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Tobit analysis of farmer to farmer diffusion of improved pulse seeds in Bundelkhand region of India

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ABSTRACT

The study was conducted during 2010-13 among randomly sampled 124 pulse farmers from Jalaun district of Bundelkhand region of India with the aim to analyze the effectiveness of farmer to farmer networks in dissemination of improved pulse seeds and to ascertain the attributes of farmers that determined for wider seed dissemination by them through informal networks. The selected lead farmers were provided seeds of improved pulse varieties and extent of dissemination of the introduced seeds was studied. Finding revealed that from 2038 kg of quality seeds that was provided to 124 key farmers, about 7486 kg of produce spread as seeds among 331 farmers that covered 300.9 acres of area through farmer to farmer networks. Thus farmer to farmer networks were found to cause 3.7, 4.4 and 2.7 times enhancement in quantity of seed diffused, the area covered under the introduced varieties and farmers reached. Variables like extent of information utilization, land under crop, perception towards improved pulse varieties, attitude towards improved technologies and yield advantage positively and significantly ($P<0.01$) influenced farmers' decision; whereas operational land holding size and income from the crop were found to negatively and significantly influenced farmers' decision on extent of seed diffusion.

Key words: Bundelkhand region, Farmer to farmer networks, Pulse crops, Tobit analysis

Diffusion of agricultural technologies is though initiated by public extension services; it takes its own course once farmers realize the potential of technologies through local experimentation and adaptation. The informal and unstructured diffusion of proven agricultural technologies takes off and results in their spread to other farmers in the social interactions and networks. This informal dissemination method has been found vital in technology transfer among farmers, especially for seed varieties and improved livestock (Cromwell 1990). In the same line, Ndjeunga *et al.* (2000) and Hassan *et al.* (2008) also found farmer to farmer seed exchange as the effective means for diffusing new varieties to farmers especially among the small holders whom the formal seed systems were unable to cover. The informal seed diffusion can take place in terms of exchange or barter of seeds, gifts, payment of labour, sale as seed etc and in addition to making seeds available to the farmers, it also provide them seeds at a relatively lesser cost (Hassan *et al*. 2008).

In recent years, farmer to farmer transfer of agricultural technologies including improved seeds has been identified as an alternative approach for better access to extension services and technologies among the farming community. It is being considered as a more viable method of technology dissemination (Sinja *et al.* 2004). In Indian context, the approach may be more relevant in view of the existing wide extension staff–farmers' ratio, i.e. 1:1500 (Agarwal 2011) as the agricultural extension system of the country continues to operate with about 0.1 million extension personnel against the required 1.3 to 1.5 million (Working group on Agricultural Extension 2007). The farmers' reach to existing extension services in India has therefore become an issue of concern. The limitation of funds for operational cost, training and capacity development further limit the activities of extension staff (Sulaiman *et al.* 2005, Swanson 2006). On the other hand, the informal and interpersonal farmer to farmer technology diffusion is considered important as fellow farmers are preferred and trusted for their perception and information about the agricultural technology (NSSO 2005, Adhiguru, Birthal and Kumar 2009).

Pulse crops in India form the primary source of low cost protein for the poor and the vegetarians who constitute majority of the population. Despite heavy dependence of the populace on pulses for meeting their nutritional demands,

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the pulse production in the country is constrained with non-availability of seeds (Reddy 2013). The accessibility of smallholder farmers to quality seed of improved pulses varieties is constrained by both inadequate demand creation and limited supply (Gowda *et al.* 2013). Limited interest of agri-business houses about entering into seed production of high volume low margin crops like pulses, have also affected the availability of quality pulse seed in the country. The total supply of quality seeds of pulse varieties is around half of the requirement (Ali and Gupta 2012). Estimates also show that more than 95% of lentil seed in India comes from the informal sector (Materne and Reddy 2007). This indicates that a majority of the farmers resort to use their own saved seed which is the produce saved from previous harvest or to the prevailing social networks. Farmer to farmer diffusion therefore assumes special significance for availability of seeds of pulse crops to Indian farmers.

Utilizing the progressive and trusted farmers after equipping them with know how regarding improved seeds could work towards achieving a greater reach of improved seeds of pulse crops in India. However, at the centre of this farmer to farmer approach is the lead or master farmer who initially accepts and experiment with a new seed variety and is also equally willing to share it with other farmers in his social networks. Identifying the farmers' characteristics therefore remains the focal point of utilizing this farmer participatory approach for dissemination of improved seeds. Almekinders *et al.* (1994), Hassan *et al.* (2008) and Cromwell (1990) also identified key farmers as the important factors in success of the informal seed diffusion studies.

This paper discusses the experiences gained from action research on farmer to farmer dissemination of improved pulse varieties among the farming community in the semi arid tracts of Bundelkhand region of India. The study was conducted to analyze the effectiveness of farmer to farmer dissemination of improved pulse varieties and also to assess the socio psychological, economic and technological attributes predicting the farmers' decision on extent of diffusion.

MATERIALS AND METHODS

The action research was conducted at Indian Institute of Pulses Research, Kanpur during 2010-13 among 124 farmers spread across six villages in two development blocks, viz. Kadaura and Maheva, from purposively selected Jalaun district of Bundelkhand region of India. Bundelkhand region is one of the major pulse producing regions of India. The region is characterized by lowest levels of per capita income and human development in the country wherein local inhabitants rely primarily on subsistence rainfed mono-crop agriculture and small-scale livestock production for their livelihood (Singh and Joshi 2011). Also, the region witnesses a very low productivity of all crops in general.

A list of interested pulse growers from the selected villages were identified who accepted to multiply and disseminate the seeds provided to them among other farmers in their social network. From this list, farmers were randomly drawn each year and were referred as key farmers in the paper. Before providing seeds, the key farmers were also trained on the appropriate crop spacing, nutrient management, plant protection measures and related improved practices of production. Seeds of high yielding varieties of chickpea, lentil and field pea were introduced every year in the project villages by providing them to the selected key farmers, who were encouraged to diffuse received seeds to other farmers in their social networks.

During the first year (2010-11) of the study, fifteen key farmers were sampled and the improved chickpea varieties (DCP-92-3, and JG 16) were introduced. These farmers were provided 30 kg of seeds each that was sufficient for sowing 0.4 ha of area. Similarly for the year 2011-12, 88 key farmers were sampled and were provided seeds of improved variety of lentil crop (DPL 62) and field pea (IPFD 10-2) and chickpea (DCP-92-3) at the rate of 10, 20 and 15 kg respectively. The provided seeds were sufficient to cover 0.2 hectares. During 2012-13, additional 21 farmers were sampled and were provided seeds of chickpea variety (KGD-1168) at the rate of 15 kg each, for sowing 0.2 ha of area. The extent of informal diffusion of the introduced seed of improved varieties from key farmers to other farmers was assessed for one year by recording the number of farmers who received the improved seed either as gift, exchange, sale or barter, after harvest season to sowing in the next crop season. The observations were recorded at regular intervals using structured interview schedule.

Effectiveness of the farmer to farmer extension was operationalized as the enhancement in the number of farmers covered, the area covered and the quantity of seeds of introduced improved pulse varieties diffused from key farmers to other farmers for the subsequent cropping season.

The Tobit model (Tobin 1958) that describes the relationship between a non-negative dependent variable Y_i and an independent variable (or vector) X_i was used to assess the relationship between the extent of diffusion of seeds of introduced pulse varieties as carried out by the key farmer (dependent variable) and the various factors affecting, i.e. socio-personal, psychological and economic factors (independent variables). By the nature of the data it was clear that there were a number of farmers who diffused the seeds given to them ($Y_i > 0$) while there were also a number of farmers who did not diffuse the provided seeds at all ($Y_i = 0$). The following Tobit model was used in the analysis.

$$Y_i^* = X_i \beta + \varepsilon_i$$
$$Y_i = \{ Y_i^* \text{ if } Y_i^* > 0 \quad ; \quad 0 \text{ if } Y_i^* = 0$$

Where $\varepsilon_{i \sim iid\, N(0, \sigma^2)}$

The set of explanatory variables is denoted by X_i in the above equation which comprised of socio personal variables, psychological variables and economic variables. The socio personal variables included age, number of years in school, membership of social organizations and extent of information utilization. The economic variables included in the model were operational land holding, income from agriculture, off farm income, years of seed replacement and yield from the introduced improved pulse varieties. The psychological variables included training exposure, innovativeness and attitude towards improved pulse production technologies and perception towards the introduced improved pulse varieties. Data was collected using semi structured interview schedule and informal discussion techniques. Tobit analysis was carried using the SAS 9.2 software.

RESULTS AND DISCUSSION

Effect of improved varieties on yield of pulse crops

Data presented in Table 1 indicate that during the year 2010-11, the introduced improved chickpea varieties (DCP-92-3 and JG-16) yielded an average of 1509 kg/ha as compared to 859 kg/ha from the prevailing local non descript varieties. The participating key farmers thus gained yield advantage of 650 kg/ha (76%). During the year 2011-12, with the introduction of chickpea variety DCP-92-3, the key farmers gained additional 394 kg/ha (43%) in contrast to the local cultivars. During the same year, with the utilization of DPL-62 variety of lentil crop, farmers received 1268 kg/ha yield as against 963 kg/ha from the local variety. Improved field pea variety (IPFD 10-2) was also introduced in the same year in selected villages through 25 key farmers who gained additional yield of 271 kg/ha (20%). During 2012-13, improved chickpea variety KGD 1168 was introduced which resulted in yield advantage of 114 kg/ha (14.8%) compared to the local varieties (655 kg/ha). Thus, the introduced varieties resulted in substantial yield advantage to participating farmers except for cropping season 2012-13, wherein the untimely rainfall at the time of harvest resulted in lowering the yield figures. The presented data also reflects on the poor quality seeds farmers were utilizing for pulses cultivation.

Table 1 Effect of improved varieties on yield of pulse crops

Year (kg/ha)	Crop varieties	Yield obtained (kg/ha)		Yield advantage
		Local variety (Control)	Improved varieties	
2010-11	Chickpea (DCP-92-3 & JG-16)	859	1509	650 (75.7)
2011-12	Chickpea (DCP-92-3)	904	1298	394 (43.6)
	Lentil (DPL-62)	963	1268	305 (31.7)
	Field pea (IPFD 10-2)	1334	1063	271 (20.3)
2012-13	Chickpea (KGD-1168)	769	655	114 (14.8)

Figures in the parenthesis indicate percentage

Disposal pattern of pulses produced by key farmers

From the total crop harvest (7605 kg) of 15 key farmers who received the chickpea varieties (DCP-92-3 and JG-16) during 2010-11, about 55 percent (4160 kg) was sold as grain while about 6 percent (490 kg) was sold as seed (Table 2). In addition, the key farmers exchanged about 8 percent of the produce (590 kg) with other farmers at the rate of 1.25 times of the produce to be returned in the next crop season. An average of 94 kg of produce was also gifted by the key farmers to other farmers in their social interactions. Thus, about 1715 kg (14%) of the total produce of the introduced seeds was recorded to be diffused through farmer to farmer linkages within and surrounding villages. Among the informal diffusion mechanisms adopted by the key farmers, varietal diffusion was highest through gift (18.6%) followed by exchange for 1.25 times (8%) (Table 2).

During 2011-12, 43 sampled key farmers were provided improved chickpea variety (DCP-92-3). It was recorded that about 62 percent (8472 kg) from the total produce of 13630 kg was sold as grain, while about 27 percent (3635 kg) was sold as seed to other farmers in the social network (Table 3). Thus, the key farmers diffused a total of 24565 kg of produce which accounted for 11 percent of the total produce as seed to other farmers in their own village as well as surrounding villages. During the same year, another 25 key farmers were introduced the improved field pea variety (IPFD-1-10), who produced about 9020 kg, with an average production of 360 kg each (Table 3). A major part of the produce (64%) was observed to be sold as grain 5820 kg by the farmers in the local market, while about a substantial amount of 1445 kg (16%) was stored as seed for sowing in the next cropping season. A total 2140 kg (23.7%) of produce was diffused as seed to other farmers by the key farmers through sale as seed (710 kg), exchange for 1.25 times in return (490 kg) and as gift (940 kg). Lentil variety DPL 62 was provided to sampled 21 key farmers during the same year. From the received harvest (4915 kg), a major portion

Table 2 Disposal pattern of chickpea produce (variety DCP 92-3, JG-16) by the key farmers of year 2010-11 (n=15)

Unit of observation	Produce obtained	Produce consumed	Produce kept as seed	Produce sold as grain	Produce sold as seed	Produce exchanged (@ 1.25 times in return)	Produce gifted	Total produce diffused as seed to other farmers
Total (kg)	7605	315	1290	4160	490	590	1415	1715
Average (kg/farmer)	507	21	86	277.3	32.7	39.3	94.3	70.7
Percent		4.1	16.9	54.7	6.4	7.8	18.6	13.9

Table 3 Disposal pattern of produce of field pea (variety IPFD 10-2), chickpea (DCP- 92-3) and lentil (DPL-62) followed by the key farmers of the year 2011-12 (n= 88)

Crops and unit of observation	Produce obtained	Produce consumed	Produce kept as seed	Produce sold as grain	Produce sold as seed	Produce exchanged (@ 1.25 times in return	Produce gifted	Total produce diffused as seed
Chickpea (43)								
Total (kg)	13630	105	3635	8472	901	310	1115	2465
Average (kg/farmer)	316.9	2.4	84.5	197	20.9	7.2	25.9	36
Percent	100	0.8	26.7	62.2	6.6	2.3	8.2	17.1
Field pea (25)								
Total (kg)	9020	0	1445	5820	710	490	940	2140
Average (kg/farmer)	360.8	0	57.8	232.8	28.4	19.6	37.6	85.6
Percent	100	0	16	64.5	7.9	5.4	10.4	23.7
Lentil (20)								
Total (kg)	4915	455	700	2555	780	185	485	1450
Average (kg/farmer)	245.7	22.7	35	127.7	39	9.2	24.2	57.5
Percent	100	22.7	14.2	51.9	15.9	3.8	9.8	29.6

Figures in brackets refer to the crop wise number of key farmers

of about 52 percent (2555 kg) was sold as grain in market by them, while about 16 percent (780 kg) of the produce was recorded sold as seed followed by 14 percent (700 kg) was kept as seed for the next year sowing (Table 3). A total of 1450 kg of the produce that accounted for about 30 percent of the produce was thus, found to be diffused by the key farmers to other farmers through interpersonal interactions.

For the year 2012-13, 21 key farmers were sampled to introduce the chickpea variety KGD-1168 in the selected villages. From the total produce obtained (3230 kg), about 41 percent (1319 kg) was reported sold as grain while about 37 percent (1190 kg) was used for household consumption. The sale of the produce as seed accounted as low as 0.8 percent (25 kg). The total produce diffused as seed to other farmers accounted for 13.2 percent (426 kg) only, a majority of which, i e 9.3 percent (300 kg) were diffused as gift to other farmers (Table 4).

The data presented above clearly indicates the strong role of farmer to farmer networks in varietal diffusion of the introduced pulse varieties. The high diffusion rate of the introduced varieties also reflect on the quality of the prevailing seed stock utilized by farmers in the project villages and the greater need of farmers for improved pulse varieties. A substantial portion that is 14 to 27 percent of the obtained produce from the introduced pulse varieties was observed to be stored by the key farmers as seed for sowing in next cropping season. This highlights the farmers' preferences for the introduced variety and also the pattern of seed source utilized by the farmers of the project locale.

Effectiveness of farmer to farmer diffusion of improved seeds

The extent of informal diffusion of introduced pulse varieties from the selected key farmers to the other farmers in their social networks was recorded after harvest of the crop to subsequent sowing in the next season. During 2010-11 383 kg of seed of improved chickpea variety (JG-16 and DCP 92-3) was provided to 15 such key farmers. The provided seed covered about 13 acres of area in the project villages. From the key farmers, 1715 kg of produce was informally diffused as seed to 79 other farmers for sowing 83 acres of area (Table 5). Thus, about 4.5 times increase in the quantity of seed diffused was recorded. Similarly, 6.4 and 5.3 times increase in coverage of area and farmers during 2011-12 respectively, were recorded.

Further during the year 2011-12, improved seeds of lentil (DPL 62), field pea (IPFD 10-2) and chickpea (DCP-

Table 4 Disposal pattern of produce of chickpea (variety KGD-1168) followed by the key farmers of the year 2012-13 (n=21)

Unit of observation	Produce obtained	Produce consumed	Produce kept as seed	Produce sold as grain	Produce sold as seed	Produce exchanged (@ 1.25 times in return)	Produce gifted	Total produce diffused as seed to other farmers
Total (kg)	3230	1190	470	1319	25	101	300	426
Average (kg/farmer)	153.8	56.7	8.1	61.7	1.2	4.8	14.3	5.9
Percent		36.8	14.5	40.8	0.8	3.1	9.3	13.2

Table 5 Varietal diffusion, area covered and produce diffused through farmer to farmer diffusion from key farmers during 2010-13

Particulars	Unit	Diffusion from key farmers of						Total diffusion
		Year 2010-11	Year 2011-12				Year 2012-13	
		Chickpea (DCP-92-3 & JG16)	Chickpea (DCP-92-3)	Field pea (IPFD 10-2)	Lentil (DPL 62)	Total	Chickpea (KGD-1168)	
Farmers covered in	No.	79 (15)	111 (43)	49 (25)	67 (20)	227 (88)	25 (21)	331 (124)
Times increase		5.3	2.6	1.9	3.3	2.6	1.2	2.7
Area covered under variety	Acres	83.2 (13)	77.5 (21.5	53.5 (12.5)	72.5 (10)	203.5 (44)	14.2 (10.5)	300.9 (67.5)
Times increase		6.4	3.6	4.3	7.2	4.6	1.3	4.4
Seed provided	Kg	1715 (383)	2465 (645)	1430 (500)	1450 (200)	5345 (1345)	426 310)	7486 (2038)
Times increase		4.5	3.8	2.9	7.2	3.9	1.4	3.7

Figures in parenthesis indicate the base year data

92-3) were introduced in the project villages. The informal diffusion of seeds of these introduced varieties of pulses from the 88 lead farmers was recorded between harvesting to the next pre sowing season (Table 5). During this year, 645 kg seed of chickpea (DCP-92-3 variety), sufficient for 21.5 acres (8.6 ha) of area, was provided to the 43 key farmers. The informal diffusion of the obtained produce resulted in spread of 2465 kg of produce from the key farmers to 111 new farmers, covering 77.5 acres in the same or adjoining villages in the year 2012-13. During the same year, about 500 kg of seed of improved field pea (variety IPFD 10-2) was also provided to 25 key farmers that covered 12.5 acres of area. During the subsequent year, the introduced field pea variety was recorded to diffused from key farmers to 49 additional farmers covering 53.5 acres (21.4 ha) of area. Leading to 2.9, 4.3 and 1.9 times increase in the quantity of the seed diffused, area spread and farmers covered, respectively. During the same year, the improved lentil variety (variety DPL-62) was also introduced in the project villages in 10 acres (4.0 ha) of area with the participation of 20 key farmers during 2011-12. About 1450 kg of seed of this variety informally got diffused and covered 72.5 acres of area and 67 new farmers during 2012-13 (Table 5). Thus, 7.2 times increase both in the quantity of seed informally diffused and area covered for sowing in year 2012-13 was observed in comparison to the seed provided and area covered during base year 2011-12. Similarly, with respect to the number of farmers covered due to informal diffusion of seed from key farmers sampled in 2011-12, an increase in 3.3 times in 2012-13 was witnessed for lentil variety.

Again in the year 2012-13, improved chickpea variety KGD 1168 was introduced in the project villages initially covering 10.5 acres of area and 21 key farmers. The data collected on varietal diffusion of the introduced variety after the crop harvest reflected that 426 kg of obtained produce of the chickpea was informally diffused as seeds to additional 25 farmers in and around the project village during the year 2013-14 (Table 5). This resulted in an increase in the number of farmers who acquired this introduced variety (1.2 times), the area covered (1.3 times) and the seed diffused (1.4 times.) during the next crop season in the year 2013-14.

Thus, from the 124 lead farmers and initial quantity of about 2038 kg of seeds of improved pulse varieties that was introduced in the project villages during the year 2010-13; about 7486 kg of produce was spread as seeds among 331 additional farmers, covering about 300 acres of area through farmers to farmer informal diffusion. Thus, about 2.7, 4.4 and 3.7 fold increase in the number of farmers covered, area sown and quantity of seed made accessible among farmers, respectively through the informal diffusion approach in the project villages (Table 5). The findings are in line with those reported by Singh *et al.* (1997) who also found farmer to farmer seed diffusion as an important mechanism for promoting improved cowpea and soybean varieties in northern Nigeria.

The results presented above are indicative of the fact that the introduced high yielding pulse varieties could be diffused substantially through the informal farmer to farmer dissemination system which actually works on the existing social networks and interactions. Further, it would also be a reflection of the fact that the varieties were well accepted and generated great demand among pulse farmers of the project area. The improved pulse varieties introduced matched well with farmers' evaluation criteria like higher yield, marketability, disease resistance, etc as compared to the existing primarily non-descript and old varieties. In addition, it could also be inferred that the speedier diffusion of these varieties indicated the need for concerted efforts for transfer of improved pulse varieties among the farmers of the region.

Factors associated with farmers decision on extent of diffusion practiced

In order to identify the factors that influenced the likelihood of dissemination of introduced improved pulse varieties from the key farmers to other farmers of the study area, the Tobit model was estimated. The maximum likelihood estimates of the independent variables and the sigma value of Tobit model are presented in Table 6. Sigma value is similar to the estimated standard error of the regression model (i.e. estimate of the error variance σ). This value, 30.48 is comparable to the root mean squared error that would be obtained in an OLS regression model and it was found significant (P < 0.01).

The coefficient of the sociological variables possesses the expected positive sign. Variables like farmers' age and their education level were expected to influence the farmer-to-farmer dissemination of improved pulse varieties; however these observations were not found statistically significant. Information utilization variable was observed to have a significant influence on the dependent variable. A unit increase in information utilization was associated with 11.37 units increase in the predicted value of diffusion. The coefficient of the social participation variable did not agree with a priori expectations. The variable was not found to significantly influence (P<0.01) the decision to diffuse which reveals that farmers affiliated to any social organizations are not likely to share seeds among the other members of the organizations. It could be possible that they can share information among each other but not necessarily disseminate seeds.

Among the four psychological variables included in the model, perception of the key farmers towards the introduced pulse varieties and their attitude showed the positive influence on the extent of diffusion. Both of these variables were found to have positive parameter estimates (P<0.01), indicating the positive impact on the diffusion made by these lead farmers with increase in their perception score and attitude score. The coefficient of the variables measuring farmer training score and innovativeness score was found to influence farmers' decisions but not significantly.

Table 6 Tobit estimate of factors affecting the extent of total diffusion of seeds of improved pulse varieties

Parameter	Estimate	SE	T value
Socio personal variables			
Age	–0.121605	0.295722	–0.41
Education	0.181303	0.898192	0.20
Information utilization	11.366939	3.012413	3.77***
Social participation	0.737173	5.825776	0.13
Psychological variables			
Training	1.279006	1.579506	0.81
Innovativeness	3.013369	2.186820	1.38
Perception score	1.956366	0.897679	2.18**
Attitude score	4.796265	2.481860	1.93**
Economic variables			
Operational land holding	–1.072219	0.395262	–2.71***
Income agriculture	0.110793	0.069077	1.60
Off farm income	–0.093427	0.065366	–1.43
Land under given crop	22.433259	3.531722	6.35***
Income from crop	–2.184783	0.437288	–5.00***
Seed replacement	2.532755	1.060108	2.39**
Yield	0.052216	0.034097	1.53
Yield advantage	0.074900	0.034308	2.18**
Constant	–107.975641	26.695899	–4.04
Sigma	30.484300	2.252961	13.53***

Log Likelihood = –450.61993. Optimization Method used is Quasi-Newton

With respect to the coefficient of economic variables, operational land holding, land under the given crop, income from crop, seed replacement time and yield advantage were having significant impact on the dependent variable. Land under given pulse crop was found to have positive and significant (P<0.01) influence on farmers' decision to diffuse the pulse varieties. This implies that farmers with relatively larger area under the pulse crop will be more willing to transfer seed to other farmers in their social circle. The probable explanation for the results could be that farmers with larger areas under the given pulse crop have less scope of further expansion of area under the improved seeds thus they disseminate more in comparison to the famers with lesser area under the given pulse crop. Results get support from the findings of Grisley (1994) who obtained similar findings from a study among small scale bean farmers in Uganda and Sinja *et al*. (2004) who reported a positive and significant association between farmers' decision to give out Desmodium and its area on the farm.

Variables like operational land holding and income from crop were having the negative estimates indicating that with the increase in land holding and income from the crop, farmers were less likely to undertake the diffusion to other farmers in their social networks. Scope of further expansion of area under improved pulse varieties in their own farm could be the likely reason for lesser dissemination by larger farmers. These observations however are in contrast to the finding of Kormawa *et al.* (2004) who reported that farm size positively and significantly influenced farmers' decision to diffuse seeds. Further, farm size was documented in various studies to be an important factor in technology adoption and dissemination (Feder *et al*. 1985). Off farm income was observed to contribute negatively and non significantly to the farmers' decision to transfer seeds. The observation is in contrast to the findings of Sinja *et al.* (2004) in their study on transfer of fodder varieties by farmers in central Kenya.

The sign of coefficients of yield and yield advantage were found to be consistent with the prior expectations. The value of yield advantage indicated that higher the yield advantage the more likelihood of farmers to transfer seeds of improved varieties to other farmers. The coefficient of yield advantage was found to be significant (P<0.01). The probable explanation for such results could be that the key farmers received higher demand of the seeds of improved varieties from the other farmers were convinced with the yield of the new varieties in their own production settings. Seed replacement time was found to be positively and significantly (P<0.01) influence the dissemination extent of the key farmers. This implies that farmers who used older seeds and convinced with the new varieties for higher yield advantage were willing to share the seeds to other farmers.

Finding revealed that information utilization score, land under given crop, perception score, attitude score, yield advantage and yield were the independent variable that positively and significantly (P<0.01) influenced farmers' decision on extent of informal diffusion of improved seeds, whereas operational land holding size and income from the crop was found to negatively and significantly influencing the farmers decision.

Thus, the unstructured and informal approach of pulses seed dissemination was found to be effective in reaching a larger number of farmers in a short time span. Such mechanism could be guided to complement formal seed dissemination system for addressing the challenging issues of ensuring improved seed sufficiency at the village level. The informal diffusion mechanism could be formally institutionalized and promoted in partnership with the existing social and farmers' organizations who may be provided quality seeds of pulse initially for multiplication and channelizing it to the fellow farmers in the subsequent years. Though, farmers could be the ideal partners in promoting diffusion of improved seeds, their social, economic and perception factor influence their decision to transfer seeds to fellow pulse farmers through their informal social interaction. The decision of farmers to transfer improved seed to others was empirically tested to be positively and significantly influenced by information utilization pattern of the pulse farmer and their perception and attitude towards the improved agricultural technologies.

Thus, farmers who used more number of information sources, possessed average land holding size, had substantial area under the given pulse crop, constrained with low income from the crop and had not replaced seed for long, were more likely to diffuse the improved pulses seeds to other farmers on a larger scale. Thus such farmers are need to be included as initiators or key farmers in programs aimed at wider diffusion of improved varieties of pulses through farmer to farmer diffusion approach.

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