Innovation at Rural Enterprises: Results from a Survey of German Organic and Conventional Farmers

Unay Gailhard, ilkay and Bavorova, Miroslava

Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Institute of Agriculture and Nutrition Science, Martin Luther University

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Innovation at Rural Enterprises:
Results from a Survey of German Organic and Conventional Farmers[1]

İlkay Unay Gailhard[2]* and Miroslava Bavorova†

*Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Halle, Germany
†Institute of Agriculture and Nutrition Science, Martin Luther University, Halle, Germany

Abstract: The purpose of this study is to examine the influence of interpersonal networks and other information sources on the innovativeness of farmers. This understanding can be useful for organizations that are involved in extension work that aims to increase the farmers' innovativeness and/or farmers who aim to be more innovative. The study focuses on two types of farmers' network ties: friendship ties (ties to other farmers) and affiliation ties (ties to associations). Additionally, the importance of information gathered by farmers from interpersonal sources and from media is compared. We collected data within the EU-funded FOODIMA project using face-to-face interviews. Our sample, which consists of 72 farmers (organic and conventional) in Germany, was used to map farmers' innovativeness (number of innovations adopted). We use the logit and OLS regression models to find out if the structure and strength of network ties can be used as predictors of innovativeness for organic and conventional farmers. When considering both the friendship and affiliation ties, the main results show that organic farmers who communicate more frequently with other farmers are more likely to be highly innovative. The large network size indicates low innovativeness on the part of organic farmers. Membership in at least one association is positively interconnected with high innovativeness of conventional farmers. Regarding information sources, the results indicate that highly innovative farmers appreciate information from research institutes more—and information from agricultural organization less—than less innovative farmers.

Key Words: Innovativeness, social network ties, communication frequency, information sources, organic and conventional farmers

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[2] Corresponding author address is Leibniz Institute of Agricultural Development in Transition Economies (IAMO), Theodor-Lieser-Str. 2 D-06120 Halle (Saale), Germany , Phone +49(0)345-292 83 22 and email : unaygailhard@iamo.de. I certify that I have the right to deposit the contribution with MPRA.

1. Introduction

The importance of knowledge and information exchange in the innovation process has been acknowledged by sociological and economical researchers, as well as by EU policy decision makers. Policy measures such as supporting the development of Agricultural Knowledge and Innovation Systems (AKIS) were introduced in the last decade in the EU. AKIS is defined as "a concept to describe a coherent system of innovation, with emphasis on the organizations involved, the mutual links and the many interactions between them, including the institutional infrastructure with its incentives and its budget mechanisms," (47). Governmental intervention in innovation processes is justified, as innovations not only benefit those who innovate, but also produce positive externalities such as more jobs and higher incomes or safer working conditions. Since investors in innovation do not take these external effects into consideration, it can lead to underinvestment. Moreover, policy instruments in the field of innovation can mitigate negative external effects such as environmental pollution in agriculture and food production.

In preparation for the EU Common Agricultural Policy for 2014-2020, the Coordination Committee's Focus Group (FG) on Knowledge Transfer and Innovation (KT&I) was established with the aim to provide recommendations to Member States about how to promote KT&I in the next programming period. Using case studies within the EU countries, the KT&I focus group identified the following actors as being involved in the innovation process: farmers and their organizations; agri-food businesses; research institutes and/or universities; formal or informal networks; national rural networks; public or regional administrations; and local action groups (47). Knowledge transfer between partners is identified as a precondition or a significant part of the innovation process. Knowledge transfer in particular makes identifying innovation opportunities possible.

The importance of intermediates (e.g. networks, associations) for innovation diffusion is stressed in the literature. As shown in the study by Bokelmann et al. (42), the food supply chain actors in Germany highly appreciate the economic independence of such platforms. This independence creates trust and diminishes risk considering the trustworthiness of information and implementation of recommendations. Using primarily qualitative research methods, Bokelmann et al. (42) stress the positive role of networks in the innovation process and recommend their professionalization and support by policy. On the other hand, the

authors, like some other experts, assess the role of producers' interest representing associations as structure-conserving, and thus as rather unimportant in the innovation process. Membership in an association, however, is seen as increasing the social network and thus the social capital of its members. Higher level of social capital is connected with an increasing probability of innovation adoption (31).

These inconsistencies show that further research is needed to increase the understanding of the linkages between network ties and innovation diffusion. The purpose of this study is to examine the influence of interpersonal networks and other information sources on the innovativeness of farmers. This understanding can be useful for farmers who aim to be more innovative and/or for farmers' organizations that are involved in extension work that aims to increase farmers' level innovativeness.

This study's focus is twofold: firstly, the study examines whether interpersonal network ties' attributes are associated with the number of innovations (innovativeness) adopted by farmers. Secondly, the paper proposes a means of measuring the importance of interpersonal information sources for farmers, and investigates factors that influence the farmers' perception of interpersonal sources such as agricultural organizations, research institutes and extension agents. By comparing the results of organic and conventional farmers, the study contributes to the general understanding of innovation adoption behavior in various network structures. As such, we seek to answer the following questions:

1. Does interpersonal network ties' structure and strength influence the innovativeness of organic and conventional farmers, respectively?
2. How do farmers evaluate the importance of interpersonal and media information sources in the innovation adoption process? Are there differences in the evaluation of importance of sources between organic and conventional farmers?
3. What are the determining factors that cause a change in the farmers' perception of the importance of interpersonal sources?

In an effort to answer these questions, we use diffusion and decision-based theoretic models on innovation adoption. The most often used models are the logit and the probit discrete choice models. These models of adoption assume that a decision to adopt or not to adopt an innovation at a specific time is the outcome of profit-maximizing behavior. Heterogeneity among potential adopters determines the decision to adopt or abstain.

In this paper we use the logit model and OLS regression to investigate how farmers' communication/contact frequency with neighborhood farmers (friendship ties) and farmers' associations (affiliation ties) influence innovativeness, expressed as number of innovations implemented. We also consider other factors—like farmers and farm attributes—that influence the probability of innovation adoption for both organic and conventional farmers. Furthermore, we investigate whether farmers assign more importance to interpersonal information sources or to information from the media.

The study is divided into five sections. In the following section, besides the definition of the concept of innovativeness, a literature review on social networks and the farmers' interpersonal sources provide our theoretical framework. The third section details the utilized FOODIMA data-set and methodology. In the fourth section, our results are presented in two subsections: regression results from the degree of innovativeness models, and interpersonal sources analysis. In the last section, we discuss the results of the proposed models and derive implications.

2. Literature Review

Definitions

Innovations are commonly defined as the successful exploitation of creative ideas. Innovations are considered an engine of firms' competitiveness, and thus as a driver of economic development. We use the term of innovation according to the "Guidelines for Collecting and Interpreting Innovation Data," (43 p. 46)), where innovation is defined as follows: "An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organisation or external relations…The minimum requirement for an innovation is that the product, process, marketing method or organisational method must be new (or significantly improved) to the firm. This includes products, processes and methods that firms are the first to develop and those that have been adopted from other firms or organizations," (47).

Innovativeness is defined as ". . . the notion of openness to new ideas as an aspect of a firm's culture," (15, p. 44). In a small firm, innovativeness implies the willingness of the owner to

learn about and adopt innovations, both in the input and output markets (28). In this study, we measure the innovativeness of a farm as the number of innovations introduced during the previous 20 years.

Innovation diffusion is defined by Valente (29) as the "spread of new ideas, opinions, or products throughout a society, thus diffusion is a communication process in which adopters persuade those who have not yet adopted to adopt."

Knowledge is the main source of innovation, and is one of the most valuable assets of an organization (12, 16). Indeed, knowledge can be transferred between actors through interpersonal communication. We identify the term *interpersonal communication* as a "process of message transaction or transmission between people to create and sustain shared meaning," (40, p.10) which occurs when synchronized exchange between the communicating parties takes place. The parties not only interact at the same time, but also at the same place (35, p.196). Communication can take the form of bilateral communication, group meetings, and discussions (35, p.196).

The fact that some farmers first declined to adopt and then later decided to adopt can be explained by interpersonal influence. Interpersonal influence is defined by Cartwright (45, p.3) as the "modification of one person responses by the action of another." A number of studies were published analyzing who influences whom within the community on innovation adoption (1, 24; 29, 52). Cobbenhagen (33) argues that successful innovative enterprises are more externally-oriented and deal more proactively with externally-developed knowledge than do their competitors who follow innovation. A wealth of human and social capital, networking, supportive knowledge and communication infrastructure all contribute to novelty production (30).

Social networks, friendship ties and affiliation ties

In the field of innovation adoption, there is an increasing number of studies using the network approach that recognize the importance of social networks, particularly the influence of interpersonal communication channels, on farmers' behavior (2, 5, 14, 17, 33).

To clarify the importance of contact in an interpersonal network, aside from the network approach, studies on social capital investigate factors that influence a farmer's decisions (18, 23, 32). For example, Coleman (6 p. 98.) comments on the allocation of social capital thusly:

"Unlike other forms of capital, social capital inheres in the structure of relations between actors and among actors." Further, his description of the function of social capital is: "Like other forms of capital, social capital is productive, making possible the achievement of certain ends that in its absence would not be possible." Social capital is assumed to lower transaction costs and to influence farmers' behavior (21).

In our study we distinguish between friendship ties and affiliation ties. Friendship ties are ties to other farmers, whereas affiliation ties are to farmers' associations. Friendship ties are quantified using the concept of connectedness, where *connectedness "*is the degree to which the focal individual is linked to others. It is the size of the personal communication network measured in terms of the number of individuals reported by the farmer to be directly communicated with while making decisions on important farming matters," (31, based on 38 pp. 225-226). In this study, we measure connectedness by the number of farmers that the considered farmer communicates with regularly on agricultural topics. Since connectedness represents the number of sources of information on new or novel farming ideas, Warruber and Moul (31) hypothesize it to be positively related to the likelihood of innovation adoption. This hypothesis is supported by the findings of Diederen et al. (7), who studied the influence of intensity of the stream of external information a farmer is exposed to regarding innovation adoption. The intensity measure was the number of agricultural co-operative initiatives a farmer is a member of. These authors find that for Dutch farmers, the more farmers are involved in agricultural co-operative networks, the more likely they are to be early adopters of innovations.

Affiliation ties are measured by affiliation/non-affiliation to farmers' associations. Research on innovation diffusion in rural areas has shown that farmers' participation in organizations is an important determining factor for the adoption of different kinds of innovations (48). On the other hand, Bokelmann et al. (42) conclude from their investigation in Germany that interest-representing associations are rather unimportant in the innovation process.

A number of studies stress the important role of repeated collaboration and contact frequency between network actors to increase innovativeness (4, 13, 20, 46). Monge et al. (49) indicate that farmers who have high frequent conversations on technological changes in their network are more likely to adopt new knowledge and technology relative to other farmers. In the social

capital literature, participation frequency in agricultural organizations is the important variable that indicates a higher level of social capital (27, 53).

Organic and conventional farmers' interpersonal networks differences

In order to contribute to understanding the drivers of both the conventional and organic farmers' innovation behavior, we compare factors influencing adoption behavior between these two groups of farmers. We especially consider these groups' interpersonal networks, their contact frequency and the influence of these networks on innovativeness.

Two types of ties are distinguished in the theory; weak ties and strong ties (10). Weak ties maintain a higher variety of information flow between network actors, while strong ties increase the probability of information flow. Tie strength research based on Granovetter's theory uses different proxies of strength such as communication reciprocity (8), closeness of relationships (3), or interaction frequency (10, 50, 54). Similarly, in our study we use communication frequency with other farmers and participation frequency in agricultural organizations meetings as proxies of tie strength. The higher the communication or participation frequency, the stronger are the ties. From exploratory empirical analyses it seems that strong ties favor exploitation and weak ties favor exploration. But additional evidence and deep theorizing on this and other connected issues are needed (16). In our study, we test the following hypothesis.

Studies show that organic farmers have strong ties in their interpersonal networks even over long distances (25). These farmers build relatively close networks, which is difficult for newcomers to enter (19). As other studies show, a similarity of backgrounds and attitudes and the strong attraction felt by network members may diminish the innovation adoption (31, for which "weak" ties of dissimilar others in the network may be more effective (11). These findings support Bokelmann et al. (42), who found that the interaction of farmers in smaller networks develops trustful relationships, which, however, can lead to separation from other actors and new technologies (42).

Information sources

In addition to the influence of communication frequency in interpersonal network and the characteristics of informal network actors, innovation adoption behavior analysis also

considers the validation of interpersonal sources by farmers (9, 22). We distinguish between interpersonal sources and media.

A survey carried out in 2008 by Hensche et al. (44) in Mecklenburg-Vorpommern, Germany, of 66 farm managers identified farmers' professional magazines as the most important information source on agricultural issues; 82 % of respondents use them often, while the others use them occasionally. Considering the interpersonal sources, the important information sources are a farmer's supplier, buyer and consultants, and other farmers. Further, 43 % of farm managers use information from other farmers' often, while 57 % do so occasionally.

The usefulness of personal sources and media as sources of information for commercial farms were examined for the U.S. in 1998 (9), with 1,742 farms participating in the survey. Possible factors influencing attitudes toward information sources were identified from the literature and tested. The results show that general farm magazines were one of the most useful information sources. In the case of interpersonal sources, 54.4 % of farmers find other farmers at least often useful. The probability that farmers perceived this source often or always useful declined as age increased.

In our study we test factors influencing the probability of using personal sources or media for information searches. We test whether information sources used differ between organic farmers and conventional farmers, as well as between low innovators and high innovators. Based on the literature review, we deduced seven hypotheses on farmers' innovativeness.

Hypothesis:

Strength of Interpersonal Ties:

H1: Having strong friendship ties indicates lower innovativeness of farmers.

H2: Having strong affiliation ties indicates higher innovativeness of farmers.

Degree of Innovativeness:

H3: Farmers who communicate with their peers more frequently are more likely to be highly innovative.

H4: Farmers who have a large network size (connectedness) are more likely to be highly innovative.

H5: Farmers who participate in agricultural organizations' events more frequently are more likely to be highly innovative.

H6: Farmers who are attached to at least one agricultural organization are more likely to be highly innovative.

Interpersonal Information Sources:

H7: Highly innovative farmers valuate interpersonal information sources more than less innovative farmers.

3. Data and Methodology

The dataset used for the analysis consists of 72 cereal farmers located in Central Germany. The data were collected in 2008 during face-to-face interviews with farm managers within the EU-funded FOODIMA Project (EU Food Industry Dynamics and Methodological Advances). Two types of farmers—organic (n=52) and conventional (n=20)—are surveyed in order to capture the innovation adoption behavior. The survey provides information on innovation adoption, farms' and farmers' characteristics, interpersonal communication network relations (formal and informal network), and importance of sources of information on agricultural issues. Descriptive statistics for two study groups of organic and conventional farmers are reported in Table 1.

Table 1: Descriptive Statistics

Degree of Innovativeness

The first dependent variable, degree of innovativeness of farmers, was developed from the part of a questionnaire on innovation adoption capacity. Each respondent was asked to provide detailed information on innovations adopted on their farm over the previous 20 years. Indicated innovations were classified according to Community Innovation Survey's (CIS) definition of innovation in the OSLO manual innovation measurement framework (43).

CIS differentiates between four kinds of innovation: product innovation, process innovation, organizational innovation, and marketing innovation. Product innovation is the market introduction of a new good or service, or a significantly improved good or service with respect to its capabilities. Process innovation is the implementation of a new or significantly improved production technology or production process, or distribution method. In the survey

we did not observe any innovation adoption that could be classified as organizational innovation defined as the implementation of new or significant changes in enterprise structure or management methods. A marketing innovation is the implementation of new or significantly changed sales methods used to increase the appeal of the enterprise's goods and services or to enter new markets. Table 2 gives some examples of cited innovations by surveyed farmers.

Table 2: Examples of Cited Innovation by Surveyed Farmers

Due to the low number of cited products and marketing innovations, in the regression models, the sum of the four major types of innovation are used as the dependent variable that shows total innovation activity of farms (Table 1). More precisely, we used the sum of cited innovations that are calculated as the types of innovation, where value 0 = none of the four major types of innovation are implemented, and 1 = one of the major types of innovation is implemented, etc. As seen in Table 1, the max. value is 6 for conventional and 5 for organic farmers. The average values of 1.84 for organic and 2.4 for conventional farmers indicate that the innovativeness of organic farmers was lower than the conventional farmers over the examined period (1988-2008).

The degree of innovativeness model is based on the literature that concerns the enterprises' innovativeness as its past investments in innovation activities (15, 41). We define innovativeness as an operationalized number of new ideas that had been adapted by the organization (15). Additionally, in the model we do not explicitly consider the costs of innovation activity (26, 51). Farms' innovation activity is examined in terms of number of adopted innovative projects, which was already calculated as an innovation adoption from the farmers' perspective. We separated farms into two degree of innovativeness categories by clustering a total innovation activity variable. The cluster analysis led us to divide our sample into two groups: low degree of innovativeness (sum of cited innovations are less than 2 and equal to 2; this holds for 52 farms) and high degree of innovativeness (sum of cited innovations are more than 2; this holds for 20 farms). Table 1 shows the degree of innovativeness variable within the division of organic and conventional farmer samples. The average value, 0.27 for organic and 0.49 for conventional farmers, shows that 27 % of organic and 49 % of conventional farmers are involved in the high degree of innovativeness cluster.

We conducted regression analysis (logit regression for the organic and entire sample; ordinary least squares (OLS) regression for the conventional farmer sample) when testing our hypotheses on the degree of innovativeness. Logistic regression estimates the probability of an outcome. Dependent variables are coded as binary variables with a value of 1 representing the occurrence of a targeted outcome, and a 0 value representing the absence of a targeted outcome.

OLS can be used to model the binary variables in linear probability models (36 p 6). Both models can be constructed with continuous, ordinal and categorical independent variables.

The general logit regression model is

$$logit(p) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k$$

where $(\beta_0 \ldots \beta_k)$ are maximum likelihood estimates of the logistic regression coefficients, and the X_s are vectors of the values for the independent variables. In our model, degree of innovativeness is a binary variable measuring the innovation adoption behavior of farmers. Coding $Y_i = 1$ if case i is a farmer involved in a high degree of innovativeness cluster, and 0 otherwise, then let P_i= the probability that Y_i= 1.

Interpersonal Network

Two dimensions of interpersonal communication ties were created by grouping network ties under friendship and affiliation ties. Friendship ties were measured by communication frequency with other farmers, number of frequently communicated farmers (network size) and characteristics of regularly communicated farmers. Affiliation ties were measured by membership status of farmers and participation frequency to agricultural organizations (Table 1).

A large part of the survey questionnaire was devoted to the farmers' interpersonal communication network. Farmers were asked to quantify (with a given rank) their communication frequency with other farmers on agricultural issues, as well as their participation frequency in an agricultural organization's events. This ranking led us to construct a dichotomous variable for communication and participation frequency variables (0 = farmers with low (<=50%) frequency rates, 1 = farmers with high (<=75%) frequency

rates). As seen in Table 1, the average value for the communication frequency is 0.40 for the organic and 0.50 for the conventional sample, indicating that while 40 % of organic farmers communicate with high frequency; this percentage is 50 % for conventional farmers. Similarly, we also observe a higher number of participation frequency (0.49) for conventional farmers relative to organic farmers.

With respect to friendship ties, each respondent was asked to provide detailed information on her/his three most frequently consulted friends, such as their age, education and innovativeness. In the model, we use the average of responses given as a characteristic of three frequently communicated friends. In Table 1, while the variable age and education of regularly contacted friends are presented as continuous variables, the innovativeness variable is depicted as a ratio scale with values ranging from 1 to 10 (1= hardly accept an innovation in general, 10= easily accept an innovation in general). Similar averages for the age and innovativeness of two study samples indicate that there are no large differences regarding the characteristics of organic and conventional farmers' friends (Table 1). However, the average value for years of education is 15 for organic and 13 for conventional farmers, which indicates that organic farmers' regularly contacted friends have slightly higher educations compared to conventional farmers (Table 1).

Additionally, information was gathered on the membership status of farmers in agricultural organizations. The study constructs membership status as a dichotomous variable (Table 1). The value 1 indicates that the farmer is a member of at least one agricultural organization, and 0 indicates that the farmer is not a member of any agricultural organization. The average, 0.85 for organic and 0.75 for conventional farmers, indicates that while 85 % of organic farmers are a member of one or more agricultural organizations, this number is slightly lower (75 %) for conventional farmers.

Finally, with all the given interpersonal network variables, we construct dichotomous variables of friendship tie strength (0 = farmers that have a large network size and communicate with low frequency, 1 = strong friendship ties; farmers that have a small network size and communicate with high frequency), as well as affiliation tie strength (0 = farmers that are not attached to any agricultural organization and participate on agricultural organizations' events with low frequency, and 1= strong affiliation ties; farmers that are

attached to at least one agricultural organization and participate in agricultural organization events with high frequency).

Interpersonal Information Sources

The second dependent variable, importance of interpersonal sources on agricultural issues, is examined for German farms. The importance of interpersonal sources is measured by the variable developed from the survey where farmers were asked to rate the importance of 13 information sources. Each information sources' perceived importance by farmers was ranked on a percentage scale so that the sum of the validations is 100 %. These sources were assigned to three groups: other farmers, agricultural institutions (interpersonal sources) and media.

The study examines the relationship between farmers' attitudes towards interpersonal sources and the factors that influence these attitudes with a regression model. The independent variables in the model are: being an organic or conventional farmer, and having a low or high degree of innovativeness. In addition, the variables of age, education, farm size, and share of farm income are introduced into the model as controlling variables. The continuous dependent variable represents the sum of importance rate (%) cited by farmers for interpersonal sources.

Similar to the degree of innovativeness model for conventional farmers, the study conducted OLS regression analyses when testing the hypotheses on the importance of interpersonal information sources. The OLS models depict the relationship between a dependent variable and a collection of independent variables. The value of a continuous dependent variable is defined as a linear combination of the independent variables, plus an error term:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + \varepsilon.$$

While β_s show regression coefficients, X_s provide the column vectors for the independent variables, and ε is a vector of errors of prediction (34). The regression coefficients are interpreted as the change in the value of dependent variable Y associated with a unit increase in an independent variable, and other independent variables are constant.

4. Results

The main objective of the study is to examine whether interpersonal ties characteristics are associated with the number of innovations adopted by farmers (innovativeness). Table 3 depicts the relationship between strong interpersonal ties (friendship and affiliation ties) and

farmers' innovativeness. In order to observe the differences between organic and conventional farmers, the model is tested for three farmers' samples: organic, conventional, and the entire (organic + conventional) sample.

Table 3: Influence of Interpersonal Ties on Total Innovation Activity

The results show a positive significant relationship between strong friendship ties and total innovation activity for all tested samples. This result implies that there is no support for hypothesis 1 (H1: Having strong friendship ties indicates lower innovativeness of farmers).

Additionally, we observe a positive significant relationship between strong affiliation ties and innovativeness of conventional farmers. In general, hypothesis 2 (H2: Having strong affiliation ties indicates higher innovativeness of farmers.) has been verified for the sample of conventional farmers, but not for the organic and entire farmers' samples.

In Table 3, with respect to the entire sample results column, the regression coefficient shows that the farmers, on average, adopt 1.04 innovation when farmers have strong friendship ties (coefficient= 1.049, $p<.05$). Additionally, significant Chi2 test (0.069) for strong friendship ties suggests that the presence of strong friendship ties influences innovativeness. However, the strength of this relationship is not significant for affiliation ties. These results raise the question of whether interpersonal network ties have an influence on total innovation activity. In the following part, therefore, we offer further analysis of the interpersonal communication network variables.

4.1. Results from Degree of Innovativeness

Table 4 shows the results of the regression models with degree of innovativeness as the dependent variable within the entire sample (Analysis I), only for organic farms (Analysis II) and only for the conventional farms sample (Analysis III), respectively. As opposed to Analyses I and II, in Analysis III, due to the high number of missing values for friendship ties' variables and the low sample size, the logit model failed to explain the predictors. Thus, the study provides results of the OLS regression model for the conventional farmers' sample.

Table 4: Results of Regression Analysis with Degree of Innovativeness as Dependent Variable

The results of the logit analysis for all farmers and organic farmers, including estimates of explanatory variables and corresponding standard errors, appear in the first and second columns. The last column shows the OLS regression coefficient and standard errors for the predictors of explanatory variables for the conventional farmer sample. In these three analyses, the dependent variable is a dichotomous variable (low/high innovativeness). Tested predictors were treated as significant when the p-value was lower than 0.10.

All analyses were tested for multicollinearity with a variance inflation factor (VIF) and pairwise correlation coefficient between explanatory variables (37). No problems were reported except for a high correlation between share of farm income and farms size variables in the organic farmer sample. This problem was solved by eliminating the farm income variable from Analysis II. In Analyses II and III, the explained variance of R2 adjusted is 0.52 and 0.71, respectively. This quite high value indicates that in these two models the employed variables fit well to the model.

In Analysis I, the logistic probability model serves mainly to answer the question of whether friendship and affiliation ties influence the high degree of innovativeness, and to asses if other control variables such as farm and farmer characteristics are significant factors (Table 4). The model results show that high innovativeness is significantly influenced by age, share of farm income, communication frequency and network size. The negative sign of estimates for the dichotomous age variable confirms that farmers less than 40 years old are more likely to be in the high degree of innovativeness cluster. The large share of farm income is found to be significantly less favorable for innovativeness than the moderate and low share of farm income categories. Regarding interpersonal network ties, variables such as communication frequency and being a member of a minimum one agricultural association, as expected in hypotheses 3 and 6, increase the probability of farmers possessing high innovativeness. These two hypotheses have been verified for the entire sample, because the explanatory variables of communication frequency and being attached to an agricultural organization demonstrate significant influence on the surveyed farmers. With respect to network size (connectedness), contradictory to our hypothesis 4, a large network size is found to be significantly less favorable for innovativeness of a farmer than for smaller network sizes. We have rejected hypothesis 5 (H5: Farmers who participate in agricultural organizations' events more frequently are more likely to be highly innovative). The explanatory variable of participation

frequency is found not to be a significant determinant for explaining the degree of innovativeness for all three study samples.

In Analysis II, the logistic model for the organic farmer sample indicates that being highly innovative is significantly influenced by the experience of organic farming practices and communication frequency regarding agricultural issues (Table 4). The positive sign of the estimate for the communication frequency variable confirmed the hypothesis 3, which stated that farmers who communicate with their peers more frequently are more likely to innovate. Similar to entire sample estimation results, a high network size negatively influences innovativeness; thus, we also reject hypothesis 4 for the organic farmer sample. Farmers who communicate with older friends demonstrate a lower probability of innovativeness than those farmers who communicate regularly with younger friends.

The OLS regression results of Analysis III shows that age and farm size are the significant variables for explaining the degree of innovativeness of conventional farmers. We could interpret the negative sign for the age variable as farmers in the younger age group being more likely to implement a higher number of innovations than farmers in the older age group. The positive sign of the estimate for the farm size implies that conventional farmers with larger farms are more likely to adopt a high number of innovations than those with smaller farms. Regarding the influence of interpersonal network actors, communication frequency with other farmers is found not to be a significant determinant for conventional farmers' innovativeness. Thus, hypothesis 3 is rejected for the conventional farmer sample. Furthermore, and similar to Analysis I, hypothesis 6 is verified for conventional farmers. Members of at least one agricultural association are more likely to adopt a high number of innovations than non-members.

4.2. Results from Interpersonal Information Sources

Table 5 shows the results on farmers' valuation (%) of interpersonal and media sources. Mean values and t-test results are presented within the division of two study samples: organic-conventional farmer samples (Analysis IV) and low-high degree of innovativeness samples (Analysis V).

Table 5: Farmers' Mean Rating (%) of Interpersonal and Media Sources

(Total Equal to 100%)

In Analysis IV, for the organic-conventional farmer samples, other farmers are identified as the most important information source for both the organic and conventional farmers (25 % for organic and 20 % for conventional farmers) compared to the other 12 examined sources. For organic farmers, seminars are appreciated more as information sources (18 %), than by conventional farmers' (8 %). Both organic and conventional farmers valuate the importance of agricultural organizations with an average of 12 %. Conventional farmers assign a significantly higher importance rate to magazines, broadcasts and the internet relative to organic farmers.

In Analysis V, the low-high degree of innovativeness samples, we observe that for low-innovative farmers, agricultural organizations such as associations, chambers of agriculture, and research institutes are cited with a significantly higher importance rate (14 %) compared to highly-innovative farmers (6 %). Furthermore, relative to farmers in the low innovativeness cluster, the mean rating for research institutes is significantly higher for farmers in the high innovativeness cluster.

In order to examine the relationship between the importance of interpersonal sources for farmers and the factors that influence it, we use the OLS regression model. In Table 6, Analysis VI shows the results of the interpersonal information sources model within the entire sample. As explanatory variables, the model uses the following characteristics for farmers: age, education, degree of innovativeness, being an organic farmer, and farm form are all dichotomous. The continuous dependent variable represents the sum of importance rate (percentage) cited by farmers for interpersonal sources (other farmers and agricultural organizations). Similar to previous regression models, tested predictors were treated as significant when the P>|t| was lower than 0.10.

Table 6: Results of OLS Regression Analysis with Importance of Interpersonal Sources as Dependent Variable

In Analysis VI, the regression model shows that the explanatory variables age, education, degree of innovativeness, farm size and being an organic farmer are strong indicators for farmers' valuation of an interpersonal information sources' importance.

The regression coefficient shows that the importance rate for interpersonal sources decrease if the farmer's age is above 40 (coefficient= -21.2, $p<.05$). A possible explanation of this result

is that farmers older than 40 already have knowledge and experience on farming practices and do not valuate interpersonal sources as highly as younger farmers do. Farmers with an education level higher than 17 years consider interpersonal sources less important than those educated less than 17 years (coefficient= -9.3, p<.01). Contrary to our hypothesis 7 (H7: Highly innovative farmers valuate interpersonal information sources more than less innovative farmers), farmers who are in the high innovativeness cluster assign less importance to interpersonal sources than those who are in the low innovative cluster (coefficient= -13.4, p<.01). Furthermore, the cited importance rate for interpersonal sources is positively related with farm size (coefficient= 0.019, p<.01). Finally, the positive sign of the coefficient for the organic farmer variable confirms that organic farmers valuate interpersonal sources more than conventional farmers (coefficient= 12.315, p<.01).

5. Discussion and Implications

The main objective of this article is to examine the influence that friendship ties (ties to other farmers) and affiliation ties (ties to associations) have on farmers' innovativeness. Logit and OLS regression models were used to examine whether network ties' structure and strength influence farmers' innovativeness. These models were also used to investigate the importance of information gathered by farmers from interpersonal sources. The study compares the results of organic and conventional farmer samples to increase our understanding of the innovation adoption behavior in different network structures.

In this regard, the study contributes to a better understanding of the link between network ties and innovation adoption behavior of farmers, and of the importance of interpersonal information sources for farmers. This in turn may help to adjust policy measures aiming to support farm enterprises' innovativeness.

Overall, our research results suggest that in addition to farm and farmer characteristics, interpersonal networks influence farmers' innovativeness. The presented findings of innovation adoption rates with respect to the strength of farmers' interpersonal ties have shown that there is a positive significant relationship between strong friendship ties and a farmer's innovativeness (both by organic and conventional farmers). This finding implies that compared to having a large friendship network where actors interact less frequently, having a small friendship network with frequent interaction strengthens farmer innovativeness.

Regarding the findings that emerge from the degree of innovativeness regression model for the entire sample, for the friendship ties variables we observe the positive influence of communication frequency (on agricultural issues) with other farmers on the innovativeness of farmers. Additionally, the degree of farmer innovativeness decreases with the increasing network size (connectedness) of the farmer. These results are consistent with the strength of interpersonal ties findings, which state that having a small friendship network with frequent interaction strengthens farmer innovativeness. The negative influence of network size (connectedness) is contrary to the hypotheses of Warruber and Moul (31), who assume a positive influence of network connectedness on adoption behavior as the number of information sources for new or novel farming ideas increases. Different from these authors, in our study we consider the network size of friends who are farm managers, not the friends from other sectors and kinship network actors.

In the degree of innovativeness regression model for the entire sample, for the affiliation ties variables, being attached to an agricultural organization was found to be a significant determining factor explaining innovativeness. The study by Jagger and Pender (49) on innovation diffusion in rural areas showed similar results: farmers' participation in organizations positively influences the adoption of innovations. High participation frequency in agricultural association events, which indicates a higher level of social capital (53,27), does not predict the innovativeness of either organic or conventional farmers in our model.

A fairly different picture is found with respect to the degree of innovativeness model for organic and conventional farmer samples. Years of experience with organic farming practices, high communication frequency, a small network size, and having a friendship network with younger actors were found to be significant positive determinants for the innovativeness of organic farmers. These results confirm that friendship ties positively influence the innovativeness of organic farmers. In the group of conventional farmers, communication frequency with other farmers does not predict higher innovativeness of farmers, and thus contradicts the findings by Monge et al. (49), which state that farmers who have frequent conversations about technological changes in their network are more likely to adopt new knowledge and technology than other farmers. Membership in at least one association is positively interconnected with a high level of innovativeness for conventional farmers.

From the degree of innovativeness regression models' findings we derive the following recommendations: firstly, organic farms that want to be more innovative should improve cooperation and relations with close friendship ties within their narrow network, and conventional farms should become more engaged with agricultural organizations. Secondly, designers of programs for supporting innovativeness in rural areas can learn from the results, e.g., that it may be useful for extension services to create discussion groups among farmers. Such groups can encourage farmers to share their experience with different innovations. Similar groups were already established to improve farm businesses and farm profitability, e.g., in Ireland, New Zealand and the UK (55, 56).

Further results show that significant differences exist between organic and conventional farmers in the perception of information received from media sources. The importance of sources such as magazines, broadcasts and the internet were rated significantly higher by conventional farmers than organic farmers. Institutions and organizations can use these findings while choosing the most effective communication channels for this farmers' group. For high-low innovative samples, mean rating results show that highly innovative farmers place importance on information from research institutes more, and information from agricultural organizations (including associations, chambers of agriculture, state institutes, and agricultural offices) less than less innovative farmers. To support the innovativeness of farmers, agricultural organizations should place more emphasis on providing farmers with information that comes directly from research. This could be accomplished by organizing meetings with researchers or by spreading information from research through electronic or printed media such as newsletters.

Finally, the regression model examining the factors that influence the validation of interpersonal sources by farmers suggests that factors such as age, education, farm size and innovativeness were important for explaining the perceived importance of interpersonal sources. These results indicate that during the communication strategy, information providers need to consider factors that influence farmers' information search behavior. For the marketing communication strategy e.g., it is important to understand characteristics of farmers that influence their attitudes towards information sources. As interpersonal sources are relatively unimportant for the old age group in our model, agribusiness marketers should use different interpersonal communication channels for the two different age groups.

As a concluding point we would like to emphasize that instead of covering the whole range of human complexity, this paper studies the influence of certain factors on adoption behavior. We believe that our results contribute to a better understanding of the interdependencies that exist between farmers' information and innovation adoption behavior, and thus support the development of strategies that encourage more effective information distribution.

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Table 1: Descriptive Statistics

	ORGANIC FARMERS				CONVENTIONAL FARMERS			
	Mean	**Std.**	**Min.**	**Max.**	**Mean**	**Std.**	**Min.**	**Max.**
Types of Innovations								
Total Innovation Activity	1.84	1.47	0	5	2.40	1.60	0	6
Degree of Innovativeness	0.27	0.45	0	1	0.35	0.49	0	1
Farmer's Characteristics								
Age (year)	49.20	10.22	26	90	45.90	11.28	28	66
Education (year)	15.94	2.20	12	20	15.90	2.27	10	21
Farm's Characteristics								
Farm Form	0.55	0.1	0	1	0.3	.47	0	1
Farm Size (ha)	163.44	272.78	3	1665	679.32	772.62	45	2371
Share of Farm Income	2.83	1.26	1	4	3.25	1.07	1	4
Soil Quality	2.75	1.05	1	5	3.15	0.81	1	4
Experience on organic farming practices (year)	12.17	5.36	2	27	-	-	-	-
Interpersonal Network								
Friendship Ties								
Strong Friendship Ties	0.34	0.48	0	1	0.35	0.489	0	1
Communication Frequency	0.40	0.50	0	1	0.50	0.51	0	1
Network Size (Connectedness)	9.35	9.47	0	50	6.13	3.42	2	15
Age (year)	46.85	6.57	28	59	45.90	11.80	25	65
Education (year)	15.61	2.06	12	20	13.61	5.91	3	22
Innovativeness	7.04	1.81	3	10	6.20	2.68	1	10
Affilation Ties								
Strong Affiliation Ties	0.53	0.53	0	1	0.65	0.489	0	1
Membership Status	0.85	0.36	0	1	0.75	0.44	0	1
Participation Frequency	0.29	0.46	0	1	0.35	0.49	0	1

Description of categorical variables:
Farm Form= 1 is grazing livestock and/or mixed farms; = 0 otherwise.
Share of Farm Income=1 for <=25% of income coming from farm activities; =2 for <=50% of income coming from farm activities; =3 for <=75% of income coming from farm activities; =4 approximately 100% of income coming from farm activities.
Soil Quality= shows the four scale of German soil value for farmland (Bodenwertzahl): =1 for <=25 German soil value; =2 for <=50 German soil value; =3 for <=75 German soil value; =4 for German soil value.

Table 2: Examples of Cited Innovation by Surveyed Farmers

Product Innovation	Implementation of new products such as own sort of rye, carrot production, increased crop/seed varieties
Marketing Innovation	Build direct marketing store, implement new regional marketing strategies
Process Innovation	Crop rotation, precision farming, build storage for cereal stocking, using organic fertilizer, buying mulch seeder, potato sorting machine, carrier, cultivator, new tractor, investment for larger machinery, GPS navigation device, N-Sensor, telescopic wheel loader, biogas energy, solar energy, renewable energy

Table 3: Influence of Interpersonal Ties on Total Innovation Activity

	Total Innovation Activity					
Interpersonal Ties	**Entire Sample**		**Organic Farmers**		**Conventional Farmers**	
	Coef.	**Chi2**	**Coef.**	**Chi2**	**Coef.**	**Chi2**
Strong Friendship Ties	1.049**	0.069	0.757*	0.555	1.802**	0.106
Strong Affiliation Ties	0.556	0.558	0.216	0.366	1.333*	0.245

*Significance levels of regression coefficients: ** p<.05, *p<0.1. While strong friendship ties represent farmers that have a small network size and communicate with high frequency, strong affiliation ties represent farmers that are attached to at least one agricultural organization and frequently participate in agricultural organization events.*

Table 4: Results of Regression Analysis with Degree of Innovativeness as Dependent Variable

	Analysis I	**Analysis II**	**Analysis III**
Explanatory variables	**Entire Sample**	**Organic Farmers**	**Conventional Farmers**
Farmer and Farm Characteristics			
Age	-1.961** (0.966)	-0.027 (1.22)	-0.020* (0.01)
Education	-0.125 (0.146)	0.057 (2.292)	0.043 (0.051)
Farm Size	0.001 (0.001)	-0.010 (0.011)	0.001* (0.000)
Farm Income	-0.596* (0.328)	-	-0.189 (0.124)
Soil Quality	0.003 (0.368)	-0.162 (0.756)	0.352 (0.137)
Year of Experience on OF	-	0.395**(0.168)	-
Organic Farm	0.012 (0.73)	-	-
Friendship Ties			
Communication Frequency	1.196* (0.719)	4.292**(2.163)	-0.179 (0.207)
Network Size (Connectedness)	-0.709* (0.374)	-1.553* (0.86)	-
Age	-	-0.312**(0.15)	-
Education	-	-0.667 (0.473)	-
Innovativeness	-	-0.631 (0.465)	-
Affiliation Ties			
Membership Status	2.703** (1.192)	5.087 (3.26)	0.675** (0.230)
Participation Frequency	-0.333 (0.719)	-2.260 (2.26)	0.279 (0.187)
Constant	2.144 (2.792)	20.404 (14.583)	-0.578 (1.169)
Prob > chi2 ; Prob > F	0.095	0.008	0.055
R2 adj.	0.198	0.516	0.705
N	70	45	19

*Significance levels: ** p<.05, *p<0.1. Standard deviations are given in parentheses.*
In the table, Analysis I and II columns represent the results of logit regression and Analysis III column gives ordinary least squares (OLS) linear regression results.

Table 5: Farmers' Mean Rating (%) of Interpersonal and Media Sources (Total Equal to 100%)

	Analysis IV			Analysis V		
	Organic Farmers	**Conventional Farmers**	**t-test**	**High Innovativeness**	**Low Innovativeness**	**t-test**
Interpersonal Source						
Other Farmers	25.13	21.78		21.85	25	
Agricultural Organisations	11.86	12.50		6.35	14.15	**
Research Institutes	4.17	4.64		7.60	2.77	**
Extension Agents	5.57	5.00		4.75	5.64	
Seminars	18.59	9.28		17.20	16.02	
Media Sources						
Brosure	6.73	4.50		5.10	6.62	
Book	10.34	6.64		9.90	9.21	
Magazines	7.26	15.28	**	12.40	7.32	*
Broadcastings	0.19	2.64	**	1.10	0.53	
Radio	0.00	0.21	*	0.15	0.00	
Advertisements	2.73	6.14	*	5.65	2.45	*
Site Visits	6.51	4.42		6.45	5.79	
Internet	0.67	4.07	**	1.10	1.49	
Other Sources	0.19	2.85	**	0.40	0.89	
N	25	15		20	47	

*Mean value results given with two-sample t-test with significance levels: ** p<.05 and *p<0.1. The sources of agricultural organizations represent associations, chambers of agriculture, state institutes, and agricultural offices. The sources of extension agents represent private consultation and advice from the supplier. In Analysis V, farmers in low degree of innovativeness represented by total innovation activity is <=2; farmers with a high degree of innovativeness represented by total innovation activity is >2.*

Table 6: Results of OLS Regression Analysis with Importance of Interpersonal Sources as Dependent Variable.

Analysis VI			
Explanatory variables	**Entire Sample**		
	Coef.	**Std. Err.**	**P>|t|**
Farmer's Characteristics			
Age	-21.266	6.976	0.004
Education	-9.372	5.149	0.075
Degree of Innovativeness	-13.414	5.939	0.028
Farm's Characteristics			
Farm Form	8.373	5.412	0.128
Farm Size	0.019	0.010	0.052
Farm Income	6.672	6.528	0.312
Soil Quality	0.665	2.655	0.803
Organic Farmer	12.315	6.551	0.066
Friendship Ties			
Comunication Frequency	0.121	0.115	0.296
Network Size (Connectedness)	-0.743	2.169	0.733
Affilation Ties			
Membership Status	3.028	6.912	0.663
Participation Frequency	-0.485	2.534	0.849
Constant	57.994	13.951	0.000

Prob > F = 0.014, R2 adj. = 0.365, N=64

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