SOCIO-ECONOMIC FACTORS INFLUENCING THE ADOPTION OF INTEGRATED PEST MANAGEMENT TECHNOLOGIES FOR COMMON BEAN AT HOUSEHOLD LEVEL IN MBEYA DISTRICT TANZANIA

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ABSTRACT

Integrated Pest Management (IPM) technologies intend to control field pests and diseases caused by biotic and abiotic factors in common bean production. However, little information is available in Tanzania on the adoption of IPM technologies, and their contribution to productivity and production for common bean. This study assessed the adoption of IPM technologies at household level at Isuto ward in Mbeya district. Specifically, the study aimed at determining the adoption of IPM technologies at household level, and examining socio-economic and technology-specific factors influencing the adoption of IPM at household level. Experimental and cross-section research designs were adopted. Purposive sampling was used to collect data from a sample size of 111 bean farming households from villages with and without IPM intervention. Data were collected through household survey, key informant interview and focus group discussion. STATA was used for quantitative data analysis. Findings show that high-yielding disease-resistant improved variety was not adopted while the rate of adoption for pesticides was 73%. Quantitative estimation showed that experience and markets for bean had positive significant influence on the adoption of IPM technologies. On the contrary, age had negative significant influence on IPM technologies adoption. It is concluded that IPM technologies had positive influence on bean production. It is recommended that bean varieties should be released only if they have been shown to be acceptable to the bean farmers.

Keywords: Integrated Pest Management, Adoption, Smallholder farmers,

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1.0 INTRODUCTION

The common bean (*Phaseolus vulgaris* L.) is a grain legume grown in more than four million hectares in Africa (Buruchara *et al*., 2011). It provides dietary protein for over 100 million people in rural and urban communities, with an annual per capita bean consumption in Eastern Africa (50-60kg) being the highest in the world (ISAR, 2011). It is also the cheapest and most readily available source of protein, especially in developing countries and very important in rectifying the protein deficiency which is very common in diets of people especially in rural areas (Wortmann *et al*., 1998). *Phaseolus* beans may be regarded as one of the principal sources of protein as well as cash crop to many farmers in Tanzania. The crop is grown throughout the country with major production in the southern highland, northern, eastern and some parts of Lake Zone (URT, 2009).

However, bean production is constrained by biotic (field and post-harvest pests and diseases) and abiotic (drought, excessive rain/flooding, poor soil fertility, heat and cold stress) factors, each of which causes significant reduction in yield (Wortmann *et al*., 1998; Hillocks, et al., 2006). Stresses such as poor soil fertility are long term and predictable (Lunze *et al*., 2011) whereas others like drought, pests and diseases could be short-term, but acute in nature (Buruchara *et al*., 2011). Moreover, soil degradation and drought are serious threats to agriculture and, hence, a frequent cause of crop failure and hunger. These threats are exacerbated by the effects of climate change and crop intensification that lead to soil degradation, fertility decline and sudden increase of pest and disease pressure (Christensen *et al*., 2007).

As a result of field pests and diseases, yield losses of 30-100% have been recorded in some parts of Tanzania (Minja, 2005). Also, insects and diseases which are the most important constraints to bean production after low soil fertility are more common in the higher altitude marginal areas such as those of Southern highland of Tanzania including Mbeya District (Minja, 2005; Teverson, 2003).These challenges make bean crop output very low and highly variable, resulting into low and unevenly distributed income (Minja, 2005; Teverson, 2003).

Various approaches have been used in attempt to address the above-mentioned problems. Among them is Farmer Field School (FFS) approach. The Farmer Field School (FFS) Project funded by Farm level applied research methods for Eastern and Southern Africa (FARMESA) was initiated at Isangati Division, particularly at Isuto ward for highland areas in the Mbeya region. This project aimed at introducing technologies for bean production including Integrated Pest Management (IPM) (Kaihura *et al.*, 2006). Kogan (1998) defines IPM as a decision support system for the selection and use of pest control tactics, singly or harmoniously coordinated into a management strategy, based on cost/benefit analyses that take into account the interests of and impacts on producers, society and the environment.

This study assessed the adoption of IPM for common beans at household level in the Isuto ward, Mbeya district. It focused its analysis on use of high yielding- and- disease resistant improved bean, and use of synthetic pesticides on field pests and diseases of beans among technologies disseminated in the area. Rogers (1995) defines adoption as the mental process an individual possesses from hearing about an innovation to final adoption. On the other hand, for theoretical and empirical analysis, a precise quantitative definition of adoption is the degree of use of a new technology in long-run equilibrium when the farmer has full information about it and its potential (Shih and Ventakal, 1998). While IPM adoption can involve intensity, rate and scale (Elsey and Sirichoti, 2000), the assessment of IPM adoption in this study focuses on rate of adoption which represents the percentage of households adopting the technologies (Shideed and Mohammed, 2005; Golder and Tellis, 1998).

1.2 Problem Statement

Participatory rural appraisal (PRA) conducted at Isangati Division identified bean as one of the most important food and cash crops in the division (Mkuchu *et al*., 1999). However, bean productivity was low, ranging from 127kg/ha to 750kg/ha although the potential yield has been found to range between 1500kg/ha to 2000kg/ha (Mkuchu *et al*., 1999). This yield gap was due to lack of technological knowledge on improved bean technologies, including management of field pests (*aphids, pod borers,* and bean *stem maggots*) , field diseases (*Anthracnose*, *Ascochyta blight*, *Rust* and *Angular leaf spot*) and post-harvest pests (*Bruchids*), which accounted for 50% yield loss in beans and affected about 85% of the farmers in the target area. Also, the PRA results indicated that inadequate extension services resulted in a lack of understanding of pest-control technologies among smallholder farmers to overcome these problems. Therefore, IPM technologies through FFS were introduced in the ward to control field pests and diseases.

Several adoption studies have been done in Mbeya District on improved wheat and round potatoes technologies (Mussei *et al*., 2001; Namwata *et al*., 2010), development, utilization, and dissemination of improved technologies for controlling bean pests and on improving bean production using FFS as a methodology (Mkuchu *et al*., 1999). Other studies have been done on impact of diseases and increase in the production of beans by resource-poor smallholder farmers through introducing acceptable and disease resistant bean type in a sustainable, participatory manner (Teverson, 2003). However, none of these studies provides a clear picture on the adoption of IPM improved technologies for common bean among households. Therefore, the present study assessed the adoption of IPM technologies for common bean by farmers, with specific focus on use of synthetic chemical pesticides and crop cultivars bred with total or partial pest resistance. Also, the study determined the socio-economic and technology specific factors that influence the decision of farmers to adopt the integrated pest management technology as production technology at household level.

The following research questions are answered: what is the adoption and rate of adoption of IPM technologies at the household level? What socio-economic and technology specific factors influence the adoption of IPM technologies in the households?

3.0 RESEARCH METHODOLOGY

3.2 Research design

This study employed experimental approach (Baker, 2000, 1999) because it is quicker and cheaper in implementation after a programme has been phased out given sufficient existing data (Baker, 2000). Respondents with similar characteristics were involved from both treated and control villages in order to ascertain the difference in the use of IPM technology for common bean production. Doss (2003) and Baker (1999, 2000) contend that experimental design is imperative because it involves randomly assigning participants to treatment and control groups but compares outcomes for individuals who received project activities with similar group of individuals who did not receive project activities and informs discussions of causes and effects. Moreover, a cross-sectional research design was used to collect data at a single point in time (Saunders, 2009).

3.3.2 Sampling procedure

Two groups of respondents were of interest in this study, that is, those who were involved vis-à-vis those who were not involved in IPM technology project intervention. Therefore, Purposive sampling and random sampling techniques were adopted. The first stage was a purposive selection of Mbeya District, where Isangati Division had IPM technology intervention for bean growers. Second stage was to select one ward among two wards that had intervention. Third stage, one village with intervention was selected and three villages without IPM intervention were selected in the same agro-ecological zone so as to find out the extent the technology scaled-up in the ward in keeping with the aim of FFS. All the four selected villages of Isuto, Shinzigo, Idiwili and Iwowo are within coffee zone of 1500-1700 metres above sea level with a savanna climate (Biria and Kwiligwa, 1997). Purposive technique was also used to trace households engaged in bean cultivation particularly within each village. Village registry for identified and selected villages for interview was used as a sampling frame. In each household the survey focused on both household-female and male as participants in agricultural activities and bean producers.

3.3.4 Data collection

The study intended to obtain information on various aspects that could be attributed to adoption for common bean IPM technology including: changes in the level of production; Changes in socio-economic characteristics of households, changes in technology specific characteristics in the household; changes in farm inputs availability, accessibility and utilisation.

Tools used for data collection included: first, a questionnaire for household survey. This contained similar questions for both project participants and non-participants. Second, checklist was used for focus group discussion (FGD). The FGD involved six to eight participants both for those who participated in the project and those who did not participate. FGD aimed to triangulate, and cross-check the validity of information given by household members. Lastly, key informant's checklist gathered data on project implementation weighed against objectives in relation to the project goal. However, the questions asked were similar to those for other groups/tools so as to validate information obtained by other tools (La Rovere and Dixon, 2007; Baker, 2000).

Quantitative data analysis

The STATA package (version 10) was employed for descriptive statistics and quantitative data analysis. This approach focused mainly on frequencies, percentages, maximum, minimum, and cross-tabulation. Frequency analysis was used to check for consistency of data collected and outliers. However, in describing the dispersion the study relied on mean-based statistics: standard deviation, standard error, coefficient of variation and skewness of data distribution. The proportion between participants and non participants of the IPM technologies disseminated were considered homogeneous or heterogeneous when the observed mean and standard deviation were the same or different, respectively (Florens *et al*., 2008; Blundell *et al*., 2005).

The decision to adopt or not to adopt a particular IPM technology is a binary choice model (Agwu *et al*., 2008). The conceptual framework was built based on a model that allows the prediction of how a particular economic agent with given attributes is made. The objective of a model was to determine the probability of the economic agent making one choice rather than the alternative. In this study the assumption was considered either to adopt a particular IPM technology or not. One type of model has been proposed in econometric literature for estimating binary model, a logit model (Feder *et al*., 1985).

Therefore, logistic regression procedure using maximum likelihood estimation was used to estimate the probability of IPM technology being adopted as follows:

$$Ln\left(\frac{P}{1-P}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7 + \beta_8 x_8 + \beta_9 x_9 + \beta_{10} x_{10} + \varepsilon.$$

$\varepsilon = errorterm.$

$\beta_0, \beta_1, ..., \beta_{10}$ =*Coefficients of the independent variables in the adoption equation.*

The dependent variable is the natural log of probability of adopting IPM technology (P) divided by the probability of not adopting (1-P). The dependent variable takes the value 1 for adopting and 0 for not adopting. However, independent variables specified in the model were: age of household head (x_1), Sex of household head (x_2), Marital status (x_3), Education level of household head (x_4), Experience (x_5), Household size (x_6) Market for bean (x_7), Bean marketed (x_8), Bean consumed (x_9) and Bean yield (x_{10}).

The STATA version 10 programme was used for isolating socio-economic factors influencing the adoption of IPM technology for improved bean varieties and pesticides use, in the households, respectively.

Qualitative data analysis

The qualitative data collected using a questionnaire (open ended questions), FGD and Key informant-interviews were analysed by using content analysis. Through the use of this analytical tool, the data were articulated into meaningful themes, subthemes and textual units, then, organized into a logical pattern in keeping with the objectives of the study.

4.0 RESULTS AND DISCUSSION

4.1 Adoption of IPM Technologies in the Household

4.1.1 Adoption of improved varieties

Improvement in production and productivity of a given crop depends, among other things, on presence and use of better and improved seed varieties. In line with this objective, efforts have been made by the research system to generate improved varieties of common bean and as a result, many varieties have been produced. Among the released common bean varieties, Uyole 96 (DRK *Mekundu makubwa*) and Uyole 94 (*Kasukanyele*) were introduced to the study area. These two varieties were introduced to the farming community through Uyole-Agricultural Research Institute (Uyole-ARI).

Despite the existence of these technologies, high-yielding and disease-resistance improved variety has not been adopted in the study area. The rate of adoption of variety influences the amount of yield obtained by farmers. The result on rate of variety adoption is presented in Table 1. Farmers have their own variety preference criteria, which in most cases are not considered by research and extension personnel. Majority of respondents preferred local varieties for their palatability, local market demand and compatibility of the varieties to agro-climatic conditions of the area. Also, other factors included time of maturity, yield advantage if cultivated in the same manner as that of improved variety (that means the attention paid in cultivation of improved variety is relatively higher in terms of using spacing and fertilizer application but its yield is lower), better market price and disease resistance as was mentioned by a sample of bean grower farmers during FGD.

Awareness on farmers' technology preference criteria is an important attribute in technology generation and dissemination process. In most cases, technologies fail to be adopted by users due to mismatch in preference criteria between technology promoters and end users (farmers). In general, the farmers have selected bean deliciousness and short cooking time as most preferred attributes by bean consumers; these attributes can be used for selecting among varieties of common bean. This suggests the need to give emphasis to participatory research which considers farmers' technology preference criteria, needs and priorities (Rubyogo *et al.*, 2010)

Farmers in the study area have high interest in cultivating the traditional common bean varieties because of local consumption demand, high market prices (marketability) and also better suitability of seed to the agro-ecology of the area. Farmers' lack of interest in improved variety was expressed in terms of not being preferred by the farmers and unavailability of improved seeds in the study area. Non-preference of improved bean varieties can be manifested by undistributed improved seed (lack of push supply strategy).

Efforts of the government and other organizations are required towards the need of farmers at least in terms of introducing improved seed based on farmers' preference. This demand driven approach will make efforts of all actors involved in the system beneficial and fruitful. David and Sperling (1999) identified actors already engaged in seed related activities, including those focusing on local seed system, from which farmers obtain over 90% of their seed. These were Non Governmental Organisations (NGOs), Community Based Organisations (CBOs) and Farmers Organisations (FOs). Moreover, the new strategy de-emphasizes the standard approach which puts the onus of seed production and delivery on centralized National Agricultural Research System (NARS), government extension systems, and formal seed suppliers and embrace a collaboration approach which builds on varied organizational strengths and which generally decentralizes the core of action (Rubyogo *et al*., 2010)

Table 1: Distribution of bean type grown by households in the study area

Type of bean	Frequency	Percent
Maini *	45	40.5
Maini *+ *Kablanketi**	33	27.7
*Maini** + *kablanketi** + *Mwasipengile**	2	1.8
*Maini** + *Kigoma* *	2	1.8
Kablankenti *	27	24.3
*Masusu** + *Meupe**	2	1.8
Total	111	100

* Local variety seeds

4.1.2 Use of Pesticides in the field by common bean farmers

Majority (73%) of respondents used pesticides in bean farming in the study area (Table 2). Table 3 shows the adoption of the use of pesticides among villages with intervention and villages without intervention. This indicates that IPM technology scaled-up from village with intervention to villages without intervention. However, some bean farmers among project beneficiaries and non-project beneficiaries did not use pesticides. In FGD, respondent farmers reported the lack of appropriate source of pesticides (Table 4). This led to inappropriate use of chemicals/pesticides in bean cultivation. Agro-dealers distribute bottles without instruction on usage, instructions are offered by word of mouth and these even though are accessible mislead farmers on usage. Yet, some labourers spraying pesticides are incompetent in observing mixing unit (ratios) between water and pesticides.

Castle and Naranjo (2009) assert that pesticides can bring economic and social benefits to farmers by reducing labour and damage to crops and improving food supply for subsistence farmers and market value for commercial producers. However, the benefits provided by pesticides come with costs to farmers, surrounding communities, consumers and society at large (Vinegar, 2012). Atreya *et al*. (2011) found that soil, water and air pollution and bio-accumulation in living beings lead to losses to biodiversity and ecosystem functioning, both of which are essential elements for agricultural production and of great value to all. Moreover, continued use of pesticides eventually leads to the development of resistance to pests, creating further problems. With the focus on humankind, STRI, Office of Education (2006) concludes that humans are directly impacted by pesticides through acute poisoning, environmental contamination and consumption in foods.

Table 2: Use of pesticides in bean farming

Responses	Frequency	Percent
No	28	25.2
Yes	81	73.0
Total	**111**	**100.0**

Table 3: Beneficiaries with use of pesticides in bean farming

	Use of pesticides in bean farming		
Bean participants	No	Yes	Total
Non project beneficiaries	21	40	61
Project beneficiaries	9	41	50
Total	**30**	**81**	**111**

Table 3: Source of IPM knowledge

Source of IPM information	Frequency	Percent, %
Parents/family member	5	4.5
Fellow farmer/neighbour	34	30.6
Fellow farmer & input supplier	33	29.7
Extension agent	21	18.9
NGOs	5	4.5
Input supplier/private dealer	13	11.7
Total	**111**	**100**

4.2 Socio-Economic Factors Affecting the IPM Technology Adoption

4.2.1 Improved bean seed adoption

Table 5 shows that age of respondent is statistically significant (P<0.05) and inversely correlated with the adoption of improved bean variety. As age increases by 1%, the adoption of improved seed decreases by 19.23%. This suggests that respondents are able to adopt improved bean seed at the economic active age and this tends to decrease as age increases towards economic inactive age. At the active age, the adoption could be attributed to farmers own effort to look for new varieties due to their previous interest and experience in the crop, or it might be attributed to other factors that enable farmers to get networked to information on the existence of improved varieties. Bamire *et al*. (2002) reported that the age of an individual affects his mental attitude to new ideas and influences adoption in several ways. They went further arguing that younger farmers have been found to be more knowledgeable about new practices and may be willing to bear risk and adopt a technology because of their longer planning horizons, while older farmers may have more experience, resources or authority, which may give them more possibility for trying a new technology. On the contrary, findings by Tiamiyu *et al*. (2009) on factors affecting the adoption showed that farmer's age did not significantly influence improved technology adoption.

On the other hand, results (Table 4) show that experience is positively correlated with the adoption of improved bean seed and the relationship between the two variables was significant (P<0.05) meaning that as experience increases by 1% the adoption of improved bean varieties increases by 20.71%. This suggests that adoption increases as beneficiaries' experience of practicing the technology of improved bean variety increases. This could have been attributed to advantages accrued to participants engaged with the technology as they practice. Similarly, Simtowe *et al*. (2010) found that the coefficient for the number of years of experience in groundnut farming is positive and significant at 5% level suggesting that farmers with prior experience in growing groundnut have a higher propensity to get exposed to new varieties.

Table 4: Socio-economic variables regression for improved bean seed

Variables	Coef.	Std. Err.	z	P>z
Marital status	-0.2873662	0.2641574	-1.09	0.277
Age	-0.1923233	0.0921684	-2.09	0.037**
Education	-1.273314	1.040621	-1.22	0.221
Household size	-0.2004234	0.1719673	-1.17	0.244
Experience	0.2071644	0.094768	2.19	0.029**
-constant	**3.10972**	**2.58768**	**1.20**	**0.229**

** Significant at 5%

4.2.2 Pesticide use

Table 5 shows that market for bean is statistically significant and positively correlated with pesticides adoption at P<0.05 level. This suggests that market for bean determines farmers' decision to adopt pesticides use and bean variety demanded in the market contrary to other factors such as marital status, sex, household size and bean consumed. Pesticides use motivates farmers to engage in agricultural innovation due to its attractive outcomes. Increased yield from bean can lead to increased income, consumption and seeds. Findings by Negash (2007) on factors for local bean varieties selection showed that high interest in cultivating the traditional common bean variety is because of local consumption demand, high market prices (marketability) and also better suitability of seed to the agro-ecology of the area.

Table 5: Socio-economic variables regression for pesticide use

Variable	Coef.	Std. Err.	z	P>z
Marital status	-0.190594	0.1897931	-1.00	0.315
Sex	0.6583125	0.5996176	1.1	0.272
Household size	-0.1364355	0.132224	-1.03	0.302
Bean market	0.082689	0.0032272	2.49	0.013**
Bean consumed	0.0041878	0.0091967	-0.46	0.649
-Constant	**-0.12223**	**1.354648**	**-0.09**	**0.928**

** Significant at 5 %

4.3 Technology-specific factors influencing IPM technologies adoption

The results on Table 5 show that common bean market was significant ($P<0.05$) in influencing the decision to adopt pesticide use as production technology. Without pesticide use there could be low yield due to existence of field pests, diseases and cold stress and hence the market opportunity would become underutilized. According to focus group discussants, high quality common beans are highly demanded in the markets and are marketable. CGIAR (2011) concludes that common bean as an integral part of grain legume contributes in all four major ways of system level outcomes namely reducing poverty, improving food security, improving nutrition and health, and sustaining the natural resource base and hence are demanded for multiple purposes.

Also the results showed that respondents' utilisation of common bean at household level is high with mean 64 kg (Table 6) which agrees with annual per capita bean consumption (50-60kg) being the highest in the world (ISAR, 2011). Results from this study showed that virtually all farmers in the study area use common bean at household level. Common bean is rich in protein (Wortman *et al.*, 1998), which is commonly deficient in the diet of most rural communities. This implies that common bean has come to the aid of many households in the study area as a cheap source of protein. Given that majority (99%) of the population in the study area are engaged in farming, it is obvious that they will plant common bean in their farms even if only to meet the household needs. Studies elsewhere in Africa (Saginga et al., 1999) have shown that household utilization is a major rationale for the adoption of soybean.

Another factor which influences the adoption of IPM technologies is the yield. Yield of common bean was found to be higher after IPM technologies intervention than before. Before the intervention bean productivity was low, ranging from 127kg/ha to 750kg/ha (Mkuchu *et al.*, 1999) but after the intervention productivity increased from 133kg/ha to 3400kg/ha. This creates the motivation to adopt the use of IPM technologies.

Contrary to other technology-specific factors considered in this study, common bean marketed by the households, common bean consumed by the households and yield of common bean obtained by the households have shown to be significant in influencing the adoption of IPM technology (Table 7)..

Table 6: Utilisation of common bean produced (n=111)

Common bean in Kg	Min.	**Max.**	**Mean**	**Std. Dev.**
Marketed	40	760	2.2303E2	166.53402
Consumed	20.00	400.00	64.2593	48.36009
Stored for seed	4.00	200.00	53.8224	36.31332

Table 7: Common bean produced classification within households (n=111)

	Kg	Frequency	Percent, %
Bean Marketed			
Households sold bean	22,080	99	89.2
Households that did not sell beans		12	10.8
Total		**111**	**100.0**
Bean consumed			
Households consumed beans	6,940	108	97.3

Households that did not consume beans		3	2.77
Total		**111**	**100.0**
Bean stored for seed			
Households stored beans for seed	5,799	107	96.4
Households that did not store beans for seed		4	3.6
Total		**111**	**100.0**

5.0 CONCLUSION AND RECOMMENDATION

Integrated Pest Management (IPM) technologies intend to control field pests and diseases caused by biotic and abiotic factors in common bean production. However, little information was available on the adoption of IPM technologies, its contribution on productivity and production for common bean. This study (i) determined rate of adoption for IPM technologies in the households; (ii) examined socio-economic factors influencing adoption of IPM technologies in the households; and (iii) assessed technology-specific factors influencing adoption of IPM technologies in the households.

5.1 Conclusion

This study has established that high yielding- and- disease resistant improved bean: Uyole 96 (DRK *Mekundu makubwa*) and Uyole 94 (*Kasukanywele*) were not adopted in this study area. Farmers had their own variety preference criteria which in most cases were not considered by research and extension personnel. Farmers' preference of local variety was due to its palatability, local market demand and compatibility of the variety to agro-climatic condition of the area. Regarding pesticides use, majority of bean growers used pesticides in their bean farms to control pests, insects and diseases which attacked bean crop in their farms.

Socio-economic factors which influenced the adoption of IPM technologies were age and experience. Age and experience showed significant relationship with use of high-yielding and disease-resistant improved bean varieties. Based on the factors which had significant relationship with the adoption of IPM technologies, this study concludes that there is a significant association between households' socio-economic characteristics and the adoption of IPM technologies for common bean at household level.

The technology-specific factors which influenced the adoption of IPM technologies were common bean markets, consumed bean and bean yield obtained. Among these factors, markets for bean had significant relationship with adoption of IPM technologies. Based on the variable 'market for bean' the study concludes that there is a significant association between technology-specific characteristics and the adoption of IPM technologies at household level.

5.2 Recommendations

Based on the findings of this study, it is recommended that seed dealers should release varieties of improved bean only if they have been proven to be acceptable by bean farmers and consumers. Agricultural Research Institutes (ARI) have to integrate field-level evidences through their consultation with bean farmers who are usually knowledgeable on the performance of various varieties under local agro-ecological conditions and on their acceptability in terms of organoleptic and market attributes.

It is also recommended that the government should establish mechanisms for evaluation of farmer selected varieties in the list of varieties. Participatory Varietal Selection (PVS) and Participatory Plant Breeding (PPB) should be recognized officially in varietal research statements and in terms of specific access and benefit sharing arrangements.

It is further recommended that the government should promote actively decentralised models of seed production and delivery. Certified seed should be recognized as legitimate in serving small farmers' wants and needs (consumption, seeds and marketability). Standards for quality control in decentralised (community-based) seed production should be adapted to the local level (social certification) rather than having to meet zonal or national requirements. The decentralised models should also have a clear marketing component (including niche markets) while enabling them to be sustainable, not subsidized or tied just to institutional clients.

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