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ORIGINAL PAPER

Sharing seed and knowledge: farmer to farmer dissemination of agroforestry technologies in western Kenya

Evelyne Kiptot · Steven Franzel · Paul Hebinck · Paul Richards

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Abstract Although there's increasing emphasis on farmer-led extension in rural development, very few studies have been done to understand the social processes involved. This study was undertaken to identify farm and farmer characteristics that may influence dissemination of seed and knowledge of improved fallows and biomass transfer, to whom, how and what is disseminated. This was done by carrying out a formal and informal survey involving a random sample of 120 farmers from Siaya and Vihiga districts of western Kenya who were involved in a pilot project on soil fertility replenishment by the World Agroforestry Centre (ICRAF), Kenya Forestry Research Institute (KEFRI) and Kenya Agricultural Research Institute (KARI). A second survey involved 40 farmers, selected using the snowball sampling technique that were given seed and information by the first group of farmers. Descriptive statistics and logit regression models were used to analyze data. Results presented showed that seed and knowledge were mostly shared along kinship ties. Furthermore, informal social networks were found to be more effective for seed than knowledge. This calls for simplification of technical information by development professionals in order to help support farmers' understanding and communication of complex principles. Farmers with leadership status in their groups, those who belonged to many groups and those with larger farm sizes were more likely to give out seed of improved fallows. These categories of farmers could be targeted to enhance the spread of technologies.

Keywords Biomass transfer · Improved fallows · Kinship ties · Knowledge generation · Seed · Snowball sampling

E. Kiptot (✉)
Kenya Forestry Research Institute, 20412-00200, Nairobi, Kenya
e-mail: ekiptot@yahoo.com

P. Hebinck · P. Richards · E. Kiptot
Wageningen University and Research Centre, Hollandweg 1, 6706 KN Wageningen, The Netherlands

S. Franzel
World Agroforestry Centre, 30677-00100, Nairobi, Kenya

Introduction

In recent years, a number of research and development institutions working with farmers have initiated successful sustainable agricultural practices in the developing world (IIRR 2000). Despite the increasing number of successful agricultural initiatives, it is clear that most of them are still only 'islands of success' (Pretty 1995). Whether the potentials and spread of these initiatives are realized will depend on levels of investments, appropriate policies and the development and promotion of new methodologies and strategies for up scaling. New conceptual frameworks for facilitating scaling up/out are therefore needed.

In the past, public sector agricultural extension and research services in developing countries played a very important role in promoting technological innovation in agriculture. Between 1970's and the 1990's, the primary policy tool for sharing information about new agricultural technologies in the developing countries was the Training and Visit (T&V) system (Benor and Harrison 1977). Because of much criticism about the ineffectiveness of the T&V, the extension system in many developing countries has been changing to accommodate challenges presented by the linear model of technology transfer. A lot of emphasis is currently placed on participatory learning approaches where the role of extension officers is changing from agents of technical messages to facilitators. Despite the changes, the extension system in most developing countries and Kenya in particular has not made the expected impact on small scale farmers. A wide range of factors have contributed to the current situation.

First and foremost, because of the structural adjustment programs imposed by the International Monetary Fund, many government extension officers have been retrenched, leaving a skeleton staff to carry out extension. The situation that is on the ground is that of demoralized staff with limited resources to carry out extension. Secondly, because of high level corruption and mismanagement of donor funds in government circles, there was a major shift in donor support to non-governmental organizations (NGOs) which stepped in to fill the gap in extension. Thirdly, NGO's services have often been patchy and not comprehensive (Davis et al. 2004). Most of their activities are program-based and operate in an area for only a few years with no continuity after they leave. Furthermore, there is no uniformity in the extension approach used. So the question that needs to be asked is how can technologies that have been developed over the years by researchers in collaboration with farmers be extended or scaled up in the midst of these challenges? And it is not just a question of finding mechanisms of scaling-up, but also finding ways of sustaining these processes.

In order to address these challenges, new approaches based on community participation have come to the fore as a means of scaling up agricultural technologies to a wider audience (Franzel et al. 2001). These approaches promote farmers as the principal agents of change in their communities and focus on enhancing their learning processes and capacity building/empowerment, thereby increasing the capacity of farmers to adapt/innovate, make better decisions and/or influence decision making authorities and also provide feedback to the researchers. They work on the assumption that if one farmer adopts a technology successfully, other farmers may learn the innovation from him/her, and share with others thereby developing a multiplier effect.

One such approach that is being used in western Kenya to disseminate information on agroforestry is the village committee approach. This approach aims at reaching all farmers in an entire village by working with representative farmers from existing groups in village committees (Noordin et al. 2001). The committees are formed on the basis of existing social organizational structures with the village elder as the patron. The groups delegate a member to represent them in the committee. The representative farmers go through a joint learning process with researchers and government extensionists because most agroforestry technologies such as improved fallows and biomass transfer are knowledge intensive technologies that require much understanding of the principles behind the practices before implementation. The choice of working with groups is because most social networks are found within groups, where according to de Haan (2001), interaction between actors is greater and groups are also able to provide social control and social capital.

The village approach works on the assumption that the farmer delegates would facilitate further spread of agroforestry knowledge and seed in their social networks thereby generating sustainable processes and practices (Noordin et al. 2003). Although this approach has been operational for about 8 years, several issues are not clearly understood. For instance, what is disseminated and to whom? What farm and farmer characteristics are likely to influence seed and knowledge dissemination? Does the dissemination of the technologies go hand in hand with the associated knowledge? Understanding these issues will help (i) identify the categories of farmers that can be targeted to disseminate seed and knowledge of agroforestry technologies hence contribute to the efforts of enhancing community-based extension mechanisms for spreading improved technologies, (ii) identify limitations experienced by farmers in disseminating seed and knowledge hence enable researchers and other development agents target research and development to address these constraints, and (iii) provide valuable information which can be used by policy makers in planning appropriate mechanisms that would facilitate community-based extension approaches.

Conceptually, this study takes the view that innovations and adoption processes take place in contexts beyond the individual per se (Leewis and van den Ban 2004; Mudege 2005). Rather than an individual decision making process, social networks (groups, family etc.) in which farmers operate as well as their relationships with agencies such as extension and research shape the degree to which new ideas are taken up and shared. According to Mango and Hebinck (2004), sharing ideas and resources (e.g. maize seed) is a function of social relations and the respect that people have for each other. This study therefore aimed to examine empirically:

(i) Dissemination of seed/information/knowledge of improved fallows and biomass transfer from 'first-generation farmers' (farmers in contact with researchers and extension agents) to 'second-generation farmers.'
(ii) Factors that influence a farmer to disseminate information and seed.
(iii) How and what is diffused to second-generation farmers?
(iv) The reasons why second-generation farmers got seed of specific species and why they established them.
(v) The experience of second-generation farmers with the leguminous species.
(vi) The technical information given to second-generation farmers in relation to establishment and management of improved fallows.

Research on improved fallows and biomass transfer in western Kenya

Research on soil fertility in western Kenya began in the late-1980's, after ICRAF carried out a diagnostic study in the area that found that low soil fertility was a key problem (Place et al. 2003). During the same period, Smaling (1993) established that nutrient outputs from western Kenyan farmers' fields exceeded inputs by a wide margin. Drawing from this evidence, ICRAF in collaboration with KEFRI and KARI established a research program in western Kenya in 1988 to address soil fertility problems.

Initial technology design focused on the effect of hedgerow intercropping on crop yields. Later on in 1991, research on improved tree fallows began. Fallowing of land has always been part of the farming system in western Kenya. However, pressure on land has forced most farmers to reduce their fallow periods. These shortened fallows can no longer restore the fertility of the soil, hence the promotion of improved tree fallows which are regarded as a valuable low cost option for restoring soil fertility in Africa (Kwesiga et al. 1999; Niang et al. 1998). Instead of letting the natural vegetation to develop freely, selected leguminous trees/shrubs or cover crops are planted at high density to replenish soil fertility.

The only species used in on-farm trials of improved tree fallows in the early 1990's was Sesbania (*Sesbania sesban* (L.) Merill), an indigenous species which according to Kwesiga and Coe (1994) had proven its potential in Southern Africa and was a prolific biomass producer under western Kenya conditions (Onim et al. 1990). However, because of difficulty in germination and high incidence of nematodes (Franzel 1999), its uptake by farmers was very low. Based on that, research on alternative species was initiated. Screening trials resulted in the selection of new species that in most cases were shrubs and had a shorter life cycle than Sesbania and could be direct seeded. These species were: *Crotalaria grahamiana* Wight and Arn, *Tephrosia vogelii* Hook. f., *Tephrosia candida* DC, *Crotolaria paulina* Schranck, *Crotalaria striata* DC, *Crotolaria ochroeleuca* G. Don and *Crotolaria agatiflora* Schweinf (Niang et al. 1998).

Also from the mid-1990's, testing was done of locally available shrubs in collaboration with the Tropical Soils Biology and Fertility Program to look at their potential to supply nutrients to maize crops in a cut and carry system. One species, tithonia (*Tithonia diversifolia* (Hemsley) A. Gray) was found to be the best bet among several because of its ease of establishment, easy handling (free of thorns or sharp leaves), high concentration of nitrogen (N), phosphorous (P) and potassium (K) in its leaves, and good yield impacts on crops (Jama et al. 2000). In the beginning, tithonia leaves were gathered from roadsides or farm boundaries and applied to plots at planting time. After that, a whole range of management options were explored by the farmers, but in all cases, a system of biomass transfer was practiced (growing the shrub in one place and applying the biomass in another place).

After a few years of on-station trials, the technologies were taken to farmers' fields on a trial basis in researcher designed/farmer managed trials. In the mid-1990's, this evolved to farmer-designed/farmer-managed trials where farmers were invited to try out some of the species on their farms. Regular monitoring was undertaken at various stages of experimentation and adaptation (Noordin et al. 2003). In 1997, the KEFRI–KARI–ICRAF pilot project on soil fertility replenishment hereafter referred to as the 'pilot project' embarked on wide scale dissemination using community-based participatory approaches. This was done in partnership with the Ministry of Agriculture and other NGOs in the area.

Description of the research area

This study was undertaken in Vihiga and Siaya districts of western Kenya because of the fact that they were used as sites for the pilot project. Both districts are faced with high poverty and low agricultural productivity due to nutrient deficiency with the major limiting nutrient being P, although N and K are also limiting (Shepherd et al. 1996). The altitude is about 1500 m above sea level and rainfall bimodal, averaging 1600–1800 mm per year. The majority of farmers use animal manure, but typically the quality and quantity is insufficient to replenish soil fertility. The use of inorganic fertilizers is rare as farmers are too poor to afford them. Farming is further constrained by heavy infestation of *Striga hermontica* Benth.), a parasitic weed that substantially reduces maize yields. Farmers have secure rights to their land although farm sizes have been declining, averaging 0.5 ha in Vihiga and 1 ha in Siaya. Maize *(Zea mays* L.) intercropped with beans (*Phaseolus vulgaris* L.) are the main subsistence crops.

Methodology

Two surveys were undertaken to understand farmer to farmer dissemination. The first involved a random sample of 120 farmers drawn from a list of farmers in 8 villages who were participating in the pilot project from 1997. The list was constructed based on project records, information from village elders and extension officers. The 8 villages are among 17 villages in western Kenya which were used as pilot sites for dissemination of agroforestry technologies using the village approach. These farmers who have/had direct links with the pilot project are referred to in this paper as first-generation farmers. They had received seed of improved fallows between 1997 and 2000 and had been involved in various trainings (field days, tours and seminars) on agroforestry technologies while farmers who have had no direct link with the institutions but received information and seed from the first-generation farmers are referred to as the second-generation farmers.

A second survey was undertaken with 40 second-generation farmers. The sampling method used was an adaptation of snowball sampling which is defined as a technique for finding research subjects in which one subject gives the researcher the name of another subject who in turn gives the name of another (Vogt 1999). According to Spreen (1992), snowball sampling can be placed within a wider set of link-tracing methodologies which seek to take advantage of the social networks of identified respondents to provide a researcher with an ever-expanding set of potential contacts. This process is based on the assumption that a 'bond' or 'link' exists between the initial sample and others in the same target population, allowing a series of referrals to be made within a circle of acquaintance (Berg 1988).

First-generation farmers were asked to give names of second-generation farmers, that is, farmers to whom they had given seed and information. There were however some limitations. Some farmers could not remember the people they had given seed to and therefore the study may have missed out on some recipients while others could not remember the specific years. The results presented nonetheless are indicative of which people the first-generation farmers mostly shared seed and knowledge with. Based on this information, a list of second-generation farmers was constructed, and a random sample of 60 farmers picked from the list. Follow-ups were made with this group of farmers who had been given seed of improved fallows and information on biomass transfer. The research team ended up interviewing 40 second-generation farmers. The other 20 could not be interviewed because of various reasons; illness, others had passed on, some were too busy and some were not available.

The research method used for the two surveys was in-depth formal interviews using a structured questionnaire, informal interviews and participant observations e.g. the research team often interacted with farmers while they worked or in social functions such as weddings, funerals and group meetings. Ten key informants who consisted of 2 village elders, 2 KEFRI staff, 2 extension officers and 4 farmers were also interviewed using semi-structured interviews in order to identify key topics for formulating the structured questionnaires.

Data collected included variables that have been shown by Sinja et al. (2004) to play an important role in the distribution of seed of fodder legumes in central Kenya. These factors were status of farmer in the group (group official or not), number of groups a farmer belongs to as well as relative wealth (measured in terms of livestock ownership). In contrast, literature reviews such as Feder et al. (1985); Franzel (1999) and Keil et al. (2005) found that farm size, education level, labor availability, gender of household head and age influenced adoption. This study tested these variables using a logit regression model on the assumption that adopters of improved fallows with access to seed will share it out with others in their social networks.

Results

Use of improved fallows and biomass transfer by first-generation farmers

Generally the planting of improved fallows by farmers who were given seed has been very low except in 1999 and 2002 when the proportion shot up to 45% and 52%, respectively. In 2003, the percentage of planters dropped to 31% with a number of farmers abandoning planting of fallows (Table 1). By 2004, only 34% had improved fallows, 38% were using tithonia directly as a green manure while 14% were using it in compost. The reasons given for not planting fallows/abandonment were: small farm size (63%), no noticeable increase in crop yield (18%), lack of a market for seed (18%), improved fallows do not provide edible products (3%), lack of labor (3%) and lack of knowledge (2%). Since there were few farmers with the improved fallow technology, this has implications on farmer to farmer dissemination of seed. The direct use of green manure of tithonia (biomass transfer) is generally low. This is because of its labor intensiveness, while a few farmers are opting to use it in compost, which according to them is less labor intensive.

Who is a farmer more likely to give out seed of improved fallow species to?

Out of 120 farmers who got seed, only 47 (39%) farmers gave out seed of improved fallows between 1997 and 2004. Twenty-five percent of first-generation farmers interviewed gave out seed

Table 1 Proportion of first-generation farmers using agroforestry technologies in western Kenya

Year	1997 (n = 120)	1998	1999	2000	2001	2002	2003	2004
Improved fallows	20	28	45	27	33	52	31	34
Biomass transfer (Direct use of tithonia)	12	15	29	22	25	41	45	38
Tithonia in compost	0	0	0	0	0	3	20	14

to their relatives, 13% to group members, 12% to neighbors and 12% to friends (Table 2). Visiting of relatives is a social activity that is very common in western Kenya. They often visit when there's a funeral, wedding, group meeting or just a courtesy call. Those who did not give out indicated that they did not have the technologies and therefore the seed. Although all of them initially got seeds, which was distributed for free, not all planted.

Factors likely to influence giving out of seed and information

Four variables positively influenced farmers to give out seed; all were significant at $P < 0.05$. Farmers who had leadership status (were officials) in their groups were more likely to give out seed than those who did not (Table 3). The probability of giving out seed of improved fallows increases by 0.95 if a farmer is an official. Farm size also influenced giving out of seed with the probability increasing by 0.50 if 1 additional hectare of land is available. Education was also an important influence, but surprisingly, its influence was negative. An increase in the number of years of schooling reduced the probability of giving out seed by 0.16. Number of groups a farmer belonged to also influenced giving out of seed with the probability increasing by 0.5 with the increase in the number of groups a farmer belonged to. Several variables had no significant influence on giving out seed for improved fallows: age, gender, number of improved cows (a proxy for wealth) and number of adults working on farm. Only one of the above variables significantly influenced giving out of information on biomass transfer: farmers status in the group ($P < 0.10$) with the probability of giving information increasing by 0.89 if a farmer is an official of his/her group.

Table 2 Categories of people who received seed

People given seed	Percentage of first-generation farmers who gave seed (n = 120)
Relative	25
Group member	13
Friends	12
Neighbors	12
Others	10

NB: There were multiple responses. The total adds up to less than 100 because the majority (73 out of 120) of first-generation farmers did not give out seed at all)

Who are the people who gave second-generation farmers seeds of improved fallow species?

This is the same variable as shown in Table 2, but from the opinion of the recipient of the seed. The variable is the relationship between giver and recipient. The reason there is a difference between data in table 2 and 4 is because there is some overlap in values; a person can be a neighbor and a friend and the giver may say he/she gave seed to a neighbor while the recipient identifies the giver as a friend. Thirty-five percent of the second-generation farmers were given seed by their relatives, followed by their group members, friends, neighbors and about 8% said they were given by members of their respective churches (Table 4). These results agree with the findings in Table 2 whereby relatives were the majority in terms of those farmers who were given seed of improved fallows. Apparently very few farmers cited neighbors as an avenue for sharing seed. There were several reasons given by farmers for not seeking seed from their neighbors. One of the reasons was that some of the neighbors had a higher social status and therefore the other farmers could not feel comfortable going to their homes for

Table 3 A logit regression model of factors likely to influence giving out of seed of improved fallows and information on biomass transfer

Parameter	Giving out seed of improved fallow (Y_1)		Giving out information on biomass transfer (Y_2)	
	Coefficient	Standard error	Coefficient	Standard error
Age	– 0.02	0.02	0.01	0.02
Gender	0.10	0.51	– 0.28	0.55
Farmers' status in group	0.95**	0.49	0.89*	0.49
Farm size	0.50**	0.20	0.15	0.19
Education (No. of years of schooling)	– 0.16**	0.08	0.01	0.08
No. of improved cows	– 0.39	0.25	– 0.19	0.24
No. of adults working on farm (Labour)	0.05	0.30	– 0.40	0.34
No. of groups a farmer belongs to	0.54**	0.24	0.11	0.25
Constant	– 0.67	1.60	– 1.40	1.68
Nigelkerke R^2				
Model Y_1 = 0.22				
Model Y_2 = 0.09				

Dependant variables: Y_1 = giving out seed of improved fallows and Y_2 = giving out information on biomass transfer (0 = no, 1 = yes)

Definition of qualitative independent variables: Gender = dummy = 0 if male and 1 if female; farmers' status in group (non-official = 0, official = 1)

*, **, Significant at 10%, 5% level of probability

Table 4 Source of seed given to second-generation farmers

Relationship with the person who gave seed	Percentage of farmers given seed (n = 40)
Relative	35.0
Group	25.0
Friend	17.5
Neighbor	10.0
Church member	7.5
Others	5.0

Table 5 Seed disseminated to second-generation farmers

Seed received	Percentage of second-generation farmers who received seed (n = 40)
Tephrosia vogelli	68
Crotolaria grahamiana	33
Tephrosia candida	23
Crotolaria ochroleuca	8
**Mucuna Puriens* (L)DC	5
Others	5

* It is a leguminous cover crop used for fallow that was introduced by partner NGOs so that farmers could have a wide range of species to choose from

seed. Secondly, farmers who have been collaborating with development projects have had a lot of attention from the pilot project i.e. being visited by dignitaries, taken for tours, participation in workshops etc. This has in turn made the other farmers develop some jealousy and resentment towards them.

Species/technology that was disseminated to second-generation farmers

The most popular species that second-generation farmers received seed was *Tephrosia vogelli* followed by *Crotolaria grahamiana* (Table 5). Tephrosia was most popular because many farmers believed it repels moles, a major problem in western Kenya. Moles destroy such crops as sweet potatoes, bananas and cassavas and farmers have no means of getting rid of them. There are a few people who trap moles, but they do it at a fee, which most farmers cannot afford. *Crotolaria grahamiana* was also in high demand because it is a prolific seeder and is also a short duration fallow crop. It takes only six months in the farm and therefore if planted, farmers would only forego one seasons crop unlike Tephrosia which takes longer in the farm. And once planted, the seeds continue germinating every season. With the availability of a ready market for seed, farmers thought they would make a lot of money. A few (8%) planted *Crotolaria ochroleuca*, G. Don especially women because its leaves are used as a vegetable (Table 5). But it is not effective for soil fertility improvement because it produces very little biomass

Technical information given to farmers at the time of receiving seed of improved tree fallows

When second-generation farmers were given seed, not all of them were given the technical advise on how to establish and manage an improved fallow. Thirty-eight percent indicated that they did not receive any technical advice. While 65% were given information about the benefits of improved fallows, only 30% were instructed on how and when to sow (Table 6). The study did not ascertain the quality of information given. But the fact that some established their improved fallow trees/shrubs scattered in their farms instead of following the recommended spacing implies that they may not have been given the right information or they might have decided to try out their own designs or, more likely, they were trying to prevent moles and scattering would have been the best way to do that. Only 23% of the second-generation farmers indicated that they had also received information on the use of tithonia as a green manure.

Table 6 Technical information received by farmers

Information received at the time seed was given	Percentage of farmers
Benefits of an improved fallow species	65
No technical advise given	38
When and how to sow an improved fallow	30
Biomass transfer and its benefits	23
When to harvest seed from an improved fallow	20
Residual effect of an improved fallow	8
Information about other ISFM options	5
Nutrients replenished by an improved fallow	5

NB: The totals are more than 100% because a farmer could give more than one response

Farmers' expectations before planting improved fallows and their perceptions there after

Farmers' expectations differed considerably from researchers' and extensions' motivations for introducing the practice. Although the shrubs/trees were mainly promoted for soil fertility improvement, second-generation farmers got seed for other reasons besides soil fertility. The majority of second-generation farmers (65%) indicated that they got seeds of *Tephrosia vogelli* because of its mole repelling qualities (Table 7). Fifty-five percent planted improved fallows for sale of seed. Fuelwood was not a major reason for planting improved fallows although it ended up being the most commonly mentioned benefit (Table 7). A few farmers, especially women, planted some of the shrubs especially *Tephrosia candida* and *Tephrosia vogelli* for firewood. As for soil fertility improvement, a minority, 28% said they had noticed an improvement in crop yield which they attributed to an increase in soil fertility. Some did not notice any increase because of a number of reasons. Firstly, some of the farmers did not plant the shrubs as recommended; they had them scattered in their farms and hence could not produce enough biomass to create an impact. Secondly, some of the farmers planted the shrubs on a very small portion of land and only for one season and hence the increase in soil fertility may have been too small for them to notice. About 48% indicated that they had noticed an improvement in soil texture. They claimed that the soil was darker, softer and much easy to till than before.

The motivating factor for most of the farmers for seeking seeds of *Tephrosia vogelli*, was because of its ability to repel moles and generate income from the sale of seeds. But after planting it only 5% of the farmers said that the moles had reduced on their farmers. It is however difficult to quantify. After seeing no effect on moles, most farmers who had planted Tephrosia for that particular purpose abandoned it completely. Market for seed was another factor that motivated farmers to plant improved tree fallows because the pilot project, bought seed from farmers so that it could distribute to other farmers. This explains why there was an increase in the use of improved

Table 7 Farmers' expectations before planting improved tree fallows and positive aspects experienced thereafter

	Percentage of second-generation farmers (n = 40)	
	Farmers expectations (before planting)	Positive aspects experienced after planting
Repel moles	65	5
Sale of seed	55	8
Soil fertility improvement	50	28
Fuelwood	18	93
Improve soil texture	0	48
Reduction of striga	0	35

NB: The totals sum to more than 100% because some respondents gave multiple responses

fallows from 2000 to 2001 with a peak in 2002 (Fig. 1). But by 2001, there was too much seed and the pilot project stopped buying. Most second-generation farmers came to learn about the seed market a little too late such that by the time they planted the shrubs, the pilot project had stopped purchasing seed. They therefore did not have a market for their seed and some of them stopped planting the shrubs (Fig. 1). In fact, only 8% of the second-generation farmers managed to get some money from the sale of seeds (Table 7).

The scenario for biomass transfer is however different in that from 2002, tithonia's direct use as green manure declined but its use in compost increased (Fig. 1). The direct use of tithonia as green manure is a very laborious task. Farmers have to harvest the shrub, transport it to their farms and then chop the leaves into small pieces before using it for planting crops. An easier alternative which farmers seem to be embracing is the use of tithonia in compost. Instead of chopping the tithonia leaves into small pieces, the farmer separates the woody twigs from the leafy biomass, and adds it to the compost pit with other farmyard refuse. By doing this, farmers save on the time and labor associated with chopping of tithonia into small pieces. Farmers claimed that when tithonia is put in the compost pit, the manure decomposes much faster than when applied on the farm.

Discussion

Seed and knowledge sharing networks

The results confirm that informal social networks such as relatives, friends and groups are important avenues for spreading new technologies. The impact of knowledge being shared along kinship ties is indeed considerable. What this means is that family linkages indicate a potential for sharing within and between villages and thereby expanding a network of seed and knowledge sharing. However, these networks of friends and relatives could likely represent people of the same social status although this study did not ascertain this and therefore further research is needed on this subject. Sharing of knowledge and seed through kinship ties has been indicated in a number of participatory learning programs such as farmer field schools. For instance, Nathaniels (2005) in a study of cowpeas and farmer-to-farmer extension in Benin reported that farmers shared information along kinship ties, with friends and neighbors. Other studies that have reported similar observations are Simpson and Owens (2002) and Vander Mey (1999).

The findings also demonstrated that kinship ties are much more important in technology dissemi-

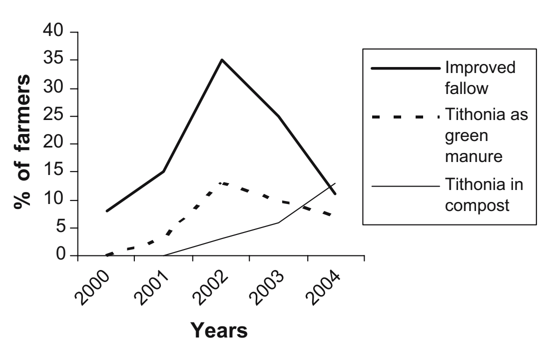

Fig. 1 Trend in the use of improved fallows and biomass transfer by second-generation farmers in Siaya and Vihiga districts from 2000 to 2004

nation than physical proximity; more farmers received/gave seed to their relatives than neighbors. Jealousy was given as a reason for some farmers not asking for seed from their neighbors who have been collaborating with development projects. The implication for this is that development projects that give too much attention to some farmers end up causing tensions in social relationships that could undermine the dissemination of agricultural innovations. Such problems can be avoided if all farmers are treated equally.

Groups featured as the second most important avenue for sharing seed and information among farmers. It is a known fact that many development organizations work with groups in their endeavor to reach many farmers. Although groups are a valuable vehicle for rural development, not everyone belongs to groups. This may be because of the inability to pay membership fees or due to other personal or social issues. In up-scaling, other mechanisms such as mass media, public meetings, seminars and even the print media could be used in order to reach more people. According to Garforth and Lawrence (1997), mass media especially radio can be a cost effective way of reaching a large population. On the hand, Davis et al. (2004) in a study of farmer groups in Kenya found that traditional methods such as public meetings played a very important role in information dissemination although some development professionals such as Bently et al. (2003) argue that quality is compromised at the expense of quantity. This places development professionals in a dilemma of how to reach more people without compromising quality.

Factors that influence farmers to share seed and information

Farmers who were officials of their groups and those who belonged to many groups were more likely to give out seed. What this implies is that social capital is a major asset in dissemination. Farmers who belong to more groups interact with more people and therefore have more opportunities of sharing information than those who do not. Those who hold leadership positions in their groups also interact with more people by virtue of their positions. These people can therefore be targeted to spread information and technologies in their communities. Similar observations were made by Sinja et al. (2004) in a study of farmer to farmer dissemination of fodder legumes in central Kenya. As for education, farmers with more years of schooling were found to be less likely to give out seed of improved fallows. The implication for this is that even the less educated can disseminate seed and therefore they should also be targeted to spread technologies.

As expected farm size influenced giving out of seed of improved fallow species. Farm size positively influences the adoption of improved fallows (Keil et al. 2005; Phiri et al. 2004; Franzel 1999); therefore it is not surprising that it also influences farmer to farmer dissemination. Improved tree fallows occupy land that would otherwise be used by crops and therefore farmers with small farm size would not want to forego a seasons' crop in order to have soil fertility enhancing trees/shrubs whose benefits are not immediate. These farms could actually be used as sites for field days and inter-farm visits so that other farmers can learn from them. But the dilemma that might be faced is that most of these farms might belong to well to do farmers although there's no evidence to suggest that farm size alone is evidence of wealth. If it is the case, then poor farmers may not be comfortable to visit them if they are used for demonstration. This cannot be ruled out because the results presented showed that some second-generation farmers did not seek seeds from their neighbors because they belonged to a higher social status than them. If researchers are confronted with such a dilemma, then other ways of learning and dissemination that do not marginalize the poor should be explored.

What is shared among farmers: seed versus knowledge

This study showed that not all farmers who receive seed plant it and therefore development practitioners need to be aware that some farmers receive seed just because it is distributed for free but may have no intention of planting. Follow-ups should often be made during the initial phases of projects to ascertain whether farmers plant or not and the reasons behind their actions. This will give development practitioners information about farmers' perceptions of the technology. Secondly, not all farmers who receive seed from their fellow farmers are given the technical information that goes with it, and even for those who are given, the quality is suspect. Farmers indeed need support from institutions that have the expertise. This information does not need to come from high-cost sources such as extension; it can often be effectively communicated at much lower cost mechanisms such as radio.

The results also showed that seed is more easily shared than the technical principles. Some of the technical issues such as nutrients replenished and the residual effects of the technologies may be too complex for farmers to understand and disseminate to other farmers. Similar observations were made by Simpson and Owens (2002); Van Mele et al. (2005) and Van Duuren (2003) in their studies of Integrated Pest Management (IPM) and farmer field schools whereby farmers easily shared seed than information on agro-ecological concepts or principles. This poses a major dilemma for development professionals' efforts to upscale. If farmers with the technologies cannot explain the concepts/principles to other farmers, then there is the real danger of farmers adopting technologies without sufficient information needed to help them get maximum benefits. What is needed are simple techniques and decision support tools developed jointly between farmers and researchers to help support communication and understanding of more complex principles. It will then be easier for farmers to readily share technologies and principles with other farmers irrespective of their literacy status.

Farmers also seem to readily share information on secondary uses/benefits of the technology rather than the initial use that the technology was designed for. For instance, second-generation farmers got seed of *Tephrosia vogellii* and *Crotolaria grahamiana* mainly because of the mole repelling qualities and for sale respectively and not because of soil fertility improvement. This clearly demonstrates that farmers are indeed more concerned with technologies that have immediate benefits and are easy to implement. Future research on soil fertility should therefore emphasize on improved fallow options that have other tangible economic benefits in addition to replenishing soil fertility. Farmers' claim of the mole repelling qualities of Tephrosia in western Kenya is not something new, it has been reported elsewhere by Place et al. (2003). Similar claims in Uganda were reported by Douthwaite et al. (2003) although the authors doubted the efficacy of Tephrosia in repelling moles. The fact that 68% of the farmers got seed of Tephrosia for this purpose and after planting it only 5% claimed that they had noticed a reduction in the number of moles raises further doubts about its efficacy. It is therefore important that scientists study the chemical components of Tephrosia to ascertain whether it has mole repelling properties.

Knowledge generation by farmers

This paper has demonstrated that knowledge is dynamic. It is constantly produced and reproduced, shaped and reshaped and yields many types of knowledge, differentiated within and between localities (Mango 2002). This means that knowledge that enters a locality is not simply internalized, but becomes transformed by various actors to suit their circumstances. According to Joshi et al. (2004), knowledge continuously evolves as farmers learn both by evaluating the outcomes of previous actions and by observing the environment. In the study presented here, improved fallows and biomass transfer technologies were introduced to address the problem of soil fertility in western Kenya. Farmers transformed the initial knowledge and came up with other uses of the technologies to address pressing problems such as pests and scarcity of labor. The original innovation of chopping tithonia into small pieces and applying it as green manure did not fit in well with the socio-economic conditions of most farmers and therefore they came up with the less laborious alternative of using it in compost (Fig. 1). According to Jama et al. (2000), considerable labor is required for cutting and transporting biomass to fields, especially if tithonia is far from the homestead. As for Tephrosia, some of them discovered that in addition to soil fertility improvement, it could also repel moles, a claim that has been contested by other farmers after getting disappointing results (Table 7).

The implication for this is that knowledge generation is a continuous process and therefore researchers and extension staff need to continuously keep in touch with farmers so that they can capture knew knowledge that is generated. This new knowledge can then be fed back into the research and development (R&D) system for further research to address issues that need answers for instance; the mole repellent qualities of Tephrosia and the merits/demerits of using tithonia in compost versus direct application as green manure. According to Tiwari et al. (2004), this demands new thinking and skills amongst researchers and extension staff, and new institutional mechanisms and tools to facilitate their interaction with farmers. One way is by creating knowledge bases that are designed to capture new knowledge that farmers generate and feeding it back into the R&D system (Walker et al. 1995). A carefully developed, managed and updated knowledge base provides a powerful central point of reference in the process of developing interventions to constraints to land use systems. A good example of knowledge base creation has been provided by Walker et al. (1997) in a case study of Pakhribus Agricultural Centre situated in the eastern hills of Nepal.

Conclusion

This study reported here has shown that farmer to farmer dissemination provides a potential alternative mechanism for the spread of agricultural technologies. However, more studies are needed at a number of different sites to see if the same results are found in different areas with different social characteristics. More understanding is also needed on whether information and seed travels across different socioeconomic groups and whether women are as frequent givers and/or recipients as men are.

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