Sustainable or conventional production? The influence of farmer demographic characteristics

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Abstract

Resource efficiency issues, environmental problems and socio-economic challenges resulted in an increased focus on sustainable production. At a European level, despite the policy incentives (i.e. CAP reform) and major investments on innovation – digitalization research for sustainability, the adoption of sustainable production practices remains low. Understanding the farmers' behaviour is of strategic importance to alter this state. To that end, we explored the demographic characteristics of farmers in an intensive agricultural area. We interviewed the entire set of the region's farmers that have adopted sustainable practices and a random sample of farmers practising conventional farming. The main results suggest that a high level of vocational training and practising farming as the main job are of fundamental importance towards adopting sustainable farm management practices. Further analysis also reveals the importance of the dynamics and interactions among farmers.
Keywords: sustainability, producers, farm management, vocational training,

clustering

1. Introduction

The global food system faces numerous challenges, yet contemporary agriculture fails to respond efficiently, for example, neither on feeding properly the increasing population (Godfray et al., 2010) nor on minimizing the environmental impact related to the production, processing and transportation of food (Foley et al., 2011). Within this context, alternative farm management systems have introduced novel cultivation techniques and procedures that could resolve -in the long run- most of these issues. Without any doubt, among the several sustainable production systems available organic farming and integrated farm management are the most acknowledged (Garibaldi et al., 2017). Both these systems are well known and adopted in the last three decades while growing evidence support their contribution towards a more sustainable production regime. Increasingly farmers globally are converting to a more sustainable way of farming; for instance, key facts about organic farming (the most sustainable practice available) support that the organic agricultural land from 11 million hectares in 1999 reached 50.9 in 2015, while the producers from 200.000 in 1999 reached 2.4 million in 2015 (Willer and Lernoud, 2017). Nonetheless, the same key figures indicate that the organic share of total agricultural land globally in 2015 was only 1.1 %.

In the direction of the adoption of more sustainable farm management practices, exploring the factors influencing the implementation of such practices is vital (Phondani et al., 2020). Similarly, the farmer's attitude toward sustainability also holds an important role (Khanpae et al., 2020). For example, understanding the behaviour of the producers about adopting (or not) a sustainable way of farming is essential towards a larger share of agricultural land under sustainable management (Riley, 2009, Etsay et al., 2019). A study about the environmental behaviour of farmers indicates different viewpoints towards natural resources (Walder and Kantelhardt, 2018). Several studies have detected a connection between farmer demographic characteristics and environmentally friendly behaviours, yet they have also often been found to be inconsistent or contradictory (Burton, 2014).

The objective of this paper is to further explore this complex issue. Thus, we designed a study in a highly intensive agricultural region researching the entire set of farmers that have adopted a sustainable practice and a similar random sample of conventional farmers. This way we captured the dynamics and interactions among farmers, a critical factor concerning their decision-making process about the adoption of farm management techniques (Anastasiadis and Poole, 2015).

2. Literature review

2.1 Towards sustainable production

Key elements for the EU in the development of sustainable production are to improve the impact of agriculture on biodiversity and climate change and to support young, small and medium-sized farmers in the sustainable development of the countryside. The EU agricultural policy has evolved considerably in recent decades to help farmers successfully meet new challenges and also to respond to the ever-changing consumer needs. Successive reforms have led farmers to now base their production decisions more on market demand than on decisions in Brussels. The latest reforms focus on the following: (a) more environmentally friendly farming practices; (b) research and dissemination of knowledge; (c) a fairer farmer support system; (d) enhanced position of farmers in the food chain (James, 2014).

Policy incentives such as Common Agricultural Policy (CAP) reform, point out that this is the direction (Buller and Hoggart, 2017). The CAP of the European Union is a dynamic policy, which, through successive reforms, has been adapted to the new challenges that European agriculture is facing. These challenges include the more sustainable use of natural resources, climate change, increased competition from world markets and the need to maintain rural areas throughout the EU flourishing. The CAP must continue to ensure sustainable production and a stable supply of food while considering food safety, the rural economy, animal welfare and various social and environmental issues.

The new CAP covers the period 2014-2020. This was the first time that the CAP reform was adopted under the ordinary legislative procedure, in the context of which the Council co-legislated with the European Parliament. The legislative texts were finally adopted by the Council on 16 December 2013. The reform came into force in January 2014. Many of the new rules weren't implemented until 2015 to give the Member States the necessary time to implement the new

policy and to inform and prepare farmers. The reform is fully in line with the fundamental principles of the common agricultural policy. These principles will continue to focus on providing sufficient supplies to consumers in the EU and globally, with safe and high-quality food at affordable prices. At the same time, the reform fully respects the EU's rules on animal welfare and the environment, while ensuring a satisfactory standard of living for European farmers (Martino and Muenzel, 2018).

The CAP reform includes the following: the ecological orientation of aid granted to agricultural holdings, including the introduction of environmentally sound farming practices such as crop diversification and the conservation of the ecologically rich landscape features and the minimum area of permanent pasture, greater equality in the distribution of aid to reduce the large disparities in the levels of income support received by farmers in the EU and reduce aid of above an amount for larger agricultural holdings to better target the income support for farmers that are most in need, especially young farmers, and farmers who operate in low-income areas and farmers in areas with natural constraints. The CAP remains organized in pillars. The first pillar includes income support and market management measures, while the second pillar covers rural development. The CAP budget for 2014-2020 accounts for about 38% of the total EU budget. The total amount of CAP spending for the next seven years amounts to €408.31 billion. The annual budget is expected to decline in the period from 2014 to 2020. At the level of commitments, the CAP budget in 2020 is projected to be reduced by about 15% compared to 2013 (Mili et al., 2017).

2.2 How farmers select production methods

The current generation of farmers combines the roles of the farmer, the rural manager and the entrepreneur. Reforms have turned farmers more towards the market. Some of them process the foods on their farm and sell them locally, boosting the agricultural economy. Farmers support their communities through agritourism, the creation of new businesses and cultural activities. At the same time, they help ensure a future for the next generations of farmers. Two-thirds of European farmers are now over 55 years old. The delivery of the baton to the next generation must be organized. The alternative scenario looks gloomy: abandoning the countryside, rapid population ageing and lack of new people in the sector. Realizing the importance of continuity, the CAP offers training and support to encourage young people to engage in agricultural activities. Today's CAP offers specific incentives for farmers to act as entrepreneurs, to sell their goods directly to the market and respond to market signals about supply and demand. They are free to determine their production according to their business plan and their opinion on consumer preferences. They can initiate new activities with the support of the CAP, such as the distribution of their products through their farms, i.e. crafts and cultural activities or village and agricultural rehabilitation projects and create new local jobs. These need not be directly linked to agriculture. The CAP is once again undergoing extensive reform. The aim is to adapt it to the requirements of 2020 and beyond. The main objectives are to achieve a more ecological, fair and efficient policy. European agriculture

needs to increase its competitiveness both economically and ecologically (Weaver et al., 2017).

A study with Austrian farmers (Darnhofer et al., 2005) highlights the reasons and constraints involved in their decision to use, or not to use, organic production techniques. Based on farmer's strategies and values, they suggest five types of farmers: the 'committed conventional', the 'pragmatic conventional', the 'environment-conscious but not organic', the 'pragmatic organic' and the 'committed organic'. These five types underline the importance of considering heterogeneity in farmers' attitudes, preferences and goals and their impact on the choice of farming method, yet there no insights regarding the influence of their sociodemographic status. The agricultural professionals hold a significant role in influencing farmers and therefore their understanding of farm management practices is vital for overall adoption. An analysis of several variables (e.g. knowledge; experience; education) suggests that professionals with increased organic knowledge and experience are more likely to think positively about organic farming. (Wheeler, 2008b, Wheeler, 2008a).

A comparison of the opinions and attitudes between organic and non-organic farmers in north-eastern Thailand indicated several factors influencing their decision towards organic rice farming systems, such as educational level, farm holding and extension worker contact and their farming experiences (Chouichom and Yamao, 2010). The early, medium and late adoption of organic farming are also significant, particularly concerning the farming intensity, age, information gathering as well as attitudes of the farmer (Läpple and Rensburg, 2011). A study about the driver and barriers to organic adoption among pragmatic conventional producers in Texas, compared to organic and conventional producers suggests that the formers focus more on an increase in revenue as a major facilitator of organic adoption (Constance and Choi, 2010). Another study in Michigan also highlighted that both organic and conventional farmers share a concern for the economic risks related to farming. However, organic farmers scored higher in awareness and concern for environmental issues of farming (McCann et al., 1997).

The factors that influence best management practices (BMPs) adoption by farmers, (Liu et al., 2018) based on a review of the findings of BMP adoption studies from both developed and developing countries, are: 1) Information and awareness; 2) Financial incentives; 3) Social norms; 4) Macro factors; 5) Farmers' demographics, knowledge, and attitudes; 6) Farmers' risk and time preferences and uncertainty; 7) Farmer's environmental consciousness; 8) Characteristics of farms; 9) Characteristics of BMPs; 10) Interactions among BMPs. Specifically, the fifth factor refers to Age; Gender (being female); Income and capital, and level of gross farm sales; Lifestyle (or hobby); The household life stage, history of family ownership of a landholding, family size and structure; Family member planning to take over the farm; Higher caste; Farmers' experience and education; Political views and socio-political beliefs. The numerous factors associated with BMPs -and as a result with the adoption of sustainable farming practices- illustrate the complexity of the topic under investigation.

3. Methodological approach

This section consists of two parts, the first is about the data due to the importance of the sampling and the data-set while the second is about the statistical analysis.

3.1 Data

Building on the outcome of the literature review, we further define the objective of this study. As presented in the previous section, the demographic characteristics of the farmers hold a significant role concerning their decision in adopting a more sustainable way of farming.

Tab. 1. *Descriptive statistics*

		N	%
Gender	Male	218	83,2%
	Female	44	16,8%
Age	<25	6	2,3%
	26-35	45	17,2%
	36-45	67	25,6%
	46-55	91	34,7%
	56-65	50	19,1%
	66>	3	1,1%
Family status	Single	52	19,8%
	Married	199	76,0%
	Other	11	4,2%
Children	None	59	22,5%
	One	54	20,6%
	Two	109	41,6%
	>=3	40	15,3%
Education	None	2	,8%
	Elementary	32	12,2%
	Middle school	61	23,3%
	High school	129	49,2%
	Technical	18	6,9%
	BSc	20	7,6%
Annual farm income	0 – 10.000 €	83	31,7%
	10.000 – 15.000 €	93	35,5%
	15.000 – 20.000 €	63	24,0%
	20.000 – 30.000 €	17	6,5%
	> 30.000 €	6	2,3%
Farm income's % in your total income	<25%	19	7,3%
	26 – 50%	39	14,9%
	> 50%	204	77,9%
Agricultural family	Yes	251	95,8%
	No	11	4,2%

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Farm management	Organic	42	16,0%
	Integrated	120	45,8%
	Conventional	100	38,2%

However, diverse and contradictory findings in the literature indicate that the exact way that demographics influence such a decision requires additional exploration. Therefore, the prime objective of this study is to investigate any associations between an extended list of demographics and the decision to adopt sustainable farming. Further researching these associations, a secondary objective is to classify farmers'

behaviour and respectively create profiles that provide insights on their decision-making process; responding this way on the issue of causality involved in the inconsistencies of previous studies on the topic (Burton, 2014).

Given the influence of the dynamics and interactions among farmers on the way they make critical decisions regarding their business, the objectives set above shall be explored under a prism that could capture such interdependences. To secure that, initially, we emphasized on the sampling process; selecting a whole region from a highly intensive agricultural area of Northern Greece. The sample includes the entire set of farmers that have adopted a sustainable practice (i.e. organic - integrated) and a similar random sample of conventional farmers – 262 farmers; key characteristics of our sample are presented in Table 1. Additionally, the questionnaire used to collect the data, on top of the well-known demographic questions/variables (e.g. age, income, education etc.) also includes elements concerning the collaboration and interactions among farmers (e.g. member in farmers groups).

3.2 Analysis

From a statistical analysis perspective, to address the prime objective - given the categorical nature of the data - we employed Pearson's chi-square test (Field, 2013) to see whether there is any relationship between 'farm management practice' and the demographic variables. Concerning the secondary objective, we have employed cluster analysis to group similar observations into several clusters based on the observed values of several variables for each individual (Hahs-Vaughn, 2017).

4. Results and discussion

In addition to the descriptive statistics presented above (Table 1), 85.1% of the sample declared as professional farmers while 77.9% specified that more than half of their income is from agriculture, 56.9% stated that they are members of a farmer's group and 67.2% that have attended at least one course of vocational training (e.g. seminars). The results above are consistent with previous publications on relevant topics in the same area (Aggelopoulos et al., 2009, Papadopoulos et al., 2015), suggesting representative sample and data collection process.

4.1 Relationships

Addressing the main objective of the study, we run numerous chi-square tests between the 'farm management practice' and the demographic variables, using SPSS v25. The summary of those having a significant association (i.e. p-value < 0.005) is presented in Table 2 below.

Tab. 2. *Summary of significant chi-square results*

		Farm Management Practice						
		Sustainable		Conventional				
		N	%	N	%	Pearson X^2	df	p
Member of Farmers Group	No	138		11		138.735	1	.000
	Yes	24		89				

Farm Income %	< 25%	3	16	18.436	2	.000
	26 – 50%	25	14			
	> 51%	134	70			
Professional Farmer	Yes	151	72	21.954	1	.000
	No	11	28			
Vocational Training	Yes	131	45	36.068	1	.000
	No	31	55			

The results suggest that: (i) membership in farmers' group, (ii) farm income, (iii) professional farming (i.e. practising farming as the main job) and (iv) vocational training are associated, one or another way, with the decision to adopt a more sustainable way of farming. Moreover, the significance of the first three variables highlights the importance of the dynamics and interactions among farmers on the way they make essential entrepreneurial decisions.

4.2 Clusters

We used the significant variables identified above (see Table 2), employing a Two-step clustering algorithm in SPSS v25, to create farmers' profiles that could shed more light on their decision to adopt or not a more sustainable way of farming. In two-step clustering, all variables, regardless of measurement scale, are considered simultaneously and the importance of each clustering variable to the cluster is computed (Hahs-Vaughn, 2017). Among the numerous sets of clusters created, we have selected the one with the strongest statistics i.e. having a Good (>0.5) '*Silhouette measure of cohesion and separation*' and having 1.11 (<2) '*Ratio of sizes: Largest cluster to smallest cluster*' (Norusis, 2008). The selected classification set consist of two clusters, the largest with 138 (52.7%) farmers and the smallest with 124 (47.3%) farmers (see clustering statistics in Annex).

Tab. 3. *Two-step clustering output*

	Cluster 1 *N=124 (47.3%)*	**Cluster 2** *N=138 (52.7%)*
Members of farmers group	**Yes** (91.1%)	**No** (100.0%)
Farm Management Practice	**Conventional** (80.6%)	**Sustainable** (100.0%)
Vocational training	**No** (50.8%)	**Yes** (83.3%)
Professional farmer	**Yes** (75.0%)	**Yes** (94.4%)
Farm income %	**>50%** (69.4%)	**>50%** (85.5%)

The key characteristics of every cluster - as presented in Table 3 - suggest that the first cluster consists of farmers that: practice conventional agricultural methods; are

members of a farmers group; have not attended vocational training; they state to be professional farmers; more than half of their income comes from agriculture. While the second cluster consists of farmers that: practice sustainable agricultural methods; are not members of a farmers group; have attended vocational training; they state to be professional farmers; more than half of their income comes from agriculture.

The alignment with the group's mentality and the fact that they are not so keen on training neither on "new" farm management practices suggest labelling Cluster 1 as *Conservative Farmers*. On the other hand, the commitment to sustainable farming (i.e. a new/alternative management practice), the inclination towards further training and the detachment from group-initiatives indicates labelling Cluster 2 as *Alternative Farmers*. It is worth highlighting the vocational training one as the differentiating factor since 83.3% of the *Alternative Farmers* have attended at least one agricultural-related seminar. To make this point even stronger we should consider that the specific cluster consists exclusively (100%) of farmers applying sustainable practices. The agreement under the 'professional farmer' and 'farm income' variables in both groups confirms that all the participants have farming as their main job. However, the major difference concerning the farmers' group membership reveals the importance of the dynamics and interactions among farmers. Given that the predominate farming practice is the conventional one, the fact almost all the *Conservative Farmers* (Yes:91.1%) participate in a farmer's group indicates a strong influence of the established "decision" of the majority not to convert to alternative and sustainable farming practices. Additionally, the fact that none of the *Alternative Farmers* (No:100%) participate in a farmer's group suggests a more open-minded mentality.

5. Conclusions

Moving towards sustainable production and more environmentally friendly farm management practice is without question one of the key goals at EU and global level. Towards that direction, understanding farmers' decision-making mechanism about selecting conventional or sustainable farm management practises is of strategic importance. The contribution of the current study in this complex issue relies on the acknowledgement of the dynamics and interactions among farmers regarding any final decision about their selected farm management practice. To that end, we have designed our study selecting as a sample the entire population of farmers that have adopted a sustainable practice (i.e. organic - integrated) and a similar random sample of conventional farmers, capturing this way their interactions.

The key findings underlined, among others, the level of vocational training as a dominant factor influencing the adoption of sustainable practice, which is consistent with previous studies globally (Aggelopoulos et al., 2009, Papadopoulos et al., 2015, Zhao et al., 2019). However, further analysis revealed a far more interesting factor: the importance of the dynamics and interactions among farmers regarding their decision-making mechanism. Specifically, our study highlighted that a high level of involvement in a farmers group seems to indicate an alignment of the individual member with the group's collective mentality. Given the sampling technique of this work, the added value behind the mechanism connecting individual and collective mentality is significantly greater. From a scientific perspective, analysing the entire population of farmers that have adopted a sustainable practice strengthen both the validity and applicability of our findings.

The implication of these findings could be at both managerial and policy-making level. Regarding the former, the main implication is improving the sustainability

performance of the entire supply chain by engaging the production-related stakeholders in sustainable practices. Furthermore, the alignment of the individual member with the group's collective mentality could be extremely useful in applying several best practices at a supply chain level towards improving its overall efficiency. From a policy-making perspective, a major implication is designing targeted training programs (about sustainable practices) on farmers groups. For example, this could be exploited in the direction of the EU's recent financial plan for moving to a green economy and achieving carbon neutrality in the European Union by 2050 (IOE&IT, 2020). Similarly, investing in sustainability skills vocational training is in line with a report by the European Court of Auditors that suggests that the European Commission should present a new action plan for monitoring the environmental performance of the Common Agricultural Policy (Guerra, 2020). Nevertheless, the main limitation of the study, that confines any generalization of the result in a broader context, is that it covers only a specific region in Greece. Thus, future research should replicate the study in other regions and countries to verify and probably expand the findings.

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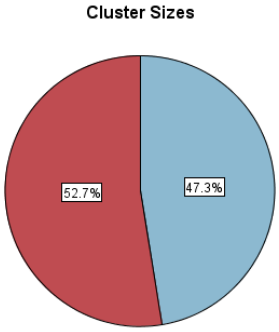
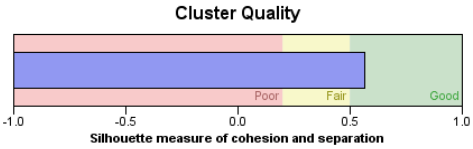
Annex – Clustering statistics

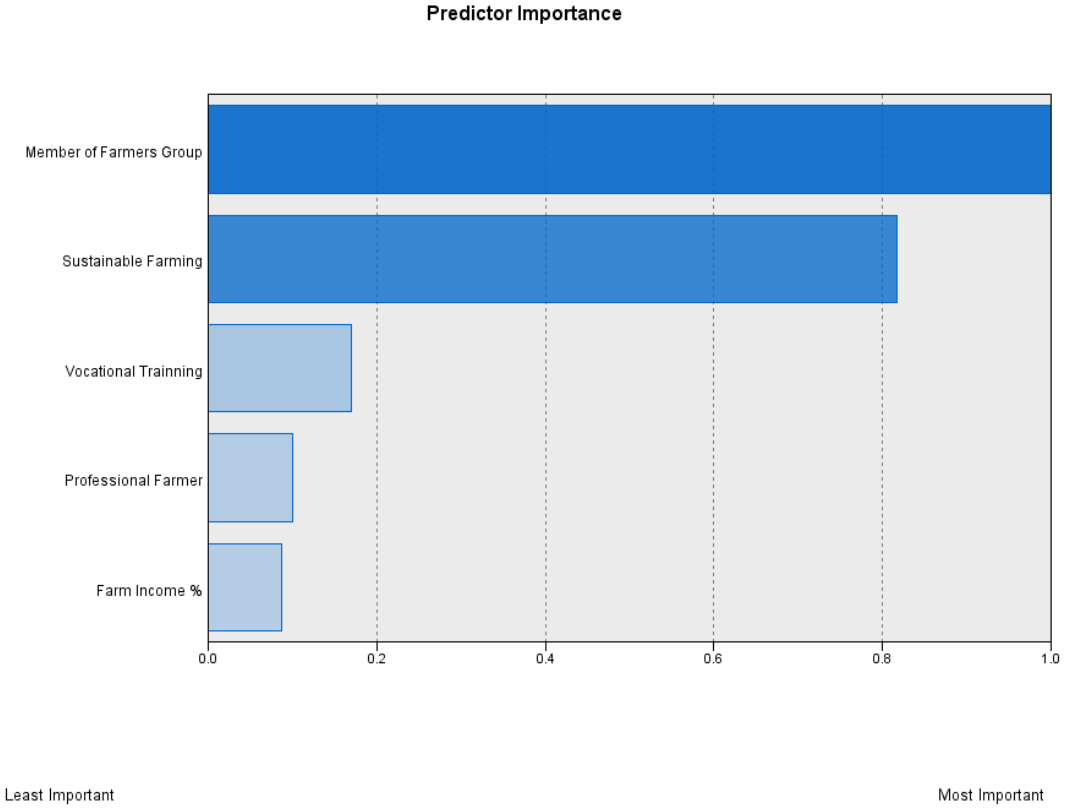


Model Summary

Algorithm	TwoStep
Inputs	5
Clusters	2



Size of Smallest Cluster	124 (47.3%)
Size of Largest Cluster	138 (52.7%)
Ratio of Sizes: Largest Cluster to Smallest Cluster	1.11

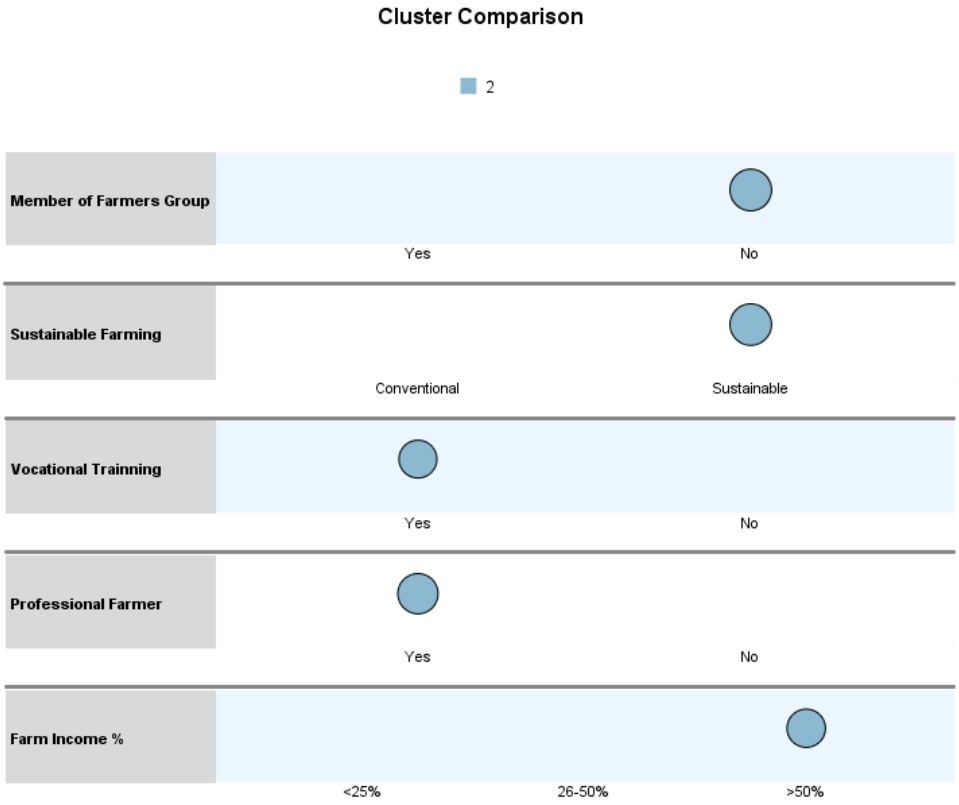


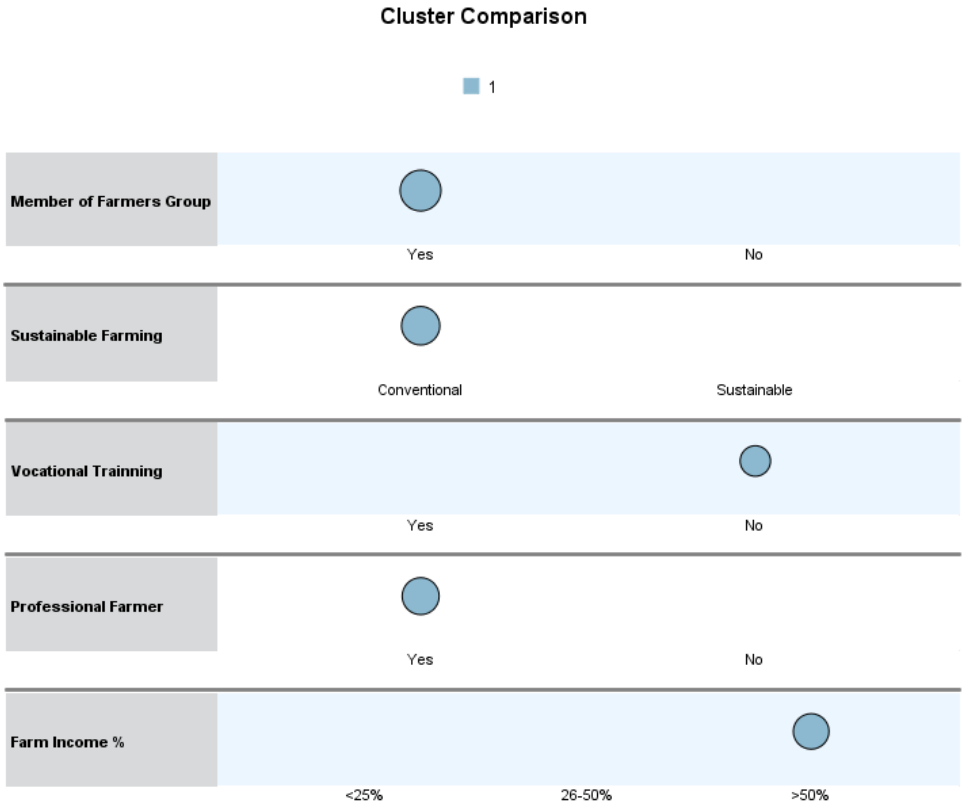
Clusters

Input (Predictor) Importance

1.0 0.8 0.6 0.4 0.2 0.0

Cluster	2	1
Label		
Description		
Size	52.7% (138)	47.3% (124)
Inputs	Member of Farmers Group No (100.0%)	Member of Farmers Group Yes (91.1%)
	Sustainable Farming Sustainable (100.0%)	Sustainable Farming Conventional (80.6%)
	Vocational Trainning Yes (83.3%)	Vocational Trainning No (50.8%)
	Professional Farmer Yes (94.2%)	Professional Farmer Yes (75.0%)
	Farm Income % >50% (85.5%)	Farm Income % >50% (69.4%)


Cluster Comparison
2
Member of Farmers Group
Yes
No
Sustainable Farming
Conventional
Sustainable
Vocational Trainning
Yes
No
Professional Farmer
Yes
No
Farm Income %
<25%
26-50%
>50%


Cluster Comparison
1
Member of Farmers Group
Yes
No
Sustainable Farming
Conventional
Sustainable
Vocational Trainning
Yes
No
Professional Farmer
Yes
No
Farm Income %
<25%
26-50%
>50%