusters with some indicators created with the farms' characteristics, that could be similar to the objectives (Table 12: Indicators).

Table 12: Indicators

Indicator	Formula
Rice self-sufficiency	((rice produced in 2016 [kg] - rice sold in 2016 [kg])/ HH's member)/200 [5]
Diversity of activity	1 point for each activity
Level of intensification	1 point for each crop chemically fertilised, sprayed with herbicides and for each asset (tractor, rototiller…)
Labour/ per area	HH's main labour/area total

3. Farmers' feedback

The last step of the study of farmers' objectives is to present the results to the farmers. We organised a focus group in each village to present the different clusters from the data analysis. The participants of the meeting were a mix of farmers surveyed and non-surveyed. Each cluster was presented with their respective characteristics and the participants were asked to write on a paper the number of the cluster that seems to be corresponding to their HH priorities. Making the farmers writing down the number is a way to avoid gregarious behaviour. Once the groups are made we asked them to justify their choices.

We also asked a description of each group by the three others. Doing this meeting is first a way to compare the results found with the survey and the farmers' perception. The feedback was also a mean to ask to farmers if for them the priorities are something they try

[4] Note that this analysis based on the BWS scores provides robust indicators of the priorities and of the groups. More sophisticated analysis, based on ordered logit model will be tested at a later stage. However, results from other studies tend to show that both approaches provide similar results, at least in terms of average priorities.

[5] Lao PDR annual rice consumption per capita (kg) (Eliste, Santos, and Pravongviengkham 2012)

to reach or something they want to maintain (e.g.in a group where the rice self-sufficiency is important, does it mean that they are not self-sufficient and want to be; or does it mean that they are already self-sufficient and still want to focus on it?

Another objective of the farmers' feedback was to know what main changes they are planning for the 5 next years. We discussed the consistency between the plans for the near future and the group the participants belong. We summed the number of individual from each group to compare the distribution of the revealed priorities (from the BWS) and the stated priorities (from the focus group).

2. Results

1. Farmers' objectives

The table below (Table 13) shows the different objectives found with the card game and their definition given to each farmer.

Table 13: Objectives

N°	Objective	Definition
1	Having a transmissible farm (TRANS)	"Having enough assets, cattle and field to ensure that when your children be the heads of the farm, they can continue the activities and have an guaranteed income."
2	Having high incomes punctually (HIP)	"Having a huge amount of money, once or twice a year, for example selling cattle or maize."
3	Having small incomes regularly (SIR)	"Having a small amount of money every month or every two month, all along the year, from any activity, for example weaving, selling chicken."
4	Reducing cash out (CA_OUT)	"Reducing the investments of the farm, for example by reducing the inputs purchases."
5	Reducing work and effort (WORK)	"Reducing the amount of work and its arduousness, like the transition between the land preparation by buffalo and by rototiller."
6	Reducing risks by diversifying (RISK)	"Having a global income from various activities (off and in-farm) and not depending on only one."
7	Being self-sufficient in rice (SUFF)	"Having enough paddy field, to provide rice all along the year for the family."

2. Global and mean results per objective

To have a global ranking of the objectives, we summed for each objective and for every participant the number of time that it was chosen as the best (Best) and as the worst (Worst). The best-worst result (BW) is the difference between the Best and Worst. To get an average

individual score we had to divide the best-worst result by 360, which is the product of the number of participants (120) and the number of time that each objective can be chosen (3). We obtained an average ranking per individual. The objectives have been ranked by scores on Table 14. “Being self-sufficient in rice” (SUFF) is the most rated objectives because it has the best score; and “Reducing cash-out” (CA_OUT) is the least rated. For each individual a personal BW result has been calculated the same way has the general BW. BWn is

Table 14: Results of BWS

N°	Objectives	Best	Worst	BW	BWn
7	SUFF	220	44	176	0.489
1	TRANS	199	49	150	0.417
3	SIR	113	113	0	0.000
6	RISK	89	139	-50	-0.139
2	HIP	71	124	-53	-0.147
5	WORK	75	172	-97	-0.269
4	CA_OUT	73	199	-126	-0.350

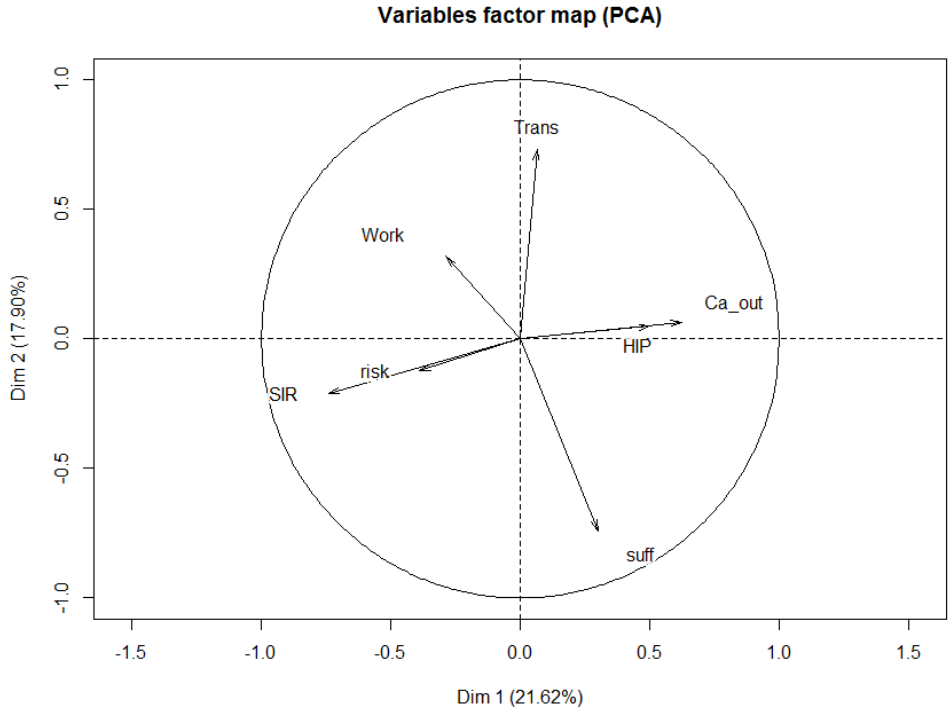

Figure 12: Variable factor map

3. *Groups of priorities*

To compare the individual results to the average individual results we to do a Principal Component Analysis. We realised the PCA by using the BWS results as variables. The first dimension is composed principally by the objectives “Having High Incomes Punctually” (HIP) and “Reducing the Cash-Out” (CA_OUT); the second dimension is composed principally by “Having a Transmissible Farm” (TRANS) and the third dimension is composed by “Reducing Risks by Diversifying” RISK and “Having High Incomes Punctually” (HIP). Figure 12 is the

variable factor map of the PCA. It shows the relation between the variables in two dimensions. We can see that there is a strong correlation between CA_OUT and HIP and between RISK and SIR. These couples of variables are also strongly negatively correlated. SUFF is also negatively correlated to WORK and TRANS. SUFF, WORK and TRANS are not correlated to RISK, SIR, CA_OUT and HIP.

Once the universe defined, we made a hierarchical clustering to create different groups of priorities based on every individuals' BW scores compared to the mean scores. We found 4 clusters. (cf. Appendix 5) A positive value indicate that the variable's mean value of the cluster is higher than the overall mean; a negative value indicate that the variable's mean value of the cluster is lower than the overall mean. Sd means standard deviation, it quantifies the variation around the mean of the individuals of a category. The four clusters have different characteristics:

1. Cluster 1

Cluster 1 (Table 15) prioritise more the objectives "having small incomes regularly" (SIR) and "reducing risks by diversifying "(RISK) and less farm's transmissibility (TRANS), rice self-sufficiency (SUFF) and high incomes punctually (HIP) (cf.). 20% of the sampled population belongs to this cluster. The most populated cluster is the cluster 3 (32%) followed equally by the cluster 1 and the cluster 2 (24%). Figure 17: Comparison of the v.test results of cluster 4 and the average results shows the comparison between the v.test results of cluster 4 and the average.

Table 18: Characteristics of cluster 4

Cluster 4

Variable	v.test	Mean in category	Overall mean	Sd in category	Overall sd
HIP	5.00	1.22	-0.39	2.02	1.76
WORK	2.51	0.14	-0.79	2.78	2.02
CA_OUT	2.48	-0.36	-1.22	1.61	1.89
TRANS	-2.24	0.72	1.61	0.80	2.17
SIR	-3.76	-1.41	0.05	1.63	2.12
SUFF	-4.45	0.03	1.98	1.55	2.39

5. Comparison between the clusters

Figure 18 represent the different clusters' characteristics.

4. Dependence between BWS clusters and farms' characteristics

In the χ^2 test, two variables are dependent when p-value < 0.05. The Table 19 summarize the results of the test between the BWS clusters and the farms' characteristics indicators and also the clusters from the FAMD. The hypothesis of dependence is rejected for all indicators and for the FAMD clusters.

). 24% of the sampled population belongs to this cluster. Figure 13: Comparison of the v.test results of cluster 1 and the average results shows the comparison between the v.test results of cluster 1 and the average.

Table 15: Characteristic of cluster 1

Variable	v.test	Mean in category	Overall mean	Sd in category	Overall sd
SIR	5.71	2.02	0.05	2.13	2.12
RISK	4.58	0.92	0.33	1.74	1.68
TRANS	-3.15	0.5	1.61	0.86	2.17
SUFF	-3.66	0.56	1.98	0.97	2.39
HIP	-3.78	-1.47	-0.39	1.57	1.76

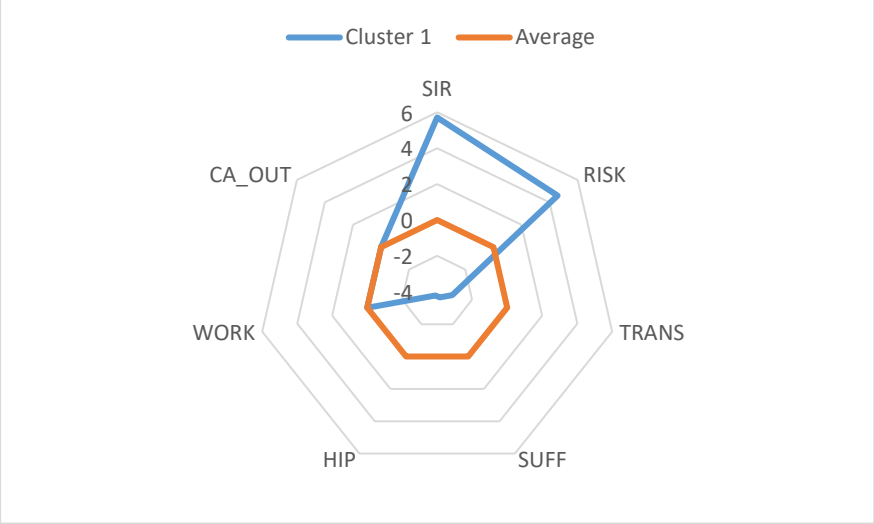

Figure 13: Comparison of the v.test results of cluster 1 and the average results

2. Cluster 2

Cluster 2 prioritise more having a transmissible farm (TRANS) and less reducing risks by diversifying (RISK) and rice self-sufficiency (SUFF) (cf. Table 16). 24% of the sampled population belongs to this cluster.

Figure 14 shows the comparison between the v.test results of cluster 2 and the average.

Table 16: Characteristics of cluster 2

Cluster 2					
Variable	v.test	Mean in category	Overall mean	Sd in category	Overall sd
TRANS	9.64	5.01	1.61	1.06	2.17
RISK	-2.46	-1.00	-0.33	1.50	1.68
SUFF	-2.64	0.96	1.98	0.86	2.39

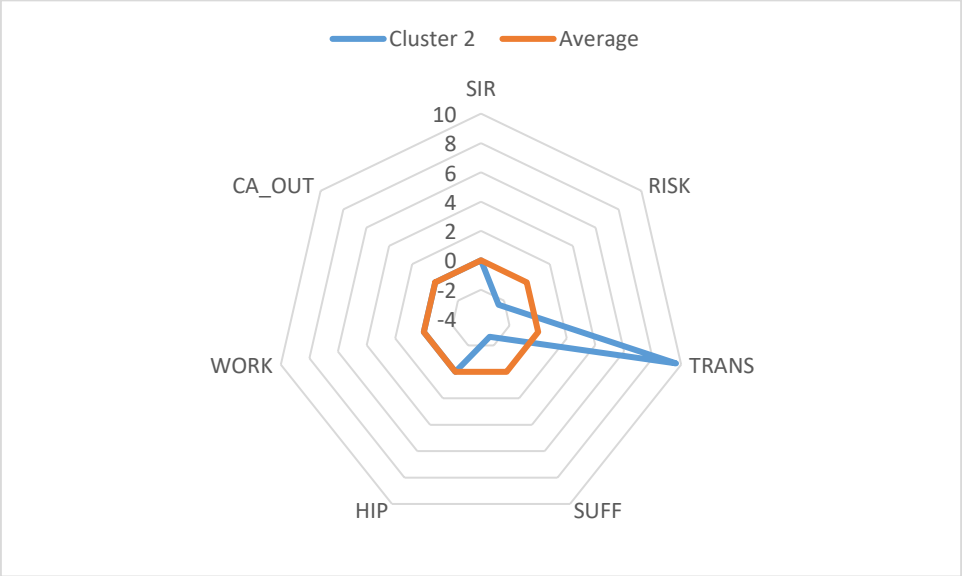

Figure 14: Comparison of the v.test results of cluster 2 and the average results

Cluster 3					
Variable	v.test	Mean in category	Overall mean	Sd in category	Overall sd
SUFF	9.63	5.08	1.98	0.94	2.39
RISK	-2.68	-0.94	-0.33	1.28	1.68
TRANS	-4.05	0.43	1.61	1.19	2.17

Table 17 : Characteristics of cluster 3

3. Cluster 3

Cluster 3 prioritise more rice self-sufficiency (SUFF) and less “having a transmissible farm” (TRANS) and “reducing risk by diversifying” (RISK) (cf.). 32% of the sampled population belongs to this cluster. Figure 15 shows the comparison between the v.test results of cluster 3 and the average.

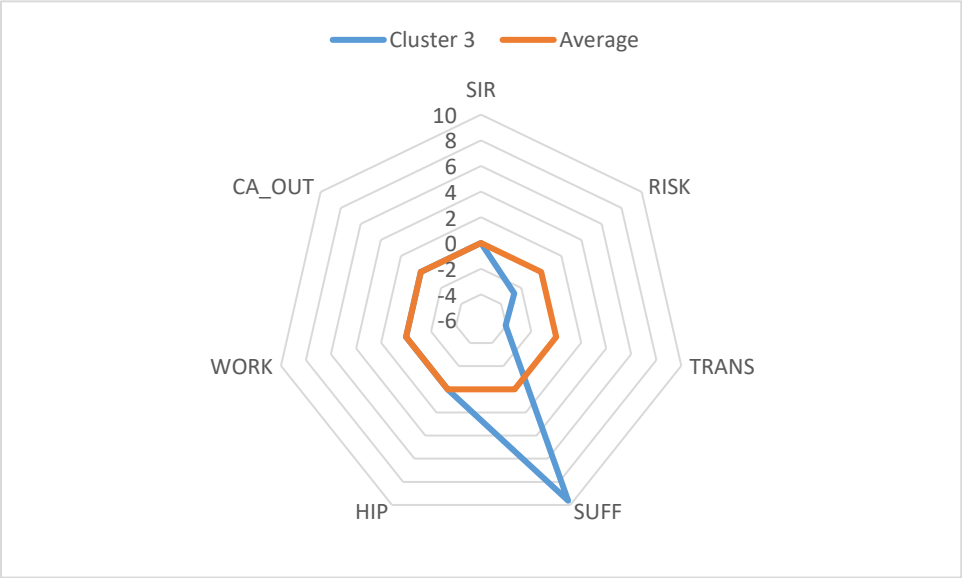

Figure 15: Comparison of the v.test results of cluster 3 and the average results

4. Cluster 4

Cluster 4 prioritise more “having high incomes punctually” (HIP), reducing work and efforts” (WORK) and “reducing cash-out” (CA_OUT) and less “having a transmissible farm” (TRANS), “having small incomes regularly” (SIR) and rice self-sufficiency (SUFF) (cf. **Error! Reference source not found.**). 20% of the sampled population belongs to this cluster. The most populated cluster is the cluster 3 (32%) followed equally by the cluster 1 and the cluster 2 (24%). Figure 17: Comparison of the v.test results of cluster 4 and the average results shows the comparison between the v.test results of cluster 4 and the average.

Table 18: Characteristics of cluster 4

Cluster 4					
Variable	v.test	Mean in category	Overall mean	Sd in category	Overall sd
HIP	5.00	1.22	-0.39	2.02	1.76
WORK	2.51	0.14	-0.79	2.78	2.02
CA_OUT	2.48	-0.36	-1.22	1.61	1.89
TRANS	-2.24	0.72	1.61	0.80	2.17
SIR	-3.76	-1.41	0.05	1.63	2.12
SUFF	-4.45	0.03	1.98	1.55	2.39

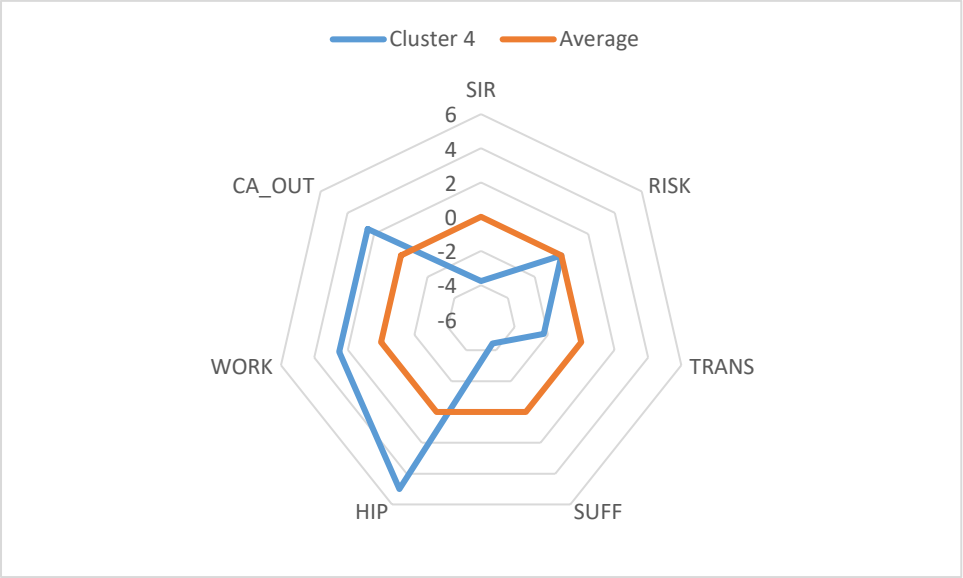

Figure 16: Comparison of the v.test results of cluster 4 and the average results

6. Comparison between the clusters

Figure 18 represent the different clusters' characteristics.

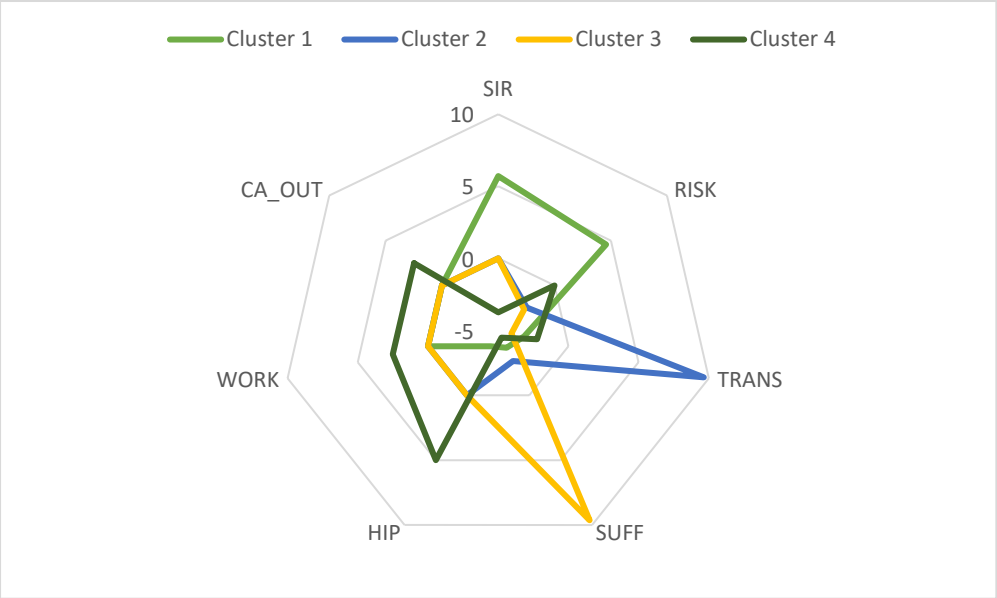

Figure 17: Comparison of the v.test results of all clusters

5. Dependence between BWS clusters and farms' characteristics

In the χ^2 test, two variables are dependent when p-value < 0.05. The Table 19 summarize the results of the test between the BWS clusters and the farms' characteristics indicators and also the clusters from the FAMD. The hypothesis of dependence is rejected for all indicators and for the FAMD clusters.

Table 19: Results of the χ^2 test

Indicator	χ^2	df	p-value	Hypothesis of dependence with BWS clusters
Rice self-sufficiency	15.128	9	0.08747	Rejected
Diversity of activity	2.8732	3	0.4116	Rejected
Level of intensification	4.5963	6	0.5965	Rejected
Labour/ per area	8.2087	6	0.2232	Rejected
FAMD clusters	5.5415	6	0.4765	Rejected

5. Farmers' feedback

1. Comparison between revealed priorities and stated priorities

We compared the revealed priorities (from the BWS) and the stated priorities (from the focus group) with the farmers already surveyed; to see the difference of results. Among the 6 focus groups, 54 farmers have already been surveyed with the BWS. Figure 18 shows at first that there is a variation of the population in three clusters : cluster 1, cluster 2 and cluster 3. More people considered that the objectives of cluster 1 were their priorities than it was revealed with the BWS; from 11 people initially to 16 (+45%). For cluster 2 and cluster 3, less people considered that the objectives of these clusters were matching with their priorities, than it was found with the BWS. The number of people decreased in cluster 2, from 13 to 11

(-15%) and in cluster 3, from 15 to 12 (-25%). The amount of people in cluster 4 stayed the same with the BWS and the focus group.

We also compared the results individually, to see how many people classified in a cluster with the BWS, stayed in the same cluster with the focus group. We can observe that very few individuals classified themselves in the same cluster as the one they were assigned with the BWS. Among the 54 farmers, we found 11 in cluster 1 with the BWS, but only 3 of them considered belonging to the same cluster. For cluster 2 out of the 13 farmers classified in it with the BWS, only one considered belonging to it. For cluster 3 and cluster 4, with both 15 farmers revealed by the BWS, in both cases, only 3 considered belonging to the same clusters.

Figure 18: Comparison of the revealed and stated priorities of the farmers surveyed

2. Comparison of the clusters' distribution

1. General distribution

To compare the stated and revealed results, we studied the general distribution of each clusters based of the choice during the focus group. Figure 20 shows the proportion of

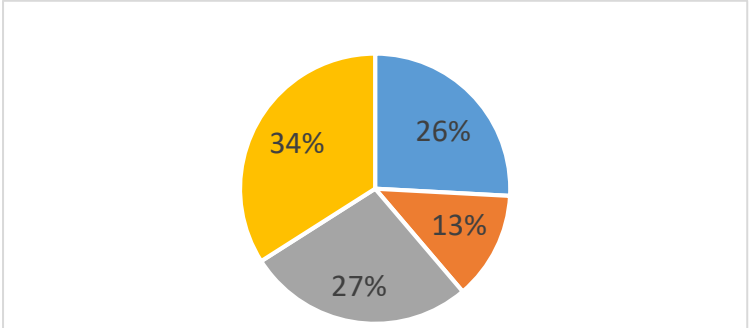

Figure 19: Proportion of individual in each clusters, from the focus group results

individuals in each cluster based on the perception of 127 farmers in 6 villages. The most popular cluster is cluster 4 (34%) followed by cluster 3 (27%), cluster 1 (26%) and the least popular is cluster 2 (13%).

In Figure 20, we compared the percentage of the clusters' distribution from the BWS (revealed) and from the focus group (stated). We observe that the distribution of the population in cluster 1 is slightly higher in the stated results (26%) than in the revealed (24%). For cluster 2 the difference is larger: the BWS results show that 24% of the farmers are in cluster 2 and the focus group's results show that only 13% of the farmers consider themselves belonging to cluster 2. The proportion of individual in cluster 3 is also lower in the results from the focus group (27%) than from the BWS (32%). The distribution of individuals in cluster 4 is higher in the results from the focus group (34%) than from the BWS.

2. Distribution per village

To highlight an eventual effect from the villages, we compared the clusters' distribution results from the focus group and the BWS in each village.

1. Ban DokKham

Figure 21 shows the distribution of the surveyed in each cluster from the BWS and the focus group, in Ban DokKham. The distribution of people in cluster 1 is the same from the revealed results and the stated results (35%). For cluster 2, the distribution with the revealed results (25%) is higher than the one from the stated results (10%). In the case of cluster 3, the stated result (26%) is slightly lower than the revealed one (30%). The stated results in cluster 4 (29%) is higher than the revealed results (10%). If we classify the clusters by order of importance, the most-populated clusters from the revealed results are cluster 1, cluster 3 and cluster 2; whereas the most-popular clusters from the focus group are cluster 1, cluster 4 and cluster 3.

Figure 20: Comparison of the clusters' distribution between the revealed results and the stated results

2. Ban Houat

The Figure 22 shows the distribution of the surveyed in each cluster from the BWS and the focus group, in Ban Houat. The distribution of people in cluster 1 is the same from the revealed results and the stated results (15%). For cluster 2, the distribution with the revealed results (40%) is higher than the one from the stated results (15%). In the case of cluster 3, the stated result (59%) is higher than the revealed one (20%). The stated results in cluster 4 (11%) is lower than the revealed results (25%). If we classify the clusters by order of importance, the most-populated clusters from the revealed results are cluster 2, cluster 4 and cluster 3; whereas the most-popular clusters from the focus group are cluster 3 and equally cluster 1 and cluster 2.

3. Ban Le

Figure 23 shows the distribution of the surveyed in each cluster from the BWS and the focus group, in Ban Le. The distribution of people in cluster 1 is higher from the revealed results (40%) than from the stated results (27%). For cluster 2, the distribution with the revealed results (15%) is higher than the one from the stated results (7%). In the case of cluster 3, the stated result (35%) is higher than the revealed one (3%). The stated results in cluster 4 (63%) is higher than the revealed results (10%). If we classify the clusters by order of importance, the most-populated clusters from the revealed results are cluster 1, cluster 3 and cluster 2; whereas the most-popular clusters from the focus group are cluster 4, cluster 1 and cluster 2.

Figure 21: Comparison of the clusters' distribution between the revealed results and the stated results in Ban DokKham

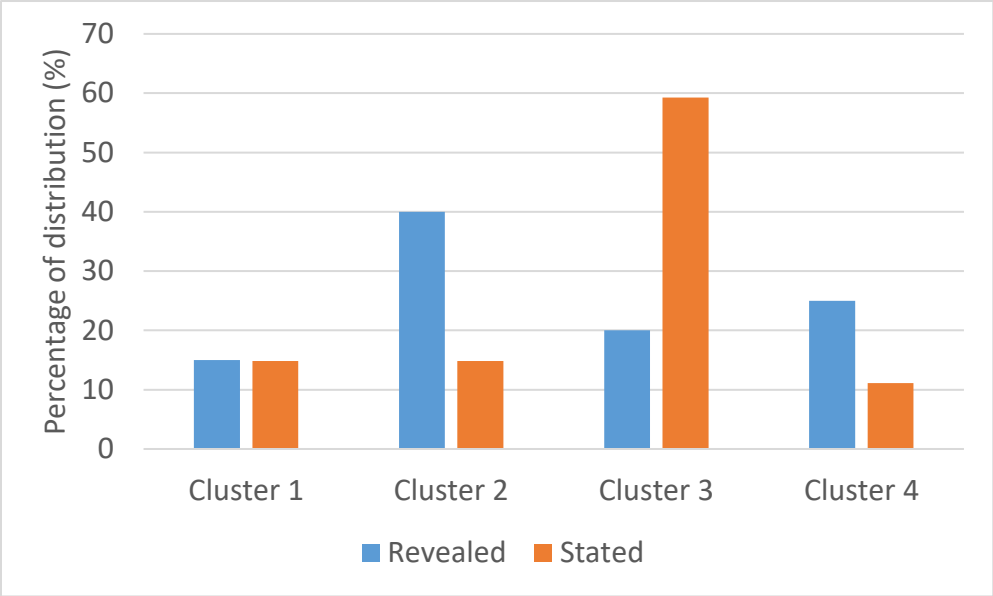

Figure 22: Comparison of the clusters' distribution between the revealed results and the stated results in Ban Houat

4. Ban Leng

Figure 24 shows the distribution of the surveyed in each cluster from the BWS and the focus group, in Ban Leng. The distribution of people in cluster 1 is higher from the revealed results (10%) than from the stated results (5%). For cluster 2, the distribution with the stated results (40%) is higher than the one from the revealed results (10%). In the case of cluster 3, the stated result (30%) is lower than the revealed one (50%). The stated results in cluster 4 (25%) is slightly lower than the revealed results (30%). If we classify the clusters by order of importance, the most-populated clusters from the revealed results are cluster 3, cluster 4 and equally cluster 1 and cluster 2; whereas the most-popular clusters from the focus group are cluster 2, cluster 3 and cluster 4.

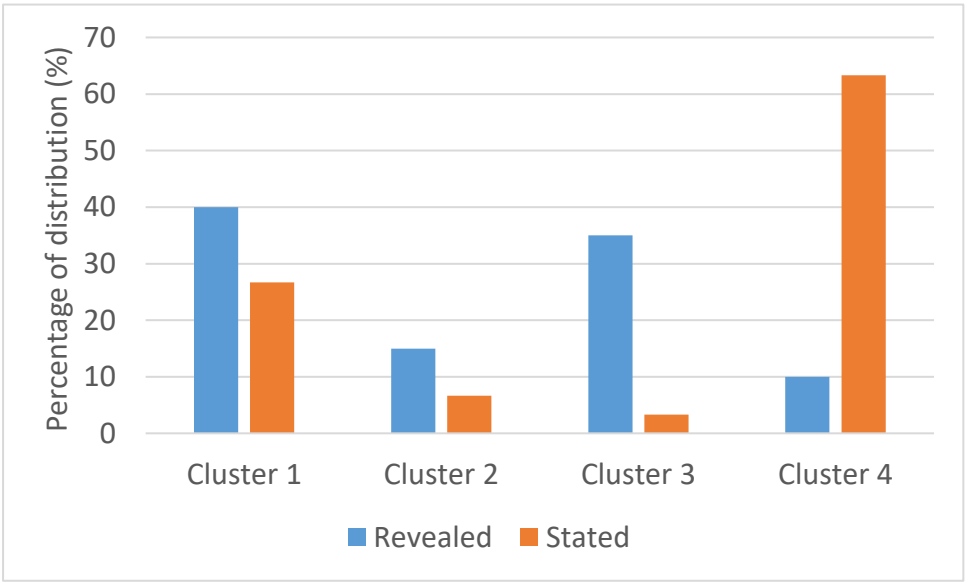

Figure 23: Comparison of the clusters' distribution between the revealed results and the stated results in Ban Le

5. Ban Nadou

Figure 25 shows the distribution of the surveyed in each cluster from the BWS and the focus group, in Ban Nadou. The distribution of people in cluster 1 is higher from the revealed results (30%) than from the stated results (23%). For cluster 2, the distribution with the revealed results (25%) is higher than the one from the revealed results (9%). In the case of cluster 3, the stated result (41%) is higher than the revealed one (25%). The stated results in cluster 4 (27%) is higher than the revealed results (20%). If we classify the clusters by order of importance, the most-populated clusters from the revealed results are cluster 1 and equally cluster 1 and cluster 2; whereas the most-popular clusters from the focus group are cluster 3, cluster 4 and cluster 1.

6. Ban Xay

Figure 26 shows the distribution of the surveyed in each cluster from the BWS and the focus group, in Ban Xay. The distribution of people in cluster 1 is higher from the stated results (53%) than from the stated results (15%). For cluster 2 and 3, the distribution is the same for the revealed results (25%) and for the stated results (0%). If we classify the clusters by order of importance, the most-populated clusters from the revealed results are equally cluster 2 and cluster 3; whereas these clusters are the least popular with the stated results.

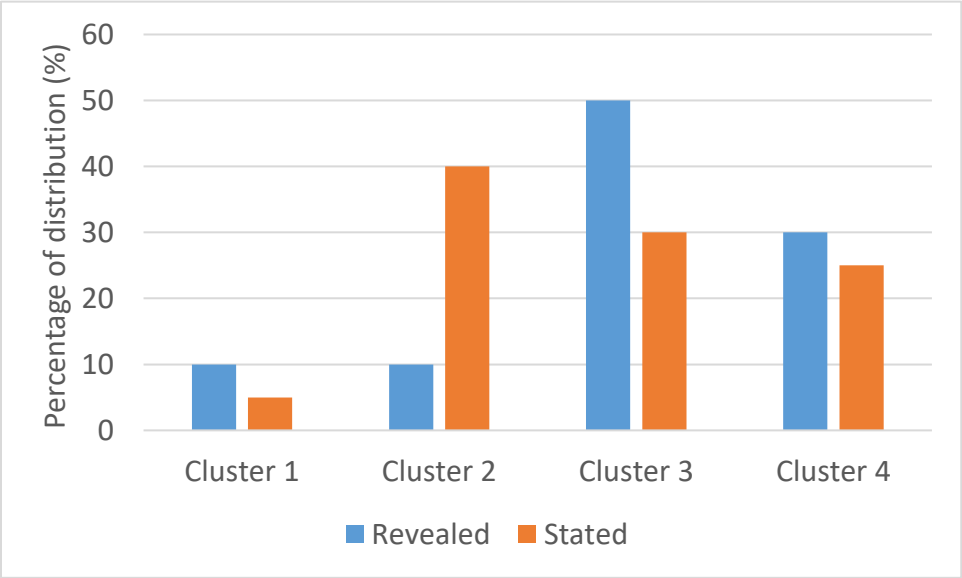

Figure 24: Comparison of the clusters' distribution between the revealed results and the stated results in Ban Leng

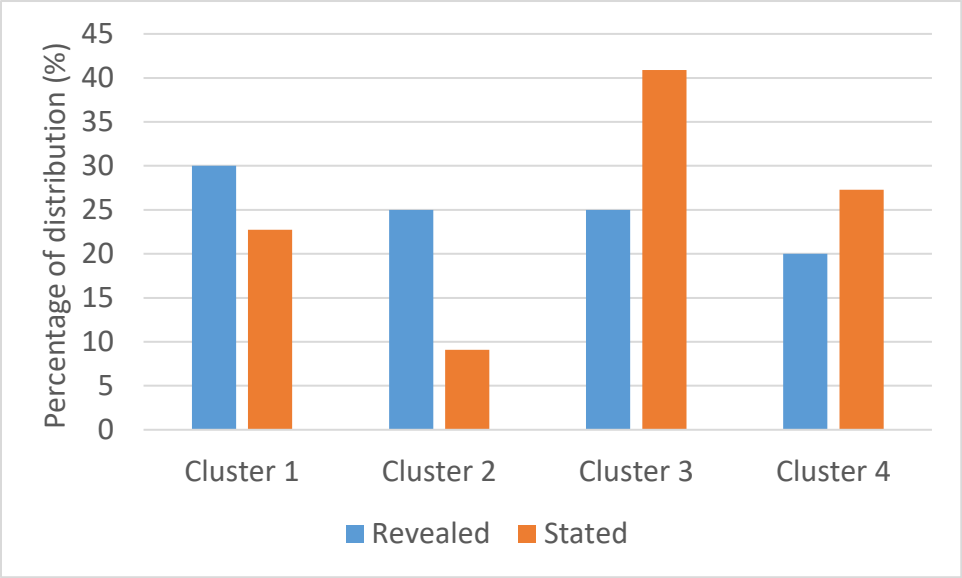

Figure 25: Comparison of the clusters' distribution between the revealed results and the stated results in Ban Nadou

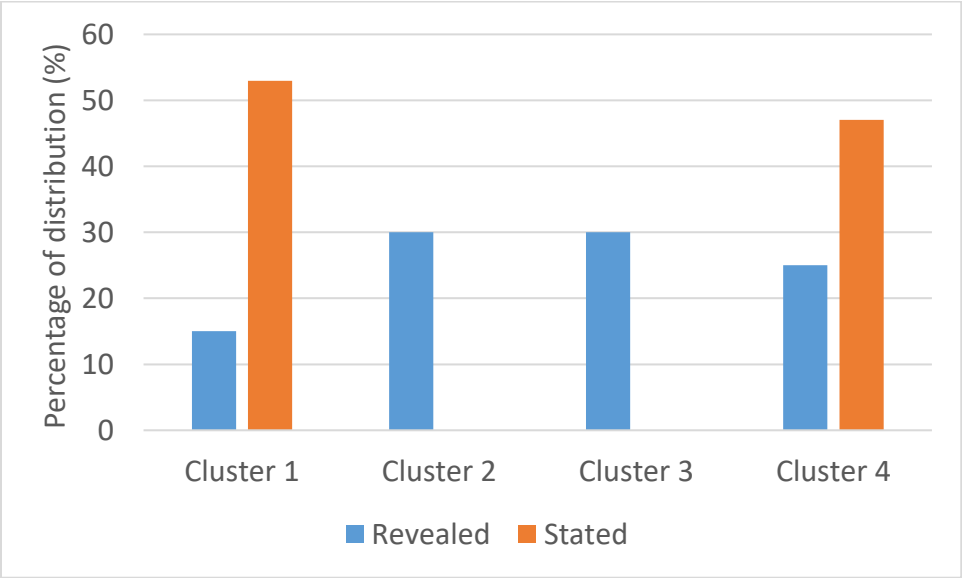

Figure 26: Comparison of the clusters' distribution between the revealed results and the stated results in Ban Xay

IV. Discussion and perspectives

1. Discussion des résultats

1. Typologie d'exploitation

Les résultats de l'AFMD suggèrent que les clusters sont principalement déterminés par la richesse et la possession foncière du ménage La gestion des cultures (par exemple, l'usage d'intrants) ne semble pas être un facteur de différenciation des exploitations. C'est, par contre, le cas pour la superficie des champs et la main-d'œuvre parmi les ménages.

L'un des facteurs les plus discriminants au sein de la population paysanne est le revenu. Les résultats indiquent qu'il existe différentes stratégies pour générer des revenus élevés. Nous pouvons voir ,avec le cluster « agriculteurs démunis », que les ménages avec les revenus les plus bas sont aussi ceux qui disposent le moins de surface agricole et de tête de bétail. Le levier utilisé par certains agriculteurs de ce groupe pour générer plus de revenus sont les activités non agricoles, en particulier le tissage. Le tissage n'est pas apparu comme un facteur discriminant parmi la population du cluster «agriculteurs démunis » car il est largement pratiqué dans presque tous les villages du district de Kham.

Les résultats du groupe « Uplanders » montrent la transition qui se produit avec la production de maïs. Nous pouvons voir d'autres utilisations des hautes terres comme le pâturage ou le *canna indica*. Ce cluster montre que le rendement du maïs n'est pas un facteur discriminant ni l'utilisation des intrants. Les agriculteurs ont une plus grande superficie de hautes terres, ce qui peut expliquer les bénéfices plus élevés du maïs. Il semble que le rendement du maïs pour chaque cluster est loin d'être à la hauteur du potentiel et la stratégie pour en augmenter les bénéfices est l'extension des hautes terres. La possibilité d'appliquer cette stratégie dépend du contexte de la ferme, ancré dans le contexte villageois. C'est pourquoi nous pouvons remarquer un effet de village sur la composition des clusters. Les possibilités d'extension des terres sont plus grandes à Ban Houat que dans d'autres villages, ce qui peut expliquer la prédominance des agriculteurs de Ban Houat au sein du groupe « Uplanders ».

Les résultats du groupe « Paddyistes » suggèrent que la production de riz peut être une autre stratégie pour les agriculteurs pour générer des revenus. On remarque qu'il n'y a pas de grandes différences entre la superficie de rizière de ce cluster (valeur moyenne: 2,04 ha) et celle du cluster « Uplanders » (valeur moyenne: 1,88 ha). La différence entre ces groupes est que les agriculteurs du groupe « Uplanders » ont plus de hautes terres. La stratégie de ce groupe est davantage basée sur l'intensification de l'utilisation de la rizière, avec des cultures de contre saison, comme on peut le voir avec les bénéfices de l'ail ou de la surface en pastèque. Cependant, la possibilité de produire des récoltes en saison sèche dépend davantage du contexte du village que du contexte de la ferme en raison des besoins d'irrigation. On peut voir que 2 villages entrent dans la composition du cluster « Paddyistes », Ban Le et Ban Leng ; ce qui devrait s'expliquer par un meilleur accès à l'irrigation.

La typologie suggère que le contexte villageois est un facteur important dans cette région pour expliquer la structure d'exploitation Cependant, les résultats du cluster « agriculteurs démunis » montrent une plus grande hétérogénéité par rapport au village paysan. Cela signifie que même si le contexte et l'emplacement du village peuvent expliquer une partie de la caractéristique d'une ferme, il y a encore des facteurs individuels, du parcours de vie, qui peuvent expliquer l'autre partie.

2. Préférence des agriculteurs

Les résultats de l'enquête et du BWS montrent qu'il existe une diversité de préférences parmi la population d'agriculteurs. Il semble que l'autosuffisance en riz est un objectif important pour la plupart des agriculteurs, même si ce n'est pas toujours leur priorité pour les 5 prochaines années.

Nous avons constaté qu'il n'y a pas de caractéristiques évidentes de la ferme qui peuvent expliquer les objectifs. La différence de résultats entre les villages suggère que le contexte du village est un déterminant important des objectifs des agriculteurs. Les résultats du BWS montrent qu'il y a une variation des objectifs entre les villages. Par exemple, les clusters les plus représentés à Ban DokKham sont le cluster « agriculteurs démunis » et le cluster « Uplanders » alors qu'à Ban Nadou c'est le cluster « Paddyiste ».

Les résultats de la restitution montrent que les objectifs ne sont pas les mêmes pour un même individu, en comparant au résultats révélés par le BWS . Il semble que la perception des objectifs et des choix change selon la manière par laquelle ils sont présentés. . Une explication de cette différence peut être la manière de présenter les objectifs. Certains groupes d'objectifs peuvent sembler plus positifs aux agriculteurs que d'autres. La différence de résultats entre les objectifs déclarés et révélés peut aussi être liée à un conformisme social. Lors des enquêtes individuelles avec les agriculteurs, il est apparu que pour la plupart d'entre eux la première réaction devant une nouveauté est de se conformer à la réaction des autres villageois.

Outre l'influence des autres villageois, on peut supposer que l'objectif d'un ménage est différent que celui évoqué par un seul des individus qui le composent. Il serait intéressant dans de futures études de réaliser une entrevue séparée, de l'épouse, du mari, puis des deux ensembles, et de comparer le choix de chaque individu, par celui qui est pris en commun

Il semble que même si les objectifs de l'enquête préliminaire sont divers, ils constituent tous un moyen de maximiser les revenus, il peut s'agir de petits revenus réguliers, mais aussi de réduire les dépenses ou d'avoir des revenus élevés ponctuellement. Une relation entre les objectifs des individus et le sexe n'apparaissait pas clairement au cours de la typologie en raison d'une surreprésentation des hommes interrogés. Au cours de la restitution des résultats, il nous a semblé par exemple que les protagonistes féminins sont plus susceptibles de se concentrer sur les petits revenus ponctuellement que les hommes. Comme nous connaissons l'organisation du travail parmi les HH des districts de Kham, ces choix peuvent être influencés par le travail généralement effectué par les épouses des ménages, comme l'artisanat ou l'élevage de volaille.

2. Perspectives

L'approche avec l'objectif des agriculteurs est un outil intéressant pour déterminer la décision du ménage. Il pourrait être utile d'étudier plus spécifiquement certains ménages afin de modéliser le processus décisionnel. Les groupes issus des résultats de la AFMD et du BWS vont permettre de sélectionner des exploitations-type afin de les modéliser. La fonction-objectifs sera écrite à l'aide des caractéristiques du cluster.

Cette approche également peut être également utilisée pour d'autres types de recherche, comme les questions de genre ; par exemple la perception des objectifs en fonction du genre.

Cette approche peut aussi être retenue pour déterminer si la décision du ménage ne peut être résumée qu'avec l'objectif de maximisation des revenus ou s'il existe d'autres objectifs émergeant des deux chefs de famille.

Conclusion

Notre étude avait pour ambition de connaitre la diversité de structure d'exploitations et des objectifs des agriculteurs dans 6 villages du district de Kham. Ce travail a été réalisé en trois parties : une partie typologie des exploitations, une partie basée sur les préférences et priorités des agriculteurs et une partie étudiant le lien entre typologie et objectifs. Les trois hypothèses de bases autour desquelles s'est articulé le mémoire sont les suivantes : 1) la diversité des exploitations est liée à leur structures, 2) il existe pour les agriculteurs une diversité d'objectifs dans une perspective de 5 ans, en dehors de la simple maximisation du revenu, et 3) il existe un lien entre structure de l'exploitation et objectifs.

Il nous aura fallu, dans un premier temps, enquêter sur la structure des exploitations afin pouvoir regrouper les exploitations par caractéristiques communes à l'aide de l'AFDM. Nous avons trouvé trois groupes de fermes distincts. Une partie de la population est relativement démunie et possède en moyenne moins de terrain, de bétail et de revenus. Une autre partie concentre ses activités et ses revenus dans la production de riz inondé. Un dernier groupe d'agriculteurs focalise sa production dans les terres hautes, produisant principalement du maïs, mais avec une tendance à convertir ces terres en pâturage. Ce dernier groupe se distingue aussi par le nombre de tête de bétail, supérieur à la moyenne et une plus grande propension à cultiver du *Canna indica*.

Nous avons ensuite cherché à connaitre la nature et évaluer l'importance des objectifs stratégiques des agriculteurs. La première étape a été de définir la nature même des objectifs, à l'aide d'un jeu de carte, représentant l'exploitation, auprès de 20 agriculteurs. La deuxième étape a consisté à connaitre les priorités des agriculteurs vis-à-vis des objectifs définis par l'étape 1. La méthode utilisée pour classer les objectifs se nomme le Best-Worst Scaling. Nous avons trouvé 7 objectifs différents, et dont le Best-Worst Scaling (BWS) auprès de 120 agriculteurs. Nous avons obtenu 4 groupes de priorités. Nous avons aussi croisé des indicateurs proches des objectifs afin de vérifier l'existence d'un lien entre les objectifs et des données socio-économiques. Les résultats n'ont pas montré de lien de manière significative.

Nous avons croisé les résultats du BWS avec ceux de la typologie pour voir si la structure de l'exploitations et les priorités stratégiques des agriculteurs. Nous avons aussi présenté les différents groupes d'objectifs à des agriculteurs déjà enquêtés. Le BWS avait déjà révélé le groupe auquel appartenaient ces agriculteurs, mais nous voulions confronter les résultats révélés et affirmés. Nous n'avons pas trouvé de relation entre la typologie et les objectifs stratégiques ; de plus il semble que la majorité des agriculteurs ne se reconnaissent pas dans le groupe révélé par le BWS.

Le but de ce travail est de contextualiser des exploitations afin d'avoir un ensemble de profils contrastés. Connaitre les objectifs des agriculteurs est un moyen de prévoir l'évolution de l'exploitation, en particulier face à des perturbations. Il semblerait compte tenu des résultats, que les agriculteurs cherchent tous à maximiser leur revenu ; mais par divers moyens. Il serait intéressant à l'avenir de connaitre les préférences en terme de systèmes de cultures afin de pouvoir modéliser l'évolution des exploitation compte tenu de leurs priorités.

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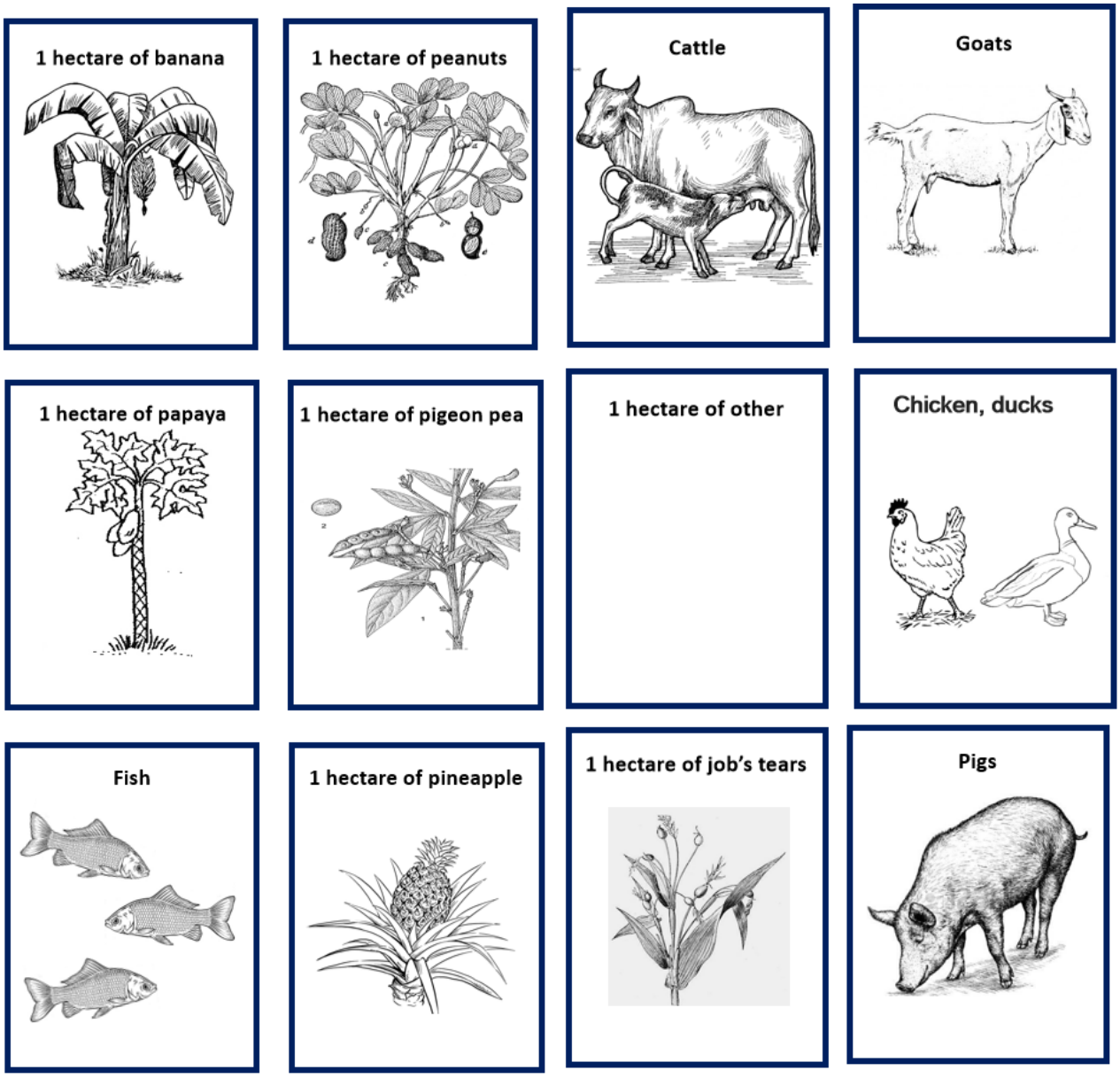
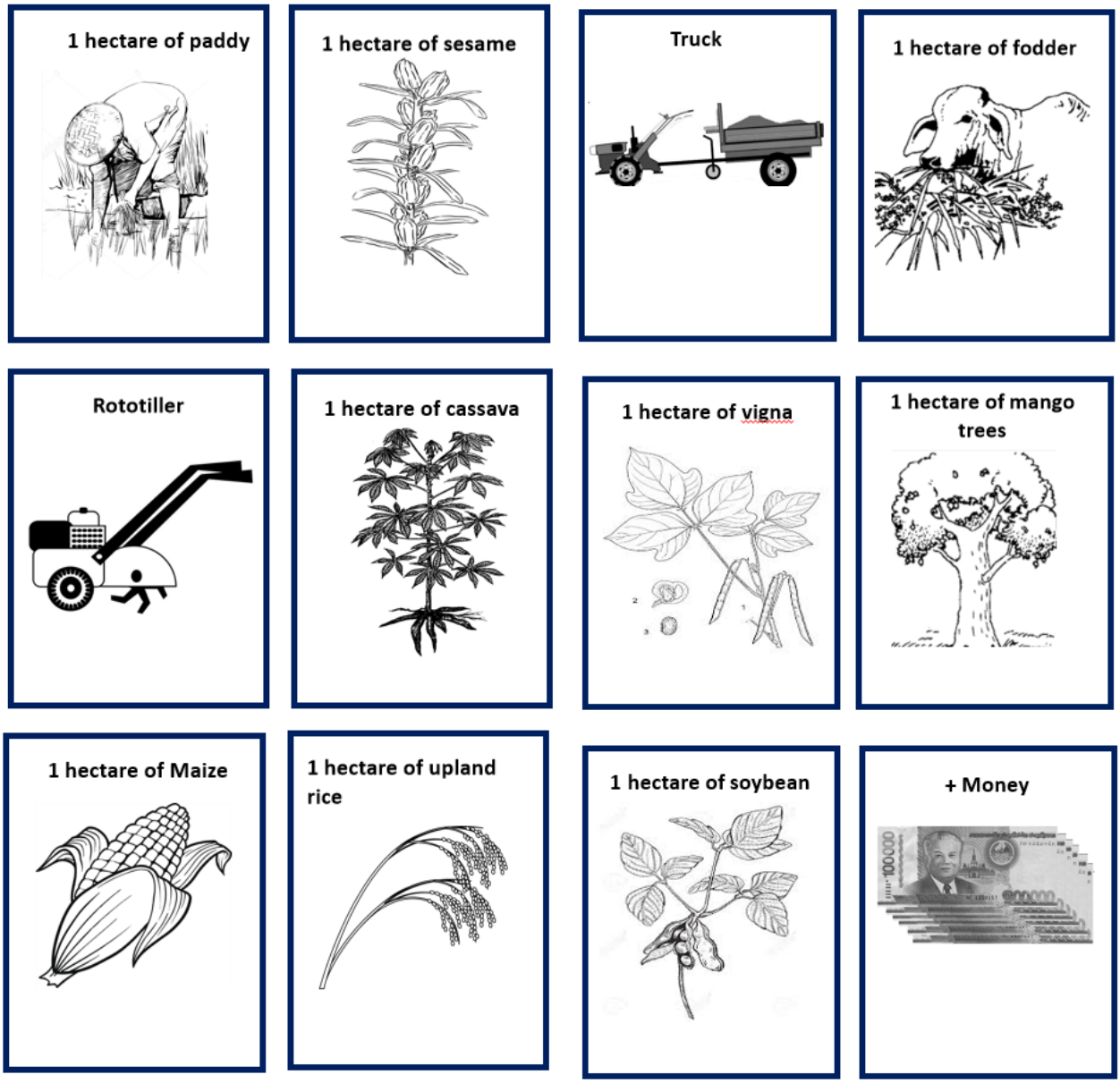
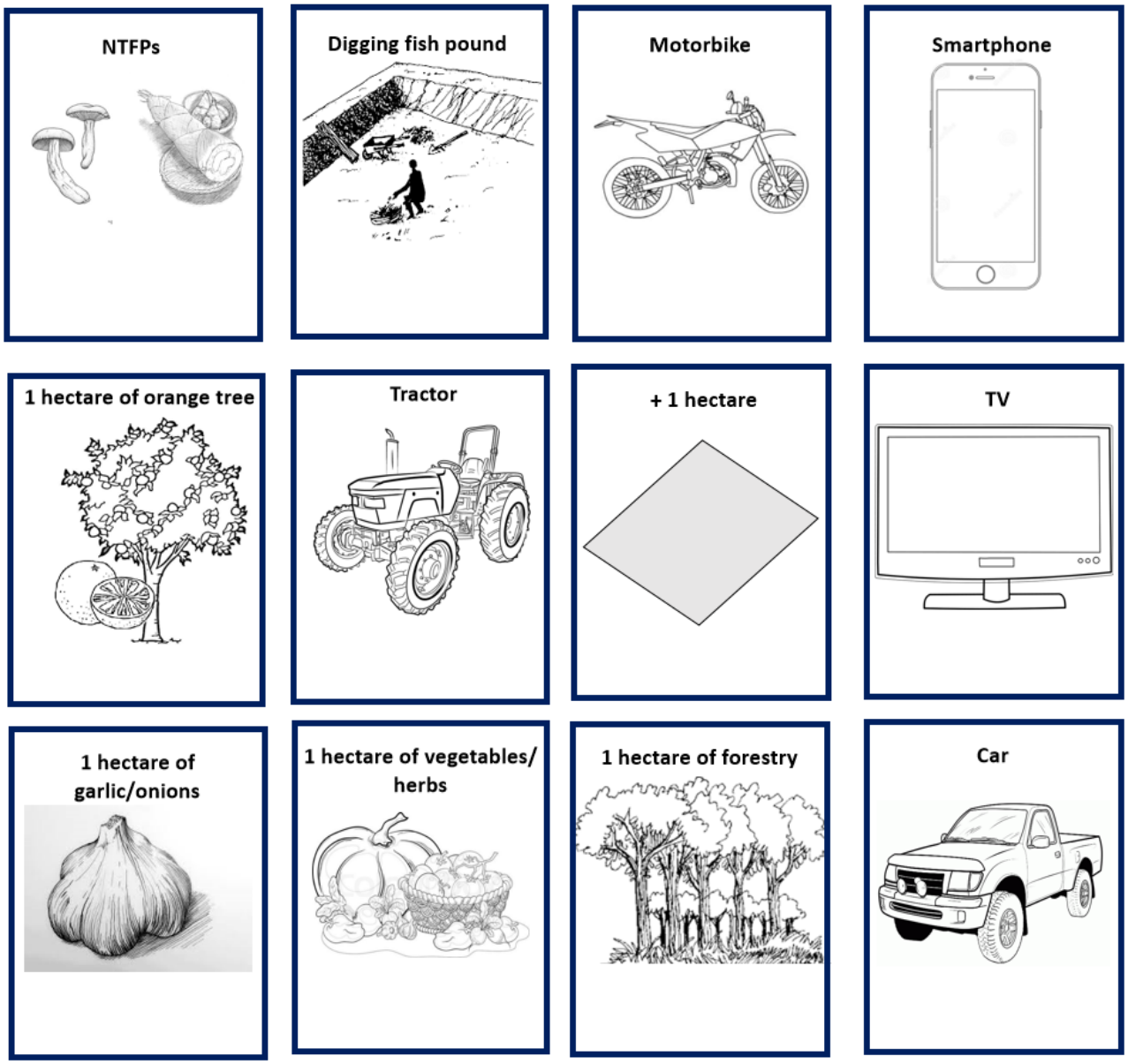
APPENDIX



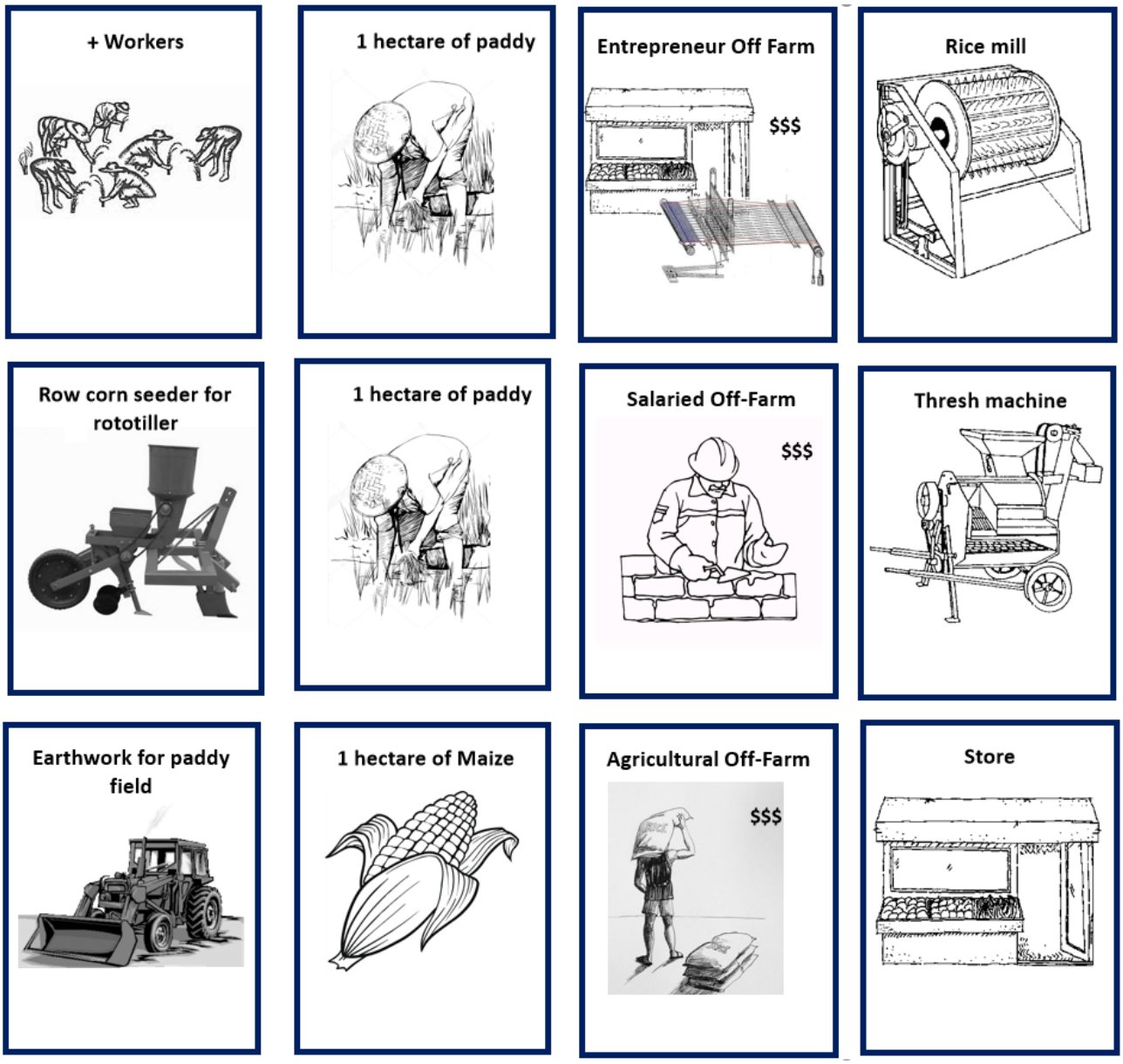
Appendix 1: Set of cards for the game



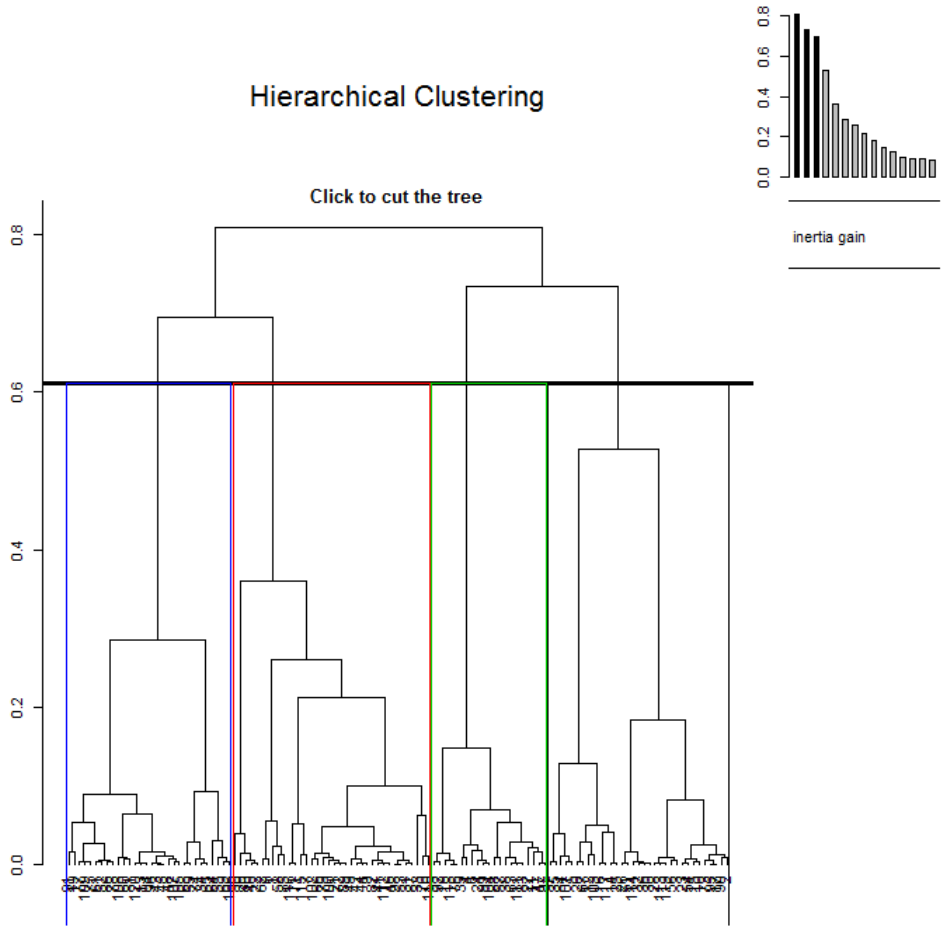
Appendix 2: Set of cards for the game



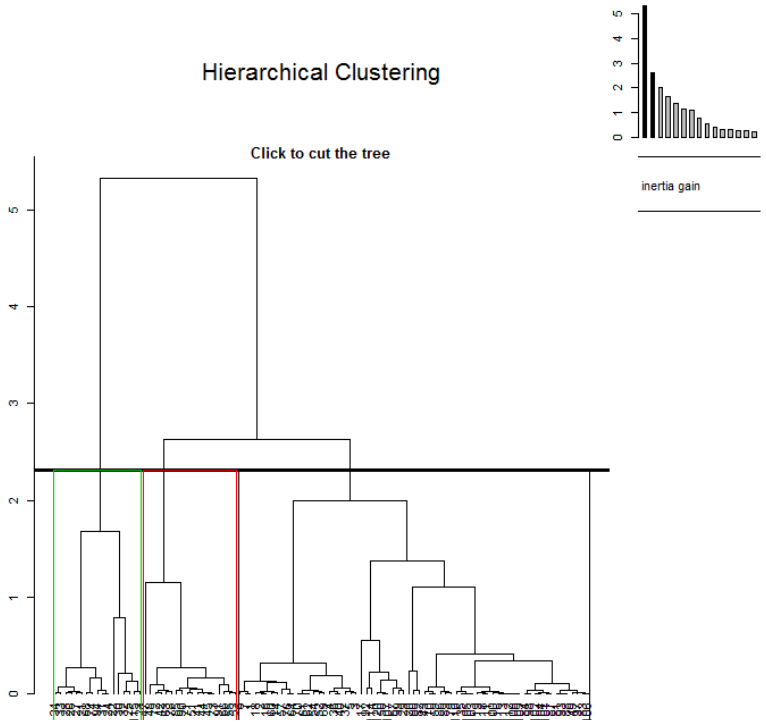
Appendix 3: Set of cards for the game



Appendix 4: Set of cards for the game



Appendix 5: Hierarchical clustering of the BWS



Appendix 6: hierachical clustering for the FAMD