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Diffusion of information among small-scale farmers in Senegal: the concept of Farmer Field Schools

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Abstract

Recent research on the Farmer Field School (FFS) approach in agriculture in developing countries has raised some doubts on the economic impacts of this concept and especially the knowledge diffusion effects from trained to non-trained farmers. Based on a study in Senegal this paper hypothesizes that the question of the project placement strategy is vital when analyzing knowledge diffusion effects of FFS in Africa. Results show that the share of trained farmers in a community is a decisive factor for adoption behavior and knowledge diffusion. It is concluded that when introducing an FFS, a critical mass of trained farmers is important to attain effective dissemination of information and to generate positive stimuli for adoption and learning among non-participants.

Key words: Africa, Senegal, agricultural extension, Farmer Field School, diffusion

1. Introduction

Knowledge is an important factor to realize productivity increases in agriculture in developing countries. The generation and diffusion of knowledge on sustainable farming practices has long been a problem in promoting rural development especially in Africa. . A new concept of farmer training called the "Farmer Field School" (FFS) was developed in the 1980s by the Food and Agriculture Organization (FAO) in Indonesia for the promotion of integrated pest management (IPM[1]), and promised to be an effective tool to extend knowledge to farmers (Pontius *et al.* 2002). It has been shown that FFS helps to increase farmer knowledge (Godtland *et al.* 2004), and studies in several Asian countries demonstrated that FFS can be effective in reducing the excessive use of chemical pesticides (e.g. Tripp *et al.* 2005; Winarto 2004; Praneetvatakul and Waibel 2005). However, the expected economic benefits are not always unambiguously ascertainable as shown for example by a study of Feder *et al. (*2002) in Indonesia. While much of the investment in FFS has taken place in Asia, more recently FAO has introduced FFS in Africa, which some analysts have questioned from a strategic point of view (Eicher 2003). In particular, doubts were raised regarding the expected diffusion effects of knowledge from trained farmers to non-participants, which are essential for achieving large-scale impact of FFS (Rola *et al.* 2002; Feder *et al.* 2004).

Empirical studies on diffusion of innovations and knowledge in agriculture show that diffusion[2] is a complex process, which depends on multidimensional, interrelated factors (Rogers 2003; Roeling 1988; Palis *et al.* 2002; Fuglie and Kascak 2001). Apparently, interpersonal networks are the predominant method by which farmers acquire knowledge (Rola *et al.* 2002; Birkhaeuser *et al.* 1991; Tripp *et al.* 2005). Thus, psychosocial determinants play an important role for the flow of information in a community. The investigation by Palis *et al.* (2002) in the Philippines showed that family relations and farm neighborhood compose homophilous[3] social clusters, which offer good conditions for spontaneous diffusion of FFS knowledge. This poses the question, whether knowledge transmission is determined by the intrinsic characteristics of knowledge alone, e.g. the complexity or the abstract nature of IPM knowledge as hypothesized by Feder *et al.* 2004 and Rola *et al.* 2002. Or whether it is rather dependent on outside, social, conditions, i.e. the type of farmers selected for training and the number of farmers trained. For example, the strategy of FFS placement in the context of a national program could be an important factor for the diffusion of knowledge taught to the participants of the FFS. When implementing a development program agricultural administrators often try to cover large geographical areas in order to be politically visible and to reach nation-wide impact. Thus a typical placement strategy is to introduce one FFS per village and therefore maximize the number of "FFS villages" in a country for a given budget. Consequently, the proportion of trained farmers in a given area is small. The alternative strategy is to concentrate on fewer villages, which may be selected due to their history of pest outbreaks, excessive use of pesticides or reported problems with pesticide intoxication. In this case, the project budget would be spent to train a critical mass of farmers (in several FFS) including follow-up training. Both approaches can be expected to have implications for the diffusion of knowledge. In the latter strategy, due to the high visibility of FFS in a village, trained farmers may have a stronger influence on non-participants as compared to a village where only a few farmers attended an FFS. This influence could then result in higher adoption through farmer-to-farmer communication. Hence the question of knowledge diffusion is coupled with the question of project placement in the context of an overall extension strategy.

This paper investigates knowledge transfer from FFS training in Senegal, one among several West African countries where FAO has introduced a project on FFS in 2001. It is hypothesized that the degree and intensity of information diffusion is affected by the degree of training exposure as measured by the proportion of farmers trained in a community. First, the factors that can explain the likelihood and the intensity of information diffusion are identified. In a second step, the effects of information diffusion on the motivation of farmers to learn and to adopt FFS-specific knowledge are analyzed.

The paper aims to introduce a methodology that could capture the factors driving diffusion of knowledge in agriculture in the context of an African country. Thereby it could contribute to a better understanding of the mechanisms that determine the success or failure of the FFS approach and provide some hints for an effective strategy of spatial placement of FFS in the context of agricultural extension in Africa.

The paper is organized as follows: In the next section the state of diffusion theory and research is presented. This serves as the basis for the hypotheses of the study, which are derived in section 3. Then the methodology used for data collection and data analysis is discussed. Section 5 presents the results of the study and finally, conclusions and implications are discussed.

2. Diffusion theory

Diffusion is a dynamic process that focuses on the penetration of a social system by some kind of new knowledge or an introduced technological innovation. Usually, it is defined as the "path of aggregate adoption" (Fuglie and Kascak 2001) by a multiplicity of decision units. According to general diffusion theory, the spread of an innovation usually follows a common pattern (Rogers 2003). Most of the psycho-social factors that affect the pace and pattern of diffusion are normally distributed, which leads to a Gaussian distribution of adoption behavior (Rogers 2003). Diffusion of knowledge, innovations or technologies usually is preceded by awareness. While at the beginning the flow of information is slow, the message is spreading more rapidly, when a greater proportion of the population is aware of the new idea, i.e. is exposed to it. If the cumulative number or percentage of adopters is plotted, the result is the typical S-shaped diffusion path, or rate of adoption (Figure 1).

Insert Figure 1 about here

The shape of the diffusion curve depends on two factors: the rate of awareness and the innovation-decision period (see Figure 1). The first factor is the speed of information dissemination. A more rapid communication of information about a new idea leads to an earlier creation of knowledge. This is portrayed as a left-shift of the rate of awareness. The second is the time required for an individual to decide to adopt after becoming aware of the innovation, i.e. the innovation-decision period. Supplying the individual with additional information and decision support can shorten the time of decision-making, or more generally, the time of forming an opinion concerning the innovation. This again leads to a left-shift of the rate of adoption (Rogers 2003). The result of both effects is the acceleration of the diffusion process.

Both processes - the spread of awareness and the adoption of a new technology - are reciprocal and influence each other. At a certain point, which varies depending on the social system or the nature of the innovation, these effects become self-sustained and the speed of diffusion accelerates enormously without any external influence (Rogers 2003). The so called critical mass is particularly relevant for interactive technologies (e.g. telephone, e-mail) where the utility of the innovation increases for all adopters in the course of diffusion. Not only do earlier adopters influence later adopters, but later adopters also influence earlier adopters in this process of reciprocal interdependence.

Critical mass technologies show a very low variance of individual thresholds, i.e. a great share of decision makers is willing to adopt when the critical mass has been reached. For an innovation such as IPPM, where, due to the common property nature of pest control decisions, synergetic effects occur with an increasing rate of adoption, the critical mass theory is likely to be relevant. Early adopters still have to put up with negative externalities from their farm neighbors relying on chemical pesticides as a major method of control. Furthermore, the existence of markets for pesticide-reduced, pesticide free or organically produced agricultural products is related to reaching a critical mass. With an increasing rate of adoption, early and late adopters alike benefit in terms of pest control and better commercialization possibilities.

An important assumption for this study is the distinction between information, knowledge and adoption. Farmers participating in FFS have the opportunity to increase their knowledge and then may or may not apply this knowledge on their own fields. Untrained farmers in the same village or the surrounding areas may interact with trained farmers and therefore have the chance to access information on alternative ways of managing pests, which in turn they may try to apply in their fields. Obviously, some of the technologies that participants learn in FFS (e.g. identification of natural enemies of pests) are less transferable than other type of information (e.g. choice of a resistant variety).

The distinction between different forms of information and knowledge is blurred, and drawing a line between explicit and implicit knowledge, or between knowledge and information, is often difficult. This is also true for adoption. Particularly in the case of a complex technology such as IPPM, adoption is not a clear-cut decision but has to be defined carefully. Information is defined here as "awareness" or "knowledge *about* something" and the reception of information can be voluntary or accidental, through visual or oral information channels. Knowledge is understood as the outcome of an active learning process, driven and influenced by different factors, such as the ability to learn and the educational level of the learner, the complexity of knowledge, the access to information, the information channel, and the intrinsic as well as extrinsic motivation of the individual (e.g. through social pressure). It is defined as explicit and implicit knowledge *of* something.[4] The definition of adoption (of IPPM) is given by the national coordinator of the IPPM programme in Senegal: "The two first and most important issues of IPPM are reduction of pesticide use and the conscious and informed management of farm inputs. The rest is a bundle of different production and pest control techniques. Of course, rarely will the whole package be adopted, but without implementation of the two most important issues you cannot talk of adoption of IPPM." In this study, adoption is further specified as "partial adoption", which means that farmers apply IPPM techniques on a part of their farm only (for different reasons), and "full adoption", which means that farmers changed their production completely, according to IPPM principles.

It is assumed that the impact of information can be far-reaching, since it is a major driving force of human behavior, and especially of learning processes (Bandura 1986; Deci and Ryan 1993; Wild *et al.* 1997). Bandura's social cognitive theory (1986) postulates that environmental events, personal factors and behavior, all operate as interacting determinants of each other. Thus, in the process of learning, people not only draw conclusions from their own experiences, but are considerably influenced by extrinsic feedback. In this regard the theory of cognitive dissonance (Festinger 1957) provides a helpful model of human behavior and motivation. Festinger found that a main motivator of human behavior is an internal or cognitive dissonance, which he defines as “the existence of non-fitting relations among cognitions” (Festinger 1957). The term cognition means any information, opinion, or belief about the environment, about oneself, or one’s behavior. Cognitive dissonance can be seen as an antecedent condition, which leads to activity, oriented toward dissonance reduction just as hunger leads to activity, oriented toward hunger reduction. For example, a farmer, who has learned that chemical pesticides are extremely perilous for his and his family's health as well as for the environment, experiences a state of psychological discomfort, which drives him either to change his behavior (reducing the application of pesticides) or to change his “knowledge” about the effects of pesticides.

3. Objectives and hypotheses of the study

In the light of this theoretical discussion, the objective of this study is to analyze how the diffusion of information is influenced by social conditions and to estimate its effects on learning and adoption behavior of farmers. The main hypothesis of this study is therefore as follows: A more concentrated training effort in a village, resulting in a relatively high share of FFS farmers (possibly above the critical mass), increases the degree and intensity of information sharing. The more farmers are trained in IPPM through participation in farmer field schools, the more conversations and discussions are initiated on this topic in a community. Information is disseminated by word-of-mouth and by visual demonstration, encouraging FFS farmers to full adoption, and motivating non-participants to learn and possibly to adopt IPPM.

Thus, two steps can be distinguished: First, the impact of training intensity on the diffusion of information (Hypotheses 1 and 2), and second, the impact of information on the motivation of participants and non-participants to learn more about IPPM and to advance in the process of adoption (Hypotheses 3 and 4).

H_1: The likelihood of information reception by non-participants increases with an increasing share of FFS farmers.

H_2: The intensity of information sharing increases with an increasing share of FFS farmers.

H_3: The diffusion of information affects the stage of adoption of FFS-farmers.

H_4: The diffusion of information affects the intrinsic motivation of Non-FFS farmers to learn more of IPPM or to adopt it.

4. Methodology and data collection

Data collection

Data were collected in 2004 in the western part of Senegal. The approach used in this investigation was to compare two communities with a different share of trained farmers in IPPM. Therefore two villages had to be chosen with similar characteristics, such as ecological conditions, infrastructure or size of village, but with different intensities of FFS training. To choose the sample villages, seven villages of the same climatic zone, the Niayes region, were visited, and information was gathered in group discussions with village elders and by observation. The choice was conditional on a sufficient difference in the proportion of trained farmers. Finally, two villages (Keur Abdou Ndoye and Gollam) at a distance of about 20 km were selected, as they meet the established selection criteria best. In Gollam one FFS was conducted in 2002/2003 on cabbage and onion. The 20 participants make up about 3% of farmers in that village. In Keur Abdou Ndoye the first FFS took place in 2000/2001. From the season of 2002/2003 on, two FFS have been conducted every year, so that at the time of the survey, in December 2004, 105 farmers (14% of all farmers) had been trained in 5 FFS on different vegetable crops.

Nine contiguous household clusters (carré) were randomly chosen out of the total 16 clusters in Keur Abdou Ndoye and 20 clusters in Gollam. Within these carrés every farmer was interviewed. The total sample size of the survey was 194 farmers in Keur Abdou Ndoye and 147 in Gollam.

Social network analysis

The way of sampling allowed for capturing the social networks in the two villages. For any kind of relation between individuals, like kinship, friendship, advice, financial relations etc., a specific network exists in every social system (Jansen 1999; Scott 1991). The social network analysis permits to calculate certain characteristics for every farmer reflecting his or her role in the specific relation. The relative importance of individuals within these networks is supposed to play a role for the diffusion of information and was therefore included as an explanatory variable.

For this study, two relationships were captured, the "respect and advice network" and the "IPPM interaction network". The characteristics selected for the analysis are the "sociometric status" of the "respect and advice network", the "closeness" of the "IPPM interaction network", and the mean of the sociometric status of a Non-FFS farmer's conversation partners.

The centrality index of closeness reflects the reachability and power position of a person. Farmers with high closeness are well connected within the network and can react swiftly to changes in the network because they are closest to all other farmers. Because of this, they can move information more quickly through a network as they will require few intermediaries to accomplish the task. This structural advantage can be translated into power to influence others. Closeness is defined as the inverse of the sum of the geodesic distances from one node to all the other nodes[5]. The geodesic distance between two given nodes is the shortest possible path between them. The length of a path is the number of links that comprise that path.

$$\text{Closeness} = \frac{1}{\sum_{j=1}^{g} \delta_{ij}}$$

where g is the size of the network and δ_{ij} is the geodesic distance from node i to node j.

Figure 2 illustrates a network of 5 farmers (or nodes). Farmer a_1 has a central position within this network and his closeness index is highest.

Insert Figure 2 about here

The sociometric status is the sum of its emission and reception degrees relative to the number of all other nodes in that network.

$$\text{Emission Degree} = \sum_{j=1}^{g} x_{ij}$$

$$\text{Reception Degree} = \sum_{j=1}^{g} x_{ji}$$

$$\text{Sociometric status} = \frac{1}{g-1}\sum_{j=1}^{g} (x_{ij} + x_{ji})$$

where i is the index of the current node, x_{ij} are the link values from node i to node j, x_{ji} are the link values from node j to node i, and g is the total number of nodes in the network.

The example in Figure 2 illustrates that farmers a_1 and a_4 have the same sociometric status, since both of them have a reception and an emission degree of two, whereas the other network members are connected to only one neighbor.

These social network characteristics have been included in the analysis in order to control for differences in the social status of farmers. Information may be disseminated to a higher extent from/to farmers who are more central in the village network, or who have a higher social status. Further, the transmission of information may have different impacts on the receiver, depending on the standing of the sender.

Model specification

Following the hypotheses, the analysis is conducted in two steps, first, examining the diffusion of information, and second, its effects on the motivation of farmers.

The 21 variables used in the analysis can be summarized in five groups (see Table 1):

- Social Network Characteristics (SN_i)
- Demographic Characteristics (D_i)
- Intensity of Individual Exposure to IPPM (IE_i)
- Likelihood and Intensity of Information Sharing (LIS, IIS_i)
- Adoption of IPPM by FFS ($A_{FFS,i}$) /Assessment of IPPM by Non-FFS Farmers ($A_{NFFS,i}$)

In the first step, the diffusion of information was analyzed by use of three models. Model (1) hypothesizes the likelihood (*LIS)* to depend on the intensity of FFS training as captured by the 'village' dummy variable, while for models (2) and (3) the individual exposure to IPPM (IE_i) was explicitly included. Social network characteristics (SN_i) and demographic attributes (D_i) are taken into the regression model to control for other influences on the flow of information. A binary logistic model was used to assess the likelihood of information reception while to explain intensity of information sharing OLS regression was used.

$$\ln(LIS_k) = \beta_0 + \beta_{SN,i} SN_{ik} + \beta_{D,i} D_{ik} + u_k \tag{1}$$

$$IIS_{1\,(=\text{ number of contacts})} = \beta_0 + \beta_{SN,i} SN_{ik} + \beta_{D,i} D_{ik} + \beta_{IE,i} IE_{ik} + u_k \tag{2}$$

$$IIS_{2\,(=\text{ communication frequency})} = \beta_0 + \beta_{SN,i} SN_{ik} + \beta_{D,i} D_{ik} + \beta_{IE,i} IE_{ik} + u_k \tag{3}$$

where $LIS_k = \dfrac{p(y_k = 1)}{1 - p(y_k = 1)}$, $\beta_0, \beta_{SN,i}, \beta_{D,i}, \beta_{IE,i}$ are the regression coefficients and u_k is the error term.

In the second step of the analysis, the impact of information on adoption and learning motivation of farmers was assessed. Therefore, the dependent variables of (2) and (3) were taken as explanatory variables for the following regression estimations. The dependent variables in models (4) to (6) were A_{FFS} and $A_{NFFS,i}$. A_{FFS}, the stage of adoption by FFS farmers is a variable with three possible values (0 = no adoption, 1 = partial adoption, 2 = full adoption), which required a multinominal logistic model. The assessment of IPPM by Non-FFS farmers, which was assumed to depend on the intensity of information about IPPM, was captured by two variables: a personal evaluation of IPPM (on a scale from 0 to 4) in model (5), and the wish to adopt IPPM in model (6). Again, OLS, binary and multinominal logistic models were used.

$$\ln(A_{FFS}) = \beta_0 + \beta_{SN,i} SN_{ik} + \beta_{D,i} D_{ik} + \beta_{IIS,i} IIS_{ik} + u_k \quad (4)$$

$$A_{NFFS(personal\ evaluation)} = \beta_0 + \beta_{SN,i} SN_{ik} + \beta_{D,i} D_{ik} + \beta_{IIS,i} IIS_{ik} + u_k \quad (5)$$

$$\ln(A_{NFFS(wish\ to\ adopt)}) = \beta_0 + \beta_{SN,i} SN_{ik} + \beta_{D,i} D_{ik} + \beta_{IIS,i} IIS_{ik} + u_k \quad (6)$$

where $\ln(A_{FFS,partial}) = \dfrac{p(y_k = 1)}{p(y_k = 0)}$ and $\ln(A_{FFS,full}) = \dfrac{p(y_k = 2)}{p(y_k = 0)}$, $\beta_0, \beta_{SN,i}, \beta_{D,i}, \beta_{IE,i}$ are the regression coefficients and u_k is the error term.

5. Results

Table 1 displays all relevant variables for both villages. For most of the variables the differences between Gollam and Keur Abdou Ndoye are highly significant.

The mean values of the individual social network characteristics display a considerable dissimilarity of the two villages. The communication network for IPPM information is much denser and better established in Keur Abdou Ndoye (the village with the higher FFS training intensity) than in Gollam. In the latter it is star-like, i.e. there are only very few sources of information on IPPM. This also explains the reverse distribution of the mean sociometric status of conversation partners. All three variables are expected to have a positive effect on the diffusion of information, as well as on the motivation of farmers to adopt IPPM.

Insert Table 1 about here

As for the demographic variables, it is noticeable that land tenure is more equally distributed in Keur Abdou Ndoye. More than 55% of respondents were proprietors of the land they farmed, while in Gollam only one third of farmers were landowners.

Following the hypothesis of the study the share of exposed farmers is significantly higher in Keur Abdou Ndoye. To what extent this is attributable to the intensity of FFS training in the village, will be investigated in the regression analysis. Table 1 shows that a higher share of FFS farmers automatically transfers into a much higher individual exposure to IPPM by Non-FFS farmers.

A positive correlation exists between FFS intensity and a more intense sharing of information. The number of contacts as well as the communication frequency is almost twice as high for Keur Abdou Ndoye.

The "stage of adoption" of FFS participants and the "wish to adopt" of the non-participants do also significantly differ between the two villages, which is likewise reflected in the personal assessment of IPPM by all farmers.

Hence, the conditions for a successful diffusion of FFS knowledge seem to be more favorable in Keur Abdou Ndoye as compared to Gollam. It can be hypothesized that five FFS and the continued support by the national coordinator and several dedicated farmer facilitators over 4 years have had a deeper impact on diffusion and adoption than only one FFS two years ago.

This impact is analyzed in detail in the following sections.

Information sharing

The models (1) to (3) concern the diffusion of information (see Table 2). Model (1) explores the likelihood that a Non-FFS farmer receives any information about IPPM. The second and third models deal with the intensity of information sharing.

As hypothesized, demographic characteristics play a role. Property status (D_6) and right of decision (D_7) both have a significant positive effect. Thus, landowners are almost 5 times more likely to receive information on IPPM than landless farmers (Exp (B_j) = 4.9). The size of carré (D_4), although statistically significant, has a rather negligible impact. The sign of the gender coefficient (D_1) is positive for all dependent variables, which means that women are more likely to receive information than men, and that they interact more intensely with their neighbors. Results for the effect of education (D_3) are conflicting. It is positive for the likelihood of information reception, but it is negative for the frequency of communication. This could imply that educated farmers (i.e. younger farmers[6]) have a higher chance to be aware of a new innovation like IPPM, but the intensity of interaction is higher for non-educated farmers. The effect of age (D_2) is insignificant.

Quite affirming results are received for the variables on intensity of exposure (IE_2-IE_5), captured by the number of FFS family members (IE_2), friends and neighbors (IE_3), the observation of a change (IE_4) and the time since first exposure (IE_5). These four variables are central to the investigation and were expected to have a significant positive impact on the diffusion of information. The findings confirm this hypothesis. A Non-FFS farmer having more relatives or friends, who underwent FFS training, shows a higher communication frequency and the number of contacts with FFS farmers increases. Particularly the fact that a farmer observed FFS participants applying the newly acquired knowledge on their farms (and getting positive results) positively affects the intensity of information sharing.

The number of FFS kinsmen or friends is not the only important variable. In addition, the social status of those FFS farmers (SN_3) considerably increases the intensity of information exchange. This result is in accordance with the cognitive dissonance theory that suggests that the magnitude of dissonance can be decidedly influenced by public opinion. The influence of another person's or the public's view on a farmer's behavior is rising with the expertise and the attractiveness or social status of the person voicing the opinion. In this model, this "attractiveness" is specified by the mean sociometric status of conversation partners.

The "closeness" of Non-FFS farmers in the network (SN_2) also seems to promote the diffusion of information by increasing the communication frequency. This means, the more central a farmer is placed within the communicational network, the lower are his "transaction costs" in terms of time and effort, and the better is his access to information.

Insert Table 2 about here

An important outcome of the model is the coefficient of the dummy "village" variable (0.01 level of significance). This is in line with the hypothesis, because the share of trained farmers is implicitly included in the "village" variable. The odds ratio shows that a farmer in Keur Abdou Ndoye is over 5 times more likely to receive information on IPPM than a farmer in Gollam. This suggests that a higher FFS intensity can stimulate diffusion.

Adoption and motivation

Regression results, however, do not straightforwardly support the hypotheses concerning adoption behavior of farmers. Communication frequency and the number of contacts were expected to have a positive impact on adoption by FFS- and the motivation to adopt by Non-FFS farmers. As far as the first effect is concerned, the coefficients suggest that the intensity of information (IIS_1 and IIS_2) indeed increases the chance of a partial adoption by a factor of 3.3, and the chance of full adoption by 2.2, if the number of contacts (IIS_1) rises by 1. Also the frequency of communication (IIS_2) has a strong influence on full adoption. Only 5 conversations more per month increase the chance of full adoption by 2.1 (which is Exp(Bj) to the power of five).

No significant effect was found related to the motivation of Non-FFS farmers as measured by the stated "assessment of IPPM" as well as "wish to adopt". The secondary effect of the share of trained farmers (through fostering of better information flow) seems to be non-existent. This suggests that there are other factors that shape the motivation and the learning behavior of Non-FFS farmers.

The observation of a change in the agricultural practice of FFS farmers emerges as the most important factor for the motivation to adopt. The odds ratio is 240.7, which is defined as: $\frac{p(A_{NFFS,2}=1)}{p(A_{NFFS,2}=0)}$. Hence, a farmer is much more willing to acquire FFS knowledge and to adopt IPPM, if he had actually seen the impact of IPPM in practice. In addition, the assessment of IPPM increases by about two points on the scale[7], which means a considerable gain in reputation. Thus, whether a farmer develops an interest and is eager to learn and to apply FFS knowledge is mainly attributable to the image and the "perceived performance" of the FFS farmers in the village. On the other hand, "perceived performance" is also dependent on the intensity of information diffusion (Table 3). Thus, there is an indirect effect of information sharing on the learning and adoption motivation of non-participants. In summary, the results suggest that training of a higher share of farmers per village results in faster diffusion of information about IPPM. The speed of diffusion affects the stage of adoption and the performance of FFS farmers, which in turn implies a more convincing demonstration of IPPM to Non-FFS farmers.

The goodness-of-fit statistics show high explanatory power of the models, even though only few of the variables are significant. Thus, information sharing in connection with visible application of knowledge are identified as the most important factors to explain adoption behavior under the conditions found in the study area.

Insert Table 3 about here

It shall be added that for full adoption on the whole farm there are some village-specific characteristics which were not controlled for by the model that could have further explained diffusion and adoption. As shown by the odds ratio of the village effect in table 3, farmers in Keur Abdou Ndoye are by far more likely to adopt IPPM than in Gollam. Casual observations during the survey revealed that the FFS alumni network is vibrant in KAN. Farmers supported by the FFS facilitators are meeting regularly once a week in different groups to discuss crop management and other problems which may well help to facilitate their decision making. The facilitators are supporting and supervising their “students”, always promoting the cause of IPPM. To the contrary in Gollam, FFS farmers experience practically no support. With only 20 trained farmers there is little moral assistance and encouragement, which has led to a dormancy state of IPPM in that village.

6. Conclusions

The findings of the study suggest that the current strategy of implementing one Farmer Field School with about 25 farmers per community or village and at the same time aiming for a maximum number of locations per country or region should be reconsidered. The often-political pressure for rapid program up-scaling, in order to achieve widespread impact may be counter-productive to and incompatible with the genuine strengths of the FFS concept. There exists a trade-off between achieving a rather widespread placement of FFS in a country and the impact of the training in each FFS location. Small proportions of trained farmers in a village might be insufficient to induce change beyond the participants of the training. This study submits that a critical mass of trained farmers is needed in order to attain effective dissemination of information and positive stimuli for adoption and learning among non-participants. To achieve a significant demonstration effect of FFS within the community and thus stimulate demand for more information a high-quality training is important. It is reasonable to assume that training quality will be higher if a more concentrated and a longer-term strategy of program placement is used. The results also lend some support to the conclusion that the strengths of FFS projects lie in their use as an intervention in special situations, concentrating efforts and resources on selected sites rather than using it as a substitute for a national extension strategy of introducing participatory methods. These results are also in line with the conclusions of a study by Fleischer et al. (2002 and 2004) who found based on comparison of cost-effectiveness of projects in Egypt, that public investments in participatory agricultural extension can be economically justified if the targets are well chosen.

In addition, clustering of FFS can also have other benefits like reducing the negative externalities of pesticide spraying and improve the general state of the ecosystem and biodiversity. Besides, an agglomeration of FFS farmers may facilitate the formation of local markets for pesticide-reduced, pesticide free or even organic products and the commercialization of bio-pesticides, and may lower the costs of introducing other institutional and technical innovations.

Hence, concentrating development efforts like FFS in well-defined target areas could be an effective tool of poverty reduction through sustainable rural development.

Further studies should assess the productivity impact of such FFS strategy and include the program and farm level costs in the context of a cost benefit analysis.

Notes

1. The introduction of IPM FFS in Africa has shown that there are broader agronomic, management and production issues that have to be addressed by the facilitators. This has led to the use of the term IPPM (integrated production and pest management) instead of IPM. Hence, the term IPPM is used in the succeeding text.

2. The terms diffusion, dissemination, information sharing, or transmission of information, are used as synonyms in this paper.

3. Homophily is the degree to which a pair of individuals is similar. The similarity may be in certain attributes, such as beliefs, education or social status. According to Rogers (2003) communication is more effective if individuals have much in common.

4. Explicit knowledge is formal knowledge that can be made explicit by means of a verbal statement and that can be recorded. Implicit knowledge is personal knowledge, rooted in individual experience and involving personal belief, perspective, and values.

5. "Node" is a technical term of Social Network Analysis, which in this case simply means "individual" or "farmer".

6. In both villages formal school education only exists for the last 10 to 15 years, which means that there is a relatively strong negative correlation between age and education.

7. The scale was defined as: 0 = IPPM is no solution at all; 1 = IPPM is worthwhile trying; 2 = It is as good as traditional farmer practice; 3 = IPPM is much better than farmer practice; 4 = every farmer should practice IPPM!

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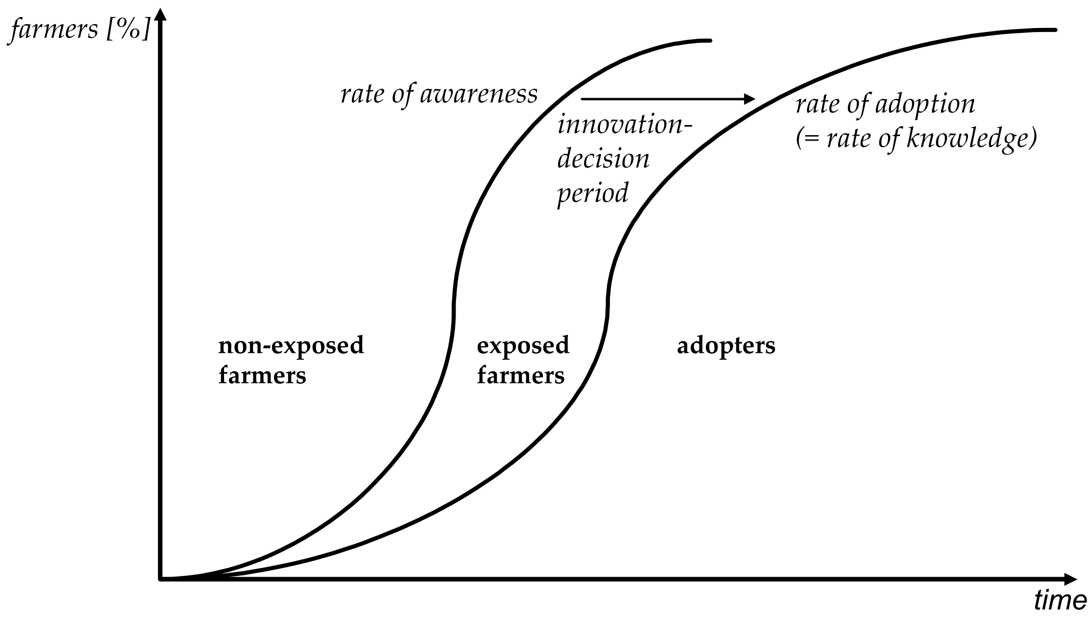

Figure 1: The rate of adoption, the rate of awareness and the innovation-decision period
Source: adapted from Rogers (2003)

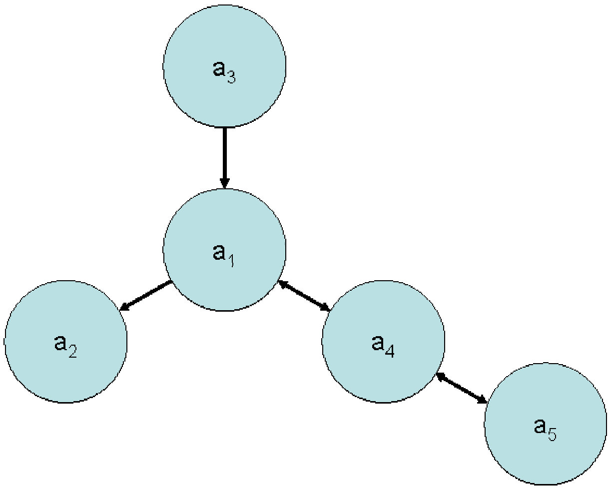

Figure 2: Schematic illustration of a social network.

Source: own illustration

Table 1: Descriptive statistics of variables used in the regression analysis

			Gollam			Keur Abdou Ndoye			
			FFS	**Non-FFS**	**Total**	**FFS**	**Non-FFS**	**Total**	Significance[1]
Category	Variable	Description	n = 14	n = 133	n = 147	n = 58	n = 127	n = 185	
Social Network characteristics	SN_1	Mean Sociometric Status (Respect and Advice Network)	0.0268	0.0362	0.0353	0.0132	0.0095	0.0106	ns
	SN_2	Mean Closeness (IPPM Interaction Network)	0.0027	0.0025	0.0025	0.0615	0.0457	0.0507	***
	SN_3	Mean Sociometric Status of Conversation Partners	-	0.0265	-	-	0.0173	-	***
Demographic characteristics	D_1	Gender [% women]	42.86	66.17	63.95	44.83	47.24	46.49	***
	D_2	Age [years]	35.36	35.49	35.48	32.24	31.54	31.76	**
	D_3	Educated Farmers [%]	28.57	29.32	29.25	27.59	33.07	31.35	ns
	D_4	Size of Carré [Number of Inhabitants]	13.86	14.74	14.66	19.62	17.73	18.32	***
	D_5	Size of Farm [ha]	2.63	2.30	2.33	2.06	1.58	1.73	***
	D_6	Landowners [%]	57.14	30.83	33.33	44.83	60.63	55.68	***
	D_7	Right of Decision [% of landless farmers]	92.86	87.97	88.44	86.21	86.61	86.49	ns
Individual exposure to IPPM	IE_1	Exposed Farmers [%]	-	61.65	-	-	90.55	-	***
	IE_2	FFS Family Members [number]	0.00	0.74	0.67	1.16	1.68	1.52	***
	IE_3	FFS Friends and Neighbors [number]	0.00	2.44	2.20	3.14	4.60	4.14	***
	IE_4	Non-FFS Farmers having observed a change in the practice of FFS Farmers [%]	-	59.4	-	-	85.83	-	ns
	IE_5	Time since first IPPM exposure [months]	2.50	14.80	13.63	11.86	25.98	21.56	***
Intensity of information sharing	IIS_1	Number of Contacts [number]	1.71	0.88	0.96	2.33	1.50	1.76	***
	IIS_2	Communication Frequency [talks per month]	4.93	2.51	2.74	6.22	4.60	5.11	***
Adoption / Assessment of IPPM	A_{FFS}	Stage of Adoption [mean value of a scale 0 to 2]	0.54	-	-	0.64	-	-	***
	A_{NFFS1}	Assessment of IPPM [mean value of a scale 0 to 4]	3.07	1.50	1.65	3.60	2.83	3.08	***
	A_{NFFS2}	Wish to Adopt [% of exposed farmers]	-	90.25	-	-	100.00	-	**

[1] *, **, *** : significant difference between Gollam and Keur Abdou Ndoye at 0.1, 0.05 and 0.01 level of significance, respectively, based on t-test

Table 2: Results of the first step of analysis: the likelihood and intensity of information diffusion

	Model (1) Exposure to information (IE_1)		Intensity of information sharing: Model (2) Number of contacts (IIS_1)	Intensity of information sharing: Model (3) Communication frequency (IIS_2)
	binary logistic		OLS	OLS
	regression coefficient Bj	odds ratio Exp (Bj)	non-standardized coefficient Bj	non-standardized coefficient Bj
Variable				
Intercept	-5.628***		-0.701*	-0.836
Village	1.692***	5.428	0.306**	0.276
SN_1	-2.346	0.096	0.019	-0.178
SN_2			-0.404	4.873**
SN_3			9.444***	19.041*
D_1	0.879**	2.409	0.041	0.820
D_2	0.009	1.009	0.010**	-0.044*
D_3	0.726**	2.068	0.097	-0.887***
D_4	0.062**	1.064	-0.001	0.024
D_5	0.058	1.060	-0.036	0.149
D_6	1.589***	4.899	-0.048	1.560**
D_7	0.830*	2.293	-0.014	-0.168
IE_2			0.164***	-0.289
IE_3			0.035**	0.346***
IE_4			0.688***	1.859*
IE_5			0.001	0.048*
R^2	0.370		0.508	0.311
N	197		197	197

* 0.1 level of significance, ** 0.05 level of significance, *** 0.01 level of significance

Table 3: Results of the second step of analysis: the stage of adoption and the motivation of Non-FFS farmers to adopt

			Motivation of Non-FFS farmers	
	Model (4) Stage of adoption of FFS farmers (A_{FFS})		**Model (5)** Assessment of IPPM ($A_{NFFS,1}$)	**Model (6)** Wish to to adopt ($A_{NFFS,2}$)
	multinominal logistic		OLS	binary logistic
	partial adoption Bj (Exp(Bj))	full adoption on the whole farm Bj (Exp(Bj))	non-standardized coefficient Bj	Bj (Exp(Bj))
Variable				
Intercept	-3.091**	-8.798***	0.020	-4.916**
Village	0.762 (2.143)	3.149*** (23.316)	0.091	0.925 (2.522)
SN_1	-1.343 (0.261)	0.599 (1.821)	-0.028	-10.008 (0.000)
SN_2	0.528 (1.697)	1.168 (3.216)	0.060	-1,149 (0.316)
SN_3			0.512	-3.208 (0.040)
D_1	0.191 (1.210)	0,174 (1.190)	0.009	0.185 (1.202)
D_2	-0.006 (0.993)	-0.015 (0.985)	-0.004	0.001 (1.001)
D_3	0.154 (1.166)	0.031 (1.031)	-0.047	-0.191 (0.826)
D_4	0.006 (1.006)	-0.007 (0.993)	0.001	0.0191 (1.019)
D_5	-0.045 (0.956)	0.241 (1.273)	-0.012	-0.161 (0.850)
D_6	-0.507 (0.602)	-0.004 (0.996)	0.068	0.910 (2.485)
D_7	-0.268 (0.765)	0.064 (1.065)	0.069	-0.124 (0.883)
IE_2	-0.365 (0.694)	0.020 (1.020)	0.022	0.159 (1.172)
IE_3	-0.192* (0.824)	-0.028 (0.972)	0.007	-0.003 (0.996)
IE_4			2.161***	5.483*** (240.747)
IE_5	-0.074*** (0.928)	-0.120*** (0.887)	0.007**	0.058** (1.059)
IIS_1	1.207*** (3.345)	0.787*** (2.196)	-0.037	-0.329 (0.719)
IIS_2	0.037 (1.037)	0.149*** (1.160)	0.003	-0.006 (0.993)
R^2	0.640		0.839	0.849
N	72		197	197

Note: Odds ratio Exp(B_j) is given in parentheses

* 0.1 level of significance, ** 0.05 level of significance, *** 0.01 level of significance